South Bay Salt Pond Restoration Project
Restoring the Wild Heart of the South Bay

23 March 2017

Gary Stern, San Francisco Bay Region Supervisor
North-Central Coast Office
NOAA Fisheries West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, CA 95404

RE: South Bay Salt Pond Restoration Project, Phase 2, Biological Assessment

Dear Mr. Stern:

On behalf of the U.S. Fish and Wildlife Service (USFWS) Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) and the State Coastal Conservancy (SCC), I am submitting this letter to request formal consultation for Phase 2 of the South Bay Salt Pond (SBSP) Restoration Project under Section 7 of the Endangered Species Act of 1973 (Act) (16 U.S.C. 1531 et seq.) and for Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (16 U.S.C. §§ 1801 et seq.). Enclosed with this letter, please find the SBSP Restoration Project's Phase 2 Biological Assessment (BA).

The SBSP Project is the largest wetland restoration project on the West Coast, encompassing 15,100 acres of the former Cargill Inc. (Cargill) salt ponds in the South San Francisco Bay (South Bay) that were acquired by a public-private partnership for restoration and management by the USFWS and the California Department of Fish and Wildlife (CDFW) in 2003. The Refuge and SCC propose to continue implementing the SBSP Restoration Project through the construction, operation, and maintenance of selected ponds as part of Phase 2 project activities that cover approximately 2,200 acres on the Refuge. Phase 2 of the SBSP Restoration Project continues the collaborative efforts among federal, state, and local agencies working with scientists and the public to develop and implement project-level plans and designs for habitat restoration, flood management, and wildlife-oriented public access. These activities will result in the restoration, enhancement or conservation of thousands of acres of tidal marsh, managed pond, subtidal, or open water habitats as well as contribute to the recovery of endangered, threatened, and other special-status terrestrial and aquatic species.

Restoration of habitat for listed species was successfully achieved during Phase 1 which converted former commercial salt ponds to 1,600 acres of tidal habitats and 1,440 acres of muted tidal habitats. These tidal habitats will contribute to the recovery of endangered, threatened, and other special-status species; tidal marsh-dependent species; and the recovery of South Bay fisheries and water quality. In fitting with the SBSP Restoration Project goals, Phase 2 work was designed to increase the net conservation benefits to federally listed species in the Action Area and the estuarine habitats that they rely on. Based on these goals, the results of the project's Initial Stewardship Plan, and Phase 1 action results, we are confident that the SBSP Restoration Project has demonstrated a proven track record of successful implementation of producing a beneficial effect to listed species. In addition, the Project is directly implementing the goals set forth in regional planning documents such as the Baylands Ecosystem Habitat Goals Science Update, the San Francisco Bay Conservation and Development Commission's San Francisco Bay Plan, and many others.

Scope of Consultation Request and Relationship to Previous and Anticipated Future Consultations

After completing the Programmatic and Phase 1 consultations for the SBSP Restoration Project, the initial authorizations included actions on both the State and Federally-owned pond complexes. These consultations also were submitted in conjunction with the Operations and Maintenance (O&M) actions within all SBSP Restoration Project ponds, including those that were not the subject of actual Phase 1 restoration actions. At this time, the Phase 1 actions are complete, and the project ponds included in the programmatic authorizations are still operating under the current O&M approvals, which expire in 2019.

For Phase 2 actions, the USFWS was determined to be the lead federal agency, as it is the federal agency with the best expertise and relationship to the proposed action. For Phase 1 and Programmatic SBSP Restoration Project actions, the Refuge worked in collaboration with the USACE's Shoreline Study. Since that time, Phase 1 operations have been completed and Phase 2 actions are distinctly separate from the Shoreline Study. Therefore, for Phase 2 actions, the USFWS was determined to be the appropriate federal lead as it owns and manages the land as part of the Refuge.

This request for consultation is limited to Phase 2 restoration actions on property owned by the USFWS, and includes additional subsequent O&M actions within those ponds. A separate BA will be submitted for Phase 2 actions on CDFW owned ponds (Eden Landing) subsequent to the CEQA/NEPA approvals which are anticipated later in 2017. Renewal of the broader authorizations for O&M activities on ponds that are not subject to specific restoration actions for both agencies is anticipated to occur prior to the existing permit's expiration in 2019.

Summary of the Enclosed Biological Assessment

The enclosed BA describes the Phase 2 design elements, conservation measures, environmental setting, Action Area, consultation history with multiple agencies, and presents the determination of effects to federally listed species. A separate consultation with the USFWS for potential effects to federally listed birds, terrestrial mammals, and resident fishes regulated under their jurisdiction is occurring simultaneously.

As described in the attached BA, there is potential for Southern Distinct Population Segment (DPS) green sturgeon (*Acipenser medirostris*) and Central California Coast (CCC) DPS steelhead (*Oncorhynchus mykiss*) to occur in the action area, and designated critical habitat (DCH) for these species is present in the action area. The Action Area also contains Essential Fish Habitat (EFH) pursuant to MSA as designated under the Coastal Pelagic (PFMC 2016), Pacific Coast Groundfish (PFMC 2005), and Pacific Coast Salmon (PFMC 2014) Fishery Management Plans (FMP).

Adverse effects to listed species from construction are anticipated to be minor and temporary in nature; potential effects may include increases in turbidity, changes in water quality, and increases in underwater noise. Small numbers of ESA-listed fish species may be injured or killed as a result of in-water construction or entrainment into managed ponds during operations. Conservation measures are provided to avoid or minimize effects related to construction and operation. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the extent of similar habitats in the San Francisco Bay estuary.

The proposed action is expected to result in considerable increases in the quantity, quality, and connectivity of estuarine habitat in the South Bay, far outweighing the small areas of fill in habitats to create habitat transition zones and habitat islands and the minor, localized impacts to habitat that would occur during construction, operation, and maintenance activities.

The Refuge and the SCC have determined in the attached BA that due to the potential for listed fish to interact with construction activities, the proposed action *may affect, and is likely to adversely affect* Southern DPS green sturgeon and CCC DPS steelhead. Additionally, it has been determined that the proposed action *is not likely to adversely affect* critical habitat for those two fish species.

With regards to EFH, the project may result in short-term changes that *may adversely affect* EFH, but such effects would be minimal, and the long-term effects to EFH would be greatly beneficial.

Thank you for your consideration of this request and for the important work you do in our shared goal of recovery for endangered species and their habitats. Please feel free to contact me if you have further questions at John.Bourgeois@scc.ca.gov or 408.314.8859.

Sincerely,

John Bourgeois
Executive Project Manager
South Bay Salt Pond Restoration Project

California State Coastal Conservancy
1515 Clay Street, 10th floor
Oakland, California 94612

cc: Anne Morkill, Chris Barr, and Jared Underwood, USFWS
John Krause, CDFW
Brenda Buxton, SCC
Seth Gentzler, AECOM

South Bay Salt Pond Restoration Project, Phase 2, National Marine Fisheries Service Biological Assessment

February 2017

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List of Acronyms

ARWTF	Advanced Recycled Water Treatment Facility
AAC	All-American Canal
ABA	Architectural Barriers Act
ADA	Americans with Disabilities Act
AMP	South Bay Salt Pond Restoration Project Adaptive Management Plan
ABAG	Association of Bay Area Governments
BMP	Best Management Practice
BA	Biological Assessment
Bay	San Francisco Bay
BCDC	San Francisco Bay Conservation and Development Commission
BO	Biological opinion
CCC	Central California Coast
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife (formerly CDFG)
CEQA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
dB	Decibel
Delta	San Francisco Bay Delta

DCH	Designated Critical Habitat
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
EIS/R	Environmental Impact Statement/Environmental Impact Report
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FMP	Fishery Management Plan
HAPC	Habitat Area of Particular Concern
h:v	horizontal to vertical
HDPE	high density polyethylene
HTL	High-Tide Lines
ISP	Initial Stewardship Plan
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MHHW	mean higher high water
MHW	mean high water
NASA	the National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NAVD88	North American Vertical Datum, 1988
NMFS	National Marine Fisheries Service
PBO	Programmatic Biological Opinion
PFMC	Pacific Fishery Management Council
PG&E	Pacific Gas and Electric Company
ppt	parts per thousand
Project	South Bay Salt Pond Restoration Project
QAPP	Quality Assurance Program Plan
Refuge	Don Edwards San Francisco Bay National Wildlife Refuge
RMS	root mean square
ROD	record of decision
ROW	right-of-way
RWQCB	Regional Water Quality Control Board
SBSP	South Bay Salt Pond
SCC	California State Coastal Conservancy
SEL	Sound exposure level
SCVWD	Santa Clara Valley Water District
SR	State Route
SSC	suspended sediment concentration
South Bay	South San Francisco Bay
SUMC Project	Stanford University Medical Center Facilities Renewal and Replacement
SWPPP	Storm water pollution prevention plan
TTS	Temporary threshold Shift
UPRR	Union Pacific Railroad
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WPCP	Water Pollution Control Plant

Executive Summary

This document presents the Biological Assessment (BA) for Phase 2 of the United States Fish and Wildlife Service's (USFWS) and the California State Coastal Conservancy's (SCC) South Bay Salt Pond (SBSP) Restoration Project at the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge). The Phase 2 actions would take place in portions of the Alviso pond complex and the Ravenswood pond complex, both of which are part of the USFWS's properties in the larger Refuge.

The proposed Phase 2 Project activities are in four pond clusters including the Alviso-Island Ponds (Ponds A19, A20, and A21); the Alviso-A8 Ponds (Ponds A8 and A8S); the Alviso-Mountain View Ponds (Ponds A1 and A2W); and the Ravenswood Ponds (Ponds R3, R4, R5, and S5). This BA describes potential effects of the proposed Project to the Action Area containing fish species under the jurisdiction of the National Marine Fisheries Service (NMFS) pursuant to Section 7 of the federal Endangered Species Act (ESA; 16 Unites States Code [U.S.C.] §§ 1531 et seq.), and for Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (16 U.S.C. §§ 1801 *et seq.*). The Action Area, as defined in 50 Code of Federal Regulations (CFR) Section 402.02, includes all areas that are directly or indirectly affected by the federal action, as well as interrelated and interdependent actions. The Action Area for this proposed Project is described in Section 3 of the main text.

A background database and literature review was conducted within the Action Area to determine the potential for occurrence of ESA-listed fish species including designated critical habitat (DCH). The Action Area also contains EFH pursuant to MSA as designated under the Coastal Pelagic (PFMC 2016), Pacific Coast Groundfish (PFMC 2005), and Pacific Coast Salmon (PFMC 2014) Fishery Management Plans (FMP).

Adverse effects to listed species from construction are anticipated to be minor and temporary in nature; potential effects may include increases in turbidity, changes in water quality, and increases in underwater noise. Small numbers of ESA-listed fish species may be injured or killed as a result of in-water construction or entrainment into managed ponds during operations. Conservation measures are provided to avoid or minimize effects related to construction and operation. These include controls to prevent the release of toxic materials, sampling and monitoring for contaminated sediments, minimization of disturbance to marsh vegetation, working at low tide, and biological monitoring. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the extent of similar habitats in the San Francisco Bay estuary.

A relatively small area of intertidal and subtidal habitat will be lost due to the placement of fill for levee improvements and the creation of habitat transition zones and habitat islands. In the long term, however, there would be an overwhelmingly positive benefit to such habitats because the proposed action is expected to result in considerable increases in the quantity, quality, and connectivity of estuarine habitat in the South Bay, far outweighing the small areas of fill in habitats and the minor, localized impacts to habitat that would occur during construction, operation, and maintenance activities.

Table ES-1 contains a list of all fish species federally listed as threatened or endangered and their DCH, as well as EFH and representative species that may be affected by the proposed activities in four pond clusters. Effects determinations and the rationale are also summarized in **Table ES-1**.

Table ES-1. Listing Status, Rationale, and Effects Determinations for Federally Listed Species and, Designated Critical Habitat, and Essential Fish Habitat for Proposed Phase 2 Project

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS	EFFECTS DETERMINATION	RATIONALE
SPECIAL STATUS FISH				
Oncorhynchus mykiss	Central California Coast steelhead DPS	Federal Threatened	Likely to Adversely Affect	Spawning populations are known in several South Bay creeks (including Coyote, Stevens Creek, and Alameda Creek) and the Guadalupe River. Suitable spawning habitat is not present in the project area, but this species may be seasonally present in waters with active tidal connection during migration. Juveniles may use ponds and sloughs with tidal connection for foraging during outmigration. Construction within active tidal waters may cause injury to individuals or expose them to increased turbidity and impaired water quality, and a small number of individuals may be injured or killed as a result of project construction and due to entrainment into managed ponds during operation. Small areas of habitat will be lost due to fill; however, much larger areas would be opened to tidal flow or enhanced, providing a net benefit to the species.
Designated Critical Habitat, *Oncorhynchus mykiss*	Central California Coast steelhead DPS	Designated Critical Habitat	Not Likely to Adversely Affect	Designated critical habitat for Central California Coast steelhead includes all portions of the Action Area below Mean Higher High Water that have an active tidal connection and are accessible to the species. Construction within active tidal waters may cause temporary habitat degradation due to increased turbidity and briefly impaired water quality. Small areas of critical habitat will be lost due to fill; however, much larger areas would be opened to tidal flow or enhanced by re-establishing full tidal action to some ponds and increasing habitat diversity. This will provide a net benefit to DCH for this species.
Acipenser medirostris	Southern DPS North American green sturgeon	Federal Threatened	Likely to Adversely Affect	Green sturgeon are known to occur in the South Bay, and may be present year-round in ponds and sloughs with an active tidal connection. It is expected that green sturgeon occur very infrequently and in low numbers within the Action Area. Construction within active tidal waters may cause injury to individuals or expose them to increased turbidity and impaired water quality, and a small number of individuals may be injured or killed as a result of project construction and due to entrainment into managed ponds during operation. Small areas of habitat will be lost due to fill; however, much larger areas would be opened to tidal flow or enhanced, providing a net benefit to the species.

Table ES-1. Listing Status, Rationale, and Effects Determinations for Federally Listed Species and, Designated Critical Habitat, and Essential Fish Habitat for Proposed Phase 2 Project

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS	EFFECTS DETERMINATION	RATIONALE
Designated Critical Habitat, *Acipenser medirostris*	Southern DPS North American green sturgeon	Federal Threatened	Not Likely to Adversely Affect	Designated critical habitat for Southern DPS green sturgeon includes all portions of the Action Area below Mean Higher High Water that have an active tidal connection and are accessible to the species. Construction within active tidal waters may cause temporary habitat degradation due to increased turbidity and impaired water quality. Small areas of critical habitat will be lost due to fill; however, much larger areas would be opened to tidal flow or enhanced by re-establishing full tidal action to some ponds and increasing habitat diversity, and potentially improving local prey base for sturgeon. This will provide a net benefit to DCH for this species.
ESSENTIAL FISH HABITAT (EFH)				
FISHERY			EFFECTS DETERMINATION	RATIONALE
Coastal Pelagic FMP* Includes habitat for species such as Pacific sardine (*Sardinops sagax*), jack mackerel (*Trachurus symmetricus*), and northern anchovy (*Engraulis mordax*) and prey items such as Pacific herring (*Clupea pallasii pallasii*) and jacksmelt (*Atherinopsis californiensis*).			May Adversely Affect	EFH designation includes subtidal and intertidal habitats within the Action Area. Construction within active tidal waters may cause temporary habitat degradation due to increased turbidity and impaired water quality. Small areas of EFH will be lost due to fill; however, much larger areas would be opened to tidal flow or enhanced by re-establishing full tidal action to some ponds and increasing habitat diversity. This will provide a net benefit to EFH.
Pacific Groundfish FMP** Includes habitat for species such as starry flounder (*Platichthys stellatus*), English sole (*Parophrys vetulus*), leopard shark (*Triakis semifasciata*), and soupfin shark (*Galeorhinus galeus*) and prey items such as Pacific herring (*Clupea pallasii pallasii*) jacksmelt (*Atherinopsis californiensis*).			May Adversely Affect	EFH designation includes all subtidal and intertidal habitats within the Action Area. Construction within active tidal waters may cause temporary habitat degradation due to increased turbidity and impaired water quality. Small areas of EFH will be lost due to fill; however, much larger areas would be opened to tidal flow or enhanced by re-establishing full tidal action to some ponds and increasing habitat diversity. This will provide a net benefit to EFH.
Pacific Coast Salmon FMP*** Includes habitat for chinook salmon (*Oncorhynchus tshawytscha).*			May Adversely Affect	EFH designation includes all subtidal and intertidal habitats within the Action Area. Construction within active tidal waters may cause temporary habitat degradation due to increased turbidity and impaired water quality. Small areas of EFH will be lost due to fill; however, much larger areas would be opened to tidal flow or enhanced by re-establishing full tidal action to some ponds and increasing habitat diversity. This will provide a net benefit to EFH.

Notes: Fishery Management Plan (FMP), *PFMC 2016, **PFMC 2005, ***PFMC 2014, [1] 70 FR 52488, [2] 74 FR 52300

1 Introduction

1.1 Project Overview and Background

The South Bay Salt Pond Restoration (SBSP) Project is a multi-agency 50-year effort to restore tidal marsh habitat, reconfigure managed pond habitat, maintain or improve flood protection, and provide recreation opportunities and public access in 15,100 acres of former salt-evaporation ponds purchased from and donated by Cargill Incorporated (Cargill) in 2003. The former salt-production areas are no longer used for that purpose, and, in many cases, they are no more saline than San Francisco Bay (Bay) itself. Immediately after the March 2003 acquisition and subsequent transfer of those ponds from Cargill, the landowners, the U.S. Fish and Wildlife Service (USWFS) and California Department of Fish and Wildlife (CDFW), began implementation of the Initial Stewardship Plan (ISP) (USFWS and CDFG 2003), which was designed to maintain open water and unvegetated pond habitats with enough water circulation to preclude salt production and maintain habitat values and conditions until the long-term restoration actions of the SBSP Restoration Project could be implemented. The longer-term planning effort involves a 50-year programmatic-level plan for restoration, flood protection, and public access. This effort has already seen the implementation of Phase 1 projects, which are described in the SBSP Restoration Project's Environmental Impact Statement/Report (hereafter, "2007 EIS/R") and the associated Biological Assessments and Biological Opinions (BO) for the Project's Phase 1 actions (USFWS PBO 2008). That longer-term planning was facilitated by the California State Coastal Conservancy (SCC) and was completed in January 2009. The planning phase of the SBSP Restoration Project was completed in January 2009 with the publication of the Final 2007 EIS/R.

Phase 1 implementation in the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) began in 2010 and was completed in December 2014. Phase 1 involved the construction of 3,040 acres of tidal or muted tidal wetlands, 710 acres of enhanced managed ponds, 7 miles of new public access trails, and habitat islands and improved levees. In 2010, the Phase 2 planning was initiated. The initial project elements included restoration, public access, and flood protection[1] actions in all three pond complexes: Alviso, Ravenswood, and Eden Landing. In April 2016 the Final EIS/R for Phase 2 at the Refuge (i.e., Alviso and Ravenswood) was completed (AECOM 2016). Phase 2 at Eden Landing is proceeding separately.

The selection of and planning for the Phase 2 projects started in 2010 and completed its Final EIS/R in April 2016.

Phase 2 of the SBSP Restoration Project is a collaborative effort among federal, state, and local agencies working with scientists and the public to develop and implement project-level plans and designs for habitat restoration, flood management, and wildlife-oriented public access. Phase 2 of the SBSP Restoration Project builds on previous efforts to develop and implement plans and designs

[1] The terminology used by the SBSP Restoration Project to describe its goals has changed from "flood protection" to "flood risk management". Not only can this distinguish improvements to existing berm-like salt pond levees from engineered levees specifically designed for flood protection, but it also reflects a general shift in terminology used by the partner organizations. This document generally uses the former term to refer to overall Project goals that were established prior to this terminology change but uses the latter term for forward-looking statements and actions that would be taken in the future.

for habitat restoration, flood risk management, and wildlife-oriented public access. The former salt ponds are part of the USFWS-owned and managed Refuge, and cover approximately 9,600 acres in the South Bay. The Refuge ponds in Phase 2 are collectively nearly 2,400 acres in size. A Final EIS/R for the Phase 2 Actions was adopted by the California State Coastal Conservancy (SCC; the State lead agency under the California Endangered Species Act (CEQA)). The Federal lead agency under the National Environmental Policy Act (NEPA) will file a Record of Decision for the Final EIS/R for the Phase 2 Project following the completion of this Section 7 consultation.

The ponds that were neither part of Phase 1 nor part of Phase 2 will continue to be actively managed according to the goals set forth in the Interim Steward Plan and the Refuge's Pond Management Plan until further implementation planning and the appropriate adaptive management studies are completed. They may be included in future project phases as well.

1.2 Phase 2 NMFS Biological Assessment

The purpose of this Biological Assessment (BA) is to assess the impacts of the proposed Phase 2 actions (proposed action) on federally protected species for consultation with NMFS under Section 7 of the Endangered Species Act, as well as Essential Fish Habitat (EFH) as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA). Based on historically and recently collected data of species occurrence, habitat assessment, and research of species distribution data, the following threatened or endangered species may be affected by Phase 2 actions:

- Central California Coast (CCC) distinct population segment (DPS) steelhead (hereafter will be referred to as CCC steelhead; *Oncorhynchus mykiss*; threatened) and their designated critical habitat (DCH).
- Southern DPS of the North American green sturgeon (hereafter will be referred to as green sturgeon; *Acipenser medirostris*; threatened), and their DCH.

Species under the jurisdiction of the USFWS are identified and addressed in a separate BA.

The Action Area contains EFH for various life stages of fish following the Coastal Pelagic, Pacific Groundfish, and Pacific Salmon Fishery Management Plans under the MSA. In addition, the San Francisco Bay, including the Action Area, is designated as a coastal estuary Habitat Area of Particular Concern (HAPC).

1.3 Consultation History

Coordination between the National Wildlife Refuge section of the USFWS and the Endangered Species section of the NMFS regarding the SBSP Restoration Project has occurred regularly since 2004. The following is a list of the major steps and events in the consultation history, including that for Phase 2 Actions, though there are individual emails and telephone conversations that may not be captured here.

Programmatic and Phase 1

- Multi-agency biennial (every other year) SBSP Restoration Project meetings, as follows:
    - 2004-2007. The Refuge and other Project partners coordinated with other Federal, State and local agencies as well as stakeholders regarding the development of the proposed action's components for NEPA and CEQA review.
    - 2006 – 2008. The Refuge and other Project partners continued coordination with other Federal and State and agencies regarding the development of the proposed action's programmatic and project-level biological assessments.
- Written correspondence between Refuge and USFWS between the period of 2007 and 2010.
    - The Refuge requested formal consultation on implementation of the SBSP Restoration Project (including Phase 1 Actions) from the USFWS via the U.S. Army Corps of Engineers (USACE) in December 2007.
- The Refuge and CDFW released the South Bay Salt Pond Restoration Project Final Environmental Impact Statement / Report for the Program in December 2007; it was certified early in 2008.
- The Refuge submitted a draft Programmatic BA to USFWS for review in July 2007.
- The Refuge submitted draft Phase 1 BAs to USFWS for review in November 2008
- NMFS issued BOs for the both the programmatic SBSP Restoration Project as a whole and for the Phase 1 actions in August 2008.
- Biennial regulatory agency work group meetings continued throughout the planning process for Phase 2 actions. Those meetings occurred in 2010, 2012, 2014, and 2016. Details are in the Phase 2 sub-section below.
- Annual Stakeholder Forum meetings, to which the USFWS, NMFS, and other regulatory agencies were invited, have taken place since 2010

Phase 2

- A 2010 charrette specific to the Phase 2 actions, including which ponds to include in consideration for a Phase 2 project, was conducted. The USFWS was a participant.
- Alviso Working Group meetings occurred in August 2011 and June 2012; the USFWS and NMFS were invited participants.
- The biennial regulatory agency work group was convened in November 2012, at which the earliest Phase 2 ponds and restoration concepts was presented. Design sufficient for inclusion in an EIS/R proceeded thereafter.
- A public scoping meeting on the Phase 2 actions took place in September of 2013 to present the conceptual alternatives and the plans for developing and analyzing the Phase 2 alternatives.
- The 2014 regulatory agency work group was convened in May of 2014. The refined conceptual alternatives for Phase 2 actions were presented. Work on the Draft EIS/R was in progress at this point and was completed in summer of 2015.
- SBSP Restoration Project Executive Project Manager John Bourgeois held several meetings with San Francisco Bay Conservation and Development Commission (BCDC) between 2013 and 2016 to discuss upland transition zones and Bay fill, including participation in BCDC Bay Fill subcommittee and its "Policies For A Rising Bay" project.

- SBSP Restoration Project Executive Project Manager John Bourgeois met to discuss the Phase 2 project with regulatory staff from the U.S. Environmental Protection Agency.
- SBSP Restoration Project Executive Project Manager John Bourgeois conducted a 2015 site tour and project orientation meeting with the USFWS' Endangered Species staff.
- The Phase 2 SBSP Draft EIS/R was released in August of 2015. Following a public comment period, responses to comments, the Phase 2 SBSP Final EIS/R was prepared and released in April of 2016.
- The biennial regulatory agency work group was convened in July 2016. A strategy for permitting, including Section 7 consultation with the USFWS and the NMFS, was included. The NMFS attended and participated.
- SBSP Restoration Project Executive Project Manager John Bourgeois conducted an August 2016 site visit with Frances Malamud-Roam of the USACE to field-verify some of the jurisdictional delineation details.
- Throughout 2015 and 2016, a number of telephone conversations, in-person meetings, and email messages took place between the SBSP Restoration Project executive project manager John Bourgeois and representatives from NMFS, including Gary Stern and Brian Meux. These discussions largely pertained to the question of whether a fish screen would be needed for the relocated water intake for the City of Mountain View's Shoreline Park sailing lake if the breaches and other project actions to hydraulically connect the Alviso-Mountain View Ponds and Charleston Slough to the known CCC steelhead run on Stevens Creek were implemented. The conclusion was that fish screens would be needed. Because of the limited space for a larger water intake necessitated by a screened intake, and because of other, long-term questions of cost, effectiveness, and functionality, the incorporation of Charleston Slough and all related elements was removed from the Preferred Alternative for Phase 2.

1.4 Proposed Action

The purposes of the Phase 2 action are to: 1) restore and enhance a mix of wetland and other habitats; 2), provide wildlife-oriented public access and recreation; and 3), maintain or improve flood risk management in four pond clusters in the project area. Restoration of the former salt-production ponds in the South Bay would create habitat for marsh-dependent fish and wildlife, retain sufficient habitat for pond-dependent fish and wildlife, improve water quality, not increase the risk of local coastal flooding, and open up new areas in the South San Francisco Bay for wildlife-compatible public access and recreation.

A brief overview list of Phase 2 actions is provided below. Detailed descriptions of these actions and their location are provided in Chapter 2.

1.4.1 Tidal Marsh Restoration

Construction activities involved in tidal habitat restoration include the following, not all of which are planned to be implemented in all Phase 2 areas:

- Breaching sections of outboard levees or widening existing breaches;
- Lowering and removing sections of outboard levees;
- Breaching or removing internal levees;
- Raising and improving internal and external levees to maintain current levels of flood protection;

- Armoring and bridging certain breaches to retain vehicle access;
- Excavating pilot channels to sloughs through the existing fringing marsh outboard of levee breaches;
- Excavating pilot channels inside of ponds to improve filling and draining;
- Constructing ditch blocks in the internal borrow ditches with material excavated from the levee breaches and lowered levees, or from other clean sediment;
- Importing and placing fill material from offsite upland excavation projects;
- Building habitat islands;
- Building habitat transition zones between pond bottoms and adjacent uplands or levees; and
- Removing or abandoning existing water control structures or other derelict salt works infrastructure.

1.4.2 Managed Pond Enhancement

Construction activities involved in establishing or enhancing the habitat in managed ponds include the following, not all of which are planned to be implemented in all Phase 2 areas:

- Building habitat transition zones between pond bottoms and adjacent uplands or levees;
- Building habitat islands;
- Excavating and grading pond bottoms to achieve desired grades and elevations;
- Installing water control structures to allow management of water depths, salinity, and other elements of water quality; and
- Raising and improving internal and external levees to maintain current levels of flood protection.

1.4.3 Flood Protection

Construction activities involved in maintaining or improving current levels of flood protection include the following, not all of which are planned to be implemented in all Phase 2 areas:

- Raising and improving existing levees and berms around former salt-production ponds and in other locations;
- Installing water control structures to enhance control over water levels within managed ponds; and
- Building habitat transition zones that would reduce wave run-up and provide some additional protection to the levees and other lands behind them.

1.4.4 Public Access and Recreation

Construction activities involved in installing or upgrading public access and recreation components include the following, not all of which are planned to be implemented in all Phase 2 areas:

- Construct several miles of new trail, most of which would be spur trails off of the Bay Trail spine;
- Construct three viewing platforms with benches and interpretive panels and signage;
- Reconstruct existing portions of the existing Bay Trail and other existing public access features that would be disturbed by construction; and
- Trails and platforms would be compliant with requirements of the Americans with Disabilities Act and Architectural Barriers Act.

1.5 Organization of the BA

This BA is organized as follows:

- **Section 2 – Description of the Proposed Action –** Describes the location of the proposed action, design elements, access, construction process, schedule, and conservation measures.
- **Section 3 – Environmental Setting –** Describes the physical and biological conditions in the area of the proposed action.
- **Section 4 – Action Area –** Describes the Action Area for determining the potential direct and indirect effects.
- **Section 5 – Species and Critical Habitats Considered –** Discusses the existing biological resources and natural environment including descriptions of federally listed species and critical habitat that may be present in the Action Area.
- **Section 6 – Effects of the Proposed Action -** Provides an analysis of the effects of the proposed action to fish species, DCH, and EFH.
- **Section 7 – Determination –** Summarizes the potential adverse effects on fish species, DCH, and EFH and final impact determinations.
- **Section 8 – Maps**
- **Section 9 – References**

2 Description of the Proposed Action

2.1 Location

The SBSP Restoration Project is in South San Francisco Bay (South Bay) in Northern California (see **Figure 1**). Phase 2 of the SBSP Restoration Project includes parts from two complexes of former salt ponds and adjacent habitats in the South Bay that the USFWS acquired from the Cargill in 2003. The pond complexes consist of the 8,000-acre Alviso pond complex and the 1,600-acre Ravenswood pond complex, both of which are owned and managed by USFWS as part of the Refuge (see **Figure 2**). Within these two pond complexes, there are four groups of ponds (or "pond clusters") that are included in the proposed Phase 2 actions; these are illustrated in **Figure 3a** through **Figure 3d**. They are as follows:

- Alviso–Island Ponds (Island Ponds) in the Alviso pond complex, shown in **Figure 3a**
- Alviso–A8 Ponds (A8 Ponds) in the Alviso pond complex, shown in **Figure 3b**
- Alviso–Mountain View Ponds (Mountain View Ponds) in the Alviso pond complex, shown in **Figure 3c**
- Ravenswood Ponds in the Ravenswood pond complex, shown in **Figure 3d**

The Alviso pond complex consists of 25 ponds on the shores of the South Bay in the cities of Fremont, San Jose, Sunnyvale, and Mountain View, within Santa Clara and Alameda Counties. The pond complex is bordered on the west by the Palo Alto Baylands Park and Nature Preserve and the City of Mountain View's Charleston Slough; on the south by commercial and industrial land uses, Mountain View's Shoreline Park, the National Aeronautics and Space Administration (NASA) Ames Research Center, and Sunnyvale Baylands Park; and on the east by Coyote Creek in San Jose and Cushing Parkway in Fremont. The Phase 2 project actions in the Alviso pond complex focus on three clusters of ponds. The first cluster, the Island Ponds, containing Ponds A19, A20, and A21 is between Coyote Creek and Mud Slough near the eastern end of the Alviso pond complex. The Island Ponds were breached in 2006 as part of tidal marsh restoration actions covered by the ISP.

The second cluster, the A8 Ponds, containing Ponds A8, and A8S is in the southern and central portion of the Alviso pond complex. The A8 Ponds are west of the town of Alviso, north of Sunnyvale and State Route (SR) 237, and east of other parts of the Alviso pond complex. Ponds A8 and A8S were also included in the Phase 1 work; they were made reversibly tidal through the installation of a variable-size and reversible "notched" gate that opened in July 2010. Ponds A5 and A7 were also connected to Pond A8 and Pond A8S as part of Phase 1 actions. There would be no Phase 2 actions at that end of this group of ponds.

The third cluster, the Mountain View Ponds, containing Ponds A1 and A2W is on the western edge of the Alviso pond complex. The City of Mountain View lies immediately to the south, and the Charleston Slough and the Palo Alto Flood Control Basin lie to the west.

The Ravenswood pond complex consists of seven ponds on the Bay side of the Peninsula, both north and south of SR 84, west of the Dumbarton Bridge, and on the Bay side of the developed areas of the City of Menlo Park in San Mateo County. Bayfront Park in Menlo Park is directly west of the Ravenswood pond complex, and of SR 84 is along its southern border. The Phase 2 project actions in the Ravenswood pond complex are focused on the western half of the pond complex, which contains Ponds R3, R4, R5, and S5, here referred to as the Ravenswood Ponds.

Table 1 lists each pond, the cluster it is part of, and its area, centroid, and latitude and longitude coordinates in decimal degrees. Pond areas in the following table are sourced from the 2007 SBSP Program FEIS/R and provide general estimates for each pond. Areas calculated for Phase 2 operations have been updated and may slightly differ from those estimated in the programmatic FEIS/R.

Table 1. SBSP Phase 2 Approximate Pond Area, Location, and Tidal State

POND CLUSTER	POND	*AREA (ACRES)	LATITUDE	LONGITUDE	CURRENT TIDAL STATE	PHASE 2 TIDAL STATE
ALVISO -ISLAND PONDS	A19	265	37.467092	-121.957692	Open to Tides	No Change
	A20	65	37.464876	-121.970986	Open to Tides	No Change
	A21	150	37.465142	-121.979427	Open to Tides	No Change
ALVISO - A8 PONDS	A8	410	37.428778	-121.991558	Muted Tidal	No Change
	A8S	160	37.420860	-121.989553	Muted Tidal	No Change
ALVISO - MOUNTAIN VIEW PONDS	A1	275	37.442525	-122.086577	Limited Muted	Open to Tides
	A2W	435	37.441989	-122.074607	Limited Muted	Open to Tides
RAVENSWOOD PONDS	R3	270	37.486675	-122.155291	None; Seasonal Rainfall Only	No Change
	R4	295	37.493048	-122.161933	None; Seasonal Rainfall Only	Open to Tides
	R5	30	37.488054	-122.170371	None; Seasonal Rainfall Only	Managed Ponds
	S5	30	37.485913	-122.170712	None; Seasonal Rainfall Only	Managed Ponds

Note: Pond areas excerpted from the 2007 SBSP Final EIR/S.

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2.2 General Site Restoration Components

The Phase 2 sites include several common restoration features and operations that are proposed to meet project goals. These features include levee breaching, levee raising/improvement, levee lowering or removal, habitat transition zones, habitat islands, ditch blocks, and water control structures, as well as public access and recreation features. In addition, there would be an initial overbuild for some of the features described below to compensate for the expected subsidence and settlement following material placement. All of these features are illustrated by pond cluster on **Figure 3**, sheets a-d. Detailed information proposed actions and operations and maintenance at each site is provided in Section 2.3, Section 2.4, and Section 2.5. A general summary of these operations and features follows.

2.2.1 Levee Breaching

Levee breaches are proposed at specific pond locations to open the ponds to full tidal flows and/or to establish hydraulic connections between ponds. Levees would be breached after all internal pond activities are completed. Levees would be breached mechanically using earth moving equipment. Most breaches would not be reinforced and would be allowed to scour and widen naturally. Select locations would have armored breaches to support bridges where access by levee roads would be maintained. Material from breaches would be used for levee enhancements, placed into the ponds and used to create ditch blocks or pond bottom to speed the return to marsh plain elevation.

2.2.2 Levee Raising/Improvement

Levee enhancements are proposed at some locations to maintain or improve flood control, improve levee conditions for public access features and promote the establishment of wildlife habitat and native plant composition. These activities involve raising, widening, compacting, and otherwise improving existing levees where it is necessary to do.

2.2.3 Levee Lowering

At select locations, levees would be lowered by scraping their tops down to the local mean higher high water (MHHW) elevation. Levee lowering would enhance habitat connectivity and provide transition of some locations to tidal marsh. Levee material would be used for levee enhancements, placed into the ponds and used to create ditch blocks or pond bottom to speed the return to marsh plain elevation.

2.2.4 Levee Removal

Levee removal is proposed at specific ponds to restore managed ponds to tidal wetland and to enhance hydraulic connections between ponds. Levee removal would bring certain sections of levees down to the elevation of the adjoining marsh plain and would thereby help connect aquatic habitat at high tides and speed the overall restoration of tidal marsh. Levee material would be used for levee enhancement, placed into the ponds and used to create ditch blocks or pond bottom to speed the return to marsh plain elevation.

2.2.5 Habitat Transition Zones

As an adaptation to future sea level rise, the project is proposing the creation of habitat transition zones as part of Phase 2 actions. Habitat transition zones involve the beneficial reuse of material to create transitional habitats from the pond or marsh bottom to the adjacent upland habitat along portions of the upland edge. These habitat transition zones, are sometimes referred to elsewhere as “upland transition zones,” “transition zone habitats,” “ecotones,” or “horizontal levees”; this document uses the term “habitat transition zones” for these constructed features. Habitat transition zones are specifically called out in documents such as the U.S. Fish and Wildlife Service’s Tidal Marsh Recovery Plan USFWS (2013) and the recent Science Update to the Baylands Ecosystem Habitat Goals Project Report (Goals Project 2015). A gradual transition from submerged Baylands, ponds, or open waters to uplands is largely missing in the current landscape of the South Bay, where there is often an abrupt boundary between the bay or ponds and the built environment. The SBSP Restoration Project’s intention in including habitat transition zones in the Phase 2 alternatives is to restore this missing habitat feature. Doing so would:

- Establish areas in which terrestrial marsh species can take refuge during high tides and storm events, thereby reducing their vulnerability.
- Expand habitat for a variety of special status plant species that occupy this specific elevation zone.
- Provide space for marshes to migrate upslope over time as sea-level rise occurs.

Before proposing these features, the SBSP Restoration Project examined the landscape to see if there were any areas adjacent to the project site where this could occur naturally. In general, the best locations for building these features would be located adjacent to open space or park land where the project can provide an even greater extent of transition into upland habitats. However, at the edge of the Bay, these open space areas are largely former (now closed and capped) landfills which present a variety of challenges for creating the missing upland habitat. First, the existing elevation gradient between the restored marsh and the edge of the landfill is usually too steep to provide a gradual transition. Secondly, these landfills would otherwise pose a water quality risk from erosion if tidal action were introduced immediately adjacent to the protective clay liner or un-engineered rip rap slopes. In these instances, it is necessary that the project place material inside the former salt ponds to create the desired slope (generally 15:1 to 30:1 but potentially larger). At other locations, the actual elevations landward of the project sites are too low to create an uphill slope with the desired habitat functions. Therefore, once new levees are built to protect that area from tidal flooding, the only area remaining to build the transition zones is in the former salt ponds. Finally, most of the adjacent property is not within the SBSP Restoration Project’s ability to acquire, whether or not it has the desired elevation profile, because it is currently developed. In addition to being very expensive to acquire these areas, it would be infeasible to relocate all of the residences and businesses that have been built adjacent to the ponds.

For these reasons, the project plans to construct the habitat transition zones inside the former salt ponds. The transition zones would improve the habitat quality of the restored marsh, particularly for endangered and threatened species, and improve resiliency of the shoreline over time as sea levels rise.

2.2.6 Habitat Islands

Within specific ponds, habitat islands would be constructed from fill and existing levees to provide isolated nesting areas for birds. These islands would increase the quality, complexity, and availability of bird habitat in the Phase 2 areas and in the Refuge in general. As the ponds transition to marsh, the island habitat would eventually become marsh mounds (possibly requiring active vegetation management), which have various ecological benefits as high-tide refugia and as focal points for further sediment aggregation and vegetation formation.

2.2.7 Ditch Blocks

To create the existing salt production evaporation ponds, earth was piled in a mound around each pond's perimeter to establish a levee that separated the pond from communicating with the waters of the Bay. The material for these levees was sourced from digging ditches around the inside perimeter of the pond, leaving a borrow ditch around the raised levees. Operations and maintenance of the levee maintained this process during salt production. Phase 2 proposes the use of ditch blocks within the borrow ditches as a means of enhancing tidal flow as select ponds are restored to tidal marshes.

Ditch blocks would be built by placing fill material inside of the historic borrow ditches to direct tidal flows into the center of the ponds instead of allowing them to flow around the interior perimeter. Fill material would be sourced from levee lowering, removal and breaching operations at each pond as well as from off-site sources.

2.2.8 Water Control Structures

Within the Ravenswood Ponds at four locations, water control structures would be installed. Water control structures are proposed to allow management of water levels and quality in managed ponds. They would give Refuge staff more ability to avoid water quality problems, algal blooms, or other adverse impacts. The water control structures would be pipe culverts with gates at each end to provide directional control.

2.2.9 Initial Overbuild

To achieve final design goals, many fill operations would require that construction elevations are built at a higher elevation than the final design. This planned overbuild is to allow for compaction, address wind and water erosion, and compensate for settling that will occur after fill is placed. Constructions elevations for levee improvements, habitat transition zones, and habitat islands would typically be constructed 2 to 4 feet above design goals.

2.2.10 Public Access and Recreation Features

At two of the four locations, there would be trails and viewing platforms placed to add or improve public access and recreational opportunities in these areas. None of these features would require fill or excavation or other construction activities solely for their placement; all of these public access features would be placed on existing developed uplands or on levees that would be improved for flood risk management or other purposes. Since none of these features would be placed in NMFS jurisdiction or would affect NMFS-protected species, they are not described in detail in this document.

2.3 Proposed Action

The SBSP Restoration Project's proposed actions for Phase 2 provide a variety of habitat enhancements at all four pond clusters and include maintained or increased flood risk management, and additional public access and recreation features at two of the pond clusters. **Figures 3a through Figure 3d illustrate** the proposed construction as it would be implemented at each of the Phase 2 pond clusters. The pond-cluster specific operations are discussed in detail in the following sections.

2.4 Alviso-Island Pond Cluster

The proposed project would increase habitat connectivity, tidal flow and expedite the transition of these ponds to tidal marsh.

Proposed project activities at the Island Ponds include the following actions, all of which are illustrated in **Figure 3a**.

2.4.1 Lower Portions of Pond A19 Northern Levee

Lower much of Pond A19's northern levee to MHHW elevation (approximately 7 feet NAVD88), but leave portions of that levee at existing elevations to provide more high-tide refugia and roosting or nesting areas. Levee lowering locations would be grubbed and cleared before constructions and would be hydroseeded with native plan seed mix after lowering is complete. The levee lowering would further increase habitat complexity and connectivity, while unchanged sections of this levee would become island-like high-tide refugia. Cut volumes and areas for levee lowering at Island Ponds are provided in **Table 2**.

2.4.2 Widen the Westernmost of the Two Existing Breaches on the Southern Levee of Pond A19

Widening the existing western breach along Pond A19's southern levee would improve the circulation and flow of sediment into the pond, speed the breakdown of the remaining levee, and increase the rate of transition to marsh habitat. Following the widening, the breach would have a bottom width of approximately 150 feet, an invert elevation near 3.5 feet NAVD88 and 3:1 (h:v) side slopes. The length of the cut would be approximately 90 feet. Cut volumes and areas for breach widening are provided in **Table 2**.

2.4.3 Remove Most of the Western Levee of Pond A19 and the Eastern Levee of Pond A20

Removing most of the levees between Ponds A19 and A20 would add more habitat connectivity by connecting the two former ponds. Removal of these levees would be to the elevation of the strip of existing marsh between the two ponds, to an approximate elevation of 6.6 feet NAVD88. Sections of these two levees would be left at their existing elevations to provide high-tide refugia for birds and other wildlife species. Their removal would create a larger area of connected marsh and aquatic habitat. Cut volumes and areas for levee removal are provided in **Table 2**.

2.4.4 Construct Two Breaches on the North Side Levee of Pond A19 to Connect the Pond with Mud Slough

By adding north side breaches, the habitat connectivity at the Island Ponds would increase, and the distribution of sediment and vegetation would improve. This action would include excavating a channel through the adjacent fringing tidal marsh. Both breaches would be roughly 50 feet wide at the bottom with an invert elevation of 3.5 feet NAVD88 with 3:1 (horizontal to vertical [h:v]) side slopes. The length of channels cut to connect Pond A19 with Mud Slough through the levees would be approximately 150 feet at the Pond A19 northwest breach and approximately 90 feet at the Pond A19 northeast breach. Cut volumes and areas for levee breaches and associated channels are provided in **Table 2**.

2.4.5 Install Ditch Blocks and Fill Existing Borrow Ditches

Placement of material from levee breaching and other modifications would be used to establish ditch blocks or placed into the ponds' borrow ditches. Placing fill into borrow ditches and constructing ditch blocks would speed the transition to tidal marsh. Phase 2 operations would build approximately 6 ditch blocks in Pond A19. Ditch blocks would be established in the existing borrow ditches to direct tidal flows into the interior of the ponds. The material for the ditch blocks would be sourced on-site from levee lowering or breaches. All fill for ditch blocks and pond bottom material would be below MHHW elevation. All proposed fill at the Island Ponds would be sourced on-site from the Island pond levees. Therefore, there would be no imported fill at the Island Ponds. Estimated fill volumes for ditch blocks and levee material placed on pond bottoms is provided in **Table 3**.

Table 2. Island Ponds – Estimated Cut Volumes and Areas

CUT LOCATION	CUT PURPOSE	CUT (CUBIC YARDS)	CUT BELOW HTL/MHHW (CUBIC YARDS)	FOOTPRINT AREA (ACRES)	AREA BELOW HTL/MHHW (ACRES)
Pond A19	Northwest Levee Lowering	5,000	1,000	1.4	0.4
Pond A19	North Levee Lowering (Middle)	1,800	450	0.5	0.1
Pond A19	Northeast Levee Lowering	2,600	520	0.6	0.2
Pond A19	Southwest Levee Lowering	1,400	280	0.5	0.2
Pond A19	Southeast Levee Lowering	1,900	380	0.5	0.2
Subtotal	Levee Lowering	12,700	2,630	3.3	1.0
Pond A19	Southwest Levee Removal	1,400	467	0.4	0.2
Pond A19	Northwest Levee Removal	3,200	1,067	0.8	0.2
Pond A20	Northeast Levee Removal	1,400	467	0.4	0.2
Pond A20	Southeast Levee Removal	2,900	967	0.9	0.4
Subtotal	Levee Removal	8,900	2,967	2.5	1.0
Pond A19	Northwest Breach	1,400	800	0.2	0.2
Pond A19	Northeast Breach	1,000	230	0.1	0.1
Pond A19	South Breach Widening	1,500	560	0.2	0.2
Subtotal	***Levee Breaches***	***3,900***	***1,590***	***0.6***	***0.4***
Totals	**Existing Levee Fill Removed**	**25,500**	**7,187**	**6.4**	**2.4**

Note: due to rounding, totals may not sum to 100%
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Table 3. Island Ponds - Estimated Fill Volumes and Areas by Purpose

FILL PURPOSE	VOLUME* (CUBIC YARDS)	AREA (ACRES)
Pond A19 - Northwest Breach – Ditch block 1	1,800	0.3
Pond A19 - Northwest Breach – Ditch block 2	1,900	0.3
Pond A19 - Northeast Breach – Ditch block 1	1,500	0.3
Pond A19 - Northeast Breach – Ditch block 2	1,400	0.3
Pond A19 - South Breach Widening – Ditch block 1	2,200	0.3
Pond A19 - South Breach Widening – Ditch block 2	2,200	0.4
Other Levee Material Placed in Ponds	14,500	4.7
Total	**25,500**	**6.6**

Note: *All fill volumes and areas are below MHHW

Note: due to rounding, totals may not sum to 100%AECOM 2016

2.5 Alviso-A8 Pond Cluster

Proposed project activities at the A8 Ponds, illustrated in **Figure 3b**, would include building habitat transition zones at the southwest and southeast corners of Pond A8S to provide a range of benefits. The benefits of this operation include establishment of habitat complexity and diversity, erosion protection for the landfill and adjacent levees, and preparation for long-term sea-level rise adaptation. These benefits would provide critical components to the potential long-term restoration plan for the A8 Ponds – to restore them to full tidal action. The operations would include building the tops of the proposed habitat transition zones to approximately 9 feet elevation NAVD88. The lengths of the transition zones along the MHHW line at the southwest and southeast corners would be approximately 2,075 feet each. The habitat transition zones would be separated in the middle so that potential future connections with San Tomas Aquino Creek to the south are not be precluded.

Establishing these habitat transition zones would require import and placement of submerged fill above and below MHHW elevation as shown in **Table 4**. The habitat transition zones would be constructed of fill material from upland construction projects and would extend into the center of the pond at a typical slope of 30:1 (h:v). Fill placed to build transition zones below MHHW tidal elevation would convert ponds to tidal wetlands, but fill placed above that elevation would convert waters to uplands. The areas and volumes above and below MHHW elevation are presented because that elevation represents an ecologically relevant boundary for many plant and wildlife species in tidal areas. In the permitting documents for the USACE, BCDC, and the San Francisco Regional Water Quality Control Board (RWQCB), the Mean High Water (MHW) and High-Tide Lines (HTL) are provided because these are the jurisdictional boundaries established under the Clean Water Act and the Porter-Cologne Act.

Table 4. A8 - Estimated Fill Volumes and Areas

FILL PURPOSE	TOTAL VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL AREA (ACRES)	FOOTPRINT AREA BELOW HTL/MHHW (ACRES)
A8S West HTZ	94,100	91,500	12.1	11.7
A8S East HTZ	84,900	82,500	12.5	12.2
Total	**179,000**	**174,000**	**24.6**	**23.9**

Note: due to rounding, totals may not sum to 100%

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2.6 Alviso-Mountain View Pond Cluster

The restoration goals for the Mountain View Ponds are to restore them to tidal marsh by connecting them to the Bay, adjacent streams, and sloughs through proposed breaches. After breaching, the ponds would accrete sediment until they reached marsh plain elevation and then begin to develop marsh vegetation. The proposed project includes those breaches as well as a number of other habitat enhancements, flood risk management components, and additional public access and recreation features.

Proposed project activities at the Mountain View Ponds include the following, all of which are illustrated in **Figure 3c**.

2.6.1 Raise and Improve the Western Levee of Pond A1

Most of the western levee of Pond A1 would be raised to provide flood risk management to inland areas west and south of the Mountain View pond cluster. The levee breaches in Pond A1 would remove some of the de facto flood protection currently provided by the outboard levees of Pond A1, but raising the western levee of Pond A1 would offset that loss and maintain the current levels of flood risk management in the communities and southward would be raised to an elevation of approximately 14.7 NAVD88 to match that of the raised Coast Casey Forebay levee (described in the next bullet) that it connects to on its southern infrastructure to the southwest of Pond A1. Much of the material for raising the levee would come from off-site, upland sources, though some would come from on-site breaching. The length of levee that would be raised is approximately 4,400 feet. The improved levee would have a 12-foot wide crest north of the proposed viewing platform where no trail would be present and a 14-foot wide crest from the viewing platform southward where a trail would be added. Levee side slopes would be 3.5:1 (h:v). The crest of the levee north of the proposed viewing platform would be constructed to an elevation of 11 feet NAVD88 along its length north of the viewing platform. The crest of the Pond A1 western levee at the viewing platform and southward would be raised to an elevation of approximately 14.7 NAVD88 to match that of the raised Coast Casey Forebay levee (described below) that it connects to on its southern terminus.. Estimated fill volumes and areas for A1 levee improvements are provided in **Table 5**.

2.6.2 Raise and Improve the Coast Casey Forebay Levee and Associated Structures

Improvements to the Coast Casey Forebay are shown in **Figure 3c**. To offset the loss of de facto protection provided by Pond A1, the Coast Casey Forebay levee that is along the western end of the southern border of Pond A1 would be improved between the Palo Alto Flood Control Basin levee and the high ground in Shoreline Park. In accordance with that necessity, the City of Mountain View, which owns that levee, seeks to raise the entire length of that levee even beyond its intersection with the Pond A1 levee. To incorporate the highest sea-level rise prediction from the City of Mountain View's Sea Level Rise Study, Feasibility Report, and Capital Improvement Program (ESA PWA 2012), this levee improvement would build a levee base and foundation support sufficient to support a 16-foot NAVD88 cross section but to a crest elevation of 14.7 feet NAVD88. This design levee height satisfies the FEMA design criteria for 100-year flood level plus 3 feet and gives the City of Mountain View the option of future improvements to address sea-level rise. Further, the Santa Clara Valley Water District (SCVWD), which is the flood protection agency in Santa Clara County, has recommended that a levee-top elevation of 14.7 feet NAVD88 be used for long-term sea-level rise planning. This design levee height would also improve flood risk management along the southern end of Charleston Slough and the communities and infrastructure behind it. The length of the levee improvements would be approximately 1,440 feet. The top width of the improved levee would be approximately 24 feet. In and around this levee are a pump station, a valve vault, and several utility access ports, and all would remain as existing. An existing pump station control building to the southwest would remain in place and the raised levee would be built around it. . The existing wooden platform and viewing station that extend into the slough from the trail near the water intake would remain in place, and an ADA-compliant sloped path would be installed to connect it to the raised Coast Casey Forebay levee. A similar path would connect the top of the Coast Casey Forebay levee to the existing trail from the parking area to the south. Estimated fill volumes and areas for all of these levee improvements and associated structural improvements at the Coast Casey Forebay are provided in **Table 5**.

Finally, an excavation is required to place the shear key that is necessary to complete the improvements on the Coast Casey Forebay levee. A shear key is a volume of strengthened material that extends into the existing material to increase the stability and resistance to sliding for the improved levee. The volume and area for this ground excavation-and-replacement activity are included as part of the Coast Casey Forebay improvement estimates in **Table 5**. The cut volume and area for this portion of work are shown in **Table 6**. All cut and fill work for the shear key excavation would occur below MHHW, though the forebay itself is not tidally connected. The shear key excavation would remove and replace an equal volume of fill over the same area and would improve material and stability to existing conditions.

2.6.3 Add Recreation and Public Access

Three recreation and public access features would be added. All of these features would be placed above MHHW.

- In the first, a viewing area including a platform, informational signage, and benches would be constructed within the City of Mountain View's Shoreline Park or near the existing trail on the southern border of Pond A1 near the eastern end of the pond. The viewing platform area would be graded and its surface would be improved, but no elevated structures would be built.
- In the second, a spur trail would be constructed along the improved western levee of Pond A1 to a viewing platform similar to the one described above. It would be placed near the point where the habitat transition zone meets the Pond A1 west levee. The viewing platform would be established

on a somewhat widened section of the existing levee where the benches and interpretive panels can be placed. The height of the levee-top trail from its split with the Bay Trail atop the Coast Casey Forebay levee would be at 14.7 feet elevation NAVD88 to match the elevation of the Bay Trail spine. (Beyond the viewing platform area, the levee top elevation would be at approximately 11 feet NAVD88, as discussed above.) This would provide viewing access to Charleston Slough and Pond A1. Benches and interpretive signage are proposed on both sides of the trail at the A1 western levee viewing platform.

- In the third, a trail along the levee on the eastern and northeastern side of Pond A2W. The trail on the eastern and north-eastern levees of Pond A2W would be approximately 6,440 feet (1.2 miles) long. The surfaces and side slopes of those levees would be maintained for PG&E access and would also open that route for public recreational access, add signage, and include more-frequent maintenance for safety. A viewing platform, similar to the ones described above, would be added at the end of the trail. This area would provide access to views of Pond A2W and the Bay.

2.6.4 Construct Habitat Transition Zones in Ponds A1 and A2W

Habitat transition zones would be constructed in Ponds A1 and A2W inside the southern edges of Ponds A1 and A2W to create transitional habitat between the lower elevation of the pond bottoms and the uplands and levees behind them. Once vegetated, the habitat transition zones would provide habitat for salt marsh harvest mouse and other terrestrial species. They would also provide a gentle slope for dissipation of wave energy and reduction of erosion potential, thereby protecting the closed landfill below Shoreline Park. The transition zone in Pond A1 would extend all the way across the southern border of the pond. In Pond A2W the transition zone would only cross the central portion of the pond's southern border, so that potential future connections with the existing mitigation marshes to the south (the Mountain View mitigation marsh and the Stevens Creek mitigation marsh) would not be precluded. The habitat transition zones would be constructed primarily of upland fill material from off-site projects. Roughly 3,700 linear feet and 3,200 linear feet of transition zone would be established along the inside slope of Ponds A1 and A2W, respectively. The habitat transition zones would have a top elevation of approximately 9 feet NAVD88. The slope of these features in Pond A1 would be varied to provide a range of different slopes including slopes at 10:1, 20:1, 30:1 and 40:1 (h:v). The intent of this variation is to execute a pilot project that would provide observational data about the habitat values, erosion protection, and sea-level rise adaptation that would result from these varying slopes. This approach is proposed as part of the SBSP Restoration Project's commitment to developing and sharing scientific insights to inform not only future phases of this project, but also to develop insights and test hypotheses that have broader application to other projects. In Pond A2W, the slope would be 30:1 (h:v). Estimated fill volumes and areas for the habitat transition zones at the Mountain View Ponds are provided in **Table 5**.

2.6.5 Construct Bird Habitat Islands in Ponds A1 and A2W

Nesting and roosting habitat for shorebirds, terns, and dabbling ducks would be created through the construction of islands in Ponds A1 and A2W. This would include building up to ten islands, with 3 to 5 islands per pond. The islands would be constructed largely of upland fill material from off-site projects. Each island would have a top area of roughly 10,100 square feet, a top elevation of 12.5 feet NAVD88 (roughly 3 feet above MHHW) and side slopes would be approximately 3:1 (h:v). As the ponds transition to marsh, the island habitat would eventually become marsh mounds, which have various ecological benefits as high-tide refugia and as focal points for further sediment aggregation and vegetation formation. Estimated fill volumes and areas for habitat islands at Mountain View Ponds are provided in **Table 5**.

2.6.6 Breach Pond A1 at Two Locations and Pond A2W at Four Locations

These breaches and the associated channels that would be excavated to connect them to the surrounding sloughs would allow tidal flows to enter, sediment to accrete, and vegetation to become established. The two Pond A1 breaches would be at the northwest corner of the pond on the western levee and along the eastern levee into Permanente Creek/Mountain View Slough. Two of the four Pond A2W breaches would be on the western levee into Permanente Creek/Mountain View Slough. The other two breaches would be on the eastern levee into Stevens Creek/Whisman Slough. The specific locations of these breaches would be determined during advanced construction design, but their locations would generally follow the locations of historical slough traces and are also being chosen to minimize the amount of existing fringing marsh through which the channel to connect the breaches to the sloughs must be excavated. The breaches would all have an invert elevation of approximately 2 feet NAVD88 and have approximately 2:1 (h:v) side slopes. The bottom widths would be approximately 60 feet. The length of the channel cut connecting Pond A1 to adjacent Mountain View Slough would be approximately 110 feet. At Pond A2W's western levee, the channel cut through the south breach connecting Pond A2W to Permanente Creek/Mountain View Slough would be approximately 230 feet and through the north breach the channel cut would be approximately 200 feet. On Pond A2W's east levee, the channel cut through the south breach connecting A2W to Stevens Creek/Whisman Slough would be approximately 210 feet long and through the north breach it would be approximately 200 feet long. The two breaches on the eastern levee would be designed such that the top width would be wide enough to span access bridges (described below). Both of the breaches on the eastern side of Pond A2W would be armored on both sides to protect the bridge abutments from future erosion or scour. Estimated cut volumes and areas of breaches and the associated channels are provided in **Table 6**.

2.6.7 Armor the Two Eastern Breaches of Pond A2W and Add Bridges over the Two Breaches

Two single-span precast/prestressed I-girder bridges would be installed to extend over the armored breaches on the eastern levee of Pond A2W and would provide access to existing PG&E utilities. To accommodate the load of maintenance vehicles, bridges would be designed to accommodate a vehicle load of 4,000 pounds. The bridges would consist of pile supported abutments and wing walls at each end that would provide a foundation for the superstructure and would also serve to armor the breaches and prevent further scour and widening. Foundations and wing walls would be cast in place concrete footings supported on top of piles driven into the existing levee and its edges, where it meets the fringing marsh and the pond interior. Each foundation's abutment is estimated to require 8 supporting piles. The total pile count for both bridges is estimated to be 32 piles. The superstructure would be cast-in-place concrete bridge deck on precast/prestressed 2.5 feet deep I-girders. Concrete barriers (Type 732 or similar) would be placed on each side of the bridge. Each bridge would be approximately 60 feet long and 19 feet wide. This length would allow for a minimum of 40 feet channel bottom width through the bridge opening. The bridge deck elevation would be 12.25 feet NAVD88 and the soffit would be at 9 feet NAVD 88 elevation. The dimensions of the fill for abutments and piles are presented in **Table 7**. A trail approximately 15 feet wide with 2-foot wide shoulders on each side with would traverse the top of the bridges.

2.6.8 PG&E Infrastructure Improvement

Phase 2 would elevate the existing PG&E access boardwalks in Pond A2W and construct a new section of boardwalk outside of Pond A1 to connect Pond A2W's outboard levee with the existing boardwalk outside of the Palo Alto Flood Control Basin. All existing boardwalks would be raised a maximum of 4 feet, utilizing the existing boardwalk pillars. The existing boardwalks in Pond A2W are made of wooden planks on a wooden frame that rests on concrete foundations set into the pond bottom. The decking is approximately 6,700 feet long, two to three feet wide, and only intermittently used by PG&E for pedestrian access to the towers. This boardwalk would be removed and replaced with a higher one to retain PG&E access to the towers. The replacement would increase the width of the boardwalk by approximately two feet and thus increase the shaded area of the Bay. The exact amount of added surface area would not exceed 13,500 square feet (0.31 acre). In addition to raising the boardwalk within the pond, a new section of boardwalk would be added to connect the end of the Pond A2W boardwalk with the end of an existing one that lies northwest of Pond A1. The additional boardwalk would be approximately 2,350 feet long and 3 feet wide (7,050 square feet or 0.16 acre). This area the area of new shade added to the bay. The total cross-sectional area of the piles to support this new boardwalk is less than 700 square feet (under 0.15 acre). The total volume of the piles to support the new boardwalk would be approximately 280 cubic yards, of which approximately 186 cubic yards would be below the bay floor (piles must be placed 12 vertical feet below the bay floor), and the remaining 93 cubic yards would be in the water column. The various access points to the boardwalks would be gated to protect against unauthorized human entry and would be designed to exclude terrestrial predators of marsh wildlife species that may use them.

2.6.9 Mountain View Ponds Summary Tables

Table 5 Mountain View Ponds – Estimated Fill Volumes and Areas by Purpose

FILL PURPOSE	VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL FOOTPRINT AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
Coast Casey Forebay Levee Improvement	27,400	12,050	2.3	1.5
Pond A1 West Levee Improvement	89,100	40,320	12.7	8.3
10 Habitat Islands	53,500	40,600	5.1	5.1
Bridge Piles, Abutments	540	100	0.1	0.0
Pond A1 Habitat Transition Zone	77,100	73,480	16.9	15.9
Pond A2W Habitat Transition Zone	80,000	77,120	15.7	15.7
Total	**327,640**	**243,670**	**52.8**	**46.4**

Note: due to rounding, totals may not sum to 100%

AECOM 2016Table 6 Mountain View Ponds - Estimated Cut Volumes and Areas

CUT LOCATION	CUT PURPOSE	CUT (CUBIC YARDS)	CUT BELOW MHHW (CUBIC YARDS)	FOOTPRINT AREA (ACRES)	AREA BELOW HTL/MHHW (ACRES)
Pond A1	Northwest Breach	1,700	990	0.2	0.1
Pond A1	Southeast Breach	1,700	660	0.2	0.1
Pond A2W	Northwest Breach	2,400	660	0.3	0.1
Pond A2W	Southwest Breach	3,000	880	0.4	0.1
Pond A2W	Northeast Breach	1,100	330	0.1	< 0.1
Pond A2W	Southeast Breach	2,200	1,650	0.3	0.2
Subtotal	***Mountain View Pond Breaches***	***12,100***	***5,170***	***1.5***	***0.7***
Pond A1 (Coast Casey Forebay)	Shear Key Excavation	3,100	3,100	0.7	0.7
Totals		**15,200**	**8,270**	**2.2**	**1.3**

Note: due to rounding, totals may not sum to 100%

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Table 7. Mountain View Ponds - A2W Bridge Details

LOCATION	BRIDGE SUPERSTRUCTURE FOOTPRINT (SQARE FEET)	PILE QUANITITY	PILES LENGTH (FEET)	PILE DIAMETER (INCHES)
Pond A2W Northeast Breach	1,131	16	45	14
Pond A2W Southeast Breach	1,131	16	45	14

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2.7 Ravenswood Pond Cluster

The restoration goals for the Ravenswood Ponds are to restore Pond R4 to tidal marsh by connecting it to the Bay through a breach into Ravenswood Slough, to improve Pond R3 as an enhanced managed pond for small shorebirds, including western snowy plover, and to convert Ponds R5 and S5 to enhanced managed ponds for dabbling ducks and other bird guilds. The proposed project includes the breach, four water control structures, a number of other habitat enhancements and flood risk management components, and additional public access and recreation features.

Proposed project activities at the Ravenswood Ponds include the following, all of which are illustrated in **Figure 3d**. Estimated cut volumes and areas are summarized in **Table 8**. Estimated fill volumes and areas are summarized in **Table 9**.

2.7.1 Convert Ponds R3, R5 and S5 to Enhanced Managed Ponds and Install Water Control Structures

There would be four water control structures installed within and between these ponds to allow them to be managed to achieve different habitat goals. First, a water control structure would be installed into the eastern levee of Pond R3 where the historical slough trace intersects with Ravenswood Slough. This water control structure would allow direct control and management of the water levels in the pond to provide for better water quality, better control over water levels, and improvement of the existing western snowy plover forage habitat in Pond R3. There would also be a channel excavated through the external fringing marsh to connect the water control structure with Ravenswood Slough.

Ponds R5 and S5, which are currently seasonal ponds, would be converted into a single enhanced managed pond through removal or modification of levees within and between the ponds. There would be four water control structures (pipe culverts through levees) installed. One would be installed at the levee between Ponds R4 and R5. Another would be installed between Pond S5 and Flood Slough. A third would be installed between Ponds S5 and R3. The fourth would be installed between Pond R3 and Ravenswood Slough. By providing the means for year-round control of water levels and some control of the salinities and other aspects of water quality in the ponds, these structures would allow for separate control of different types of managed pond habitat for various guilds of birds by allowing different bottom depths and elevations.

The water control structures would be circular high density polyethylene (HDPE) pipes (culverts). The number of pipes, pipe size, and invert elevations of the water control structures that would be installed at proposed locations around the project site, are listed in **Table 10**. The water control structures would be gated at both ends to allow two-way control over flows in or out of each pond.

To support loads from the control structure gates and access to gate controls by Refuge personnel, bridges would be constructed above each pipe culvert from the proposed or existing levee grade to the end of each pipe. The bridge decks would be pre-cast/pre-stressed concrete voided slab decks on pile caps supported by driven concrete piles. Bridge decks would include cable railing on each side of the deck for safety.

2.7.2 Improve Levees and Fill in the All-American Canal

Approximately 4,700 feet of improved levee would be constructed on existing levees and would fill in the All-American Canal (AAC). The berm-like levees along both sides of the AAC would be raised and strengthened, and the AAC would be filled in, creating a single levee. Constructing this improved levee would replace the de facto flood risk protection currently provided by the outboard levees on Pond R4. Improvements at the western end of the AAC would extend north along the Ponds R4/R5 border and south along the R3/S5 border to isolate Ponds R5 and S5 from the others so that they can be managed separately. Most of the material for the improvements would come from off-site sources, though some may be from local cut activities. The improved levee would consist of a 60-foot-wide crest with side slopes at approximately 3.5:1 (h:v) on the north side and 4.5:1 (h:v) on the south side. The crest of the levee would be at elevation 11 feet NAVD88. The improved levee would become wider as it transitions to meet the sections of improved levee that would form the eastern borders of Ponds R5 and S5 and would also be the basis of a public access trail and viewing platform. The AAC would not have a trail on top, but would allow access by vehicles for maintenance and monitoring activities. A gate would be placed at the viewing platform area to restrict access.

2.7.3 Construct Two Habitat Transition Zones in Pond R4

Construct and vegetate one habitat transition zone in the western side of Pond R4, up against the Bedwell Bayfront Park (a closed landfill) border. This habitat transition zones would be approximately 2,500 feet long. Construct and vegetate a second habitat transition zones to extend northward into Pond R4 from the improved AAC levees. This second habitat transition zones would be approximately 5,100 linear feet long. The habitat transition zones would be at an elevation of 9 feet NAVD88 along the levees or the high ground of the park and have side slopes of 30:1 (h:v) with varying steeper slopes at end transitions. The transition zones would be constructed primarily of upland fill material brought in from off-site locations.

2.7.4 Remove Internal Levees in Ponds R5 and S5

As part of converting Ponds R5 and S5 to managed ponds, four water control structures (discussed above) would be installed within and between these ponds. To further enhance the habitat, most of the levee between Ponds R5 and S5 would be removed, and the levee within Pond S5 (i.e., between the forebay and the main part of Pond S5) would be removed to an elevation of 4.5 feet NAVD88 to match the surrounding pond bottoms. This would increase the area available for aquatic habitat within the ponds. As discussed below, a portion of the existing internal levee between Ponds R5 and

S5 would be left in place and resurfaced to improve its suitability for use as a habitat island for bird roosting and nesting.

2.7.5 Establish a Habitat Island between Ponds R5 and S5

A habitat island would be created between Ponds R5 and S5 from the remnants of the internal levee currently between those ponds. The island would be modified to optimize its usefulness as upland wildlife habitat. The habitat island surface would be approximately 1.77 acres with a relatively flat top at elevation 9 feet NAVD88 (above the MHHW elevation) with side slopes of 2:1 (h:v) down to the adjacent pond bottom. Sand, shell, or other suitable topping would be added to the island to enhance its usefulness for the birds that would use it and to help control invasive vegetation.

2.7.6 Excavate a Pilot Channel in Pond R4

Portions of the bottom of Pond R4 would be modified to direct the new tidal flows (introduced by the levee breach) into the interior of the pond by creating and extending pilot channels from portions of former slough traces. The proposed pilot channels would together be roughly 2,890 feet long and would be excavated through the existing pond bed. The invert elevation would be at 2 feet NAVD88 to roughly match the invert elevation of the existing channels within Pond R4. The bottom width of the channel cut would be roughly 50 feet wide with side slopes of 2:1 (h:v). The moved material would be used to enhance levees, and construct habitat transition zones and ditch blocks.

2.7.7 Build Ditch Blocks in Pond R4

Build ditch blocks in the existing borrow ditches west of the R4 breach to direct tidal flows into the interior of the ponds. The material for the ditch blocks would be from a combination of imported fill material and local material from levee lowering or breaches.

2.7.8 Add Recreation and Public Access Features

A trail along the improved eastern levees of Ponds R5 and S5 would be constructed and linked to the existing trails outside of these ponds. As shown in **Figure 3d**, the northern end would connect to the existing trail in Bedwell Bayfront Park; the southern end would connect to the Bay Trail spine. This trail would be approximately 2,750 feet long and 10 feet wide with 2 feet of shoulder on each side. Surfacing materials would be decomposed granite with timber or concrete edging. The proposed water control structures between Ponds R4 and R5 and between Ponds R3 and S5 would be set low enough to allow trail construction over them. This trail would necessitate a break in the new fence that borders the northern side of the Bay Trail, a gate, and appropriate signage along the southern border of Ponds R5 and S5 where it leaves the Refuge and connects to the Bay Trail. The trail would be bordered on both sides with low symbolic deterrent fencing (2- or 3-foot high posts connected by chains, cables, or rails) to provide a visual reminder to trail users to stay on the trail and not enter the restoration areas. Total length of fencing to be installed would be approximately 5,160 feet.

A viewing platform would be constructed near the central point of this trail, at the junction with the improved AAC levee. The viewing platform would have benches and interpretive signage on pedestals and/or information panels. This would improve public access and supplement the visual benefits the trail and the restoration project would make available. As shown in **Figure 3d**, benches would be located near the exhibit's signage. This action would allow the public to enhance the recreational experiences at the relatively high-use Bedwell Bayfront Park in Menlo Park by incorporating the interpretive opportunities and providing a view of all three of the Refuge's restoration pond types at these ponds.

2.7.9 Lower Levee in the Northwest Corner of Pond R4

Approximately 960 linear feet of the northwestern levee on the edge of Pond R4 would be lowered to MHHW. This modification would improve habitat connectivity between Pond R4 and Greco Island/West Point Slough, and it would also provide high-tide refugia for salt marsh harvest mouse and other species. The new top elevation would be at approximately 8 feet NAVD88 and side slopes would be approximately 2:1 (h:v). Material from the lowered levee would be used to raise levees or construct habitat transition zones.

2.7.10 Breach Pond R4

Breach the northeastern corner of Pond R4 to open the pond to tidal flows from Ravenswood Slough. Material from the breached levee would be used to build ditch blocks to direct flows through the borrow ditch to the historic slough trace and into the pond's center; material could also be used to improve levees or construct habitat transition zones. The bottom width of this breach would be approximately 200 feet, with an invert elevation of 2 feet NAVD88 and with side slopes of 3:1 (h:v). The length of the excavated channel to connect the breach to Ravenswood Slough through the existing fringe tidal marsh would be approximately 470 feet.

2.7.11 Fence the Southern Border of Ponds R3 and S5

A low (3-foot-high) chain-link fence approximately 8,000 feet in length would be installed inside the Refuge property and adjacent to the existing Cargill pipeline property, north of the Bay Trail. The purpose of the fence is to deter people and their pets from leaving the trail and entering the restored habitat there. The fence would also help keep trash from blowing into the ponds and keep chicks from straying from Pond R3 onto the paved trail and roadway to the south.

2.7.12 Ravenswood Ponds Summary Tables

Table 8. Ravenswood Ponds - Estimated Cut Volumes and Areas

CUT LOCATION	CUT PURPOSE	CUT (CUBIC YARDS)	CUT BELOW MHHW (CUBIC YARDS)	AREA (ACRES)	AREA BELOW MHHW (ACRES)
Pond S5	Internal Levee Removal	2,500	1,000	0.5	0.2
Ponds R5/S5	north internal levee removal	4,100	3,900	1.5	0.9
Ponds R5/S5	South Internal Levee Removal	4,100	2,800	1.2	0.6
Subtotal	Levee Removal	10,700	7,700	3.2	1.7
Pond R4	Northwest Levee lowering	2,100	0	0.9	0.3
Pond R4	Northeast Breach	13,300	10,600	2.1	2.0
Pond R4	Pilot Channel	16,000	16,000	4.1	4.1
Pond R3	Water Control Structure	1,000	1,000	0.2	0.2
Totals		**43,100**	**35,300**	**10.4**	**8.2**

Note: due to rounding, totals may not sum to 100%

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Table 9 Ravenswood Ponds - Estimated Fill Volumes and Areas by Purpose

FILL PURPOSE	VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL FOOTPRINT AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
R5/S5 East Levee and All American Canal Levee Improvement	182,400	46,090	17.5	7.0
All American Canal HTZ	76,300	69,460	14.9	12.0
Bedwell Bayfront Park HTZ	50,200	47,240	9.1	8.3
Ditch Block west of R4 Breach	1,000	1,000	0.3	0.3
Water Control Structures	400	400	0.2	0.2
Total	**310,300**	**164,190**	**41.9**	**27.8**

Note: due to rounding, totals may not sum to 100%

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Table 10. Ravenswood Ponds - Water Control Structures

LOCATION	PIPE QUANTITY	INSIDE DIAMETER (INCHES)	PIPE LENGTH (FEET)	INVERT ELEVATION NAVD88 (FEET)	PILE QUANTITY*	TOTAL AREA** (SQUARE FEET)
Pond R5/S5 to Flood Slough	2	48	183	2	8	3,790
Pond R5/S5 to Pond R4	2	48	78	3.5	8	1,650
Pond R5/S5 to Pond R3	1	48	67	4.5	8	690
Pond R3 to Ravenswood Slough	1	48	62	2	8	640
Total	**6**	**N/a**	**390**	**n/a**	**32**	**6,770**

Notes:

*All piles are 16-inch diameter and approximately 20 feet long.

**Total Area includes pipe-culvert, gates and bridges at each control structure

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2.8 South Bay Salt Pond Restoration Project Phase 2 Summary Tables

Table 11 through **Table 15** summarizes the lengths, areas, and volumes of the proposed actions for the SBSP Phase 2 project. For ease of reference, the fill and cut estimates are provided by location (i.e., pond cluster) in one set of tables and by purpose in another set of tables. The cut information in **Table 11** and **Table 12** represent the same volumes and areas presented two different ways, likewise for the fill volumes and areas summarized in **Table 13** and **Table 14**. Additionally, each of these tables contains the total areas and volumes at each location, or for each purpose, and then parses those areas or volumes into the amounts above and below MHHW. This split of the totals is intended to help the regulatory agencies understand the portion of these totals that would be placed into intertidal or subtidal habitat versus that placed into uplands. As noted above, MHHW is not the regulatory boundary of waters of the United States or of the State of California, but they are ecologically appropriate boundaries.

The new public access features would be placed onto existing ground or onto levees that would be enhanced regardless, so these features do not have new cut or fill areas or volumes or otherwise affect habitats for species covered in this BA. The areas and volumes of fill from PG&E infrastructure activities are shown in **Table 15**.

Table 11. SBSP Phase 2 - Total Cut Volumes and Areas by Location

POND CLUSTER	CUT (CUBIC YARDS)	CUT BELOW MHHW (CUBIC YARDS)	AREA (ACRES)	AREA BELOW MHHW (ACRES)
Island Ponds	25,500	7,187	6.4	2.4
A8 Ponds	0	0	0	0
Mountain View Ponds	15,200	8,270	2.2	1.3
Ravenswood Ponds	43,100	35,300	10.4	8.2
Totals	**83,800**	**50,757**	**19.0**	**12.0**

Note: due to rounding, totals may not sum to 100%

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Table 12. SBSP Phase 2 - Total Cut Volumes and Areas by Purpose

PURPOSE	CUT (CUBIC YARDS)	CUT BELOW HTL/MHHW (CUBIC YARDS)	AREA (ACRES)	AREA BELOW HTL/MHHW (ACRES)
Levee Removal	19,600	10,667	5.7	2.7
Levee Lowering	14,800	2,630	4.2	1.3
Levee Breaches, Excavations and Pilot Channels	49,400	37,460	9.1	8.0
Totals	**83,800**	**50,757**	**19.0**	**12.0**

Note: due to rounding, totals may not sum to 100%

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Table 13. SBSP Phase 2 - Total Fill Volumes and Areas by Location

POND CLUSTER	NET FILL (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
Island Ponds	25,500	25,500	6.6	6.6
A8 Ponds	179,000	174,000	24.6	23.9
Mountain View Ponds	327,640	243,670	52.8	46.4
Ravenswood Ponds	310,300	164,190	41.9	27.8
Totals	**842,440**	**607,360**	**125.9**	**104.8**

Note: due to rounding, totals may not sum to 100%

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Table 14. SBSP Phase 2 Total Fill Volumes and Areas by Purpose

FILL PURPOSE	NET FILL (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
Levee Improvement	298,900	98,460	32.5	16.8
Habitat Island	53,500	40,600	5.1	5.1
Habitat Transition Zone	462,600	441,300	81.1	75.9
Ditch Blocks & Placement of Re-used Levee Material	26,500	26,500	6.9	6.9
Structures (Water Control and Bridges)	940	500	0.2	0.2
Totals	**842,440**	**607,360**	**125.9**	**104.9**

Note: due to rounding, totals may not sum to 100%

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Table 15. Areas and Volumes of PG&E Infrastructure Actions

ITEM	TOTAL AREA (ACRES)	TOTAL VOLUME (CUBIC YARDS)	AREA BELOW MHHW (ACRES)	VOLUME BELOW MHHW (CUBIC YARDS)
Replace boardwalks in Pond A2W	0.3	187	0.1	37
Add new boardwalk outside of Pond A1	0.2	93	0.1	47
Enlarge concrete tower footings	<0.1	80	<0.1	40
Total	**0.48**	**360**	**0.2**	**124**

Note: due to rounding, totals may not sum to 100%

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2.9 Means, Methods, and Equipment

This section discusses the construction approach at each of the Phase 2 locations. It describes the means and methods of how each component listed above would be implemented, and lists the equipment that would be used to do so. Subsequent sections address details of construction schedules and of the planned operations and maintenance.

A San Francisco Regional Water Quality Control Board (RWQCB) accepted Storm Water Pollution Prevention Plan for the project would be implemented for all project-related activities; appropriate

Best Management Practices (BMPs) would be used for all activities with potential impact on water quality. Water quality monitoring would be undertaken in compliance with a SBSP Restoration Project 401 Certification and Waste Discharge Requirements, once issued by the RWQCB, and the San Francisco Bay RWQCB Basin Plan.

Prior to performing construction activities, areas to be disturbed by construction equipment would be cleared of existing vegetation and disposed off-site.

2.9.1 Island Ponds

At the Island Ponds, the construction approach would include the following details.

2.9.1.1 Construction Access

Primary land access to the Island Ponds would be from the adjacent levees at Ponds A22 and A23. Vehicle and heavy equipment access to these ponds is available from levee roads. An amphibious excavator would be offloaded and floated across Mud Slough. Daily access for crews would be from the Fremont Boulevard exit off of Interstate 880, onto Landing Road, and then onto Coyote Creek Lagoon Trail that connects to the northeast corner of Pond A19 via a small footbridge. Construction crews would typically consist of fewer than a dozen people.

2.9.1.2 Construction Staging Areas

No staging areas are necessary for work at the Island Ponds. Equipment used for construction would stay within the project footprint, and no material would be brought into the Island Ponds.

2.9.1.3 Levee Breach and Channel Excavation

All levee modifications – including adding new breaches, widening an existing breach, and lowering and removing levees – would be accomplished by using amphibious excavators, and other conventional construction equipment. Movement of the excavator between the perimeter levees of Ponds A19 and A20 would occur at low tide utilizing mats. The excavators would work from the existing levees.

2.9.1.4 Ditch Blocks

Ditch blocks would be formed by placing material from other onsite activities into the existing internal borrow ditches and compacting it. Excavators would be used for placement and initial compaction, and a vibratory hand tamper or a roller would be used for compaction.

2.9.1.5 Construction Equipment

Construction equipment would include excavators (amphibious and/or terrestrial, fitted with long-reach attachments), a barge (for fueling and possibly for access to the project site), low-bed truck, other common construction equipment, skiff, and pickup vehicles for transportation in and out of the project site.

2.9.2 Alviso-A8 Pond Cluster

At the A8 Ponds, the construction approach would include the following details.

2.9.2.1 Construction Access

Access to the A8 Ponds would be from Gold Street or America Center Road near the southeast corner of Pond A8S and the levee crests along the perimeter levees. The ponds would be accessed by haul trucks using existing roadways and levee roads. No work would occur on the internal pond levees. Construction crews would typically consist of fewer than a dozen people. The existing levees are known to be capable of handling heavy construction equipment and trucks carrying dirt because the SCVWD uses these access roads to import material dredged from creek channels in Santa Clara County.

2.9.2.2 Construction Staging Areas

A staging area would be established for equipment and material stockpiling. The location would be within the hard-pack access and turnaround areas that exist within the landfill access areas or within the construction area along the southern border of Pond A8S.

2.9.2.3 Habitat Transition Zones

The habitat transition zones would be constructed by placing fill material along the slopes and into the pond bottom. The work would proceed from the existing levee roads outward into the pond. Material would be placed and compacted to approximately 70 percent density to enable vegetation establishment. Slope protection would be maintained by establishment of native vegetation. Hydroseeding or other seeding method with a native plant mix, development of a planting scheme, and invasive plant control would aid in establishing desirable vegetative habitat.

2.9.2.4 Construction Equipment

Construction equipment would include haul trucks, bulldozers, water trucks, compaction rollers, other construction equipment, and vehicles for transportation in and out of the project site.

2.9.3 Alviso-Mountain View Pond Cluster

At the Mountain View Ponds, the construction approach would include the following details.

2.9.3.1 Construction Access

Primary access to the project site would be from U.S. 101 via exits for major arterials. The first of those would be to the Pond A1 portion of the project using the North San Antonio Road exit, continuing north to Terminal Boulevard and then heading east onto the levee road between the Shoreline Park sailing lake and the Coast Casey Forebay. From there, the work areas along the Coast Casey Forebay, Charleston Slough, and Pond A1 would be accessible. A secondary route is available along the levee road that forms the western boundary of the Coast Casey Forebay. To reach the work areas at Pond A2W, the Rengstorff Avenue North exit would be used to leave U.S. 101 and head north, after which, Amphitheater Parkway, North Shoreline Boulevard, and Crittenden Lane would be used to reach the large levees and existing access roads around west of Stevens Creek and the northeastern corner of Shoreline Park.

The exact route(s) and timing used for material delivery are subject to modification due to City of Mountain View requirements for traffic control, Shoreline Park activities, and burrowing owl protection. The SBSP Restoration Project will develop the final haul routes in consultation with the City of Mountain View's traffic engineers to minimize potential traffic impacts.

Construction crews would typically consist of five to ten people. The pond cluster would likely be accessed by construction crews from U.S. 101, after which various arterial, collectors, and local streets provide access to Mountain View Shoreline Park and the ponds beyond it. Heavy vehicles would avoid crossing structures in the levees if the vehicle exceeds the weight-bearing capacity. If this is not possible, engineer-approved precautions would be taken to avoid damaging the structure.

2.9.3.2 Construction Staging Areas

Construction staging areas will be established within Mountain View Shoreline Park at locations to be determined in coordination with City of Mountain View. The staging areas will be adjacent to the southern borders of Ponds A1 and A2W in upland areas alongside existing roads and trails.

2.9.3.3 Levee Improvement

Levee improvements along the western side of Pond A1, the eastern side of Pond A2W, and the Coast Casey Forebay levee would require clearing of vegetation, debris, and grooving. Fill would be placed in approximately 6-inch-thick lifts and compacted either through a vibratory hand tamper or a roller to achieve approximately 90 percent compaction for the A1 west levee and 95 percent compaction for the Coast Casey Forebay levee. Some material would be largely sourced from off-site excavation projects. On-site sources would include excavated material from levee lowering, channel excavation, and breaching activities. After levee improvement operations, the A1 levee north of the viewing platform would be hydroseeded with a native plant mix.

Levee crests destined for trail access would be finished with an approximately 12-inch-thick layer of aggregate base to provide all weather access and to be compliant with the Architectural Barriers Act (ABA) on federal lands and the Americans with Disabilities Act (ADA) where the trails are part of the Bay Trail system or where project partners (e.g., city, county, or state agency) have compliance obligations.

2.9.3.4 Habitat Islands

The material for the habitat islands would be placed by long-reach excavators working from the existing levees or by using an excavator and small barges in the pond to move and place material. Material would be delivered by haul trucks to the working locations. A water truck will be used for dust control of delivered material, if necessary. An excavator would place and moderately compact material in the pond. The material would be piled in layers and compacted by a vibratory tamper or a roller. The top surface of the proposed habitat islands would be treated with a combination of rock, shell, and sand; current designs include a 12-inch-thick sand layer underlain by 6-inch-thick crushed rock to cover any surficial cracks and prevent weed establishment. The sand layer would be covered with a 4-inch-thick layer of oyster shells, or similar appropriate material, to provide a barren land sight that is typically preferred by some nesting birds.

2.9.3.5 Habitat Transition Zones

Pond A1's habitat transition zone would be constructed by placing fill material along the existing levee side slopes and into the pond bottoms at a range of different side slopes including 10:1, 20:1, 30:1 and 40:1 (h:v). Pond A2W habitat transition zone would be constructed with 30:1 (h:v) a side slope. The work would proceed from the existing levee roads outward into the pond. These features would be compacted to approximately 70 percent dry density to enable vegetation establishment. Slope protection would be maintained by establishment of native vegetation. Hydroseeding or other seeding method with a native plant mix, development of a planting scheme, and invasive plant control would aid in establishing desirable vegetative habitat.

2.9.3.6 PG&E Boardwalk and Tower Footing Improvements and Additions

The new boardwalks would be placed within the existing PG&E right-of-way (ROW), adjacent to the towers. All new sections of boardwalk would be built approximately 4 feet above the height of the existing boardwalk. The boardwalk spans would be 3-foot-wide sections and would include a double handrail. The boardwalk spans would be built in 20-foot-long sections supported by 4-inch by 4-inch vertical plastic lumber posts, known as support footings, which would be spaced 10 feet apart along the boardwalk spans. The boardwalks would parallel the transmission line towers and would include additional lateral boardwalks, which would be used to access each tower from the main boardwalk. Boardwalk work would be completed first for worker safety and to more efficiently transport materials and tools to the towers. Following the completion of boardwalk replacement and construction, work would be performed on the footings of the towers in Pond A2W. Multiple towers will be worked at the same time from each side of the boardwalks. All structures would require adding additional concrete to existing concrete foundations to a greater height of up to 4 feet above existing structure footing. Construction details for this work are provided in Appendix A.

2.9.3.7 Levee Breach and Channel Excavation

Breaching would be accomplished from the levee crests using excavators and hauling material to locations receiving fill for beneficial re-use in the project area. The breach at the northwest corner of Pond A1 would be at the location of the current water intake gate, which would be removed as part of this breach activity.

2.9.3.8 Levee Bridges

The two breaches in the east levee of Pond A2W would be bridged to provide continued PG&E maintenance access and to support a public access trail. Existing levees at connection points would be raised from approximately 10 feet NAVD88 to approximately 12.5 feet NAVD88. These bridges would include prefabricated I-girder superstructure with a cast in place concrete bridge deck on precast 2.5 feet deep concrete I-girders set on seat-type abutments with wing walls that would be cast on top of driven concrete piles. Installation of the abutment foundations would require vibratory and/or impact driving to install concrete piles, installing and dewatering cofferdams at each abutment location, setting foundation forms, and pouring concrete. Support piles at each abutment would be 14-inch diameter pre-cast concrete piles approximately 45 feet in length. Eight piles at each of four abutment footings would be driven. The total count for piles driven to support both bridges would be 32. Piles would be driven using a vibratory and/or impact hammer.

2.9.3.9 Dewatering

Armoring and bridging of breaches on the east levee of Pond A2W would require dry conditions. Therefore, installation of cofferdams at the breach and bridge locations would facilitate the construction of concrete abutments and wing walls. During cofferdam dewatering, pumped water would be managed in accordance with the 2007 SBSP Program FEIS/R and 2016 SBSP Phase 2 Mitigation Measure 3.4-5a. The language from this Mitigation Measure follows.

SBSP Mitigation Measure 3.4-5a: Stormwater Pollution Prevention Plan.

This mitigates potential impacts due to construction related-activities and maintenance activities. The Project sponsors will obtain authorization from the RWQCB prior to beginning construction. As part of this application, the Project sponsors will prepare a Stormwater Pollution Prevention Plan (SWPPP) and require all construction contractors to implement BMPs identified in the SWPPP for controlling soil erosion and discharges of other construction-related contaminants. Routine monitoring and inspection of BMPs will be conducted to ensure that the quality of stormwater discharges is in compliance with the permit.

BMPs that will appear in the SWPPP include:

- Soil stabilization measures, such as preservation of existing vegetation and use of mulch or temporary plantings to minimize soil disturbance;
- Sediment control measures to prevent disturbed soils from entering waterways;
- Tracking control measures to reduce sediments that leave the construction site on vehicle or equipment tires;
- Non-stormwater discharge control measures, such as monitoring water quality of dewatering operations and hazardous material delivery, storage, and emergency spill response requirements, and measures by the Project sponsors to ensure that soil-excavation and movement activities are conducted in accordance with standard BMPs regarding excavation and dredging of bay muds as outlined in San Francisco Bay Conservation and Development Commission's bay dredge guidance documents. These include excavating channels during low tide; using dredge equipment, such as sealing clamshell buckets, designed to minimize escape of the fine grained materials; and testing dredge materials for contaminants.

The contractor will select specific BMPs from each area, with Project sponsor approval, on a site-specific basis. The construction general contractor will ensure that the BMPs are implemented as appropriate throughout the duration of construction and will be responsible for subcontractor compliance with the SWPPP requirements.

Other impacts due to construction-related and maintenance activities can be mitigated by appropriate additions to stormwater pollution prevention plans, including a plan for safe refueling of vehicles and spill containment plans. An appropriate hazardous materials management plan will be developed for any activity that involves handling, transport or removal of hazardous materials.

2.9.3.10 Trails, Viewing Platforms, Signs, and Benches

All rebuilt trails on existing levees that would be raised or modified as part of this project would be resurfaced with decomposed granite.

A new trail would be built on a portion of the raised and improved Pond A1 west levee. A new trail would also be built on the eastern levee of Pond A2W, which would not be raised but which would be graded and filled in places as needed to make the levee top suitable for a trail. Eroded or uneven surfaces on these levees would be regraded for ADA and ABA compliance. Surfacing materials would be decomposed granite with timber or concrete edging. These materials would be placed with dump trucks and bulldozers.

The new viewing platforms would not be elevated above the levees or existing land on which they would be placed, though the A1 west levee platform would involve local levee widening to accommodate the added space required. The viewing platforms would be graded and surfaced to meet ABD and ADA standards and would have a visual appearance matching nearby conditions. The main features at the platforms would be benches and signs or panels that provide site information to the public. These features would be constructed of metal and wood and placed on cast-in-place concrete footings. The footings would be dug with an auger attachment on a bobcat. Concrete would be imported by concrete truck and the footings would be cast-in-place. The signage at the platforms would be mounted on pedestals, and one or more benches would be located near each sign or panel.

2.9.3.11 Construction Equipment

Construction would be accomplished using conventional construction equipment including excavators, bulldozers, dump trucks, compaction rollers, water tankers, refueling tanks, pile-driving equipment, pumps, sheet piles, cranes, barges, skiffs, paving equipment, and pickup vehicles for transportation in and out of the project site. Helicopters may be needed in areas where new PG&E boardwalks are constructed. Temporary fill would also be used at staging locations if required. Fill material would be transported to the project area by haul trucks.

2.9.4 Ravenswood Pond Cluster

At the Ravenswood Ponds, the construction approach would include the following details.

2.9.4.1 Construction Access

Ravenswood Ponds would be primarily accessed from the Marsh Road exit on U.S. 101 via the entrance to the City of Menlo Park’s Bedwell Bayfront Park. The USFWS has an access easement with the city for this purpose. Alternate access to the southern edge of Pond R3 is possible from the paved bicycle path/hiking trail just north of SR 84. The details of this access would be developed in coordination with the City of Menlo Park.

The construction areas in and around the ponds themselves would be accessed via existing trails in Bedwell Bayfront Park and on the Refuge levee crests. The USFWS Refuge staff drive on the levees for maintenance, cleanup, and other management purposes, and it is assumed that the existing levees are capable of handling heavy construction equipment. Ponds R4, R5, and S5 can be accessed via existing trails on the edge of Bayfront Park and the outboard perimeter levee in Ponds

R3 and R4. The crests of the berms on either side of the AAC or the levee around the perimeter of Pond R4 would be used to access various construction areas in Ponds R3 and R4.

If conditions warrant, levee improvements, including the widening of the crest to provide adequate pathway for construction equipment, would be undertaken. Heavy vehicles would avoid crossing structures in the levees if the vehicle exceeds the weight-bearing capacity of a structure. If this is not possible, engineer-approved precautions would be taken to avoid damaging the structure.

2.9.4.2 Construction Staging Areas

Staging areas would be established for equipment and material storage within the Refuge boundaries. These areas may be on existing levees or in areas that would be filled as part of the Phase 2 actions later in the project. Material staging areas would not be located within the City of Menlo Park's Bedwell Bayfront Park.

2.9.4.3 Dewatering

Construction could occur in the wet or the dry. If the contractor decides to perform construction in the dry, some localized dewatering would be required. Dewatering of pond bottom would be accomplished by evaporating the pond beds to provide access to excavate pilot channels. Limited, local dewatering using portable, generator-powered pumps would likely take place during the installation of water control structures. Pumped water would be discharged per the 2007 SBSP Program FEIS/R and 2016 SBSP Phase 2 FEIS/R Mitigation Measure 3.4-5a.

2.9.4.4 Demolition of Existing Water Control Structures

Six existing water control structures in the Ravenswood Ponds would be removed. These remnant features of the former salt production infrastructure would be removed during construction. All associated support structures would be demolished and disposed off-site or recycled as appropriate.

2.9.4.5 Water Control Structures

The four water control structures would be placed into trenches cut by excavators and/or backhoes. To reduce the corrosion concerns typically expected in brackish water and to allow for management of pond habitat, solid-wall HDPE pipes would be used. Pipe bridges would be built over both ends of each structure to allow maintenance and operations access. The pipe bridges would be built pre-cast/pre-stressed concrete voided slab decks on pile caps, supported on concrete driven piles. Pile installation methods would include auguring, casting in place, and vibratory or impact driving, depending on seasonality of sensitive wildlife species nearby.

The water control structure connecting Flood Slough to the Pond S5 forebay would be the most involved installment because a portion of the existing roadway entrance into Bedwell Bayfront Park would have to be removed to allow access to the ground below it.

2.9.4.6 Habitat Transition Zones

The habitat transition zones would be constructed by placing fill material along the existing levee side slopes and into the pond bottoms. The work would proceed from the existing levees outward into the pond. These features would be compacted to approximately 70 percent density to enable vegetation establishment. Slope protection would be maintained by establishment of native vegetation. Hydroseeding or other seeding method with a native plant mix, development of a planting scheme, and invasive plant control would aid in establishing desirable vegetative habitat.

2.9.4.7 Levee Improvements

Levee improvements at the AAC would consist of preparing the subgrade to receive additional fill material by clearing vegetation, debris, and grooving. Fill would be placed in approximately 6 inch-thick lifts and compacted either through a vibratory hand tamper or a roller to achieve approximately 90 percent compaction. Borrow material would be sourced on-site from levee lowering at Pond R4, internal levee removal at Ponds R5 and S5, and pilot channel excavation, but most would be from off-site upland excavation projects.

2.9.4.8 Levee Removal

Earth moving machinery including an excavator and loader would be used to remove most of the levees within and between Ponds R5 and S5. Removed material would be re-used on site to improve levees, fill borrow ditches, construct ditch blocks, or to construct habitat transition zones.

Portions of the internal levees between and within Ponds R5 and S5, with lengths of approximately 880 feet at the northern segment of the levee separating R5 from S5, 530 feet at the southern segment of that same levee, and at the S5 internal levee approximately 370 feet, would be removed (i.e., lowered to match the existing pond bottom elevation of about 4.5 feet NAVD88). This activity would also use an excavator and loader. Removed material would be re-used to on site to improve levees, fill borrow ditches in Pond R4, or to construct habitat transition zones.

2.9.4.9 Pilot Channel Excavation

Existing soil conditions at the R4 pond bottom are likely to be too soft to support vehicles or heavy equipment. Temporary mats with gravel cover would be deployed at the pond bottom to create a firm surface that can handle heavy equipment such as an excavator, loader, or mini-dozer to access locations where pilot channels are to be established. Alternatively, amphibious equipment such as an aquatic excavator would be used to excavate in the wet to designed depths. It is likely that removed material would be unsuitable to be used as levee fill material and would instead be used to fill borrow ditches within Pond R4 or as fill for habitat transition zones.

2.9.4.10 Ditch Blocks

Ditch blocks would be formed by placing material from other onsite activities into the existing internal borrow ditches and compacting it. Excavators would be used for placement and initial compaction of material, and a vibratory hand tamper or a roller would be used for compaction.

2.9.4.11 Levee Lowering or Removal

Levee lowering at the northwest corner of Pond R4 would be accomplished by using an excavator and loader and hauling the removed material to fill borrow ditches in Pond R4 or to construct habitat transition zones. Levee lowering at Pond R4 would remain at elevations above the MHHW until construction activities within the pond that need to be performed in the dry are complete. After construction operations within the ponds are complete, these levees would be lowered to approximately 8 feet NAVD88. This would cause levee overtopping, levee erosion and allow for improved hydraulic and habitat connectivity.

2.9.4.12 Habitat Island

Habitat islands would be cleared, grubbed and fine graded before surface enhancements are installed. The expected treatment for the top surface of the island is a 12-inch-thick sand layer underlain by a 6-inch-thick crushed rock to minimize weed establishment. The sand layer would be mixed with Bay mud to prevent formation of cracks. The sand layer would be covered with 4-inch-thick layer of oyster shells, or similar appropriate material, to provide a barren land site that is typically preferred by nesting birds. Other combinations of rock, sand, dirt, or other materials may be used as available. These materials would be brought in and placed prior to removal of the portions of the levee to be breached.

2.9.4.13 Trail, Viewing Platform, Signs, and Benches

The 2,750-foot trail on the eastern border of Ponds R5 and S5 would be at least 10 feet wide with 2-foot shoulders on each side and would be built on the improved levees described above. Erosion or uneven surfaces on existing levees would be regraded for compliance with the ABA on federal lands and the ADA elsewhere. Levees would be graded and compacted. Geotextile fabric would be laid out and gravel imported and compacted in place. Quarry fines would then be compacted over the gravel with a smooth drum compactor to create an accessible surface.

The new viewing platform would not be elevated above the levee or existing land on which it would be placed. There would be local levee widening to accommodate the added space required. The viewing platforms would be graded and surfaced to meet ABD and ADA standards and would have a visual appearance matching nearby conditions. The main features at the platforms would be benches and signs or panels that provide site information to the public. These features would be constructed of metal and wood and placed on cast-in-place concrete footings. The footings would be dug with an auger attachment on a bobcat. Concrete would be imported by concrete truck and the footings would be cast-in-place. The signage at the platforms would be mounted on pedestals, and one or more benches would be located near each sign or panel.

2.9.4.14 Levee Breach and Channel Excavation

The levee breaching and associated excavation of a channel to connect to Ravenswood Slough would be accomplished from levee crests using long-reach excavators and hauling material using trucks to on-site locations receiving fill for beneficial re-use.

2.9.4.15 Construction Equipment

Excavators, bulldozers, amphibious equipment (e.g., an aquatic excavator), dump trucks, compaction rollers or vibratory plates, a water tanker, pumps, sheet piles, refueling tanks, and pickup vehicles for transportation in and out of the project site would be used during construction. Depending on the soil conditions within the ponds, temporary heavy equipment mats or wooden mats with gravel cover would be employed to provide access and establish working conditions to excavate pilot channels at the pond bottom. Temporary fill would also be used at staging locations if required. Upland fill material would be transported to the project area by trucks.

2.10 Construction Schedule and Sequence

The following section describes the general sequence, timing, and duration of activities at each of the pond clusters. First, however, it is useful to provide a brief discussion of the construction timing as it would be affected by species-specific work windows.

2.10.1 Species-specific Construction Timing Considerations

At all four pond clusters, there are certain special-status species regulated by USFWS, NMFS, or CDFW that may be affected by construction activities. The presence of these species may limit construction activities or require certain avoidance and minimization measures. The pond-cluster-specific special-status species, as well as the limits and requirements for each species and their habitats, are addressed in the conservation measures of the SBSP Restoration Project's Programmatic and Phase 1 EIS/R and permitting documents. These include the BOs from NMFS and USFWS, the Clean Water Act Section 404 and 401 permits from the USACE and the RWQCB respectively, the BCDC permit, and others. This overview information is provided here as part of the project designs to help frame the construction sequences that follow. The timing considerations below will be incorporated into detailed designs and project planning to reduce the overall potential for adverse impacts and the need for mitigation.

- Bird nesting: Regulatory work windows for bird nesting typically run from February 1 through September 15. Work occurring within this window would implement approved avoidance and minimization measures including the presence of an approved biological monitor and preconstruction surveys.
- CCC steelhead migration: Activities that may affect upstream migration of adults or downstream migration of juveniles would be avoided to the maximum extent practicable. In-water work that has potential to impact CCC steelhead from December through February (adult upstream migration period) and from April through June (juvenile downstream migration period) would be avoided to the maximum extent practicable. If in-channel work were to be performed during these periods, fish exclusion methods may be implemented, including timing work during low tide cycles to avoid or minimize potential in-water impacts. If the use of work windows is applicable, the NMFS acceptable work windows for CCC steelhead are June through November.
- Longfin smelt and green sturgeon: There is potential for these species to be present year-round in the San Francisco Bay, therefore seasonal avoidance is not possible.

2.10.2 Island Ponds

In each pond, the construction scenario would likely initiate levee removal from the farthest end of the construction access point along the perimeter levees and proceed toward the starting point of the access. The likely order of construction at the Island Ponds would be as follows:

1. Site preparation including clearing and grubbing of debris and vegetation from construction areas.
2. Lower Pond A19 south perimeter levee and widen the existing western breach.

3. Remove Pond A20 east perimeter levee, leaving some high portions.
4. Remove Pond A19 west perimeter levee, leaving some high portions.
5. Lower and make two breaches in Pond A19's north perimeter levee, leaving some high portions.

The construction schedule would be affected by species windows, weather conditions, earthwork quantities, and land disturbance. Construction is expected to begin in 2018. A preliminary estimate shows that construction would likely be completed in approximately 4 months over a single construction season. This estimate assumes that USFWS would permit heavy construction activities to occur during the bird-nesting window using avoidance and minimization measures including the presence and direction of a biological monitor.

2.10.3 A8 Ponds

This part of the project would include:

1. Site preparation including clearing and grubbing of debris and vegetation from construction areas.
2. Placement of imported fill material into the southern corners of the A8 Ponds (**Figure 3b**). This placement may involve brief stockpiling of material along the existing levee roads and bare ground prior to placement and subsequent compaction.
3. Hydroseeding habitat transition zones to establish native vegetation.

The project is anticipated to begin in second half of 2017, depending on the material available for use in the Alviso-A8 Ponds or in other Phase 2 project ponds. If sufficient quantities of material are available, construction of habitat transition zones would take approximately 12 months in 2 construction seasons.

2.10.4 Mountain View Ponds

Construction operations would occur either simultaneously at both ponds, or would proceed in tandem. Earthwork activities would be sequenced such that operations which are more efficient and feasible to perform during the dry season, such as working on levee tops, would be completed first. Levee lowering and breaching along the outer bounds of the ponds that are designed to establish hydraulic connection with adjacent sloughs would be performed after all the internal pond activities are completed. Construction of habitat islands and habitat transition zones would be performed prior to breaching the perimeter levees. Breaching would not occur until all necessary flood control components and in-water habitat enhancement features are completed.

The likely order of construction at the Mountain View Ponds would be as follows, though availability of upland material for various actions could alter the sequence:

1. Site preparation including clearing and grubbing of debris and vegetation from construction areas.

2. Raise and improve Pond A1 western levee.
3. Construct trail on Pond A1 western levee to viewing platform.
4. Raise the Coast Casey Forebay levee to 17 feet; make other required improvements to existing Mountain View infrastructure (pump station access, etc.).
5. Rebuild the portion of trail (part of the Bay Trail spine) that is currently on top of the Coast Casey Forebay levee.
6. Modify the access to the existing viewing platform at the southern end of Charleston Slough.
7. Construct PG&E tower and boardwalk improvements around Pond A2W (must be completed prior to levee breaching).
8. Construct habitat transition zones and habitat islands (must be completed prior to levee breaching).
9. Breach perimeter levees at Ponds A1 and A2W.
10. Install cofferdams and construct bridges on eastern levee of Pond A2W.
11. Construct public access trail and viewing platform on eastern levee of Pond A2W.
12. Install viewing platform in Mountain View Shoreline Park and viewing platform on Pond A1 west levee.
13. Install gates at necessary locations along levees.

The construction schedule would be affected by seasonal work restrictions to avoid impacts to protected species, weather conditions, earthwork quantities, and land disturbance. Construction is expected to begin in 2018.

Construction would likely be completed in approximately 29 months over 4 construction seasons. This estimate is based on the assumption that some heavy construction activities would be permitted to occur during the restricted work window for nesting bird habitat under implemented avoidance and minimization measures including the presence of a biological monitor.

2.10.5 Ravenswood Ponds

Earthwork activities would be sequenced such that activities which would be efficient to perform in dry conditions would be completed first. These activities include levee improvements, installation of hydraulic controls, pilot channel excavation, and internal levee lowering. Levee lowering and breaching along the outer bounds of the ponds designed to establish hydraulic connection with adjacent sloughs would be performed after the internal pond activities are completed. Once sufficient upland fill material to complete initial construction plans for habitat transition zones and levee improvements is in place, additional material would be accepted as available to expand the habitat transition zones or to raise or improve flood risk management further. Breaching would not occur until all necessary flood control components and in-water habitat enhancement features are completed.

The likely order of construction at the Ravenswood Ponds would be as follows, though availability of upland material for various actions could alter the sequence:

1. Mobilize to site, conduct clearing and grubbing (vegetation removal), and demolish existing derelict water control structure.
2. Import material and improve levees along the All-American Canal and along the eastern levees of Ponds R5 and S5.
3. Construct habitat transition zones along (1) the western edge of Pond R4 levee; and (2) the northern side of the All-American Canal.
4. Modify central portion of levee between Ponds R5 and S5 with gravel, sand, and shells in preparation for its use as a habitat island.
5. Remove unmodified parts of internal levees between Ponds R5 and S5 and within Pond S5, as described above.
6. Install external water control structures (i.e., between R3 and Ravenswood Slough; between S5 forebay and Flood Slough).
7. Excavate pilot channels in Pond R4.
8. Build ditch blocks in Pond R4's borrow ditches
9. Install internal water control structures (i.e., between Pond R3 and Pond S5; between Pond R4 and Pond R5).
10. Build public access trail along improved R5/S5 eastern levees.
11. Install viewing platform on new public access trail.
12. Lower Pond R4 levee near Greco Island.
13. Breach Pond R4 levee at its northeastern corner.
14. Install fencing along southern border of pond cluster and gates at necessary locations.

The construction schedule would be affected by seasonal work restrictions to avoid impacts to protected species, weather conditions, and volume of earthwork quantities to be moved. Several hundred thousand cubic yards of material would need to be imported and either placed immediately or stockpiled at the site.

Although, it is assumed that the ponds would be sufficiently dry during the beginning of the construction season and that active draining or dewatering of pond bottoms would be unnecessary, limited installation of cofferdams and dewatering of small portions of the pond would be necessary for installing water control structures.

Construction is expected to begin in 2018. Some of the construction activities could take place concurrently or in tandem, with multiple crews to achieve project goals. A preliminary estimate shows that construction would be completed over approximately a 16-month period over 2 construction seasons, assuming all upland fill material would be available. This estimate is based on the assumption that some heavy construction activities would be permitted to occur during the restricted work window for nesting bird habitat under implemented avoidance and minimization measures including the presence of a biological monitor.

2.11 Operations and Maintenance

2.11.1 Island Ponds

Aside from the monitoring and management activities of the SBSP Restoration Project Adaptive Management Plan (AMP) (Appendix B) (also available as Appendix D of the 2007 Final EIS/R) and continued maintenance of the existing UPRR track, no other operations and maintenance activities would occur at the Island Ponds. The existing and newly proposed breaches would scour from hydraulic action and would gradually widen until equilibrium with the tidal flux is reached. Most levees would be allowed to degrade naturally; however, the levee containing the existing railroad track would be maintained by the UPRR to allow the continued use of the tracks. Ongoing monitoring and studies to track the progress of these ponds toward restoration as tidal marsh would be a component of the continued implementation of the AMP.

2.11.2 A8 Ponds

The USFWS would continue to operate and maintain the ponds in accordance with various Refuge operations and maintenance permits, the AMP and other ongoing management practices that have been in place since the implementation of Phase 1 actions, which includes minimal operation of the reversible armored notch in the southeast corner of Pond A8 as necessary. Phase 2 would not involve changing these ongoing management practices during or after the construction activities described above. The habitat transition zones that would be placed in Phase 2 may occasionally need maintenance such as removing invasive plant species, which would be performed in accordance with existing Refuge policies and practices for doing so.

2.11.3 Mountain View Ponds

Operations and maintenance activities would continue to follow and be determined by various Refuge operations and maintenance permits, applicable county operations, and the AMP. PG&E would continue to operate and maintain its infrastructure, which would occur in coordination with the Refuge managers to ensure consistency with the operations and maintenance of the pond cluster. The City of Mountain View would continue to operate and maintain its properties that are adjacent to the pond cluster, and these activities would also occur in coordination with the Refuge managers.

Periodic maintenance of the pond infrastructure would be required following construction. Maintenance activities would require a maintenance staff person to travel to the pond cluster one or two times a week to perform activities such as predator control, invasive plant control, and vandalism repairs. AMP monitoring activities would also occur, which would require additional workers (e.g., staff, consultants) to access the pond clusters. The frequency of visits to the pond cluster to conduct AMP monitoring activities would depend on the actual activities and would vary by season (e.g., during the bird breeding season there may be more trips to the site than during the non-breeding season).

The improved western levee of Pond A1 would require ongoing levee maintenance because it would provide flood risk management, and the north and east levees of Pond A2W would be maintained for PG&E and trail access. This ongoing levee maintenance would continue in consistency with USACE permit #2008-00103S. These levee maintenance activities could include occasional placement of additional earth on top of, or on the sides of, the levees as the levees erode or subside, with the level of settlement dependent on geotechnical considerations. In general, pond levees that are improved to provide flood risk management would likely exhibit the greatest degree of settlement. Levees that require erosion control measures would also require routine inspections and maintenance.

The northern perimeter levee, eastern levee, northern portion of the western perimeter levee at Pond A1, and the western levee of Pond A2W would not be maintained and would be allowed to degrade naturally. The eastern and northern levees of Pond A2W would be maintained for PG&E access. The eastern levee of Pond A2W would also be maintained for recreational public access on the trail atop it.

Improved levees would be inspected and maintained for slope stability, erosion control, seepage, slides, and settlement on an annual basis. Maintenance is expected to occur every 5 years to add additional fill material in areas where settlement occurs. Most of the maintenance would be accomplished during low tides and from the levee crest.

Maintenance of the habitat islands may require weed/vegetation removal as often as quarterly and the placing of fill material (sand, gravel, and/or oyster shells) before the onset of the nesting period in some years. Habitat islands would also be periodically examined for erosion.

Maintenance of habitat transition zones would include inspections and maintenance for slope stability, erosion control, seepage, slides, and settlement on an annual basis. As necessary, vegetation removal would occur to prevent colonization by invasive species. Fill material would be placed, when needed, to respond to areas where erosion is observed. Additional maintenance activities may also be a need to address an AMP-specified management trigger.

Public access and recreation features would be maintained as needed to keep trail surfaces safe and accessible. There would be a need for trash removal along trails and more intensely at staging areas and trailheads. The viewing areas would be designed to minimize maintenance by utilizing durable and sustainable materials as much as possible to prevent degradation and the need for repeated maintenance. These would need to be checked periodically for defacement of interpretive boards and other forms of vandalism.

Access bridges placed in publicly accessible areas such as city streets and highways must be visually inspected every 2 years and a report on their condition may be required every 5 years. Because there would be a public access trail along the eastern levee of Pond A2W, the two bridges over the breaches there would need to be visually inspected and reported on as described.

The proposed bridges and the concrete abutments with wing walls at both ends of the bridge would be basically maintenance free for the design life cycle of 50 to 75 years. The bridges' superstructures include main span girders, a lateral bracing system, deck slab systems, and a safety railing would need basic erosion protection maintenance work every few years. These activities may include sanding, cleaning, and re-painting as needed, which are common activities for all steel structures permanently exposed to weather.

The PG&E towers, boardwalks, and power lines would be maintained in accordance with PG&E's current practices, which are described in the April 2016 SBSP Restoration Project Phase 2 Final EIS/R, Appendix A. The maintenance of Pond A2W's eastern and northern levees and the construction of new and improved boardwalks for PG&E's use would continue to provide the necessary access at the current levels.

2.11.4 Ravenswood Ponds

Operations and maintenance activities for the components of the pond clusters within the Refuge would continue and be determined by various Refuge operations and maintenance permits, applicable county operations, and the AMP. The City of Menlo Park would continue to operate and maintain its properties that are adjacent to the pond cluster, in coordination with the Refuge managers.

Periodic maintenance of the pond infrastructure would be required following construction. Maintenance would require a staff person to travel to the pond cluster one or two times a week to perform activities such as water structure control operation, invasive plant control, and vandalism repairs. In addition, AMP monitoring activities would occur, which would require additional workers (e.g., staff, consultants) to access the pond clusters. The frequency of visits to the pond clusters to conduct AMP monitoring activities would depend on the actual activities and would vary by season (e.g., during the bird-breeding season, there would be more trips to the site than during the non-breeding season).

Ongoing levee maintenance would continue for existing levees that provide flood risk management (as part of the operations and maintenance activities described above and in consistency with USACE permit #2008-00103S). Levee maintenance activities would include the placement of additional earth on top of or on the pond side of the levees as the levees subside, with the level of settlement dependent on geotechnical considerations. In general, pond levees that are improved to provide flood risk management would likely exhibit the greatest degree of settlement. Levees that require erosion control measures would also require routine inspections and maintenance. The northern perimeter levee at Pond R4 would not be maintained and would be allowed to degrade naturally.

Improved levees would be inspected and maintained for slope stability, erosion control, seepage, slides and settlement on an annual basis. Maintenance is expected every 5 years to add additional fill material in areas where settlement occurs. Most of the maintenance work can be accomplished during low tides and from the levee crests.

Water control structures would require inspection for structural integrity of gates, pipes, and approach way; obstruction to flow passage and preventative maintenance such as visual functionality of gates, seals; and removal of debris. Inspection would be required every month through the first year and semi-annually thereafter. Maintenance would be required on an annual basis. Operations and maintenance activities would be conducted during low tides in Pond R4 and sloughs and by maintaining low storage conditions in the managed ponds.

Maintenance of habitat transition zones would include inspections and maintenance for slope stability, erosion control, seepage, slides, and settlement on an annual basis. As necessary, vegetation removal would occur to prevent colonization of invasive species. Fill material would be placed, when needed, to respond to areas where erosion has been observed. Maintenance activities would also be dictated by the AMP if an AMP management trigger is reached, especially a trigger related to a biological resource (e.g., salt marsh harvest mouse) that would utilize habitat transition zones as habitat.

Maintenance of public access and recreation features would address both viewing platforms and trail maintenance. The viewing areas would be designed to minimize maintenance utilizing durable and sustainable materials as much as possible to prevent degradation and the need for repeated maintenance. All features would be checked periodically for defacement of interpretive boards and other forms of vandalism. The eastern levees of Ponds R5 and S5 would also be maintained for recreational public access on the trail atop it. Trash removal would take place as needed along trails and at staging areas and trailheads.

Operations and maintenance of water levels in Ponds R3, R5, and S5 would be managed as follows:

- The water levels in Ponds R5 and S5 would be actively managed year-round by opening and closing the water control structures as needed to maintain desired surface elevations, flows, and water quality. The salinity of these ponds would also be somewhat controlled through the use of the water control structures. USFWS Refuge staff would operate the water control structures and provide maintenance and cleaning as needed.
- The water levels of Pond R3 would be actively managed using the new water control structures to provide for the improvement of the existing western snowy plover habitat in Pond R3. USFWS Refuge staff would operate all of the water control structures and provide maintenance and cleaning as needed.

2.12 Conservation Measures

This section presents general and species-specific conservation measures including those intended to avoid and minimize potential impacts to ESA-listed species, DCH, and EFH during implementation of the proposed action. Many of these are drawn from the PBO listed for the SBSP Restoration Project (USFWS 2008) as a whole, but others are new or updated and are particular to the ponds and species relevant for the Phase 2 action.

2.12.1 Conservation Measures — Construction, Erosion Control, and Flood Risk Management

The following conservation measures and best management practices are included in the proposed project to directly or indirectly minimize or avoid potential adverse effects to listed species during construction, operation, and maintenance of the proposed action:

- A water truck will be used for dust control on the site.
- Vehicles driving on levees to access the Bay, tidal sloughs, or channels for construction or monitoring activities will travel at speeds slow enough to minimize noise and dust disturbance.
- If land-based equipment is used, light, low-pressure construction equipment and/or equipment on mats will be employed.
- Vehicles driving on levees to access the Bay, tidal sloughs, or channels for construction or monitoring activities will travel at speeds slow enough to minimize noise and dust disturbance.
- Vehicle staging, cleaning, maintenance, refueling, and fuel storage will occur at least 150 feet from any stream, water body, or wetland.
- A hazardous spill plan will be developed prior to construction, and will state what actions will be taken in the event of a spill. This plan will also incorporate preventative measures to be implemented, such as the placement of refueling facilities, storage and handling of hazardous materials, etc.
- Staging areas will be established in upland areas that do not provide habitat for ESA-listed species; such staging areas will typically be located on bare ground, paved or graveled areas, ruderal habitat, or non-native grassland.
- Contaminants will be stored within bermed containment areas lined with an impermeable membrane and designed to hold 125 percent of total fuel capacity. Containment areas will be located as far from the waters of the bay as possible within the staging area. Contaminant absorbent materials will be stored within each containment area. Water collected within containment areas will be disposed of according to federal, state, and local regulations.
- Equipment will be refueled only in the staging area. Fuel absorbent mats will be used when refueling equipment.
- Absorbent materials will be maintained at each worksite in sufficient quantity to effectively immobilize the volume of petroleum-based fluids contained in the largest tank present at the site. Acceptable absorbent materials are those that are manufactured specifically for the containment and clean-up of hazardous materials. Sands or soil are not approved absorbent materials.
- In the event of a contaminant spill, work at the site will immediately cease while the absorbent materials are deployed to contain, control, and mitigate the spill. The contractor will immediately prevent further contamination notify appropriate authorities, and mitigate damage as appropriate.
- Site work will resume when the spill kit is resupplied with a sufficient quantity of material capable of effectively immobilizing the volume of petroleum-based fluids contained in the largest tank present at the site.
- Containers for storage, transportation, and disposal of contaminated absorbent materials will be provided on the project site. Petroleum products and contaminated soil will be disposed of according to federal, state, and local regulations.
- Any machinery that will be left on the temporary platform or parked within 150 feet of a water body including portable water pumps will be placed in a full containment cell.
- All vehicles operated within 150 feet of any water body will be inspected daily for leaks and, if necessary, repaired before leaving the staging area. Inspections will be documented in a record that is available for review on request from NMFS.
- Machines and equipment that are used during the project will be in good repair, free leaks and steam cleaned off-site prior to entering the work area. Fluid leaks will either be repaired or contained within a suitable waste collection device (e.g., drip pads, drip pans). When changing hydraulic lines, care will be taken to keep hydraulic fluid from entering a water body or soils.

- There will be no debris introduction into the channels, wetlands, or environmentally sensitive areas from project work.
- All disturbed areas will be stabilized within 12 hours of any break in work unless construction will resume work within 7 days. Earthwork will be completed as quickly as possible, and site restoration will occur immediately following use.
- A supply of emergency erosion control materials will be on hand at the project site.
- Any large wood, native vegetation, and weed-free topsoil displaced by construction will be stockpiled for use during site restoration.
- Silt fences will be erected adjacent to areas of ground disturbance to define and isolate work areas from sensitive habitats.
- In all activities involving the use of heavy equipment, the project will use best management practices that include using berms and/or silt fences to contain the placement of materials, implementing remedial measures, and minimizing the area impacted.
- All activity within vegetated marsh habitat will be minimized.
- For any activities that involve walking through a marsh repeatedly (e.g., monitoring), a route will be determined which will minimize the amount of foot traffic in the marsh and maximize the use of existing roads, trails, and boardwalks.
- A construction personnel education program will be conducted by a qualified biologist prior to the initiation of construction or maintenance activities in any of the four pond clusters. The program shall consist of a brief presentation by a NMFS-approved biologist knowledgeable in the biology of the pertinent species, habitat, and federal protection to explain endangered species concerns to contractors and their employees.
- For any given construction project, a representative shall be appointed by the applicant who will be the contact source for any employee or contractor who might inadvertently kill or injure a listed species 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 NMFS prior to the initiation of any construction or maintenance activities.
- The applicant shall provide final design drawings of the water control structures, wildlife viewing platforms, and any other public access elements to NMFS for approval prior to construction.
- Chemical concentrations and associated sampling plans and activity of upland fill material or site soils planned for use on-site shall be reviewed and approved according to the Quality Assurance Program Plan (QAPP) developed specifically for the Phase 2 actions. That QAPP has been approved by the RWQCB. The data for upland fill material proposed for use in the Action Area shall be provided to the agencies for review and approval according to the terms of the QAPP.
- Sediment suspension will be minimized when removing derelict piles or other infrastructure formerly associated with salt manufacturing or other aspects of water management. Measures to accomplish this will include cutting piles at or below the mudline or using a direct pull method to minimize sediment resuspension. Piles and other structures will be removed slowly to allow sediment to slough off at, or near, the mudline.
- Clean fill materials that will be used for islands, levees, or habitat transition zones will be stockpiled on-site and properly covered to prevent wind or water-borne transport.
- NMFS-approved biological monitors knowledgeable about sensitive species and habitats in the Action Area would be assigned to the project.

2.12.2 Conservation Measures — CCC steelhead and Green Sturgeon

Although green sturgeon have the potential to occur in the Action Area year round, the avoidance and minimization measures described in this section will help minimize impacts to this species.

- A NMFS-approved biological monitor would be present during any in-water work activities that have the potential to entrap or strand fish, such as the installation of cofferdams into wetted areas.
- When practicable, in-water work would be restricted to low tide between June 1 and November 30 to avoid the seasonally present CCC steelhead; this is the NMFS-approved window for dredging and other in-water work in San Francisco Bay.
- If individuals of listed species are observed present within a project area, NMFS must be notified. NMFS personnel shall have access to construction sites during construction, and following completion, to evaluate species presence and condition and habitat conditions.
- If practicable, cofferdams would be closed when little or no water is present (i.e. during low tide) to avoid or minimize the entrapment of fish in the construction area. This will be done by installing all but one sheet of the cofferdam, leaving an opening at the lowest point in the enclosure, and installing the remaining sheet at low tide when little or no water is present.
- If cofferdams are closed when water deeper than 1 inch is present, a NMFS-approved biologist will be the lead crew to conduct fish rescue and relocation activities to safely remove any fish that may become stranded between the cofferdams. A record of relocated fish will be provided to NMFS within 7 days of each relocation event.
- During any in-water pile driving activities, a soft-start technique would be implemented to reduce hydroacoustic impacts. The soft start technique would allow for any fish species to vacate the affected area.
- When feasible to do so without impeding water quality requirements, water control structures at the Ravenswood ponds would be operated to reduce the potential for entrainment of steelhead smolts during the outmigration period.

2.12.3 Conservation Measures — Designated Critical Habitat

- Standard best management practices (BMPs) would be applied to protect their habitat(s) from pollution due to fuels, oils, lubricants, and other harmful materials. Vehicles and equipment that are used during the course of the project would be fueled and serviced in a manner that would not affect federally protected species' DCH.
- Contractors would exercise every reasonable precaution to protect DCH from construction byproducts and pollutants.

In addition to the conservation measures listed above, the Phase 2 Action as well as the larger SBSP Restoration Project includes a robust monitoring and Adaptive Management Plan (AMP) to regularly assess adverse short-term effects and ensure large-scale improvements for species and their habitats over the long-term (See Appendix B to this BA, which contains the AMP). The plan includes tracking goals, triggers for species and habitats as well as potential actions for the adaptive management team if triggers are activated.

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3 Environmental Setting

3.1 Topography

The South Bay is defined as the portion of San Francisco Bay south of Coyote Point on the western shore and San Leandro Marina on the eastern shore (Goals Project 1999). The South Bay is both a geographically and hydrodynamically complex system, with freshwater tributary inflows, tidal currents, and wind interacting with complex bathymetry (i.e., bed surface elevation below water).

3.2 Climate and Precipitation

The South Bay, like much of California's Central Coast, experiences a Mediterranean climate characterized by mild, wet winters and dry, warm summers. Air temperatures are mild due to proximity to the ocean. Winter weather is dominated by storms from the northern Pacific Ocean that produce nearly all the annual rainfall, while summer weather is dominated by sea breezes caused by differential heating between the hot interior valleys and the cooler coast. The South Bay typically receives about 90 percent of its precipitation in the fall and winter months (October through April), with the greatest average rainfall occurring in January. The average annual rainfall in the counties surrounding the South Bay is approximately 20 inches, although the actual rainfall can be highly variable due to the influence of local topography.

3.3 Hydrology

The South Bay can be characterized as a large shallow basin, with a relatively deep main channel surrounded by broad shoals and mudflats. Tidal currents, wind, and freshwater tributary inflows interact with bathymetry to define the residual circulation patterns and residence time, and determine the level of vertical mixing and stratification. The most obvious hydrodynamic response is the daily rise and fall of the tides, although much slower residual circulation patterns also influence mixing and flushing processes within the South Bay.

The tides in San Francisco Bay are mixed semidiurnal tides (i.e., two high and two low tides of unequal heights each day). The tides exhibit strong spring-neap variability with the spring tides, which have a larger tidal range, occurring approximately every 2 weeks during the full and new moon. Neap tides, which have a smaller tidal range, occur approximately every 2 weeks during the moon's quarter phases. The tides also vary on an annual cycle, in which the strongest spring tides occur in late spring/early summer and late fall/early winter, and the weakest neap tides occur in spring and fall. The enclosed nature of the South Bay creates a mix of progressive and standing wave behavior, which causes tidal amplification as waves move southward (i.e., the tidal amplitude is increased by the harmonic addition of original waves plus reflected waves).

One of the most important factors influencing circulation patterns in the South Bay is bathymetry. Bathymetric variations create different flow patterns between the San Mateo Bridge and Dumbarton Bridge and in areas south of the Dumbarton Bridge. Circulation patterns also differ between the deep main channel and the expansive shoals. Currents in the South Bay are driven predominantly by tidally and wind-forced flows and their interaction with the bathymetry. Typically, winds drive a surface flow, which then induces a return flow in the deeper channels (Walters et al. 1985). In terms of circulation, the most significant winds are onshore breezes that create a horizontal, clockwise circulation pattern during the spring and summer. Density-driven currents occur when adjacent water bodies have differing densities, such as differences in temperature and/or salinity. Although density-driven currents are generally uncommon in the South Bay, in years of heavy rainfall, fresh water can flow from the Delta through the Central Bay and into the South Bay (Walters et al. 1985). In such events, the freshwater flows southward along the surface, while the more saline South Bay water flows northward along the bottom.

Currents and circulation affect the tidal excursion – the horizontal distance a water particle travels during a single flood or ebb tide. The tidal excursion varies between 6.2 and 12.4 miles within the main channels, and it ranges between 1.9 and 4.8 miles within the subtidal shoals; much smaller excursions occur on the intertidal mudflats (Cheng et al. 1993; Fischer and Lawrence 1983; Walters et al. 1985). Tidal dispersion is the dominant form of transport in the South Bay and the primary mechanism that controls residence times. Residence time is usually characterized as the average length of time a water parcel spends in a given waterbody or region of interest (Monsen et al. 2002). It is typically shorter during the winter and early spring during wet years and considerably longer during summer and/or drought years (Powell and Huzzey 1989; Walters et al. 1985). Residence time also varies with seasonal freshwater inflow and wind conditions.

The volume of water in the South Bay between mean low water and mean high water is the "tidal prism" of the South Bay. Tidal prism, in combination with bathymetry, determines the patterns and speed of tidal currents and subsequent sediment transport. The tidal prism for the South Bay is approximately 666,000 acre-feet, the majority of which is contained between the San Francisco-Oakland Bay Bridge and San Mateo Bridge (Schemel 1995). At mean lower low water, the volume of water in the far South Bay (south of the Dumbarton Bridge) is less than half the volume present at mean higher high water (MHHW). In addition, surface water area coverage at mean lower low water is less than half that at MHHW, indicating that over half of the far South Bay consists of shallow mudflats exposed at low tides (Schemel 1995).

3.4 Salinity

Salinity in the South Bay is governed by salinity in the Central Bay, exchange between the South Bay and Central Bay, freshwater tributary inflows to the South Bay, and evaporation. In general, the South Bay is vertically well mixed (i.e., there is little tidally averaged vertical salinity variation) with near oceanic salinities (33 parts per thousand [ppt]). Exceptions include areas within the far South Bay below the Dumbarton Bridge, which can remain brackish year-round due to wastewater treatment plant discharges.

Seasonal variations in salinity are driven by variability in freshwater inflows. High freshwater inflows typically occur in winter and early spring in wet years when fresh water from the San Francisco Bay Delta (Delta) intrudes into the South Bay. For example, during wet years when Delta outflow exceeds approximately 200,000 cubic feet per second (cfs), fresh water from the Delta intrudes into the South Bay during the winter and spring months, pushing surface salinities below 10 ppt. During dry years when Delta outflows are small, near surface salinity in the South Bay remains high (> 20 ppt) (PWA et al. 2005a). As Delta and tributary inflows decrease in late spring, salinity increases to near oceanic salinities. Similar wet-year/dry-year patterns exist in the drainages around the South Bay and have similar effects on freshwater inflows from the Guadalupe River, Stevens Creek, and other South Bay streams. High freshwater inflows can result in circulation patterns driven by density gradients between the South Bay and Central Bay (Walters et al. 1985).

3.5 Sediment Characteristics

Bay habitats such as subtidal shoals, intertidal mudflats, and wetlands are directly influenced by sediment availability, transport and fate, specifically the long-term patterns of deposition and erosion. The main losses of sediment from the South Bay are exports to the Central Bay and sediment capture within marsh areas and restored ponds. Sediments carried on flood tides into a marsh or restored ponds are typically deposited, causing the marsh or mudflat area to increase in elevation. Sediments can also be carried out with ebb tides if cohesive sediment deposition is inhibited. The rate of sedimentation in a marsh or restored pond depends on the suspended sediment concentration (SSC) near the marsh or restored pond location, the elevation of the pond bottom surface, and the degree of tidal exchange.

The capacity of many sloughs and channels in the South Bay has been gradually reduced by sediment deposition. Under natural conditions, channels adjacent to marsh lands experienced daily scouring from tidal flows. When these areas were diked off to create salt ponds, the scouring flows were reduced.

Subsequent sedimentation has constricted channels, reducing cross-sectional areas and decreasing channel conveyance. Although the South Bay as a whole has undergone periods of net deposition and net erosion, the far South Bay below the Dumbarton Bridge has remained largely depositional since bathymetric data collection began in 1857 (Foxgrover et al. 2004; Foxgrover et al. 2007; Krone 1996; Shellenbarger et al. 2013).

Suspended sediment concentrations in the South Bay exhibit short-term variability, primarily in response to variations in tidally driven resuspension, wind-driven resuspension, and riverine input from local tributaries and sloughs (Schoellhamer 1996). In the winter and early spring, the main sources of suspended sediments are local tributaries and the Central Bay. There is typically little direct input of suspended sediment in the dryer summer months; however, suspended sediment concentrations are often high due to increased wind-wave resuspension and reworking of previously deposited sediments. In recent, years, Shellenbarger et al (2014) have collected sediment flux data in the Alviso Slough. Their results show that winter storms and associated runoff have the greatest influence on sediment flux. Strong spring tides promote upstream sediment flux, and the weaker neap tides have a smaller net flux. During these neap tides, sediment transport during their weaker flood and ebb tides is suppressed by stratification of the water column, which dampens turbulence and limits sediment resuspension.

The transport and fate of suspended sediment has the potential to affect the transport and fate of contaminants, such as metals and pesticides, and the distribution of nutrients. Increasing suspended sediment concentrations are also directly correlated with increasing turbidity and decreasing light availability, thus affecting photosynthesis, primary productivity, and phytoplankton bloom dynamics.

3.6 Biological Conditions

The San Francisco Bay Estuary is the largest estuary on the west coast of North America and is an extremely productive and diverse ecosystem (Trulio et al. 2004). The South Bay includes some of the most important habitat remaining in the Bay Area for a number of wildlife species (Goals Project 1999). The habitats included in the South Bay are open waters and subtidal habitats to the upper reaches of tidal action, tidal and non-tidal wetlands, former salt evaporation ponds adjacent to the Bay, and the upland areas immediately adjacent to these features. The diversity of habitat types is largely responsible for the diversity of wildlife species that occur in the South Bay. Although the high productivity of these habitats allows those species that are not habitat-limited to achieve substantial numbers, the tidal salt marshes and open waters that sustain aquatic plants and phytoplankton and the ponds that sustain high biomass of invertebrates are the basis of the estuary's complex and productive food web. The San Francisco Estuary supports more than 250 species of birds, 120 species of fish, 81 species of mammals, 30 species of reptiles, and 14 species of amphibians (Siegel and Bachand 2002).

The 2007 EIS/R for the SBSP Restoration Project included a programmatic analysis of the project area and of the South Bay as a whole. Within that discussion, there were sections on the various habitats that are included in the program-level project. Those habitats are presented in full in the 2016 Phase 2 EIS/R and again in the Phase 2 BA prepared for delivery to the USFWS. However, much of that content is not relevant to the NMFS-protected fish species included in this BA. Thus, the following sub-sections present excerpted and modified versions of those full descriptions.

3.6.1 Tidal Salt Marsh

Tidal salt marsh vegetation consists of halophytic (salt-tolerant) species adapted to occasional to regular (tidal) saltwater inundation. Tidal salt marsh occurs on the Bay's outboard portions of salt pond levees; these are often referred to as fringing marshes.

In tidal salt marsh, cordgrass (*Spartina* sp.) dominates low marsh areas. Pacific cordgrass (*Spartina foliosa*) has hybridized extensively with smooth cordgrass (*Spartina alterniflora*), a non-native species from the east and gulf coasts of North America. One or both of these species and/or their hybrids may be present at any one location. The pickleweed and cordgrass salt marsh habitats are generally separated by elevation; cordgrass typically occurs below the Mean High Water (MHW) mark and pickleweed (*Sarcocornia depressa* and *S. pacifica*) occurs above this mark and often extends into higher elevations. The fringing marshes along the outboard levees of Ponds R4, A1, A2W, and the Island Ponds are good examples of tidal salt marsh in the Phase 2 Action Area.

Mature tidal salt marshes are productive ecological systems that contribute to a more complex and complete food web. The channels within these marshes are good forage and/or nursery habitat for a number of native fish species, including the anadromous fish species addressed in this BA. Tidal marshes (and mudflats) in several South Bay locations are also used as haul-out and pupping sites by harbor seals (*Phoca vitulina*).

3.6.2 Brackish Marsh

Brackish marsh occurs along the intertidal reaches of the creeks and sloughs that drain to the Bay, where salinities are lower due to freshwater input. Brackish marsh is found where intermediate interstitial soil salinities occur along creeks and sloughs; where freshwater channels experience periodic tidal inundation, and where groundwater emerges into tidal marshlands. Tidal salt marsh species, including pickleweed, alkali heath, saltgrass, and spearscale, may also colonize brackish habitat. The periphery of Pond A19 and the adjacent Mud Slough are exemplary of brackish marsh in the Phase 2 Action Area.

Brackish marshes support many of the wildlife species that use salt marsh and freshwater marsh habitats, including anadromous fish species. Species composition and the relative abundance of different species may vary spatially within brackish marshes depending on water salinity, vegetation type, and habitat structure. Variability in salinity within brackish marshes is likely most important for aquatic species, which are directly subject to variation in salinity. Brackish marshes are particularly important for anadromous fish (migrating from saline to fresh water to spawn), catadromous fish (migrating from fresh to saline water to spawn), and invertebrates such as shrimp, which use brackish marshes while physiologically acclimating to changing salinity on their migrations between saline and freshwater habitats.

3.6.3 Freshwater Marsh

Freshwater marsh vegetation in and around the project area exists along the upper reaches of sloughs and creeks and primarily consists of emergent vegetation adapted to freshwater wetland conditions. Though some freshwater marshes may experience tidal influence and periodic saltwater inundation, soil salinity remains relatively low due to freshwater flowing through these areas on a regular basis. The upper reach of Ravenswood Slough (along the eastern edge of Pond R3) demonstrates the vegetation transition that occurs as freshwater influence increases. Freshwater marshes are not a particularly useful habitat for anadromous fish species in the Phase 2 Action Area.

3.6.4 Upland/Levees

The primary upland habitat existing in the Alviso-Island, Alviso-Mountain View, Alviso-A8, and Ravenswood pond clusters exists along the tops of levees and along the landward sides of the project area. Levees were constructed from native tidal salt marsh soils (silty clay) in the immediate vicinity and may occasionally be reinforced with concrete debris. Due to the high salinity of these soils and their inherent disturbed nature, many levees feature areas of bare soil or are otherwise populated by non-native halophytic species, including small flowered iceplant, New Zealand spinach, sea fig (*Carpobrotus chilensis*), Russian thistle (*Salsola soda*), and Australian saltbush (*Atriplex semibaccata*). On levees and portions of levees where freshwater (groundwater or rain) has reduced soil salinity over time, other common ruderal species (non-native species that thrive in areas of disturbance) of forbs and grasses dominate.

Levees and other uplands in the Phase 2 Action Area are not useful habitat for anadromous fish species, but these habitats are heavily used for nesting by many bird species, including a number of piscivorous species. Large numbers of shorebirds use salt pond levees for roosting, particularly when intertidal foraging habitats are inundated during high tide (Warnock 2004). Common bird species to use the former salt pond levees are double-crested cormorants (*Phalacrocorax auritus*), pelicans, California gulls (*Larus californicus*), black-necked stilts, American avocets (*Recurvirostra Americana*), black-necked stilts, and Forster's terns (*Sterna forsteri*).

3.6.5 Mudflats

Naturally occurring mudflats on the outboard sides of many South Bay salt ponds begin at low tidal salt marsh areas and extend into the Bay. They form the overwhelming majority of intertidal habitat in the South Bay, with exceptions being only a narrow and deep channel near the center of the Bay and the fringing marshes and former salt ponds around the edges. Covered by shallow water during high tide, these mudflats are exposed during low tide. Narrow stretches of mudflat occur within slough and creek channels and at the mouths of major sloughs. Mudflats also exist in the basins of former salt ponds, such as Charleston Slough (adjacent to the Mountain View Ponds), and in portions of the Island Ponds (Ponds A19, A20, and A21) where the levees have been breached and the pond re-exposed to Bay waters and tides. Eventually, as sediment accretes, tidal marsh habitat is expected to replace mudflat habitat within the former salt ponds.

These mudflats are a key reason for the importance of the San Francisco Bay Area to west coast shorebird populations, with an average of 67 percent of all the shorebirds on the west coast of the United States using San Francisco Bay wetlands (Page et al. 1999). Gulls and some dabbling ducks forage on the exposed mudflats as well. Although the largest numbers of shorebirds forage on the broad flats along the edge of the Bay at low tide, some shorebirds, gulls, and large waders (e.g., herons and egrets) feed on the exposed flats along sloughs and channels, and the smaller channels in the brackish and salt marshes are the favored foraging areas for the state and federally endangered California Ridgway's rail. When the tides are in, however, mudflats are suitable habitat for passage, forage, or other use by anadromous fish species.

3.6.6 Former Salt Production Ponds

Salt ponds were previously managed for the purpose of commercial salt production. The margins and basins of some former salt ponds that are seasonally ponded but dry much of the year (e.g., Ponds R3 and R4 at the Ravenswood pond cluster) consist of bare ground and salt flat or salt panne (non-mudflat soils) areas. Historically, these basins were subject to regular tidal inundation, but following installation of levees and their use as salt ponds, the salinity has increased beyond the tolerance of most halophytic vegetation. These ponds are not connected to the Bay or to streams and are not useful habitat for anadromous fish species.

3.6.7 Open Water and Subtidal Habitats

Open water and subtidal habitat consist of a variety of aquatic habitat types, including subtidal Bay waters, tidal sloughs and channels, and areas of standing or flowing waters within the salt ponds and tidal marshes. Deep water does not support emergent vegetation. Deep bays and channels are important for aquatic invertebrates, fishes, waterbirds, and harbor seals. The open waters of South San Francisco Bay support a high diversity of benthic and pelagic macroinvertebrates. Though most of the dominant invertebrates are non-native species, they nonetheless support native oyster populations, large fish populations representing several different trophic levels, including Pacific herring (*Clupea pallasi*), northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax caeruleus*), staghorn sculpin (*Leptocottus armatus*), several species of perch (Embiotocidae family), English sole (*Parophrys vetulus*), and California halibut (*Paralichthys californicus*). The anadromous fish species addressed in this BA are important occupiers of these open water and subtidal habitats.

Many of these fish species in turn support harbor seals and piscivorous (fish-eating) birds such as the Forster's tern, California least tern, American white pelican, brown pelican (*Pelecanus occidentalis*), and double-crested cormorant. Waterfowl such as greater scaup (*Aythya marila*), lesser scaup (*Aythya affinis*), canvasbacks (*Aythya valisineria*), and surf scoters (*Melanitta perspicillata*) dive for bivalves, crustaceans, and other invertebrates in shallower subtidal areas. Bird diversity in the open Bay waters is fairly low, as the species of birds that can exploit the subtidal areas are limited to those that can forage from the air (e.g., terns) or under water (e.g., scoters) and those that can swim. However, large densities of diving ducks (e.g., bufflehead [*Bucephala albeola*], greater scaup) occur in some areas where appropriate depths and concentrations of benthic invertebrates, particularly bivalves, provide a rich food source. Some species, such as gulls, also roost on the open waters of the Bay, especially at night.

The tidal sloughs and channels that circulate water around and in between salt ponds and marsh remnants and through the marshes provide important habitat for large numbers of benthic and pelagic invertebrates and fish. These detritus-rich channels serve as important nurseries and feeding areas for estuarine fish.

3.7 Phase 2 Pond Clusters – Habitat Conditions

3.7.1 Alviso-Island Ponds

As part of the Initial Stewardship Plan (ISP), the Island Ponds were breached to Coyote Creek and tidal action in March 2006. Once breached, these ponds provided intertidal foraging habitat for shorebirds and other waterbirds at low tide and tidal foraging habitat for waterfowl at high tide. As sediment has accumulated, tidal marsh vegetation is becoming established, providing breeding and foraging habitat for the California Ridgway's rail (recently noted in Pond A21) and other marsh species. This dynamic is slowly reducing the total available habitat for anadromous fish species, but the overall effect of a mature tidal marsh at the Island Ponds is expected to continue to provide beneficial habitats, especially for juvenile salmonids outmigrating through Coyote Creek that can use those areas as nursery.

3.7.2 Alviso-A8 Ponds

These ponds provide forage habitat for terns, waterfowl, and shorebirds and the levees provide nesting habitat. Though they are muted tidal, the ponds do provide habitat for fish and benthic invertebrates that provide food for a variety of species.

During Phase 1 of the SBSP Restoration Project, levees were breached between Pond A8 and Ponds A8S, A5, and A7, and a reversible armored notch was installed (see Figure 4a). The reversible notch was installed in the eastern levee to allow muted tidal exchange. The notch may be opened to various widths or closed as needed for water quality or fish migration purposes. Notch operations are anticipated to naturally widen and deepen Alviso Slough over a period of years through tidally induced scour, thus increasing the flow conveyance of Alviso Slough.

As part of the Lower Guadalupe River Flood Protection Project, SCVWD constructed a series of floodwalls and levees along Guadalupe River and Alviso Slough. The west levee of Alviso Slough was reconfigured to act as a weir, allowing high flows in the Guadalupe River to exit Alviso Slough and enter Pond A8. The reconfigured west bank can divert up to 8,500 cfs to Pond A8 (of the 100-year flow, estimated at 18,300 cfs) and decrease water surface elevations in Alviso Slough downstream of the Union Pacific Railroad (UPRR). Flood flows would be conveyed into Ponds A5, A6, and A7. Flood waters would be held in the Pond A8 system and then pumped out (or conveyed via culverts with flap gates) over a period of time (about 1 month).

Ambient levels of mercury are elevated in Pond A8 due to sediment inputs from the upstream, long-closed New Almaden Quicksilver Mine. Therefore, there are concerns about mercury exposure in the A8 pond complex. Prior to any restoration actions, bioavailability and bioaccumulation of mercury were found to be greater in Pond A8 than in either Alviso Slough or its fringing tidal marsh. Methylmercury concentrations in water and sediment were greater in Pond A8 than in Alviso Slough or its fringing tidal marsh channels, and biosentinels representing benthic and shoreline habitats indicated more mercury bioaccumulation in Pond A8 than in the tidal marshes along Alviso Slough (Grenier et al. 2010).

As a result, a Phase 1 action was undertaken to better understand the level of the risk and any implications of taking actions to restore tidal flows to the pond. A variable crest weir with numerous gates (also referred to as the 'notch') was installed to incrementally allow tidal waters and to study the resulting effects. Adaptive management measures have been and will continue to be used to monitor effects from the A8 Ponds. Adaptive management monitoring has included methylmercury concentrations in water and sediments; special studies of sediment scour and transport; and changes in food web indicators and sentinel species. Adaptive management actions would be triggered when mercury concentrations of sentinel species increase substantially, compared to the reference site, regardless of whether they are over or under desirable levels. If triggers are exceeded, then adaptive management actions would be implemented. Examples of such actions include changing hydraulic residence times or manipulating other factors.

Findings to date include that the initial Phase 1 construction activities temporarily increased mercury levels that were observed in Forster's tern (a piscavore) eggs in this pond immediately following Phase 1 construction activities and opening of the notch at A8. However, these levels reduced and stabilized to those found at nearby reference sites by the next nesting season (Ackerman et al. 2014). A similar trend was observed in fish, but the return to ambient levels was much quicker (~3 months) and has been consistent with reference sites ever since (Bourgeois, pers. comm.). Construction at this location for Phase 2 will not include excavation of pond bottom, only the addition of clean fill material on top of existing pond bottom, therefore re-suspension of existing mercury at this location is believed to be a minimal risk. Additionally, the approved QAPP for upland fill material will ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water.

3.7.3 Alviso-Mountain View Ponds

The outboard areas of the pond levees and the lower reaches of the surrounding sloughs are characterized by tidal salt marsh and the interior of these ponds are primarily open water or mudflat with little to no visible vegetation. Suitable nesting bird habitat (for California gulls, Forster's terns, American avocets, black-necked stilts, and the occasional black skimmer) exists on a few small, isolated islands found within the interior waters of Ponds A1 and A2W. The Mountain View Ponds are currently operated for limited tidal circulation through Ponds A1 and A2W while maintaining discharge salinities to the Bay at less than 40 ppt (see Figure 4b). The intake for the Mountain View Ponds' system is located at the northwest end of Pond A1 and includes one 48-inch gate from lower Charleston Slough near the Bay. Flow moves through the system from the intake at Pond A1 though the 72-inch siphon under Mountain View Slough to Pond A2W. The system outlet is located at the north end of Pond A2W, with one 48-inch gate to the Bay. The gates are iteratively adjusted as needed to find the correct equilibrium of water inflow and discharge to account for evaporation and salinity concentration during the summer. Operations of the Mountain View Ponds' system require little active management of gate openings to maintain appropriate flows. However, flows can be modified based on changes in dissolved oxygen levels. Though they are extremely muted tidal, the ponds do provide habitat for fish and benthic invertebrates that provide food for a variety of fish species. They may occasionally be used by anadromous fish, but because there is only one gated entrance into Pond A1 and only one way back out to the Bay (through a siphon into Pond A2W and then a single gated exit from it), so these ponds are not good habitat for anadromous fish.

3.7.4 Ravenswood Ponds

All four of the Ravenswood Ponds are seasonally wet ponds that collect rainwater during winter but dry out to become salt panne in summer. There is no hydraulic or aquatic habitat connectivity with the Bay and thus no fish habitat within them.

4 Action Area

The Action Area is defined as all areas that may be affected directly or indirectly by the Federal action and not merely the immediate area directly involved in the action. The project footprint is the area where work activities would occur, including all construction, dredging, and construction staging and access, as discussed in the Project Description.

The Action Area includes the project footprint at each of the Phase 2 locations as well as the adjacent or nearby fringing marshes, mud flats, sloughs and other waterways that would be impacted by construction disturbance, turbidity, noise, or restoration-driven habitat changes, or long-term operations. **Figures 5a** through **Figure 5d** illustrate the Action Area at each of the four pond clusters. The Phase 2 Action Area is defined conservatively and includes much larger areas of waters, tidal mud flats, and fringing marshes than are expected to be actually affected when changes to the ponds and levees are made. The Action Area is inclusive of areas of potential effects on all ESA-listed species collectively, including those upland areas that are used by terrestrial species. Not all species would be affected in all portions of the Action Area. The Action Area at each of the four locations is described below.

4.1 Alviso-Island Ponds

The Action Area for the Alviso-Island Ponds (Ponds A19, A20, and A21, hereafter “Island Ponds”) is shown in **Figure 5a.** The Action Area includes the project footprint, which includes the ponds, surrounding levees, and portions of the existing fringing marshes and mudflats that would be directly modified by the proposed activities as well as areas that could be indirectly modified by changes in sediment transport or tidal flows. Coyote Creek and Mud Slough are the waterways that could be affected by these changes or could be traversed by water-based construction equipment to access the Island Ponds. In addition, portions of San Francisco Bay west of the Island Ponds could be affected by increases in turbidity during construction and changes in sediment transport or hydrology as a result of the proposed action. Work at the Island Ponds would not involve pile driving, jackhammering, explosive demolition of structures, or other increases in underwater noise from construction activities, so the Action Area at the Island Ponds does not include a large buffer for noise-related effects.

4.2 Alviso-A8 Ponds

The Action Area for the Alviso-A8 Ponds (Ponds A8 and A8S, hereafter “A8 Ponds”) is shown in **Figure 5b.** The project footprint for work at the A8 Ponds is limited to the southwest and southeast corners of these ponds, where the upland fill material from offsite excavation projects would be placed to form habitat transition zones. The Action Area includes this project footprint as well as the southern portion of the A8 Ponds, where there could be local turbidity increases during material placement. The Action Area also includes the existing levee roads that extend from the Pond A8 notch and that wrap around the southern border of this pond cluster. Work at the A8 Ponds would not involve pile driving, jackhammering, explosive demolition of structures, or other increases in underwater noise from construction activities, so the Action Area at the Island Ponds does not include a large buffer for noise-related effects.

4.3 Alviso-Mountain View Ponds

The Action Area for the Alviso-Mountain View Ponds (Ponds A1 and A2W, hereafter “Mountain View Ponds”) is shown in **Figure 5c**. The Action Area includes the project footprint, which include the ponds, levees, and those portions of the existing fringing marshes and mudflats that would be directly modified by the proposed action. The Action Area also includes the surrounding fringing marshes, mudflats and creeks or sloughs that could be indirectly modified by changes in tidal flows. Stevens Creek/Whisman Slough, Permanente Creek/Mountain View Slough, and Charleston Slough are waterways that could be affected by these changes. A portion of the City of Mountain View’s Coast Casey Forebay (a stormwater detention basin) and one of the levees surrounding it would also be directly affected by the proposed action; the rest of the forebay may be indirectly affected by construction-related activities. The uplands at Mountain View’s Shoreline Park (a closed landfill) include a mix of grasslands and other upland vegetation communities. Portions of the park itself would be used for fill material delivery and stockpiling, so it is included in the Action Area. In addition, portions of San Francisco Bay north of the Mountain View Ponds could be affected by an increased discharge of sediment during construction and changes in hydrology and mudflats as a result of the proposed action.

Work at the Mountain View Ponds would involve some pile driving (1-2 days), demolition and removal of structures, and other notably loud activities, so the Action Area was extended around these point-sources of noise (along the eastern levee of Pond A2W) to capture effects from in-air noise. Based on the noise assessment conducted for the project (Appendix C) underwater noise effects from pile driving may extend out into surrounding waters over a distance of 385 feet when not obstructed by a levee or other landform. This includes the waters of Stevens Creek/Whisman Slough, which support a known run of CCC steelhead.

4.4 Ravenswood Ponds

The Action Area for the Ravenswood pond cluster (Ponds R3, R4, R5, S5, and the S5 forebay; “the Ravenswood Ponds”) is shown in **Figure 5d**. The Action Area includes the project footprint, which include the ponds, levees, and portions of the existing fringing marshes and mudflats that would be directly modified by the activity. Further, a strip of the entry road into Menlo Park’s Bedwell Bayfront Park (a closed landfill) would be temporarily excavated to place a culvert connecting the S5 forebay to Flood Slough (it would be rebuilt and paved afterward), which makes it part of the project footprint.

The Action Area also includes its surrounding fringing marshes, mudflats and creeks or sloughs that could be indirectly modified by changes in tidal flows. Flood, Ravenswood, and West Point sloughs are the streams and waterways that could be affected by these changes. The uplands at Bedwell Bayfront Park include a mix of grasslands and other upland vegetation communities. Portions of the park would be used for fill material delivery, is also included in the Action Area. Portions of San Francisco Bay north of the Ravenswood Ponds could be affected by an increased discharge of sediment during construction and changes in hydrology and mudflats as a result of the proposed action.

Work at the Ravenswood Ponds would involve some pile driving (1-2 days), demolition and removal of structures, and other notably loud activities. Based on the noise assessment conducted for the proposed action (Appendix C) noise effects from pile driving may extend out into surrounding waters over a distance of 385 feet when not obstructed by a levee or other landform.

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5 Species and Habitats Considered

This section of the BA presents the results of background research that was conducted to identify federally listed species, their DCH, and EFH in the Action Area.

5.1 Study Methods

Preparation of this BA included review of a variety of sources to identify threatened and endangered species, DCH, and EFH that may be present in the vicinity of the proposed Action Area. The following sources were used to compile this list:

- A species list provided by San Francisco Bay-Delta Fish and Wildlife from the Sacramento Office of the USFWS was generated using project footprint coordinates located within portions of Alameda, San Mateo and Santa Clara Counties (USFWS 2016). This list is included in Appendix D.
- The California Natural Diversity Database (CNDDB; CDFW 2016) was consulted to generate a list of special-status species on record from the following 7.5-minute topographic quadrangles: Milpitas (3712148), Mountain View (3712241), Newark (3712251), Niles (3712158), Palo Alto (3712242), and Redwood Point (3712252).This list is included in Appendix E, and the CNDDB records within 5 miles of the Action Area are mapped on **Figure 6a**.
- Code of Federal Regulations (CFR) for the two federally listed species and their DCH are discussed in this BA.
- EFH mapper (http://www.habitat.noaa.gov/protection/efh/efhmapper/) and Fishery Management Plans (FMP) of the Pacific Fisheries Management Council.
- Species-specific studies presented in technical reports, scientific journals, and other publications.

Species lists generated through various sources listed above are provided in Appendices D and E. Those lists were further refined to limit the analysis in the BA to those species that could reasonably be expected to occur in the Action Area (see Appendix F for Evaluation of Occurrence Potential). Note that green sturgeon did not show up on the USFWS species list. However, green sturgeon is a threatened species protected under the ESA (71 FR 17757, Apr 7, 2006) that is known to occur within the Action Area which is also within DCH (74 FR 52300, October 9, 2009) for this species.

Many of the species discussed in this BA were also considered in the programmatic portion of the 2007 EIS/R and the SBSP Phase 1 BO (USFWS 2008 and NMFS 2008). Some listed species on found in the Appendix D and E were determined to not have the potential to occur within the Action Area or would otherwise not be affected by the proposed action. Species under the jurisdiction of the USFWS are identified and addressed in a separate BA.

5.2 Species Considered

Based upon the results of the potential to occur analysis described above this document evaluates two federally protected and NMFS-regulated species and their DCH that are present within the Action Area; green sturgeon and CCC steelhead. The Action Area also contains EFH as designated under multiple FMPs. The habitat for CCC steelhead at each of the four pond clusters is illustrated on **Figure 7a** through **Figure 7d**, respectively. Similarly, the habitat for green sturgeon at each of the four pond clusters is illustrated on **Figure 8a** through **Figure 8d**, respectively. **Figure 9a** through **Figure 9d** show the EFH at each pond cluster.

5.2.1 Central California Coast CCC steelhead

Multiple DPS's of CCC steelhead were listed as threatened on January 5, 2006 (71 CFR Vol. 3, 834-862). The Action Area is occupied by CCC steelhead DPS whose range includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in California streams from the Russian River (inclusive) to Aptos Creek (inclusive), and the drainages of San Francisco, San Pablo, and Suisun bays, eastward to Chipps Island at the confluence of the Sacramento and San Joaquin rivers (NMFS 2006). The DPS also includes tributary streams to Suisun Marsh, including Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough (commonly referred to as Red Top Creek), excluding the Sacramento–San Joaquin River basins, as well as two artificial propagation programs: the Don Clausen Fish Hatchery, and Kingfisher Flat Hatchery/Scott Creek (Monterey Bay Salmon and Trout Project) steelhead hatchery programs (NMFS 2006).

While there are no spawning areas within the Action Area, Whisman Slough/Stevens Creek (east of Pond A2W), Alviso Slough/Guadalupe River (east of Pond A8) and Coyote Creek (south of Ponds A19, A20, and A21) support known runs of CCC steelhead. In these waterways, CCC steelhead are expected to be seasonally present during the adult and juvenile migration periods. Juvenile CCC steelhead migrate as smolts to the ocean from January through May, with peak outmigration in March and April. Adults return from the ocean to freshwater between December and April, typically peaking in January and February (Fukushima and Lesh1998). Additionally, outmigrating juveniles (smolt) may utilize the tidally accessible portions of the Action Area, including the interior of ponds that receive tidal flows, as foraging areas during outmigration (January through May). Occupancy within the ponds is expected to be infrequent, as fish surveys conducted in the Alviso and Eden Landing Pond complexes during March 2004 to June 2005 and the July 2010 to October 2011 period did not find any steelhead (Mejia et al. 2008; Hobbs, Moyle, and Buckmaster 2012). Also, only the Island Ponds are open to full tidal flows; the aquatic connectivity between the A8 Ponds and the Mountain View Ponds and the streams that surround them are through water control structures of one kind or another.

5.2.2 Green Sturgeon

The southern DPS of green sturgeon was listed as federally threatened on April 6, 2006, by NMFS. This DPS of green sturgeon consists of all coastal and Central Valley populations south of the Eel River, with the only known spawning population in the Sacramento River (62 CFR 43937-43954). Like steelhead, green sturgeon are anadromous fish that spawn and rear in freshwater systems but spends the rest of their life cycle in marine and estuarine waters. Adult and juvenile green sturgeon range widely and are known to occupy and forage in estuaries, such as San Francisco Bay, where they may be present year-round (Moyle 2002). Within the San Francisco Estuary, juveniles feed on opossum shrimp and amphipods while adults eat benthic invertebrates and to a lesser extent, small fish (Miller and Kaplan 2001).

Individuals have been caught infrequently by anglers in the South Bay. Although the distribution of this species in the Action Area is not well known or documented, it is likely that individual green sturgeon occur very infrequently, and in low numbers, within the tidally accessible portions of the four pond clusters, the sloughs and creeks around them, and the portions of the open Bay within the Action Area.

5.3 Designated Critical Habitat Considered

Portions of the Action Area contain DCH for both CCC steelhead and green sturgeon, as described below.

5.3.1 CCC steelhead

Critical habitat was designated for the CCC steelhead DPS on September 2, 2005 (70 CFR 52488-52626). DCH for this species includes all portions of San Francisco Bay below MHHW. The designation includes natal spawning and rearing waters, migration corridors, and estuarine areas that serve as rearing areas. The following physical or biological features, essential to the conservation of a species on which its critical habitat is based, have been designated for this species (70 CFR 52488-52626):

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.
- Freshwater rearing sites with:
    - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
    - Water quality and forage supporting juvenile development; and
    - Natural cover such as shade, submerged and overhanging large wood, log jams, and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction and excessive predation with:
    - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh water and saltwater;
    - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and
    - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The Action Area contains some of these habitat features in the form of estuarine areas used for foraging and as a migratory pathway for CCC steelhead to move in and out of upstream spawning areas in Stevens Creek, Coyote Creek, and Guadalupe River. Generally speaking, the lateral extent of this DCH is defined by the ordinary high-water line in freshwater systems and MHHW in estuarine areas. In the Action Area (**Figures 5a** through **5b; and 7a** through **7b)**, the A8 Ponds are actively managed so that they experience muted tidal fluctuations but still have features necessary to be considered DCH. While the Ravenswood Ponds contain areas that are below the MHHW elevation, they are not connected to the Bay and thus are not part of DCH for this species. Both the Island Ponds and Mountain View Ponds are within the DCH area, as are Ravenswood and Flood sloughs.

5.3.2 Green Sturgeon

On October 9, 2009, the NMFS issued a final designation of critical habitat for green sturgeon (74 CFR 52300-52351). This includes the designation of specific rivers, estuaries, and coastal areas as critical habitat for this species. The following physical or biological features, essential to the conservation of a species on which its critical habitat is based, have been designated for this species in estuarine areas (74 CFR 52300-52351):

- Food resources. Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages. Prey species for juvenile, subadult, and adult green sturgeon within bays and estuaries consist primarily of benthic invertebrates and fishes, including crangonid shrimp, burrowing thalassinidean shrimp, amphipods, isopods, clams, annelid worms, crabs, and small fish.
- Water flow. Within bays and estuaries adjacent to the Sacramento River (i.e., the Sacramento, San Joaquin Delta, and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds.
- Water quality. Water quality, including temperature, salinity, dissolved oxygen content, and other chemical characteristics necessary for normal behavior, growth, and viability of all life stages.
- Migratory corridor. A migratory pathway necessary for the safe and timely passage of green sturgeon within estuarine habitats and between estuarine and riverine or marine habitats. Safe and timely passage requires that human-induced physical, chemical, or biological impediments do not alter the migratory behavior of the fish such that its survival or the overall viability of the species is compromised. An impediment is something that compromises the ability of individual fish to reach a thermal refuge by the time it enters a particular life stage.
- Depth. A diversity of depths necessary for shelter, foraging, and migration of juveniles, subadult, and adult life stages. Subadult and adult green sturgeon occupy a diversity of depths within bays and estuaries for feeding and migration. Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters over shallow depths of less than 33 feet, either swimming near the surface or foraging along the bottom.
- Sediment quality. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This element includes sediments free of elevated levels of contaminants (e.g., selenium, organochlorine pesticides) that can cause adverse effects on all life stages of green sturgeon.

Under this ruling, the entire San Francisco Bay, including the tidally influenced areas of all four pond clusters, below MHHW is designated as critical habitat for green sturgeon. The Action Area (**Figures 5a** through **5d, and 8a** through **8d**) contains some of these habitat features in the form of estuarine areas used for holding and foraging. Generally speaking, the lateral extent of this critical habitat is defined by the ordinary high-water line in freshwater systems and MHHW in estuarine areas. However, in the Action Area, the Ravenswood Ponds contain areas that are below the MHHW elevation, but they are not connected to the Bay and thus are not part of DCH for this species. The remainder of the Action Area that is tidally influenced is considered DCH for this species.

5.4 Essential Fish Habitat Considered

The San Francisco Bay, including the Action Area, is classified as EFH under the MSA that serves habitat for multiple federally-managed species under the three FMPs (Coastal Pelagic, Pacific Groundfish, and Pacific Coast Salmon; see Table ES-1 in the Executive Summary). Additionally, the tidally influenced waters in the Action Area are designated as a habitat area of particular concern (HAPC) within these EFH designations. The lateral extent of EFH within the Action Area is the MHHW line (**Figures 9a** through **9d**).

Coastal Pelagic FMP

The Coastal Pelagic FMP is designed to protect habitat for a variety of fish species that are associated with open coastal waters. Fish managed under this plan include planktivores and their predators.

Pacific Groundfish FMP

The Pacific Groundfish FMP is designed to protect habitat for more than 90 species of fish including rockfish, flatfish, groundfish, some sharks and skates, and other species associated with rocky and muddy underwater substrates.

Pacific Salmon FMP

The Pacific Salmon FMP is designed to protect habitat for commercially imported salmonid species. Chinook salmon is the only of these species that may be seasonally present in the Action Area.

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6 Effects of the Proposed Action

The proposed action may result in adverse effects on CCC steelhead and green sturgeon, and may affect DCHs for those species and EFH during construction or operations and maintenance activities. The proposed action will also provide beneficial long-term habitat changes for those species, DCH, and EFH. These potential effects would include disturbance to a small area of habitat, localized increases in turbidity, increases in human activity, and possible injury to fish due to construction-related underwater noise. To avoid and minimize potential adverse effects on these species, the avoidance and minimization measures identified in Section 2 would be implemented during construction. The long-term permanent effects of the proposed action are anticipated to be beneficial to fish, DCH, and EFH through the creation or enhancement of rearing and forage habitat and through more aquatic habitat connectivity and complexity.

Another one of the major goals of the SBSP Restoration Project is to maintain or improve current levels of flood protection. To that end, the project designs include a number of features intended to provide protection from flooding associated with future sea-level rise by the establishment of tidal marshes and habitat transition zones, both of which are central features of the proposed action. Thus, the SBSP Restoration Project is expected to be part of the long-term adaptation to climate change-related issues in the South Bay, while conserving habitat for listed fish species as sea levels rise by maintaining fringing marsh and shallow water habitat adjacent to flood protection levees.

In terms of long-term changes to the aquatic habitat, **Table 16** below summarizes the areas of waters that would be filled or otherwise modified by proposed project components such as creation of habitat transition zones, habitat islands, or wider levees at each of the four project locations. It also summarizes the areas of waters that would be made newly available through adding connections where none currently exist (such as at the Ravenswood Ponds) or where that connectivity is strictly confined through a water control structure (at the Mountain View Ponds), or that are otherwise enhanced through habitat complexity (at the Island Ponds). As summarized in Table 16, there will be an overall improvement to habitat for CCC steelhead and green sturgeon, as well as the opening of 288.7 acres to tidal action, providing an increase in habitat area for these species.

Table 16. Areas of Habitat Change by Pond Cluster

SPECIES	POND CLUSTER	AREA OF HABITAT CHANGE (ACRES)				
		CREATED/ NEWLY OPENED	ENHANCED/ IMPROVED	NO CHANGE	DEGRADED/ CONVERTED	LOST
Green Sturgeon and CCC Steelhead	Island	3.1	329.6	371.6	1.9	0.0
	A8	0.0	20.4	180.4	0.0	4.2
	Mountain View	1.5	721.8	347.7	2.8	11.9
	Ravenswood	284.1	0.0	582.4	0.0	0.0
	Total	288.7	1071.7	1482.1	4.7	16.1

Effects of the proposed action on listed species within the Action Area for the four pond cluster restoration activities are discussed below.

6.1 CCC steelhead

This section details the potential effects of Phase 2 on CCC steelhead in each portion of the Action Area, including the effects of construction, operations and maintenance, and long-term habitat changes on the species. The habitat for CCC steelhead at each of the four pond clusters is illustrated on **Figure 7a** through **Figure 7d** respectively.

6.1.1 Island Ponds

Construction Effects

Individual juvenile CCC steelhead have potential to occur in the Island Ponds during outmigration from the Coyote Creek watershed (January through May, with peak outmigration in March and April). During this period, there is the potential for individuals to be killed or injured during construction that involves in-water work including excavation of pilot channels, the creation of ditch blocks, levee lowering, and levee breaching. However, the implementation of conservation measures (such as the exclusion of fish with block nets or cofferdams, closed during low tide if practicable) would avoid or minimize direct injury or mortality of CCC steelhead. In-water work would be timed with the tides and implemented seasonally to the extent practicable to avoid impacts to fish that might be present in the ponds or adjacent sloughs. Biological monitors qualified for fish removal and relocation, would conduct fish rescue of enclosed waters as needed to reduce the potential of injury or death resulting from in-water activities.

Adult CCC steelhead may also be present in Coyote slough during their migratory period (December through April). However, they are not expected to utilize the margin waters where construction activities would occur. Therefore, direct injury to adults is not expected.

Construction and excavation activities, such as the creation of ditch blocks, pilot channel excavation, and levee breaches, would result in soil disturbance and are likely to temporarily increase turbidity and suspended sediment. These actions could negatively impact CCC steelhead that may be present by temporarily degrading water quality, reducing prey resources, disturbing habitat, and impeding movements. Spills or other chemical contamination from construction equipment could also negatively affect CCC steelhead habitat if they occur. There would be no pile driving conducted at this location, and none of the work is expected to create noise levels that would exceed NMFS criteria for fish.

Conservation measures are provided to avoid or minimize construction effects. These include seasonal avoidance when adults are less likely to be in the area, working at low tide, biological monitoring, and using cofferdams to keep fish and aquatic life out of the construction area if necessary. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the range of this species in the San Francisco Bay estuary.

Operations and Maintenance Effects

Operations and maintenance activities at the Island Ponds would be limited to occasional monitoring and other research actions. Also, aside from the monitoring and management activities of the AMP and continued maintenance of the existing UPRR track, no other operations and maintenance activities would occur at the Island Ponds. These ongoing activities have been included in the PBOs and other permitting and consultations. Therefore, operations and maintenance are not expected to result in increased levels of disturbance to CCC steelhead if present.

Habitat Effects

Although proposed activities may result in short-term negative impacts to water quality (brief increases in turbidity), in the long-term the restoration of tidal marshes is expected to benefit CCC steelhead by improving habitat quality (e.g., increasing invertebrate productivity in rearing habitats), as well as improving connectivity between estuarine habitat and the existing open waters of the Bay.

6.1.2 A8 Ponds

Construction Effects

While the A8 Ponds currently have a managed and muted tidal connection to the Bay via Alviso Slough, CCC steelhead could be excluded by seasonal closure of “the notch” (the water control structure). Even if the notch is left open during construction, the work could be timed to avoid CCC steelhead migrations, and there is little evidence that the species enters the pond with any degree of frequency. Thus, the direct loss of individuals and other direct effects on individuals that could occur at the A8 Ponds during construction is minimal. There may be a minor increase in turbidity during placement of material, but it would be well-contained by the remnant levee between A8S and A8. As described in Section 3.7.2, there are concerns about mercury exposure in these ponds. Construction at this location will not include excavation of pond bottom, only the addition of clean fill material on top of existing pond bottom, therefore re-suspension of existing mercury at this location is believed to be a minimal risk. Additionally, the RWQCB accepted QAPP for upland fill material will ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water and harm CCC steelhead.

Operations and Maintenance Effects

Most operations and maintenance at the A8 Ponds would not be changed as a result of Phase 2 project actions. There would likely be periodic invasive vegetation control, mosquito abatement, and occasional placement of fill to retain levees. Most of these ongoing activities have been included in the PBOs and other permitting and consultations. The habitat transition zones may need an increased amount of vegetation control or mosquito abatement than the A8 Ponds would require without them. These actions are not anticipated to bring new or different effects that were not previously evaluated on CCC steelhead. Operation of the reversible armored notch to control water levels in the A8 ponds is part of the SBSP Phase 1 actions and thus not covered in this consultation.

Habitat Effects

The proposed project activities would convert a small portion of this large muted tidal pond system to habitat transition zone wetlands and some adjacent upland. Yet, the long-term plan for this pond cluster is to open it to tidal flows and make it more accessible to outmigrating CCC steelhead and other fish. The construction of habitat transition zones is a part of this plan. Thus, the restoration of tidal marshes in the A8 Ponds are expected to benefit CCC steelhead by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats) and habitat quantity (restoring full tidal action to areas of the Bay), as well as improving connectivity between estuarine habitat and the existing open waters of the Bay.

6.1.3 Mountain View Ponds

Construction Effects

These ponds have very limited hydraulic exchange with the Bay through a single gated inlet into Pond A1 and then through a siphon from A1 into Pond A2W. It is thus extremely unlikely that CCC steelhead would occur within the ponds during migration periods. The potential for occurrence is limited, but there is a slight possibility for individuals to be killed or injured during construction activities (levee breaching, levee improvements, and construction of habitat transition zones and habitat islands) within the Mountain View Ponds if CCC steelhead are present. The implementation of conservation measures would minimize direct injury or mortality of CCC steelhead. Conservation measures include timing in-water work seasonally and with the tides to the extent practicable to avoid fish presence in the ponds or in adjacent sloughs. Standard best management practices for in-water construction would be employed. These include using exclusion nets and placing cofferdams, closed at low tide if practicable. Biological monitors qualified for fish removal and relocation would perform fish rescue of enclosed waters as needed. Additionally, the approved QAPP for upland fill material will ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water and harm CCC steelhead.

The PG&E tower foundation work and PG&E access boardwalk work would be completed using hand tools and would result in negligible construction disturbance to the habitat within the Mountain View Ponds.

CCC steelhead are also expected to be seasonally present (January through May for juveniles and December through April for adults) outside of the levee in adjacent Stevens Creek. Stevens Creek may be impacted by construction activities during breaching and installation of a railcar bridge over the new breach locations on the eastern levee of Pond A2W, which would require a few days of pile driving. The actual breaching event could take place outside of the CCC steelhead migration season, so direct effects to steelhead from breaching the levee may be avoided entirely. If that is not practicable, working at low tide and/or building those bridges prior to excavating the channel to connect the pond interior to Stevens Creek could further reduce the effects. However, even if those avoidance measures cannot be fully implemented, the underwater noise modeling presented in Appendix C indicates that underwater noise produced during pile driving for the proposed action would not exceed the 206 decibel (dB) peak or 187 dB accumulated sound exposure level (SEL) thresholds that NMFS has established for injury or temporary threshold shifts (TTS) to hearing capacity. However, the underwater noise would exceed the 150 dB root mean square (RMS) threshold used by NMFS for behavioral effects on fish. Potential behavioral effects of underwater noise include the temporary cessation of feeding, startle responses, or movements to other areas.

Depending on the timing of work, these behavioral effects could disrupt migratory movements of CCC steelhead. Following the cessation of pile driving, fish are expected to resume the use of the affected area. The estimated distance over which 150 dB RMS may be exceeded is 385 feet for impact driving of the concrete piles and 10 feet for vibratory driving of the sheet piles (Appendix C). During low tide, the pile driving areas would be separated from the wetted channel by a distance of at least 30 feet. At these times, very little of the sound energy is expected to enter waters where fish may be present. During high tide, however, the pile driving noise could more readily radiate out into the channel and affect CCC steelhead that may be present. Implementation of the conservation measures, such as the "soft start" technique would be implemented during pile installation activities to reduce hydroacoustic impacts. No injury or mortality is expected from underwater noise.

Operations and Maintenance Effects

Operations and maintenance actions would include invasive vegetation control, placing fill to address erosion of levees retained for PG&E access, PG&E's own operations and maintenance, mosquito abatement, annual bridge inspections and repairs as necessary, and ongoing species counts and other Refuge management actions. Many of these ongoing activities have been included in the PBOs, Refuge management plans, and other permits and consultations. The PG&E operations and maintenance actions are covered under separate permits. The additional or different operations and maintenance activities associated with the proposed action at the Mountain View Ponds are vegetation control on habitat transition zones, islands, and improved levees; mosquito abatement; and bridge maintenance. These are likely to temporarily disturb habitat potentially occupied by CCC steelhead. The effects of these disturbances would be similar to construction effects, but would be temporary, infrequent, and of a reduced magnitude.

Habitat Effects

The wider levee bases, habitat transition zones, and habitat islands would fill some small portions of low-value aquatic habitat. The additional section of PG&E boardwalk would add some overwater fill outside of the ponds, but the replacement boardwalk within it would not. But the levee breaching would convert uplands to waters and would also greatly improve CCC steelhead access to several hundred acres of tidal ponds and increase overall habitat value, more than compensating for the small amount of fill needed for this work.

Although these activities would result in some overall loss of aquatic habitat from creation of levee widening, islands, and habitat transition zones, the opening of the Mountain View Ponds to tidal flows and the eventual restoration of tidal marshes there are expected to benefit CCC steelhead by greatly increasing the amount of habitat accessible to steelhead and also improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats and restoring full tidal action to areas of the Bay) as well as improving connectivity between estuarine habitat and the existing open waters of the Bay. The net effect would be substantially positive.

6.1.4 Ravenswood Ponds

Construction Effects

The Ravenswood Ponds currently have no tidal connection to the Bay, so CCC steelhead would not be present in the ponds during construction activity (levee work, pilot channel excavation, ditch block installation, construction of habitat transition zones and habitat islands, and water control structure installation) in the ponds. However, when the Ravenswood Slough levee is breached and when the water control structures are added, nearby waters in tidal Ravenswood Slough and San Francisco Bay potentially supporting CCC steelhead may be affected. The breaching and coffer dam work would occur outside of the CCC steelhead migration season and/or at low-tide to the extent practicable, and thus have few direct effects to the species. Also, none of the sloughs around the

Ravenswood Ponds have connections to upstream spawning areas, and CCC steelhead use of these waters is expected to be minimal at any time.

The noise analysis (Appendix C) showed that potential behavioral effects due to noise from brief pile driving during installation of the pedestrian pipe bridge and temporary cofferdam needed for the water control structures would be limited to just a few hundred feet, which is a radius that would not reach the Bay and would thus be unlikely to affect CCC steelhead. Additionally, the implementation of conservation measures (such as the exclusion of fish with block nets or cofferdams, closed at low tide if practicable) would minimize the potential for direct injury or mortality of CCC steelhead. In-water work would be timed with the low tides and implemented seasonally to the extent practicable to avoid impacts to fish that might be present in the adjacent sloughs. Biological monitors qualified for fish removal and relocation would conduct fish rescue of enclosed waters as needed to reduce the potential of injury or death resulting from in-water activities. Additionally, the approved QAPP for upland fill material will ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water and harm CCC steelhead.

Operations and Maintenance Effects

Basic operations and maintenance actions would include invasive vegetation control, mosquito abatement, placing fill to address erosion of levees retained for water management, and ongoing species counts and other Refuge management actions. Many of these ongoing activities have been included in the PBO, Refuge management plans, and other permits and consultations. The additional or different operations and maintenance activities associated with the proposed action at the Ravenswood Ponds are vegetation control on habitat transition zones, islands, and improved levees; mosquito abatement; and operation of the four water control structures.

Operation of the water control structures would be done to manage water levels in the R3, R5 and S5 ponds. These water control structures would be managed in a way that would minimize the potential for entrapment of CCC steelhead in the managed ponds. The proposed water control structures for the managed Ravenswood Ponds are not located along a migratory pathway that CCC steelhead must use to move through the estuary, but are located within dead-end sloughs (Flood Slough and Ravenswood Slough) that are accessible to steelhead. As a result, operating the water control structures outside of the seasonal work window has the potential to entrain very small numbers of juvenile CCC steelhead into the managed ponds, where they may be exposed to increased predation, decreased DO, or other stressors. No data is available to estimate the potential magnitude of this entrainment, however fish surveys conducted in the nearby Alviso and Eden Landing Pond complexes have failed to detect any steelhead (Mejia et al. 2008; Hobbs, Moyle, and Buckmaster 2012), supporting the assumption that the number is very low. Adults are not expected to be entrained due to their stronger swimming ability and short time of residence within estuarine waters during migration. Overall, the increased access to and improvement in foraging habitat for CCC steelhead that would result from the proposed action would outweigh the low potential for fish to be entrained in a way that would expose individuals to the stressors described above.

Some of these are likely to temporarily disturb habitat potentially occupied by CCC steelhead. The effects of these disturbances would be similar to construction effects, but would be temporary, infrequent, and of a reduced magnitude.

Habitat Effects

Breaching the levee would have indirect effects to habitat for CCC steelhead due to alterations of tidal movements and sediment transport. The breach would increase tidal currents in the mouth of Ravenswood Slough, which may cause localized scouring and deepening of the channel in the Slough. Similarly, the tidal prism of the ponds may reduce tidal currents upstream in Ravenswood slough, causing siltation and reduction in the channel size upstream of the breach. Overall, the breaching of the Ravenswood Ponds would create over 625 acres of additional foraging habitat for juvenile CCC steelhead and increase habitat complexity in the South Bay as the Ponds redevelop channels and marshlands.

6.1.5 CCC steelhead Effects Summary

Phase 2 tidal restoration activities would require work in habitats that may be occupied by CCC steelhead, depending on the seasonal timing of work. CCC steelhead individuals could be injured or harassed during construction related to the placement of ditch blocks, installation of water control structures, levee breaches and construction of habitat islands and habitat transition zones if such work occurs in tidal waters outside of the work window for the species. The number of individuals affected is anticipated to be small with the implementation of conservation measures restricting timing and duration of construction activities, the use of block nets to exclude fish, and fish rescue conducted by qualified biologists if needed. Underwater noise associated with pile driving may harass small numbers of fish, depending on the seasonality and timing of the pile driving, but would not be of an intensity that may injure CCC steelhead or cause TTS.

Operation of the water control structures at the Ravenswood Ponds has some limited potential to entrain small numbers of juvenile steelhead. Entrained CCC steelhead may be exposed to increase predation or decreased water quality before they can move out of the managed ponds.

Ongoing impacts that would alter habitat include increasing the tidal prism, which could alter sediment movement in some parts of the Action Area, resulting in the deepening of some channels and sediment deposition in others. In the long term, there would be a large positive net benefit to CCC steelhead because the proposed action is expected to result in considerable increases in the quantity and quality of estuarine juvenile rearing habitat, thereby augmenting populations far beyond the minor, local adverse effects that would occur during construction, operation, and maintenance activities.

6.2 Green Sturgeon

This section details the potential effects of Phase 2 on Southern DPS green sturgeon at each portion of the Action Area, including the effects of construction, operations and maintenance, and long-term habitat changes on the species. The habitat for green sturgeon at each of the four pond clusters is illustrated on **Figure 8a** through **Figure 8d** respectively.

6.2.1 Island Ponds

Construction effects

Green sturgeon may be present in or immediately outside the Island Ponds year round, and there is the potential for individuals to be killed or injured during construction that involves in-water work including excavation of pilot channels, the creation of ditch blocks, levee lowering, and levee breaching. However, the implementation of conservation measures (such as the exclusion of fish with block nets or cofferdams, closed during low tide if practicable) would avoid or minimize direct injury or mortality of green sturgeon. In-water work would be timed with the low tides to the extent possible to avoid impacts to green sturgeon that might be present within the ponds or adjacent sloughs. Biological monitors qualified for fish removal and relocation would conduct fish rescue of enclosed waters as needed to reduce the potential of injury or death resulting from in-water activities.

Construction and excavation activities, such as the creation of ditch blocks, pilot channel excavation and levee breaches, would also result in sediment disturbance and are likely to temporarily increase turbidity and suspended sediment. Potentially elevated turbidity is not likely to be altered beyond tolerable limits for green sturgeon adapted to living in turbid environments, however these actions could negatively impact green sturgeon that may be present by reducing prey resources, disturbing habitat, and impeding movements of green sturgeon. Spills or other chemical contamination from construction equipment could also negatively affect green sturgeon habitat. There would be no pile driving conducted at this location, and none of the work is expected to create noise levels that would exceed NMFS criteria for fish.

Conservation measures are provided to avoid or minimize construction effects. These include working at low tide, biological monitoring, and using cofferdams to keep fish and aquatic life out of the construction area if necessary. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the range of this species in the San Francisco Bay estuary.

Operations and Maintenance Effects

Aside from the monitoring and management activities of the AMP and continued maintenance of the existing UPRR track, no other operations and maintenance activities would occur at the Island Ponds. As these activities have been included in prior consultations, no analysis is needed here.

Habitat effects

Although these activities may result in short-term negative impacts, in the long-term the restoration of tidal marshes are expected to benefit green sturgeon by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats), habitat quantity (restoring full tidal action to areas of the Bay) as well as improving connectivity between estuarine habitat and the existing open waters of the Bay.

6.2.2 A8 Ponds

Construction Effects

The A8 Ponds currently have a managed tidal connection to the Bay, which limits tidal exchange in within the A8 Ponds (AECOM 2016). While it is possible for green sturgeon to enter the A8 Ponds through the notch, potential for such occurrence is considered to be low. As the potential for occurrence is limited, there is a slight possibility for individuals to be killed or injured during construction activities (levee breaching, levee improvements, and construction of habitat transition zones and habitat islands) within the A8 ponds. The implementation of conservation measures would minimize direct injury or mortality of green sturgeon. Conservation measures include timing in-water work with the tides to the extent possible to avoid fish presence within the ponds or in nearby sloughs. Standard best management practices for in-water construction would be employed such as using exclusion nets and the placement of cofferdams, closed during low tide if practicable. Biological monitors qualified for fish removal and relocation would conduct fish rescue of enclosed waters as needed to reduce the potential of injury or death resulting from in-water activities.

There are concerns about mercury exposure in these ponds, as described in Section 3.7.2. Construction at this location will not include excavation of pond bottom, only the addition of clean fill material on top of existing pond bottom, therefore re-suspension of existing mercury at this location is believed to be a minimal risk. Additionally, the approved QAPP for upland fill material will ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water and harm green sturgeon.

Operations and Maintenance Effects

Most operations and maintenance at the A8 Ponds would not be changed as a result of Phase 2 project actions. There would likely be periodic invasive vegetation control, mosquito abatement, and occasional placement of fill to retain levees. Most of these ongoing activities have been included in the PBOs and other permitting and consultations. The habitat transition zones may need an increased amount of vegetation control or mosquito abatement than the A8 Ponds would require without them. It is possible, though unlikely, that these operations and maintenance activities associated with the proposed Action Area could temporarily disturb habitat potentially occupied by green sturgeon. Operation of the reversible armored notch to control water levels in the A8 ponds was included in the SBSP Phase 1 actions and thus not covered in this consultation.

Habitat Effects

Although these activities may result in short-term negative impacts, in the long-term the restoration of tidal marshes are expected to benefit green sturgeon by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats), habitat quantity (restoring full tidal action to areas of the Bay) as well as improving connectivity between estuarine habitat and the existing open waters of the Bay.

6.2.3 Mountain View Ponds

Construction Effects

These ponds have limited hydraulic connectivity with the Bay through a single inlet gate, so green sturgeon could be present year-round; however, the probability of this occurring are small and would not affect many individuals. Green sturgeon have not been known to be present in these ponds. Nevertheless, there is a slight possibility for individuals to be killed or injured during construction activities (levee breaching, levee improvements, and construction of habitat transition zones and habitat islands) within the Mountain View Ponds. The implementation of conservation measures would minimize direct injury or mortality of green sturgeon. Conservation measures include timing in-water work in the ponds and the surrounding waterways with low tides to the extent practicable to avoid fish presence within the ponds or in nearby sloughs. Standard best management practices for in-water construction would be employed such as using exclusion nets and the placement of cofferdams, closed during low tide if practicable. Biological monitors qualified for fish removal and relocation would conduct fish rescue of enclosed waters as needed to reduce the potential of injury or death resulting from in-water activities. The approved QAPP for upland fill material will ensure that any fill used in the creation of habitat transition zones or islands is free of contaminants that may enter the water and harm green sturgeon.

The PG&E tower foundation work and PG&E access boardwalk work would be completed using hand tools and would result in negligible disturbance to the habitat within the Mountain View Ponds. While the boardwalk improvements outside of Pond A1 would add a small amount of overwater fill to the pond, the levee breaching would greatly improve access for green sturgeon and increase overall habitat value, more than compensating for the small amount of fills needed for this work.

Green sturgeon may also occur year-round outside of the levee in adjacent Stevens Creek (Whisman Slough) and Permanente Creek (Mountain View Slough). Stevens Creek may be impacted by construction activities during breaching and installation of a railcar bridge over the two new breach locations on the eastern side of Pond A2W, which would require a few days of pile driving. During the actual breaching event, green sturgeon may be exposed to increased turbidity as tidal waters move over disturbed sediment, or exposure to slight changes in salinity depending on the inputs and out puts of the Mountain View Ponds at the time of the breaching.

With regard to pile driving for the railcar bridges, the underwater noise modeling presented in Appendix C indicates that underwater noise produced during pile driving for the proposed action would not exceed the 206 dB peak or 187 dB accumulated SEL thresholds that NMFS has established for injury or TTS to hearing capacity. However, the underwater noise would exceed the 150 dB RMS threshold used by NMFS for behavioral effects on fish. Potential behavioral effects of underwater noise include the temporary cessation of feeding, startle responses, or movements to other areas. Following the cessation of pile driving, fish are expected to resume the use of the affected area. The estimated distance over which 150 dB RMS may be exceeded is 385 feet for impact driving of the concrete piles and 10 feet for vibratory driving of the sheet piles (Table 3 in Appendix C). During low tide, the pile driving areas would be separated from the wetted channel by a distance of at least 30 feet. At these times, very little of the sound energy is expected to enter waters where fish may be present. During high tide, however, the pile driving noise could more readily radiate out into the channel and affect green sturgeon that may be present.

Implementation of the conservation measures, such as the “soft start” technique would be utilized during pile installation activities to reduce hydroacoustic impacts. No injury or mortality is expected from underwater noise; however, behavioral effects may occur as green sturgeon may be present year-round.

Operations and Maintenance Effects

Operations and maintenance actions would include invasive vegetation control, placing fill to address erosion of levees retained for PG&E access, PG&E’s own operations and maintenance, mosquito abatement, annual bridge inspections and repairs as necessary, and ongoing species counts and other Refuge management actions. Many of these ongoing activities have been included in the PBOs, Refuge management plans, and other permits and consultations. The PG&E operations and maintenance actions are covered under separate permits. The additional or different operations and maintenance activities associated with the proposed action at the Mountain View Ponds are vegetation control on habitat transition zones, islands, and improved levees; mosquito abatement;

and bridge maintenance. These are likely to temporarily disturb habitat potentially occupied by green sturgeon. The effects of these disturbances would be similar to construction effects, but would be temporary, infrequent, and of a reduced magnitude.

Habitat Effects

Although these activities may result in short-term negative impacts, in the long-term programmatic level restoration of tidal marshes are expected to benefit green sturgeon by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats), habitat quantity (restoring full tidal action to areas of the Bay) as well as improving connectivity between estuarine habitat and the existing open waters of the Bay.

6.2.4 Ravenswood Ponds

Construction Effects

The Ravenswood Ponds currently have no tidal connection to the Bay, so green sturgeon would not be present in the ponds during construction activity (levee work, pilot channel excavation, ditch block installation, construction of habitat transition zones and habitat islands, and water control structure installation) in the ponds themselves. However, when the Pond R4 levee is breached or modified or when water control structures are installed to connect ponds R3 to Ravenswood Slough and S5 to Flood Slough, the nearby waters potentially supporting green sturgeon may be affected. Such effects include exposure to increase turbidity as tidal waters tidal waters move over disturbed sediment, or exposure to slight changes in salinity if the Ravenswood ponds are retaining water at the time of breaching. The approved QAPP for upland fill material will ensure that any fill used in the creation of habitat transition zones or islands is free of contaminants that may enter the water and harm green sturgeon.

The noise analysis (Appendix C) showed that potential behavioral effects due to noise from brief pile driving during installation of the pedestrian pie bridge and temporary cofferdam needed for the water control structures would be limited to just a few hundred feet of Ravenswood and Flood sloughs, so few, if any, green sturgeon have any potential to be exposed. The implementation of conservation measures (such as the exclusion of fish with block nets or cofferdams, closed during low tide if practicable, would minimize the potential for direct injury or mortality of green sturgeon resulting from in-water construction. In-water work would be timed with the tides to the extent practicable to avoid impacts to fish that might be present in the adjacent sloughs. Biological monitors qualified for fish removal and relocation would conduct fish rescue of enclosed waters as needed to reduce the potential of injury or death resulting from in-water activities.

Operations and Maintenance Effects

Basic operations and maintenance actions would include invasive vegetation control, mosquito abatement, placing fill to address erosion of levees retained for water management, and ongoing species counts and other Refuge management actions. Many of these ongoing activities have been included in the PBOs, Refuge management plans, and other permits and consultations. The additional or different operations and maintenance activities associated with the proposed action at the Ravenswood Ponds are vegetation control on habitat transition zones, islands, and improved levees; mosquito abatement; and operation of the four water control structures.

Operation of the water control structures would be done to manage water levels in the R3, R5 and S5 ponds. These water control structures would be managed in a way that would minimize the potential for entrapment of green sturgeon in the managed ponds. The proposed water control structures are located within dead-end sloughs (Flood Slough and Ravenswood Slough) that are accessible to all estuarine fish. As a result, operating the water control structures has the potential to entrain low numbers of juvenile green sturgeon into the managed ponds, where they may be exposed to increased predation, decreased DO, or other stressors. No data is available to estimate the potential magnitude of this entrainment, however fish surveys conducted in the nearby Alviso and Eden Landing Pond complexes have failed to detect any green sturgeon (Mejia et al. 2008; Hobbs, Moyle, and Buckmaster 2012), supporting the assumption that the number is very low. Adults are not expected to be entrained due to their stronger swimming ability. Overall, the increased access to and improvement in foraging habitat for green sturgeon that would result from the proposed action would outweigh the low potential for fish to be entrained in a way that would expose individuals to the stressors described above.

Some of these are likely to temporarily disturb habitat potentially occupied by green sturgeon. The effects of these disturbances would be similar to construction effects, but would be temporary, infrequent, and of a reduced magnitude.

Habitat Effects

Breaching the levee would have indirect effects to habitat for green sturgeon due to alterations of tidal movements and sediment transport. The breach would increase tidal currents in the mouth of Ravenswood Slough, which may cause localized scouring and deepening of the channel in the Slough. Similarly, the tidal prism of the ponds may reduce tidal currents upstream in Ravenswood slough, causing siltation and reduction in the channel size upstream of the breach. Overall, the breaching of the Ravenswood Ponds would create over 625 acres of additional foraging habitat for green sturgeon and increase habitat complexity in the South Bay as the Ponds redevelop channels and marshlands.

6.2.5 Green Sturgeon Effects Summary

Phase 2 tidal restoration activities would require direct alteration of habitats that may be occupied by adult and juvenile green sturgeon. Green sturgeon individuals could be injured or harassed during construction related to the placement of ditch blocks, installation of water control structures, levee breaches and construction of habitat islands and habitat transition zones if such work occurs in tidal waters. The number of individuals affected is anticipated to be small with the implementation of conservation measures restricting timing and duration of construction activities, the use of block nets to exclude fish, and fish rescue conducted by qualified biologists if needed. Underwater noise associated with pile driving may harass small numbers of fish, but would not be of an intensity that may injure green sturgeon or cause TTS.

Operation of the water control structures for the Ravenswood managed ponds has the potential to entrain small numbers of green sturgeon. Entrained green sturgeon may be exposed to increase predation or decreased water quality before they can move out of the managed ponds.

Ongoing impacts that would alter habitat include, changing of tidal prism which could alter sediment movement in some areas of the Action Area, resulting in the deepening of some channels and sediment deposition in others. In the long term, there would be an overwhelmingly positive benefit to green sturgeon because the proposed action is expected to result in considerable increases in the quantity and quality of estuarine foraging habitat, thereby augmenting populations far beyond the minor, local adverse effects that would occur during construction, operation, and maintenance activities.

6.3 Designated Critical Habitat for CCC steelhead

This section details the potential effects of the Phase 2 proposed action on DCH for CCC steelhead at each portion of the Action Area, including the effects of construction, operations and maintenance, and long-term habitat changes. As described in Section 5.3.1, all tidally influenced waters in the Action Area below MHHW are DCH for CCC steelhead. The habitat at each pond cluster is illustrated in **Figure 7a** through **Figure 7d**. The Ravenswood Ponds are not connected to any tidal aquatic habitat at all and so contain no DCH. The A8 ponds are a muted tidal system that contains DCH.

6.3.1 Island Ponds

The Island Ponds have full tidal connections with Coyote Creek and thus to San Francisco Bay. They thus contain DCH for CCC steelhead.

Construction Effects

Construction and excavation activities, such as pilot channel excavation, the creation of ditch blocks, levee lowering, and levee breaches, would result in habitat disturbance and are likely to temporarily increase turbidity and suspended sediment within DCH. However, these effects would be minimal and limited temporally and spatially. They are not expected to greatly change water quality in the typically turbid waters of the Bay. .

Conservation measures are provided to avoid or minimize construction effects. These include controls to prevent the release of toxic materials into DCH, minimization of disturbance to marsh vegetation, working at low tide, and biological monitoring. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the extent of CCC steelhead DCH in the San Francisco Bay estuary.

Operations and Maintenance Effects

Aside from the monitoring and management activities of the AMP and continued maintenance of the existing UPRR track, no other operations and maintenance activities would occur at the Island Ponds. As these activities have been included in prior consultations, no analysis is needed here, and there would be no new effects on DCH from operations and maintenance.

Habitat Effects

The material from levee breaches and channel excavation would be placed into the borrow ditches on the interior of the ponds to direct flows into the interior. All material would be placed into the subtidal and low intertidal areas, so there would be no loss of aquatic habitat. The breached, lowered, and removed levees themselves and the excavated channels would be replacing uplands with aquatic habitats and enhancing connectivity. In the long-term, the restoration of tidal marshes is expected to bring a net benefit DCH for CCC steelhead by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats), habitat quantity (restoring full tidal action to areas of the Bay), and adding connectivity between estuarine habitat and the existing open waters of the Bay.

6.3.2 A8 Ponds

The A8 Ponds currently have a managed and muted tidal connection to the Bay through the notch. They therefore include DCH, though at a low quality for CCC steelhead.

Construction Effects

While seasonal avoidance and/or closing the A8 notch during construction could avoid impacts to individuals, the proposed action at the A8 Ponds (constructing habitat transition zones) could temporarily affect water quality conditions by increasing turbidity. These effects are expected to be highly localized, brief in duration, and small in overall magnitude. There are concerns about mercury exposure in these ponds, as described in Section 3.7.2. However, DCH in the A8 Ponds are only expected to be occasionally utilized by CCC steelhead, reducing the potential for exposure to a temporary increase in mercury following construction. Construction at this location will not include excavation of pond bottom, only the addition of clean fill material on top of existing pond bottom, therefore re-suspension of existing mercury at this location is believed to be a minimal risk. Additionally, the approved QAPP for upland fill material will ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water.

Operations and Maintenance Effects

Operations and maintenance related to the Phase 2 proposed action at the A8 Ponds would not affect CCC steelhead DCH because those activities would be limited to invasive weed control and possible occasional mosquito abatement on the transition zones, as well as occasional monitoring. Operation of the reversible armored notch to control water levels in the A8 ponds was included in SBSP Phase 1 actions and thus not covered in this consultation.

Habitat Effects

The A8 Ponds currently have a managed and muted tidal connection to the Bay through the notch. While seasonal avoidance and/or closing the A8 notch during construction could avoid impacts to individuals, the proposed action at the A8 Ponds (constructing habitat transition zones) would involve permanent fill in DCH and a small amount of conversion of aquatic habitat to uplands. The long-term habitat enhancements of the proposed action are expected to benefit CCC steelhead by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats), habitat quantity (restoring full tidal action to areas of the Bay) as well as improving connectivity between estuarine habitat and the existing open waters of the Bay. The restoration of full tidal action to the A8 ponds is not planned for Phase 2, but it is a target goal of future actions in the Refuge.

6.3.3 Mountain View Ponds

These ponds have limited hydrologic exchange with the Bay, so should be included as DCH for the species; however, this exchange is limited to a tide gate into one pond and a siphon into the second one. This greatly limits the availability of these ponds to CCC steelhead and their habitat quality.

Construction Effects

Construction and excavation activities such as levee breaching, levee improvements, construction of habitat transition zones and habitat islands, and pilot channel excavation may result in sediment disturbance and are likely to temporarily increase turbidity and suspended sediment within DCH. Stevens Creek also contains DCH for CCC steelhead. Stevens Creek may be impacted by construction activities during breaching and installation of a railcar bridge over the new breach locations, which would require a few days of pile driving. While the noise itself would not affect DCH, there may be slight increases in turbidity in Stevens Creek as a result of construction. Conservation measures are provided to avoid or minimize construction effects. These include controls to prevent the release of toxic materials into DCH, implementation of the QAPP to ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water, minimization of disturbance to marsh vegetation, working at low tide, and biological monitoring. The RWQCB-approved QAPP would ensure that the material imported to raise levees and build islands and habitat transition zones is sufficiently clean to be used in a restoration project. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the extent of CCC steelhead DCH in the San Francisco Bay estuary.

The PG&E tower foundation work and PG&E access boardwalk work would be completed using hand tools and would result in negligible disturbance to the habitat within the Mountain View Ponds. While the boardwalk improvements would add a small amount of overwater fill to the pond, the levee breaching would greatly improve access for CCC steelhead and increase overall habitat value, more than compensating for the small amount of fills needed for this work.

Operations and Maintenance Effects

Operations and maintenance at the Mountain View Ponds (including vegetation management, mosquito abatement, PG&E maintenance work, and occasional levee maintenance) associated with the SBSP Restoration Project would be unlikely to disturb DCH once tidal exchange is restored to the ponds. The maintenance of bridges, habitat transition zones, and islands that would be placed in Phase 2 would also have minimal effects on DCH.

Habitat Effects

The wider levee bases, construction of habitat transition zones and islands would constitute fill in CCC steelhead DCH. Some of this fill would be creating uplands in what are currently waters. However, breaching and channel excavation would be converting uplands to waters, thus reducing the amount of lost aquatic habitat. However, there would still be a net loss of DCH.

Currently, the Mountain View Ponds are part of DCH as they do technically have a required tidal connection because there is one gated connection at Pond A1, and from there a siphon leads into Pond A2W. However, these ponds are thought to receive minimal CCC steelhead use because the one opening into this pond system is at the northwest corner, and Stevens Creek (the steelhead stream) is at the eastern edge. The proposed action would directly connect the CCC steelhead habitat in Stevens Creek with several hundred acres of newly available tidal waters and eventually tidal marsh. In the long-term, this connection and restoration of tidal marshes is expected to bring a net benefit DCH for CCC steelhead by improving habitat quality (increased habitat complexity and forage quality; fully tidal instead of a pond with a single gated entrance), habitat quantity (restoring full tidal action to areas of the Bay), and adding connectivity between estuarine habitat and the existing open waters of the Bay.

6.3.4 Ravenswood Ponds

The Ravenswood Ponds currently have no tidal connection to the Bay, so this area lacks an essential habitat characteristic to be part of DCH for CCC steelhead. Following completion of construction, the R4 pond will have an open tidal connection and thus have the features necessary to be included in DCH.

Construction Effects

When the Pond R4 levee is breached, that pond would become part of DCH, adding to the total available habitat. Nearby DCH in tidal Ravenswood Slough, Flood Slough, and San Francisco Bay may be affected by temporary increase in turbidity during the levee breaching process and may also experience short-term increases in salinity as the dry salt panne in the pond mixes with waters of the Bay. Similar effects are expected when the water control structures are placed into the connections of Ponds R3 and S5 with the surrounding sloughs.

Operations and Maintenance Effects

Operations and maintenance within the Ravenswood Ponds (including vegetation management and mosquito abatement) associated with the SBSP Restoration Project would be unlikely to disturb DCH once tidal exchange is restored to Pond R4. The operation of the water control structures that would be placed in Phase 2 would also have minimal effects on habitat.

Habitat Effects

The proposed action (breaching and installing water control structures) would have indirect effects to DCH for CCC steelhead due to alterations of tidal movements and sediment transport. The breach would increase tidal currents in the mouth of Ravenswood Slough, which may cause localized scouring and deepening of the channel in the Slough. Similarly, the tidal prism of the ponds may reduce tidal currents upstream in Ravenswood slough, causing siltation and reduction in the channel size upstream of the breach. Overall, however, the restoration of the Ravenswood Ponds would open up a few hundred acres of additional foraging habitat for juvenile and adult CCC steelhead and increase habitat complexity in the South Bay as the ponds redevelop channels and marshlands, increasing the extent of DCH for CCC steelhead. This should be a net benefit to CCC steelhead DCH.

6.3.5 Designated Critical Habitat for CCC steelhead Effects Summary

Phase 2 tidal restoration activities would require direct and permanent alteration DCH for CCC steelhead, largely in the form of fill to improve levees and build habitat transition zones and islands. In the long-term, the proposed action could alter sediment movement and change the extent of mudflat and streams in some parts of the Action Area, resulting in the deepening of some channels and sediment deposition in others.

Adverse effects to DCH from construction are anticipated to be minor and temporary in nature and are limited to increases in turbidity and changes in water quality. Conservation measures are provided to avoid or minimize such construction effects. These include the approved QAPP and other controls to prevent the release of toxic materials into DCH, minimization of disturbance to marsh vegetation, working at low tide when possible, and biological monitoring. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the extent of CCC steelhead DCH in the San Francisco Bay estuary.

A relatively small area of DCH will be lost due to the placement of fill for levee improvements, the creation of habitat transition zones, and habitat islands. In the long term, however, there would be an overwhelmingly positive benefit to DCH for CCC steelhead because the proposed action is expected to result in considerable increases in the quantity, quality, and connectivity of DCH in the South Bay, far outweighing the small areas of fill in habitats and the effects to DCH that would occur during construction, operation, and maintenance activities.

6.4 Designated Critical Habitat for Green Sturgeon

This section details the potential effects of Phase 2 on DCH for Southern DPS green sturgeon at each portion of the Action Area, including the effects of construction, operations and maintenance, and long-term habitat changes. As described in Section 5.3.2, all tidally influenced waters in the Action Area below MHHW are DCH for green sturgeon. The habitat at each pond cluster is illustrated in **Figure 8a** through **Figure 8d**. The Ravenswood Ponds are not connected to any tidal aquatic habitat at all and so contain no DCH. The A8 ponds are a muted tidal system that contains DCH.

6.4.1 Island Ponds

The Island Ponds have full tidal connections with San Francisco Bay via Coyote Creek and thus contain DCH for green sturgeon.

Construction Effects

Construction and excavation activities, such as excavation of pilot channels, the creation of ditch blocks, levee lowering, and levee breaching, would result in sediment disturbance and are likely to temporarily increase turbidity and suspended sediment within DCH. However, these effects would be minimal and are not expected to greatly change water quality in the typically turbid waters of the Bay estuary. Spills or other chemical contamination from construction equipment could also negatively affect DCH for green sturgeon.

Conservation measures are provided to avoid or minimize construction effects. These include controls to prevent the release of toxic materials into DCH, sampling and monitoring for contaminated sediments, minimization of disturbance to marsh vegetation, working at low tide, and biological monitoring. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the extent of DCH for green sturgeon in the San Francisco Bay estuary.

Operations and Maintenance Effects

Aside from the monitoring and management activities of the AMP and continued maintenance of the existing UPRR track, no other operations and maintenance activities would occur at the Island Ponds. As these activities have been included in prior consultations, no analysis is needed here, and there would be no new effects on DCH from operations and maintenance.

Habitat Effects

The material from levee breaches and channel excavation would be placed into the borrow ditches on the interior of the ponds to direct flows into the interior. All material would be placed into the subtidal and low intertidal areas, so there would be no loss of aquatic habitat. The breached, lowered, and removed levees themselves would be replacing uplands with aquatic habitats and enhancing connectivity. Although these activities may result in short-term negative impacts, in the long-term programmatic level restoration of tidal marshes are expected to benefit DCH for green sturgeon by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats), habitat quantity (restoring full tidal action to areas of the Bay) as well as improving connectivity between estuarine habitat and the existing open waters of the Bay.

6.4.2 A8 Ponds

The A8 Ponds currently have a managed and muted tidal connection to the Bay through the notch, which makes these ponds of lower quality and value to the species. They therefore are included as DCH for green sturgeon.

Construction Effects

The A8 Ponds currently have a managed tidal connection to the Bay, which limits tidal exchange in within the A8 Ponds (AECOM 2016). While it is possible for green sturgeon to enter the A8 Ponds through the notch, potential for such occurrence is considered to be low. As the potential for occurrence is limited, disturbance to DCH for green sturgeon at this location would have a lesser effect on the habitat value. Construction of habitat transition zones would result in sediment disturbance and are likely to temporarily increase turbidity and suspended sediment within DCH. There are concerns about mercury exposure in these ponds, as described in Section 3.7.2. However, DCH in the A8 Ponds are only expected to be occasionally utilized by green sturgeon, reducing the potential for exposure to a temporary increase in mercury following construction. Construction at this location will not include excavation of pond bottom, only the addition of clean fill material on top of existing pond bottom, therefore re-suspension of existing mercury at this location is believed to be a minimal risk. Additionally, the approved QAPP for upland fill material will ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water. Conservation measures are provided to avoid or minimize construction effects. These include controls to prevent the release of toxic materials into DCH, minimization of disturbance to marsh vegetation, working at low tide, and biological monitoring. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the extent of DCH for green sturgeon in the San Francisco Bay estuary.

Operations and Maintenance Effects

Operations and maintenance related to the Phase 2 proposed action at the A8 Ponds would be limited to invasive weed control and possible occasional mosquito abatement on the transition zones, as well as occasional monitoring. These are likely to temporarily disturb DCH for green sturgeon when they occur. Operation of the reversible armored notch to control water levels in the A8 ponds was included in the SBSP Phase 1 actions and thus not covered in this consultation.

Habitat Effects

The A8 Ponds currently have a managed and muted tidal connection to the Bay through the notch. While closing the A8 notch during construction could avoid impacts to individuals, the proposed action at the A8 Ponds (constructing habitat transition zones) would involve permanent fill in DCH and a small amount of conversion of aquatic habitat to uplands. The long-term habitat enhancements of the proposed action are expected to benefit green sturgeon by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats), habitat quantity (restoring full tidal action to areas of the Bay) as well as improving connectivity between estuarine habitat and the existing open waters of the Bay. The restoration of full tidal action to the A8 ponds is not planned for Phase 2, but it is a target goal of future actions in the Refuge.

6.4.3 Mountain View Ponds

These ponds have limited hydrologic exchange with the Bay, so should be included as DCH for the species; however, this exchange is limited to a one tide gate into one pond and a siphon into the second one. This greatly limits the availability of these ponds to green sturgeon and reduces their habitat quality.

Construction Effects

These ponds have some hydraulic exchange with the Bay, and are thus included as DCH for green sturgeon; however, this exchange is limited to one intake structure into pond A1 and one culvert between A1 into A2W which likely limits use by green sturgeon. Construction and excavation activities, such as pilot channel excavation and levee breaches, would result in disturbance and are likely to temporarily increase turbidity and suspended sediment within DCH within and surrounding the ponds. Conservation measures are provided to avoid or minimize construction effects. These include controls to prevent the release of toxic materials into DCH, sampling and monitoring for contaminated sediments, minimization of disturbance to marsh vegetation, working at low tide, and biological monitoring. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the extent of DCH for green sturgeon in the San Francisco Bay estuary. The RWQCB-approved QAPP would ensure that the material imported to raise levees and build islands and habitat transition zones is sufficiently clean to be used in a restoration project.

The PG&E tower foundation work and PG&E access boardwalk work would be completed using hand tools and would result in negligible disturbance to the habitat within the Mountain View Ponds. While the boardwalk improvements would add a small amount of overwater fill to the pond, the levee breaching would greatly improve access for green sturgeon and increase overall habitat value, more than compensating for the small amount of fills needed for this work.

Operations and Maintenance Effects

Operations and maintenance at the Mountain View Ponds (including vegetation management, mosquito abatement, PG&E maintenance work, and occasional levee maintenance) associated with the SBSP Restoration Project would be unlikely to disturb DCH once tidal exchange is restored to the ponds. The maintenance of bridges, habitat transition zones, and islands that would be placed in Phase 2 would also have minimal effects on DCH.

Habitat Effects

The wider levee bases, construction of habitat transition zones and islands would be fill in green sturgeon DCH. Some of this fill would be creating uplands in what are currently waters. However, breaching and channel excavation would be converting uplands to waters, thus reducing the amount of lost aquatic habitat. However, there would still be a net loss of waters.

Currently, the Mountain View Ponds are DCH and they do technically have a required tidal element because there is one gated connection in Pond A1 and, from there, a siphon leads into Pond A2W. However, these ponds are thought to receive little use by green sturgeon due to the small size of these connections. In the long-term, this connection and restoration of tidal marshes is expected to bring a net benefit DCH for green sturgeon by improving habitat quality (forage quality; fully tidal instead of a single gated entrance), habitat quantity (restoring full tidal action to areas of the Bay), and adding connectivity between estuarine habitat and the existing open waters of the Bay.

6.4.4 Ravenswood Ponds

Construction Effects

The Ravenswood Ponds currently have no tidal connection to the Bay, so this area lacks an essential habitat features required for it to be part of DCH for green sturgeon. However, when the Ravenswood levee is breached the ponds would become part of DCH. Additionally, nearby DCH in tidal Ravenswood Slough, Flood Slough, and San Francisco Bay may be briefly affected by temporary increase in turbidity during the levee breaching process. Such effects include exposure to increase turbidity as tidal waters tidal waters move over disturbed sediment, or exposure to slight changes in salinity if the Ravenswood ponds are retaining water at the time of breaching.

Operations and Maintenance Effects

Operations and maintenance within the Ravenswood Ponds (including vegetation management and mosquito abatement) associated with the SBSP Restoration Project would be unlikely to disturb DCH once tidal exchange is restored to Pond R4. The operation of the water control structures that would be placed in Phase 2 would also have minimal effects on habitat.

Habitat Effects

The breaching would have indirect effects to DCH for green sturgeon due to alterations of tidal movements and sediment transport. The breach would increase tidal currents in the mouth of Ravenswood Slough, which may cause localized scouring and deepening of the channel in the Slough. Similarly, the tidal prism of the ponds may reduce tidal currents upstream in Ravenswood Slough, causing siltation and reduction in the channel size upstream of the breach. Overall, the breaching of the Ravenswood Pond R4 would create additional foraging habitat for green sturgeon and increase habitat complexity in the South Bay as the Ponds redevelop channels and marshlands, increasing the extent of DCH for green sturgeon. This should be a net benefit for green sturgeon DCH.

6.4.5 Green Sturgeon Critical Habitat Effects Summary

Phase 2 tidal restoration activities would require direct and permanent alteration DCH for green sturgeon, largely in the form of fill to improve levees and build habitat transition zones and islands. In the long-term, the proposed action could alter sediment movement and change the extent of mudflat and streams in some parts of the Action Area, resulting in the deepening of some channels and sediment deposition in others.

Adverse effects to DCH from construction activities are anticipated to be minor and temporary in nature and are limited to increases in turbidity and changes in water quality. Conservation measures are provided to avoid or minimize such construction effects. These include controls to prevent the release of toxic materials into DCH, sampling and monitoring for contaminated sediments, minimization of disturbance to marsh vegetation, working at low tide, and biological monitoring. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the extent of DCH for green sturgeon in the San Francisco Bay estuary.

A relatively small area of DCH will be lost due to the placement of fill for levee improvements, the creation of habitat transition zones, and habitat islands. In the long term, however, there would be an overwhelmingly positive benefit to green sturgeon DCH because the proposed action is expected to result in considerable increases in the quantity, quality, and connectivity of DCH in the South Bay, far outweighing the small areas of fill in habitats and the effects to DCH that would occur during construction, operation, and maintenance activities.

6.5 Essential Fish Habitat

As described in Section 5.4, all tidally influenced portions of the Action Area below MHHW are designated as EFH under the Coastal Pelagic FMP, the Pacific Groundfish FMP, and the Pacific Salmon FMP. Construction and excavation activities described in Chapter 2 and would result in disturbance of tidal waters and are likely to temporarily increase turbidity and suspended sediment. Increased turbidity and suspended sediment may temporarily degrade water quality, reduce prey resources, disturb habitat, and impede movements of EFH managed species. Spills or other chemical contamination from construction equipment could also negatively affect habitat of managed species. Conservation measures are provided to avoid or minimize these effects, such as controls to prevent the release of toxic materials into DCH, minimization of disturbance to marsh vegetation and conducting in-water work at low tide when practicable, and implementation of the approved QAPP for upland fill material to ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water.

Pilot channel excavation through fringe marsh and placement of fill for the transition zones would result in the alteration of EFH. Generally speaking, the effects of the proposed action at each pond cluster for EFH are similar to those described above for DCH for green sturgeon.

Construction, operations, and maintenance effects may be detrimental in the short term, but would greatly increase the availability of aquatic habitats, the habitat complexity, and the overall ecological habitat functions and value in the long term. The temporary negative effects of the proposed action are minimal and would be outweighed by the opening of ponds to tidal flows and the restoration of tidal marshes, which are the key part of the Phase 2 proposed actions, as well as other enhancements made as part of the overall SBSP Restoration Project.

6.6 Interrelated and Interdependent Actions

Interrelated actions include actions that are part of a larger action and depend on the larger action for justification. Interdependent actions are defined as actions with no independent utility apart from the proposed action. The proposed action is Phase 2 of the SBSP Restoration Project's larger long-term restoration plan for the former salt-production ponds, as described in the 2007 EIS/R. Some aspects of Phase 2 are possible due to activities that were permitted and conducted in Phase 1 or in its precursor, the Initial Stewardship Plan. Others are wholly independent of them. Similarly, there are activities proposed for future phases of the larger project that may build upon or expand aspects of the Phase 2 proposed action. However, the proposed actions at the four different Phase 2 pond clusters are independent of each other.

All phases of the larger project, including the proposed action, are guided by an Adaptive Management Plan, described in the 2007 Programmatic BA and the 2007 EIS/R, which would guide the activities planned as part of future phases of the project (USFWS 2007). However, each phase of the restoration plan has independent utility by providing habitat enhancements for various special-status species and habitats within the wildlife refuge, as well as providing recreation opportunities and improving flood control. There are no interrelated or interdepended actions aside from the operations and maintenance activities included in the analysis of effects provided in this BA.

6.7 Cumulative Effects

Cumulative effects as defined by the ESA are those effects of future State or private activities that are reasonably certain to occur within the Action Area (ESA, Section 402.14[g][4]). The Project in combination with other non-federal projects in the area could contribute to effects on CCC steelhead, green sturgeon, and their DCH in the Action Area as a result of increases in turbidity, adverse changes in water quality, and increases in underwater noise as well as temporary habitat exclusion or in South San Francisco Bay.

The SBSP Phase 2 Final EIS/R (AECOM 2016) contains a detailed analysis of past, present, and reasonably foreseeable future projects within the San Francisco Bay area, and having effects similar to those of the proposed action. These cumulative projects include other tidal restoration projects in the San Francisco Bay Area which could result in the same types of effects and benefits as those of the proposed action. Other cumulative projects with which the SBSP Restoration Project would be evaluated in combination include construction projects proposed by local, regional or state agencies in and around the Action Area not covered by the larger SBSP Restoration Project; city and county development projects (e.g., new or expanded residential, commercial, or industrial development projects); local agency infrastructural projects (e.g., water or wastewater facilities improvements/construction, and flood protection projects); PG&E projects (e.g., transmission line/facilities construction and/or improvements); traffic signalization and roadway construction/improvement projects of local municipalities; and recreation-related projects proposed by local municipalities, Association of Bay Area Governments (ABAG), park districts, or other non-governmental agencies.

The projects listed below are considered in the cumulative effects discussion of the Final EIS/R for Phase 2 to determine if the combined effects of all the projects would be cumulatively considerable and would result in adverse cumulative effects. Details of each project, which were identified as having potential cumulative effects to biological resources, are discussed in Section 4 of the SBSP Phase 2 FEIS/R 2016:

- Restoration Projects:
  - Redwood City Inner Harbor Studies and Plans
  - San Jose/Santa Clara Water Pollution Control Plant (WPCP) Master Plan
  - Final Damage Assessment and Restoration Plan for the November 7, 2007 Cosco Busan Oil Spill
- Flood Protection Projects:
  - San Francisquito Creek Flood Reduction, Ecosystem Restoration, and Recreation Project San Francisco Bay to Highway 101
  - Sunnyvale East and West Channel Flood Protection Project
  - Santa Clara Valley Water District Stream Maintenance Program
  - Landfill Erosion Protection
  - Lower Permanente Creek Levee and Floodwall Improvements
  - Golf Course Facilities High Ground Augmentation
  - Lower Stevens Creek Levee Improvements
  - Lower Permanente Creek Storm Drain Improvements
  - Sailing Lake Intake Pump Station Modification
  - Safe, Clean Water & Natural Flood Protection Program
  - Bayfront Canal and Atherton Channel Project
- Development Projects
  - Newby Island Sanitary Landfill
  - Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay, Fiscal Years 2015–2024
  - Zanker Materials Recycling Facility
  - San Jose/Santa Clara Water Pollution Control Plan
  - Menlo Gateway Project
  - South Bay Advanced Recycled Water Treatment Facility (ARWTF) Project
  - Cooley Landing Park
  - The Preserve at Redwood Shores Precise Plan
  - Stanford University Medical Center Facilities Renewal and Replacement (SUMC Project)
  - Yahoo! Santa Clara Campus
  - Google campus expansion
  - Creekside Landing Project
- Transportation Projects
  - Stevens Creek Crossings Project
  - Los Gatos Creek Bridge Replacement/South Terminal Phase III Project
  - Pacific Gas and Electric Company (PG&E) NERC Compliance Efforts

- Recreation Projects
  - San Francisco Bay Area Water Trail Plan
  - Facebook Campus State Route 84 Overpass Trail
  - Coyote Creek Trail Project: Story Road to Phelan Avenue

Generally speaking, the above projects would only have minor and indirect influences on the species and tidal habitats that are the subject of this BA. These influences include minor alterations to patterns of runoff, small amounts of fill in aquatic habitats (from levee improvements or other flood protection measures), and stream crossings. Many of the above projects are considered federal actions because they involve Clean Water Act Section 404 permitting, occur on federal lands, or involve federal funding, either for restoration or for the project itself. As a result, relatively few of the above projects have the potential to result in cumulative effects that would not be subject to future Section 7 consultation. Most would also therefore receive permits from the U.S. Army Corps of Engineers (USACE), the RWQCB, and/or the San Francisco Bay Conservation and Development Commission (BCDC) with terms and conditions that would limit their adverse effects.

Because of the large geographic and temporal scale of the proposed action and the overall SBSP Restoration Project, these activities would be the primary influence on CCC steelhead, green sturgeon, DCH for those species, and EFH within the Action Area, resulting in greatly beneficial effects. By comparison, other reasonably foreseeable projects within the Action Area are expected to have much less effect on these species' populations or habitats in the tidal areas of the South Bay.

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7 Determinations

7.1 CCC steelhead

Construction activities that occur in areas accessible to CCC steelhead (Island Ponds, A8 Ponds, Mountain View Ponds, and the sloughs and mudflats around all four pond clusters) that are conducted within the seasonal work window of June 1 to November 30 (when the species is not likely to be present) would be not likely to adversely affect CCC steelhead. If construction in waters accessible to CCC steelhead occurs outside of the work window, individuals may be exposed to turbidity, altered water quality, or require capture and relocation, resulting in take of the species. Very small numbers may also be directly injured or killed during the placement of fill in wetted areas or other activities if construction occurs outside of the work window. The implementation of conservation measures (such as the exclusion of fish with block nets or cofferdams closed at low tide, if practicable, would minimize direct injury or mortality of CCC steelhead. In-water work would be timed with the tides and seasonally to the extent practicable to avoid impacts to fish that might be present within the ponds or adjacent sloughs. Biological monitors qualified for fish removal and relocation would conduct fish rescue of enclosed waters as needed to reduce the potential of injury or death resulting from in-water activities.

There would also be loss of aquatic habitat due to the placement of fill required for improvements to levees and construction of habitat transition zones and islands. However, there would be additions of several hundred acres of newly accessible, better connected, and higher quality habitats from the restoration of the ponds to tidal flows and related improvements. The planned net habitat gain is several orders of magnitude greater than the losses.

After construction is completed, operating the water control structures at Ravenswood has the potential to entrain very small numbers of juvenile CCC steelhead into the managed ponds, where they may be exposed to increased predation, decreased DO, or other stressors. Overall, the increased access to and improvement in foraging habitat for juvenile CCC steelhead that would result from the proposed action would outweigh the low potential for fish to be entrained in a way that would expose individuals to the stressors described above. Adults are not expected to be entrained due to their stronger swimming ability and short time of residence within estuarine waters during migration.

However, because the conservation measures cannot completely eliminate the possibility of the proposed action directly affecting CCC steelhead and that may be present during project activities, the Project ***may affect, and is likely to adversely affect CCC steelhead*** if construction or filling of managed ponds occurs outside of the seasonal work window for the species. Following the minimal potential adverse effects from construction, the proposed action is expected to provide valuable foraging and rearing habitat, and result in a more diverse aquatic food web that would improve conditions for CCC steelhead which may contribute to an increase of their population and expansion of their current range.

7.2 Green Sturgeon

Because green sturgeon have the potential to occur year-round almost all of in the Action Area, seasonal avoidance is not possible. During construction in waters accessible to green sturgeon (Island Ponds, A8 Ponds, Mountain View Ponds, and the sloughs and mudflats around all four pond clusters), individuals may be exposed to turbidity, altered water quality, or require capture and relocation. The implementation of conservation measures (such as the exclusion of fish with block nets or cofferdams closed during low tide if practicable, would minimize direct injury or mortality of green sturgeon. However, very small numbers may still be directly injured or killed during the placement of fill in wetted areas and other construction activities. In-water work would be timed with the tides and seasonally to the extent possible to avoid or minimize impacts to fish that might be present within the ponds or adjacent sloughs. Biological monitors qualified for fish removal would conduct fish rescue of enclosed waters as needed to reduce the potential of injury or death resulting from in-water activities.

There would also be loss of aquatic habitat due to the placement of fill required for improvements to levees and construction of habitat transition zones and islands. However, there would be additions of several hundred acres of newly accessible, better connected, and higher quality habitats from the restoration of the ponds to tidal flows and related improvements. The planned net habitat gain is several orders of magnitude greater than the losses.

After construction is completed, operating the water control structures has the potential to entrain very small numbers of green sturgeon into the managed ponds, where they may be exposed to increased predation, decreased DO, or other stressors. Overall, the increased access to and improvement in foraging habitat for green sturgeon that would result from the proposed action would outweigh the low potential for fish to be entrained in a way that would expose individuals to the stressors described above.

However, because the conservation measures cannot completely eliminate the possibility of the proposed action directly affecting green sturgeon that may be present during project activities, the Project ***may affect, and is likely to adversely affect green sturgeon***. Following the minimal potential adverse effects from construction, the proposed action is expected to provide valuable foraging habitat, and result in a more diverse aquatic food web that would improve conditions for green sturgeon which may contribute to an increase of their population and expansion of their current range.

7.3 Designated Critical Habitat for CCC steelhead

Although construction activities may result in short-term and small-scale habitat changes such as increases in turbidity or alteration of water quality, these changes are minimal and are expected to fall within normal variability of the turbid waters of the south Bay. The conservation measures would eliminate or minimize such effects, including controls to prevent the release of toxic materials into DCH, implementation of the QAPP to ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water, minimization of disturbance to marsh vegetation, working at low tide, and biological monitoring. There would also be the small areas of aquatic habitat loss and conversion described above.

In the long-term the project would provide an overwhelming benefit to DCH for CCC steelhead by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats), habitat quantity (restoring full tidal action to ponded areas of the Bay and converting dry salt pan to estuarine habitat) as well as improving connectivity between ponds with limited breaching and the existing open waters of the Bay by removing other portions of existing levees. For example, restoring tidal action to the Ravenswood Ponds creates over 625 acres of new estuarine habitat within the DCH area for this species. The quality of this habitat is expected to improve as the marsh plain fills and channels are formed. Improved tidal connectivity of the Island ponds and Mountain View ponds would have a similar effect in improving habitat. As the short-term effects would be minimal, and the long-term effects greatly beneficial, it is expected that the proposed action is ***not likely to adversely affect designated critical habitat for CCC steelhead***.

7.4 Designated Critical Habitat for Green Sturgeon

The potential effects of the proposed action to DCH for green sturgeon are similar to the effects to DCH for CCC steelhead, as described in the prior Section. Construction activities may result in short-term and small-scale habitat disruption, and conservation measures would eliminate or minimize such effects, including controls to prevent the release of toxic materials into DCH, implementation of the QAPP to ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water, minimization of disturbance to marsh vegetation, working at low tide, and biological monitoring. There would also be the small areas of aquatic habitat loss and conversion described above.

In the long-term the project would provide an overwhelming benefit to DCH for green sturgeon by improving habitat quality and habitat quantity. For example, restoring tidal action to the Ravenswood ponds essentially creates over 625 acres of new estuarine habitat within the DCH area for this species. The quality of habitat is expected to improve as the marsh plain fills in with vegetation and channels are formed. Improved tidal connectivity of the Island ponds and Mountain View ponds would have a similar effect in improving habitat. As the short-term effects would be minimal, and the long-term effects greatly beneficial, it is expected that the proposed action is ***not likely to adversely affect designated critical habitat for green sturgeon***.

7.5 Essential Fish Habitat

The tidally influenced portions of the Action Area are within EFH as designated under the Coastal Pelagic, Pacific Groundfish, and Pacific Coast Salmon FMPs. Although construction activities may result in short-term and small-scale habitat changes such as increases in turbidity or alteration of water quality, these changes are minimal and are expected to fall within normal variability of the turbid waters of the south Bay. The conservation measures would eliminate or minimize such effects, including controls to prevent the release of toxic materials into EFH, implementation of the QAPP to ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water, minimization of disturbance to marsh vegetation, and working at low tide. In the long-term the project would provide an overwhelming benefit to EFH by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats), habitat quantity (restoring full tidal action to areas of the Bay) as well as improving connectivity between estuarine habitat within the ponds and the existing open waters of the Bay. Although the project may result in short-term changes that ***may adversely affect EFH***, such effects would be minimal, and the long-term effects greatly beneficial.

7.6 Cumulative Effects

Compared to the proposed action, the projects considered in Section 6.7 would likely only have minor and indirect influences on the species and habitats that are the subject of this BA. The proposed action and the overall SBSP Restoration Project, on the other hand, would be the primary influence on CCC steelhead, green sturgeon, DCH for those species, and EFH within the Action Area, resulting in greatly beneficial effects. As a result, the proposed action is ***not likely to result in adverse cumulative effects*** on CCC steelhead, green sturgeon or their DCH.

8 Map Figures

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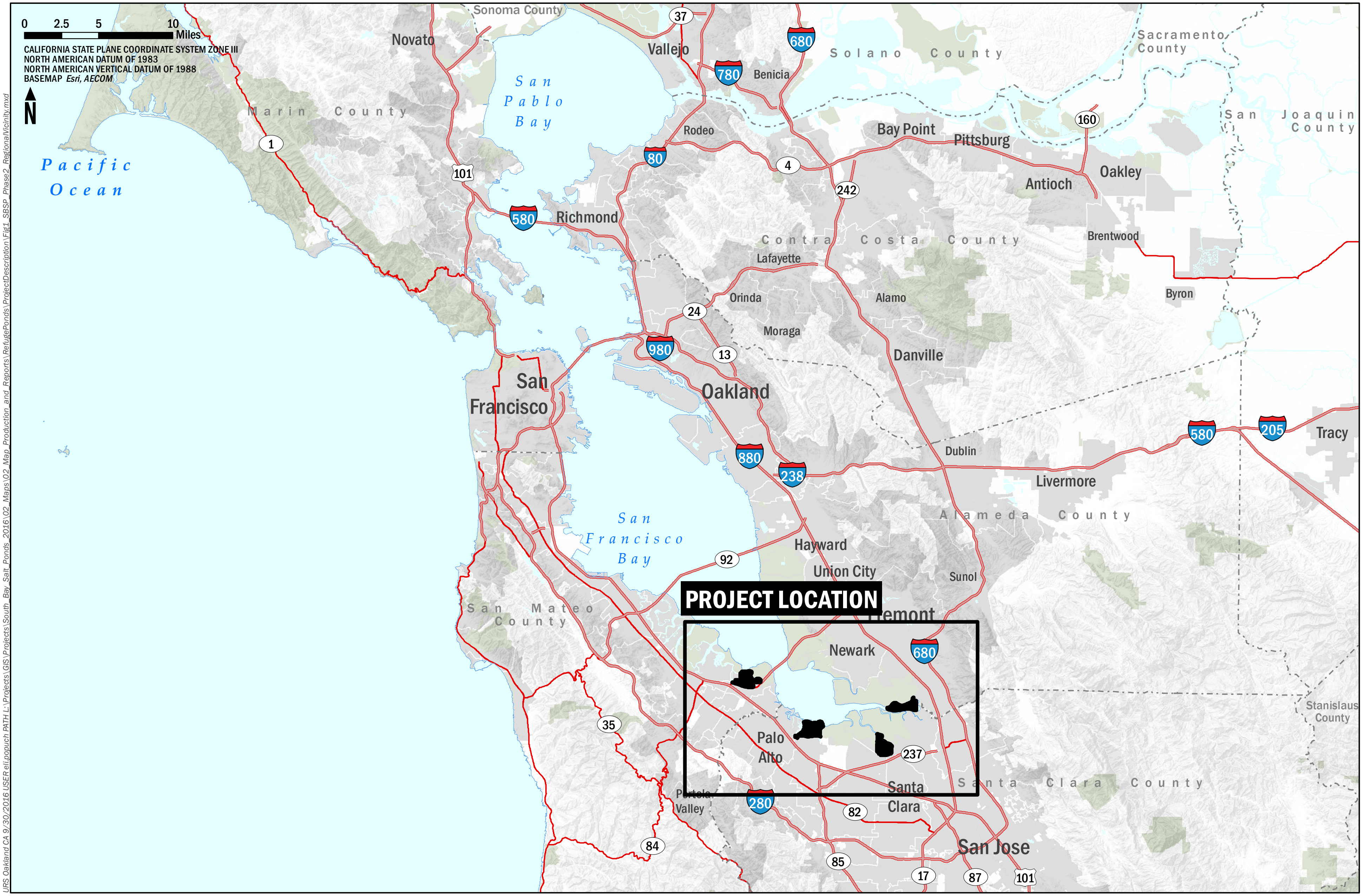


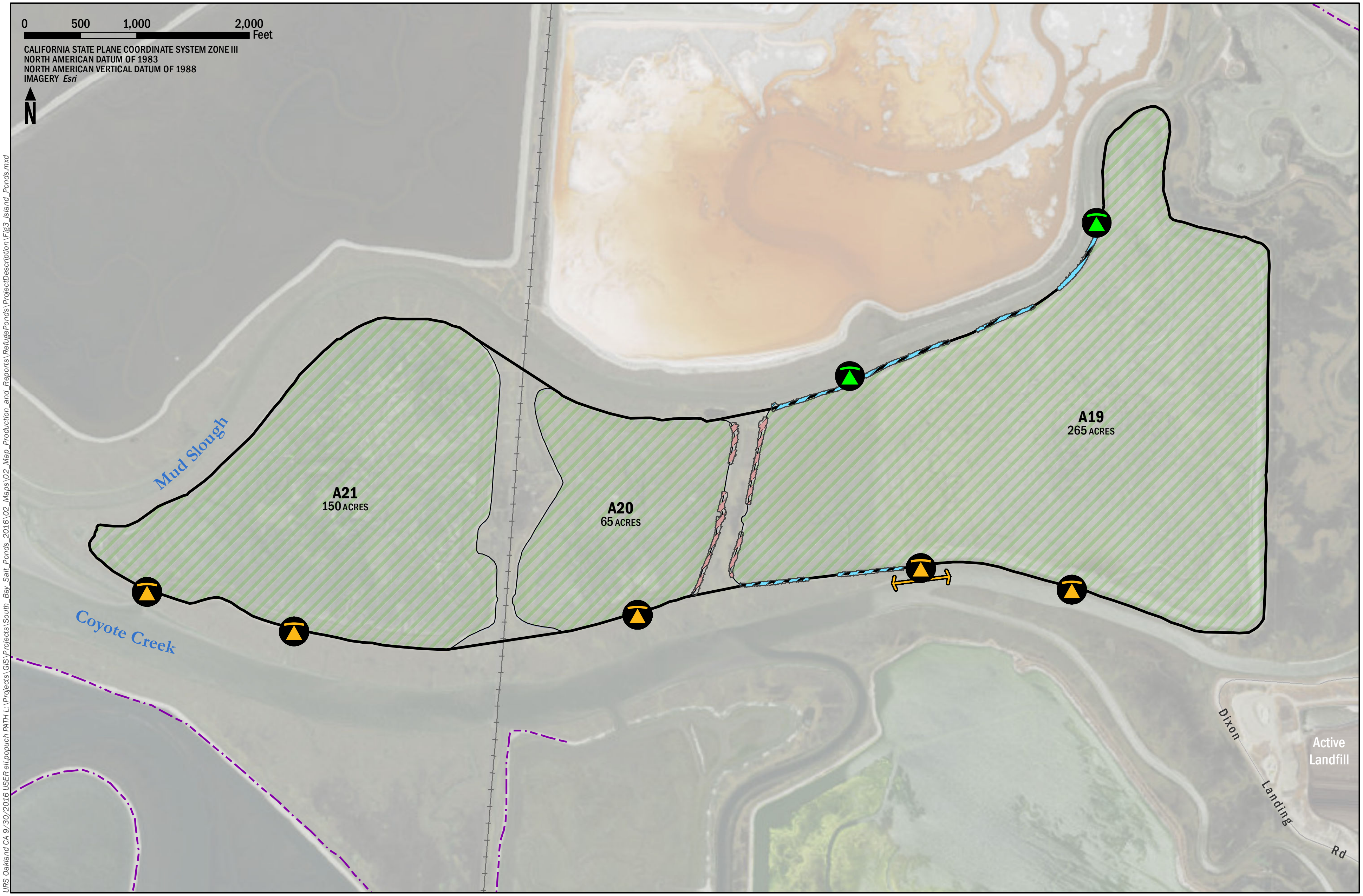
AECOM
South Bay Salt Pond Restoration Project

Figure 1
SBSP Phase 2 Regional Location

URS Oakland CA 9/30/2016 USER eli.popuch PATH L:\Projects\GIS\Projects\South_Bay_Salt_Ponds_2016\02_Maps\02_Map_Production_and_Reports\RefugePonds\ProjectDescription\Fig2_SBSP_Phase2_ProjectSites.mxd

AECOM
South Bay Salt Pond Restoration Project

Figure 2
SBSP Phase 2 Project Sites



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LEGEND

Proposed breach
Existing breach
Expand existing breach
Railroad
Existing trail
Removed levee
Lowered levee
Tidal marsh
Pond boundary

AECOM

South Bay Salt Pond Restoration Project

Figure 3a

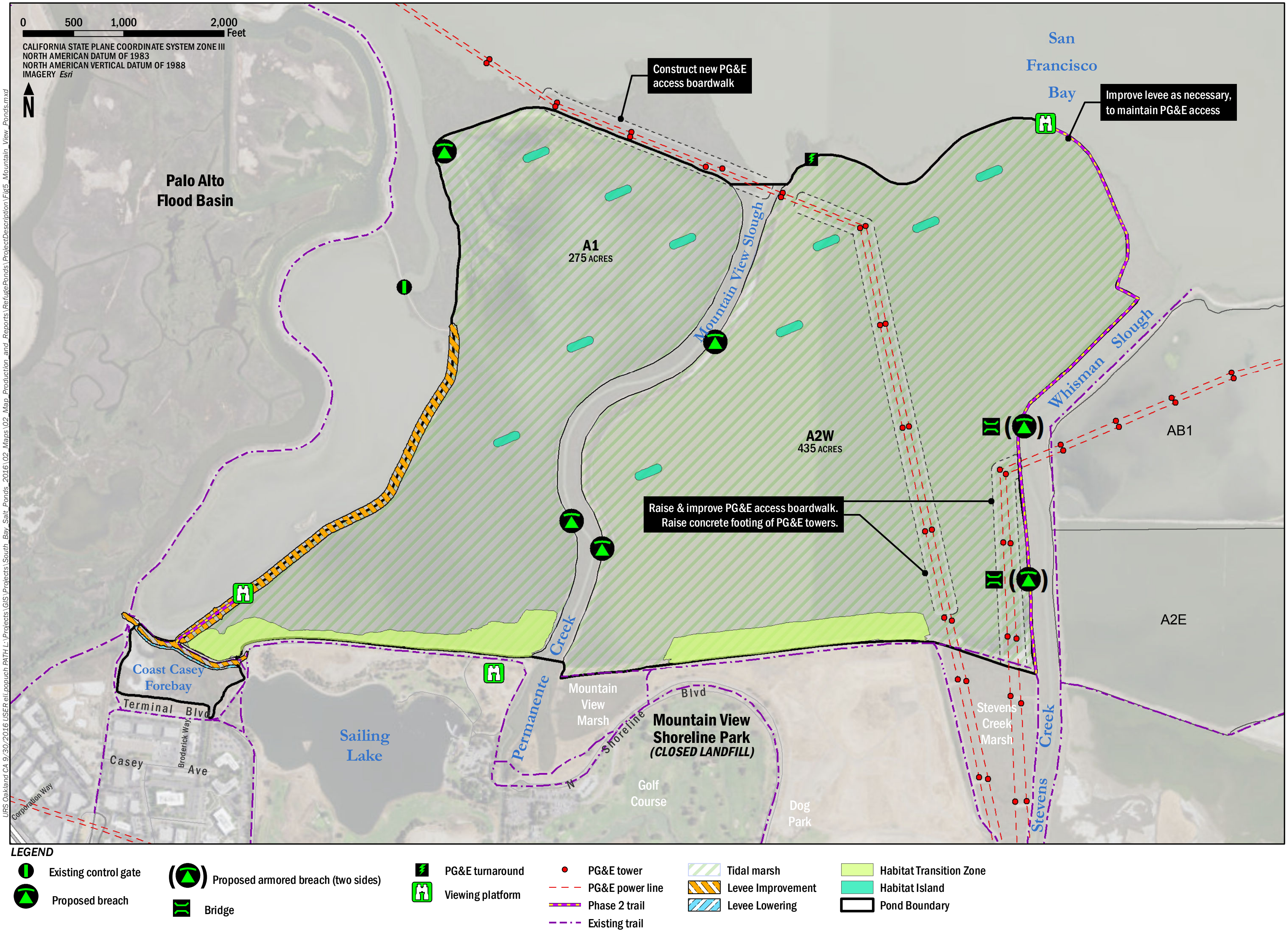
Phase 2 Proposed Action - Alviso Island Ponds

LEGEND

- Existing reversible armored notch
- Railroad
- Existing trail
- Pond boundary
- Habitat Transition Zone

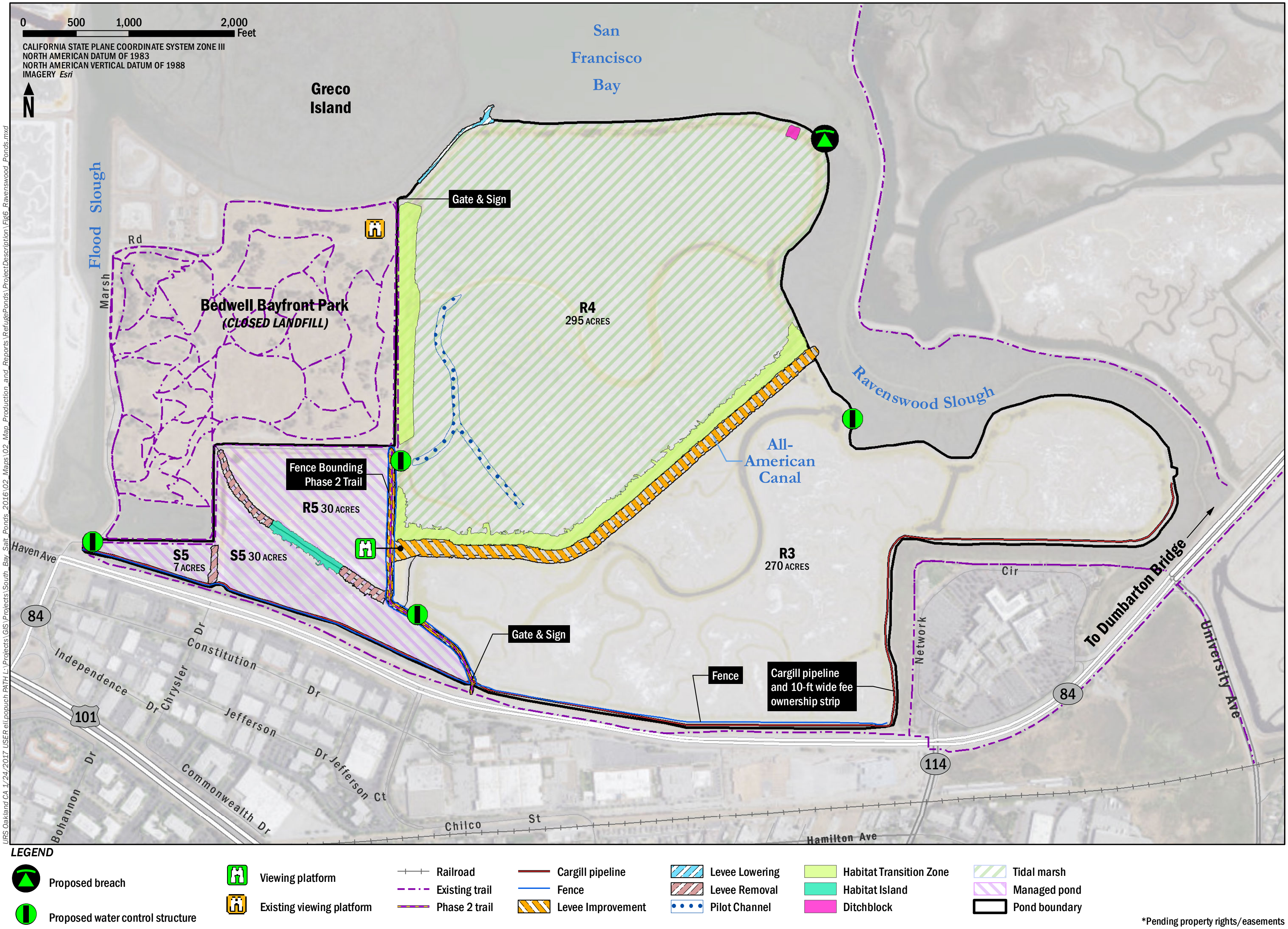
AECOM
South Bay Salt Pond Restoration Project

Figure 3b
Phase 2 Proposed Action - Alviso A8 Ponds



AECOM
South Bay Salt Pond Restoration Project

Figure 3c
Phase 2 Proposed Action - Alviso Mountain View Ponds



*Pending property rights/easements

AECOM
South Bay Salt Pond Restoration Project

Figure 3d
Phase 2 Proposed Action - Ravenswood Ponds

LEGEND

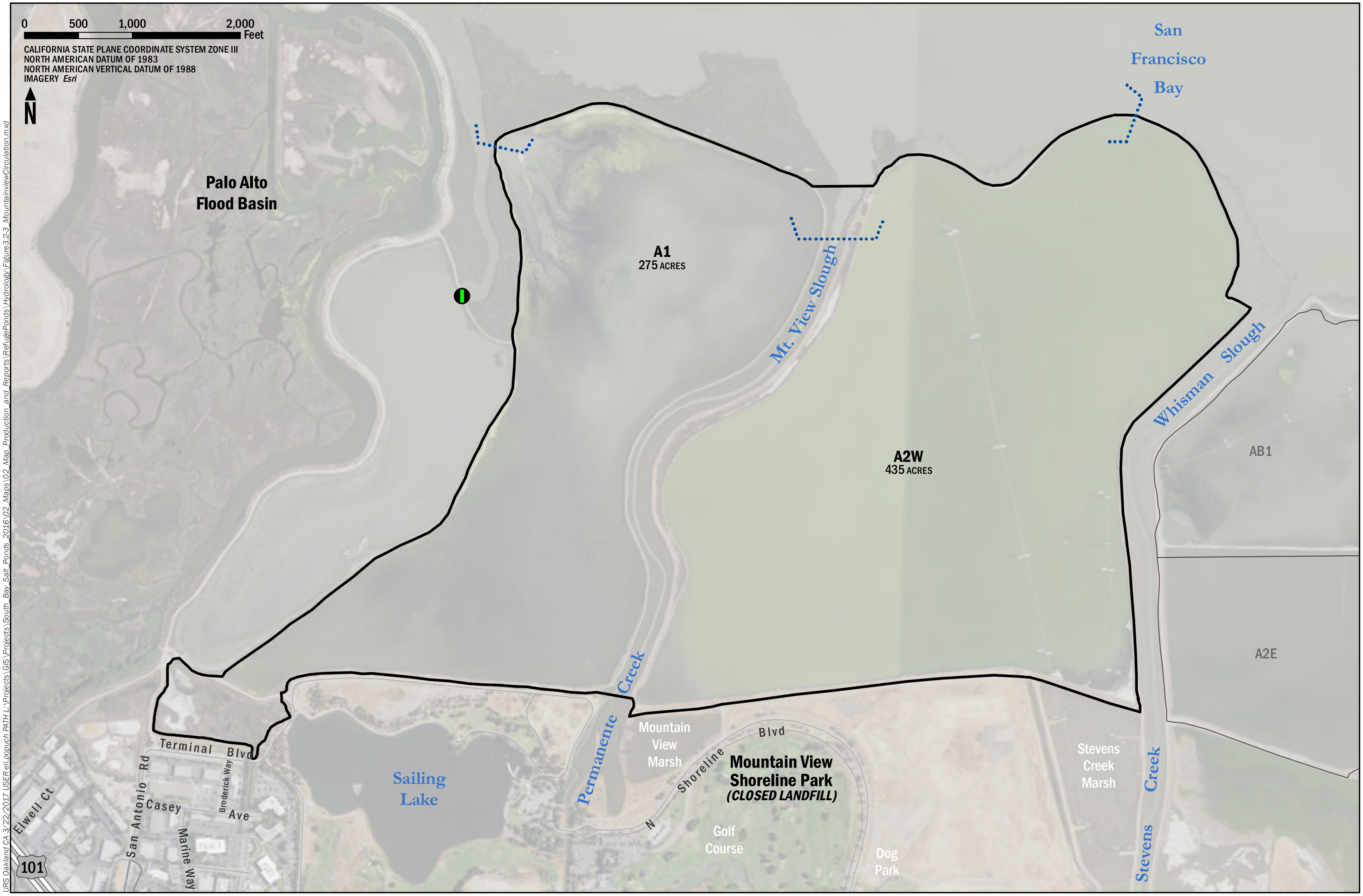
- Existing reversible armored notch
- Culvert
- Levee Cut
- Siphon
- Pond boundary

AECOM

South Bay Salt Pond Restoration Project

Figure 4a

Existing Circulation in the A8 Ponds

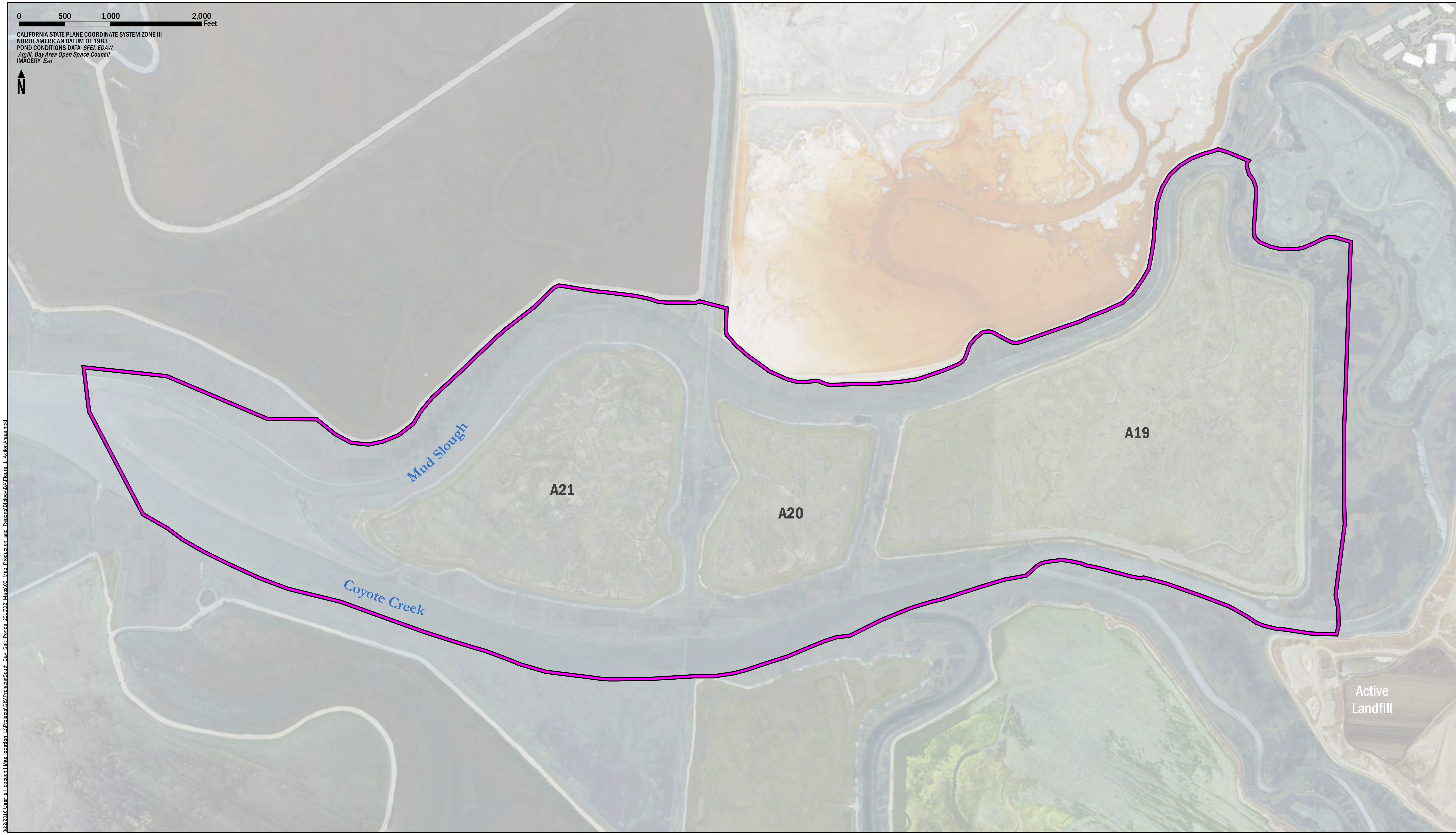


LEGEND

- Existing control gate
- Siphon
- Pond boundary

AECOM
South Bay Salt Pond Restoration Project

Figure 4b
Existing Circulation in the Mountain View Ponds



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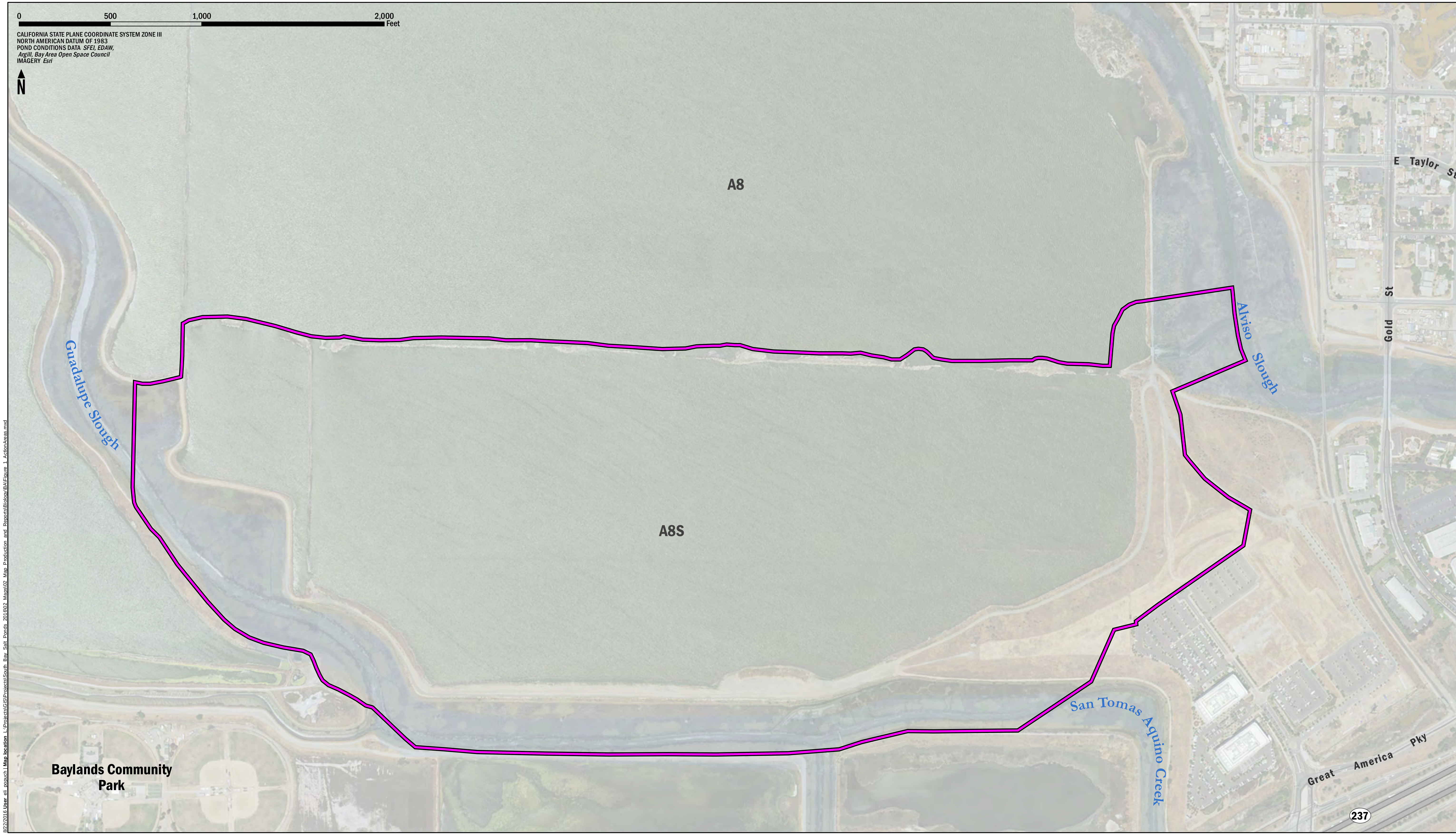
Phase 2 BA Action Area

AECOM
South Bay Salt Pond Restoration Project

Figure 5a
Alviso Island Ponds Action Area



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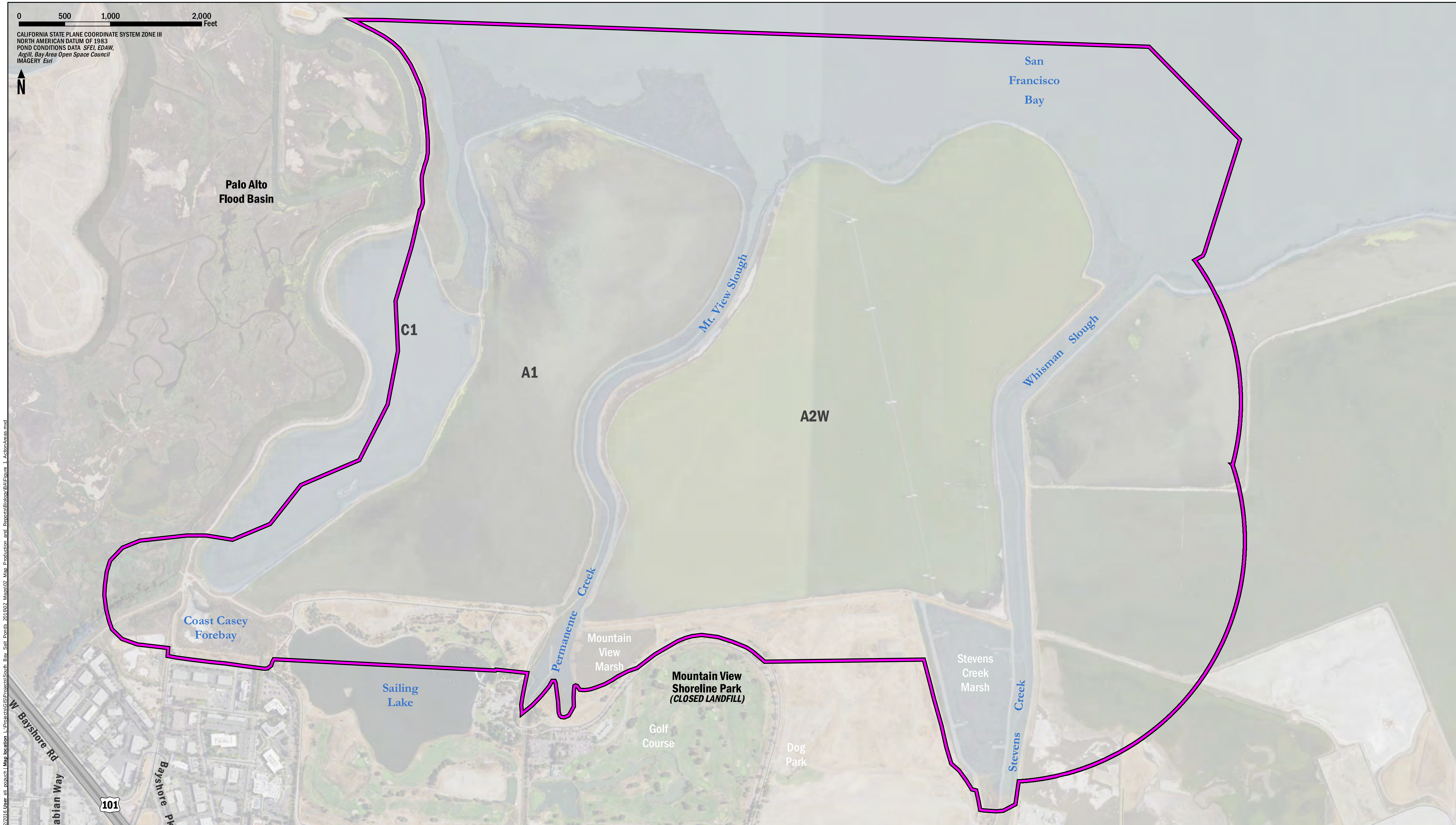
Phase 2 BA Action Area

AECOM

South Bay Salt Pond Restoration Project

Figure 5b

Alviso A8 Ponds Action Area



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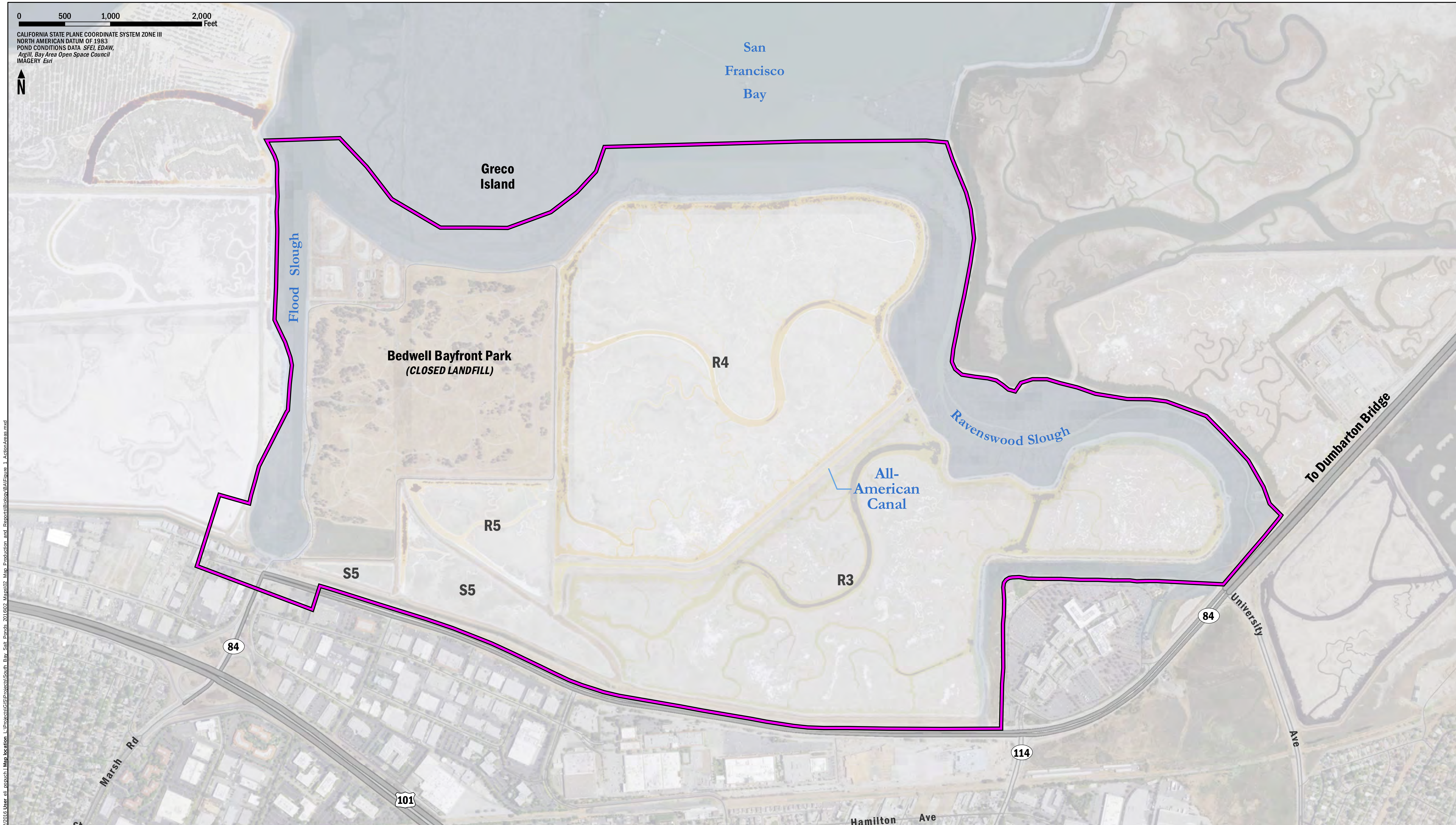
Phase 2 BA Action Area

AECOM
South Bay Salt Pond Restoration Project

Figure 5c
Alviso Mountain View Ponds Action Area



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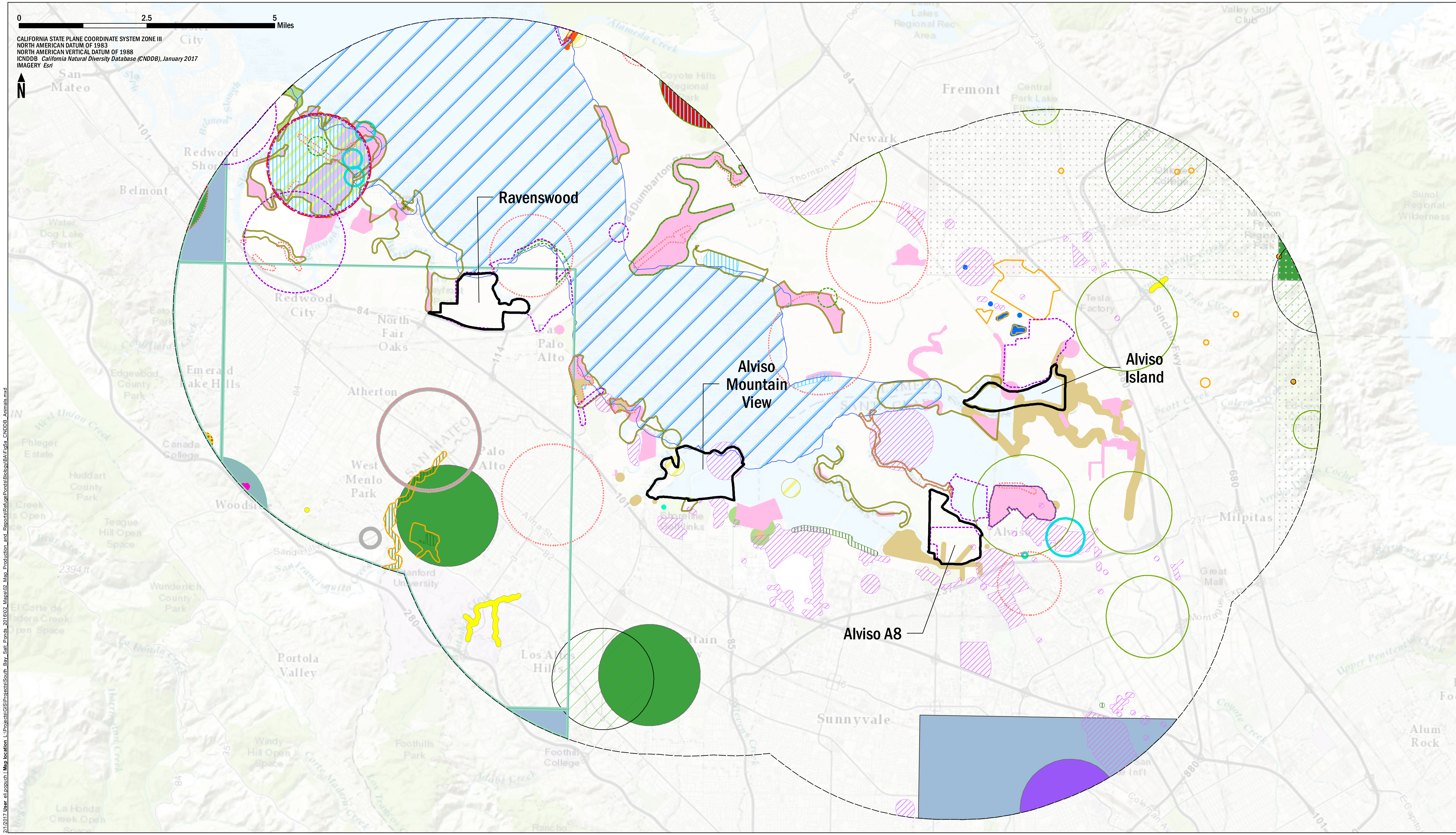
Phase 2 BA Action Area

AECOM

South Bay Salt Pond Restoration Project

Figure 5d

Ravenswood Ponds Action Area

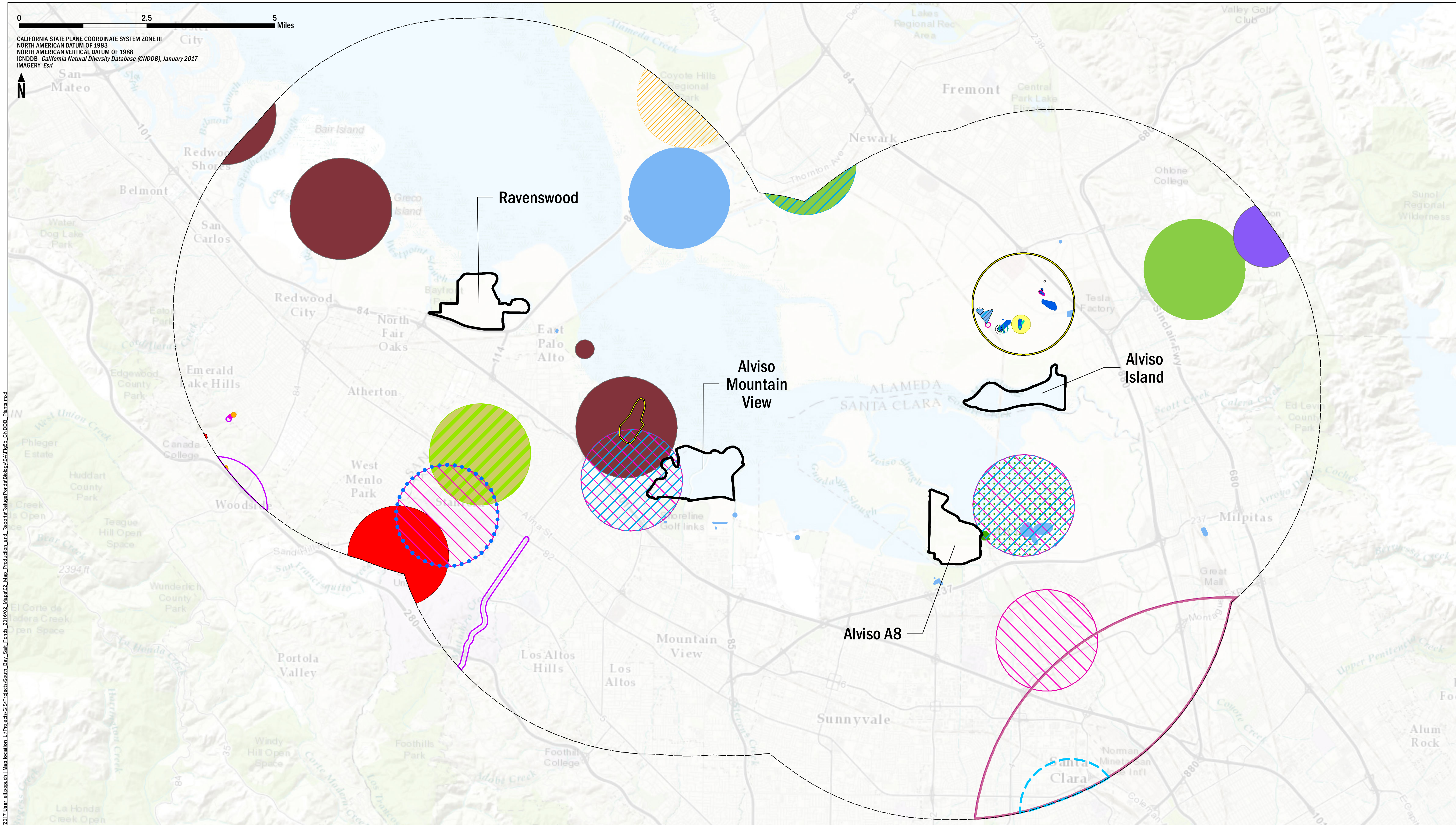


LEGEND

Phase 2 Project Boundary
Phase 2 Project Boundary 5 Mile Buffer
Alameda song sparrow
Alameda whipsnake
American badger
American peregrine falcon
Bank swallow
Bay checkerspot butterfly
black skimmer
Burrowing owl
California black rail
California clapper rail
California giant salamander
California least tern
California red-legged frog
California tiger salamander
Golden eagle
Longfin smelt
Northern harrier
Pallid bat
Salt-marsh harvest mouse
Salt-marsh wandering shrew
Saltmarsh common yellowthroat
San Francisco gartersnake
San Francisco dusky-footed woodrat
Short-eared owl
Steelhead - central California coast DPS
Swainson's hawk
Townsend's big-eared bat
Tricolored blackbird
Vernal pool tadpole shrimp
Western pond turtle
Western snowy plover
White-tailed kite

AECOM
South Bay Salt Pond Restoration Project

Figure 6a
CNDDB Special-Status Wildlife Species

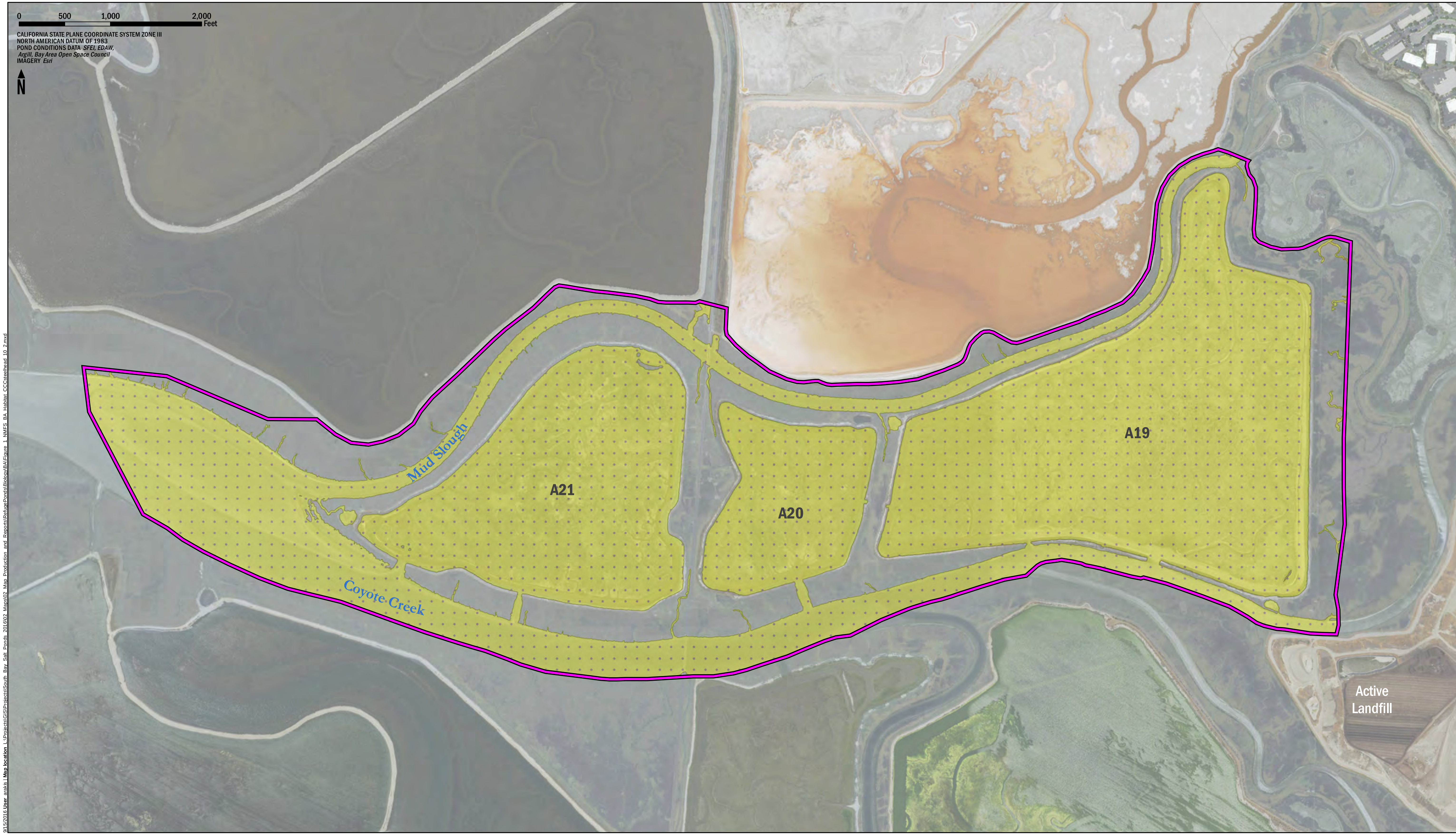


LEGEND

- Phase 2 Project Boundary
- Phase 2 Project Boundary 5 Mile Buffer
- Alkali milk-vetch
- Arcuate bush-mallow
- Brittlescale
- California alkali grass
- California seablite
- Chaparral ragwort
- Congdon's tarplant
- Contra Costa goldfields
- Crystal Springs fountain thistle
- Fragrant fritillary
- Franciscan onion
- Hairless popcornflower
- Hoover's button-celery
- Lesser saltscale
- Lost thistle
- Marin western flax
- Most beautiful jewelflower
- Point Reyes salty bird's-beak
- Prostrate vernal pool navarretia
- Robust spineflower
- Saline clover
- San Francisco collinsia
- San Joaquin spearscale
- Slender-leaved pondweed
- Western leatherwood

AECOM
South Bay Salt Pond Restoration Project

Figure 6b
CNDDB Special-Status Plant Species



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Phase 2 BA Action Area

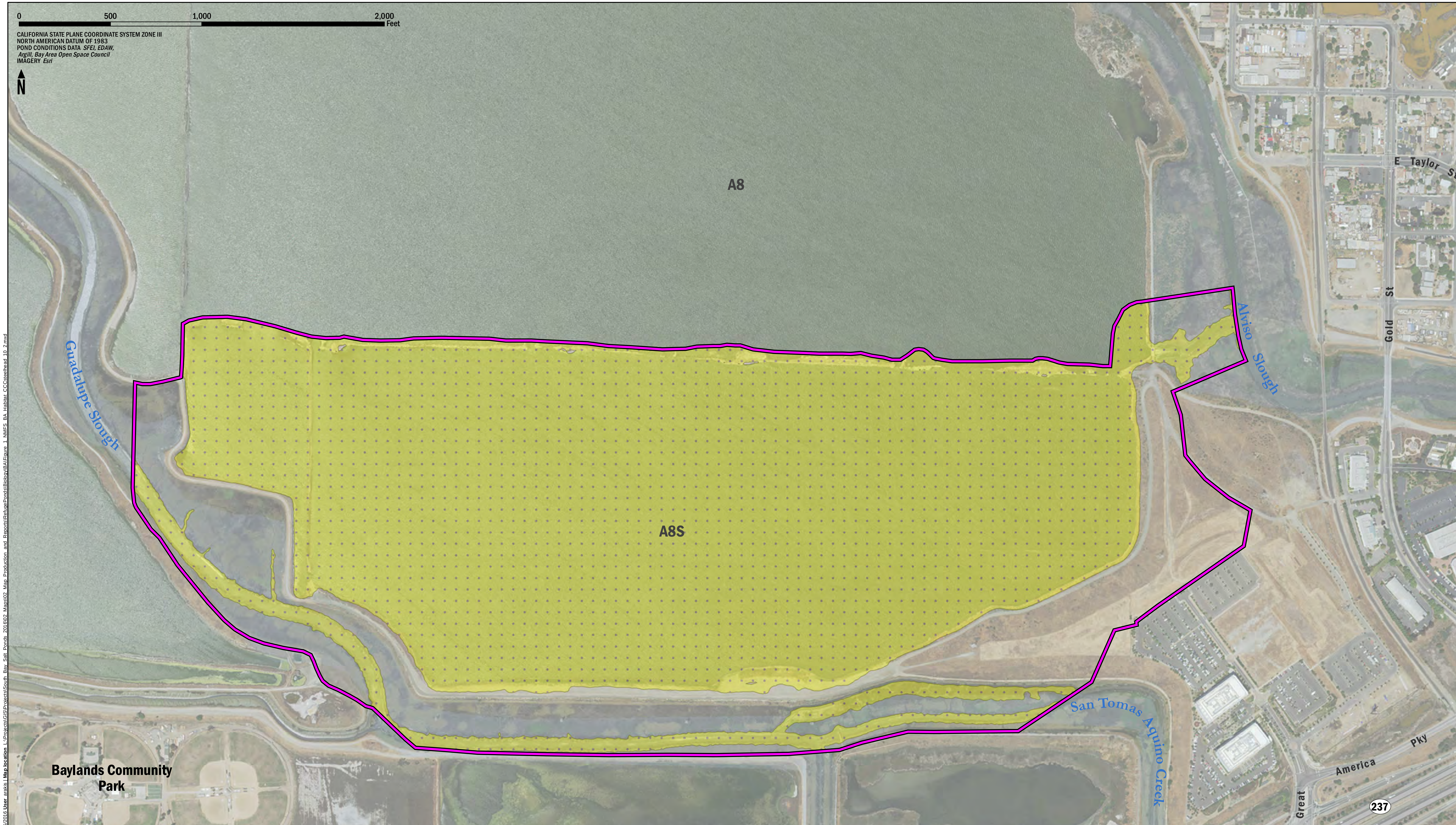
Central California Coast Steelhead Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 7a

Central California Coast Steelhead Habitat - Island Ponds



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Phase 2 BA Action Area

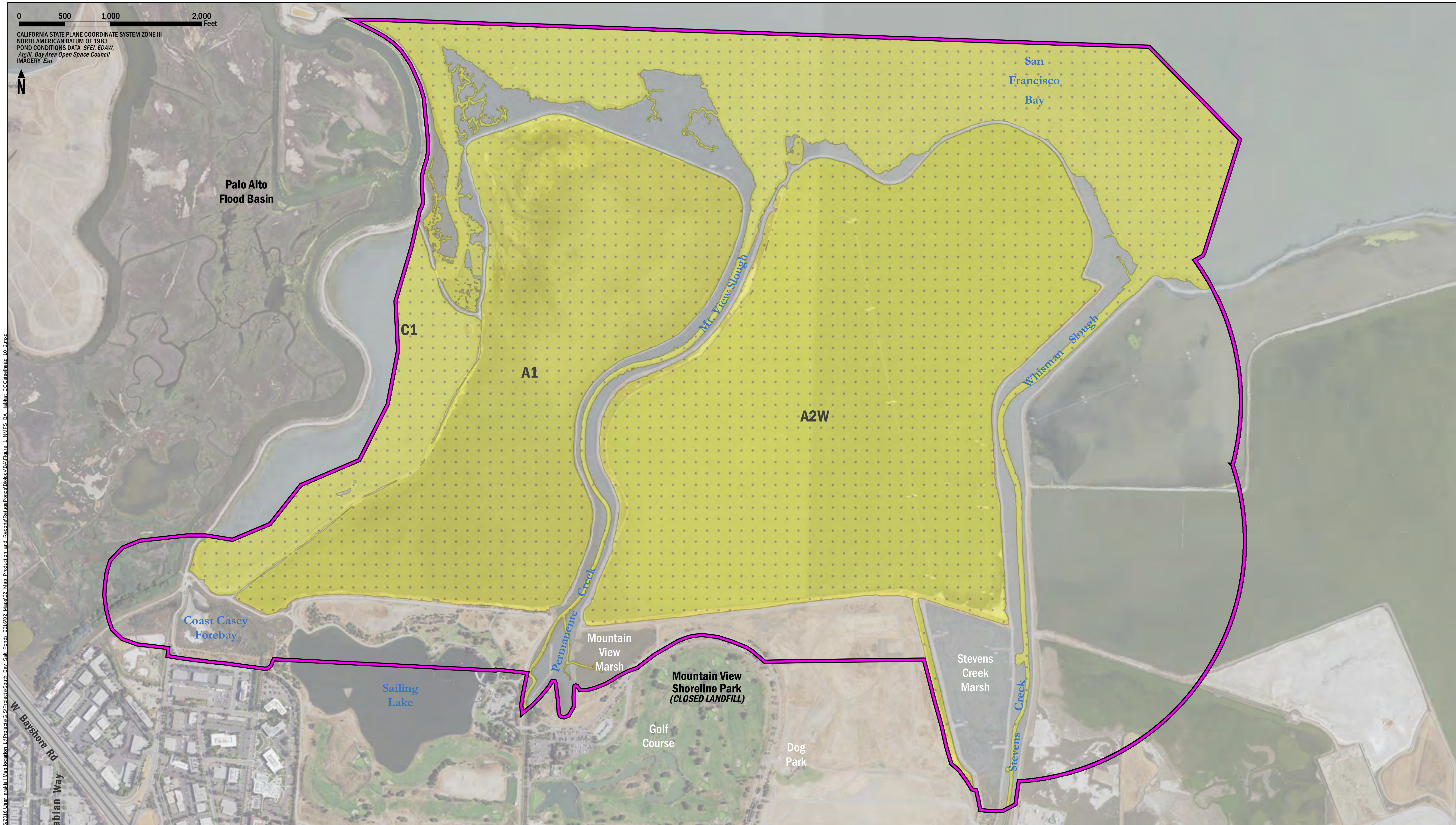
Central California Coast Steelhead Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 7b

Central California Coast Steelhead Habitat - A8 Ponds



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Phase 2 BA Action Area

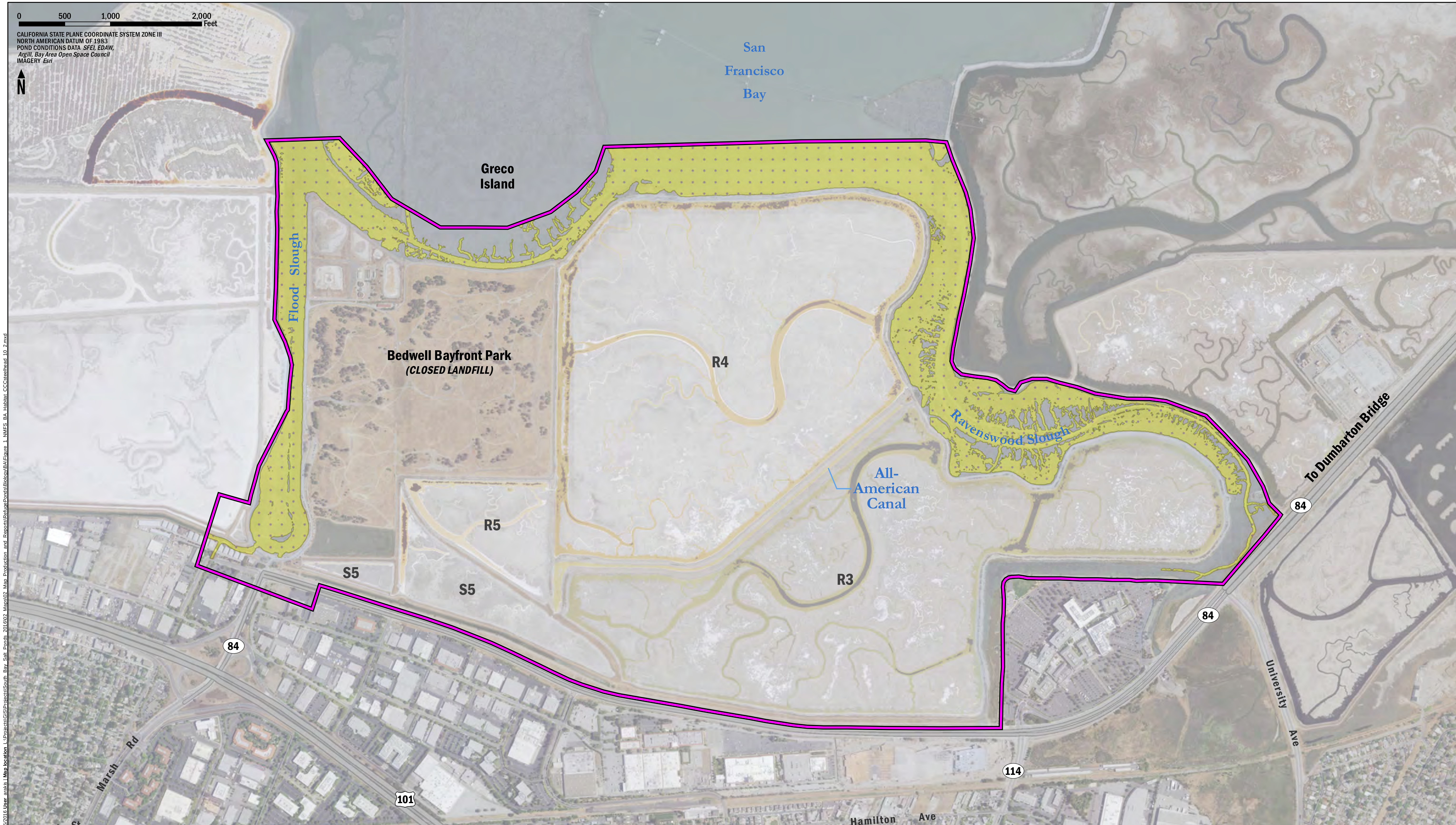
Central California Coast Steelhead Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 7c

Central California Coast Steelhead Habitat - Mountain View Ponds



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Phase 2 BA Action Area

Central California Coast Steelhead Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 7d

Central California Coast Steelhead Habitat - Ravenswood Ponds

Legend

Phase 2 BA Action Area

Green Sturgeon Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 8a

Green Sturgeon Habitat - Island Ponds

Legend

Phase 2 BA Action Area

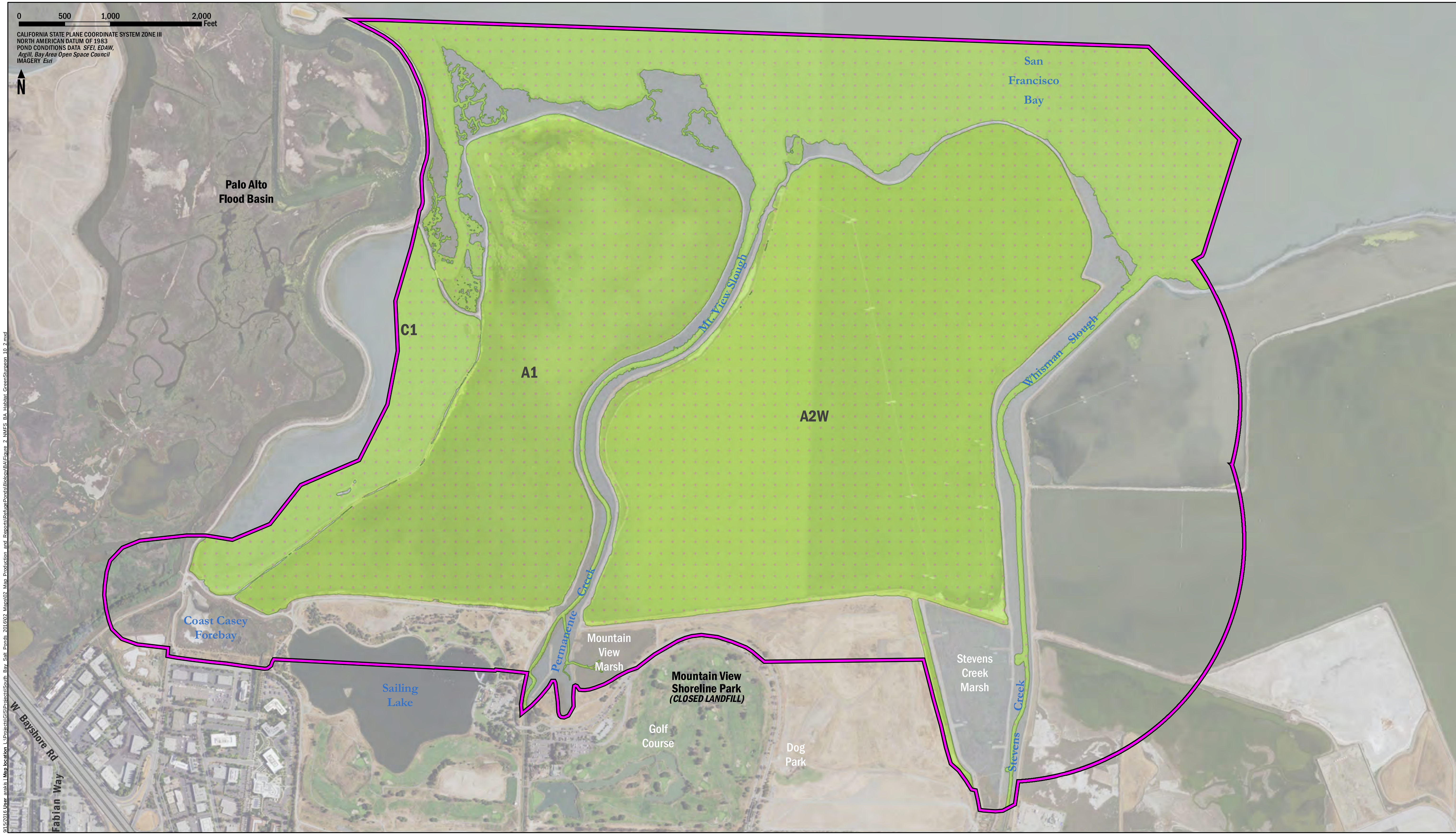
Green Sturgeon Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 8b

Green Sturgeon Habitat - A8 Ponds



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Phase 2 BA Action Area

Green Sturgeon Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 8c

Green Sturgeon Habitat - Mountain View Ponds

Legend

Phase 2 BA Action Area

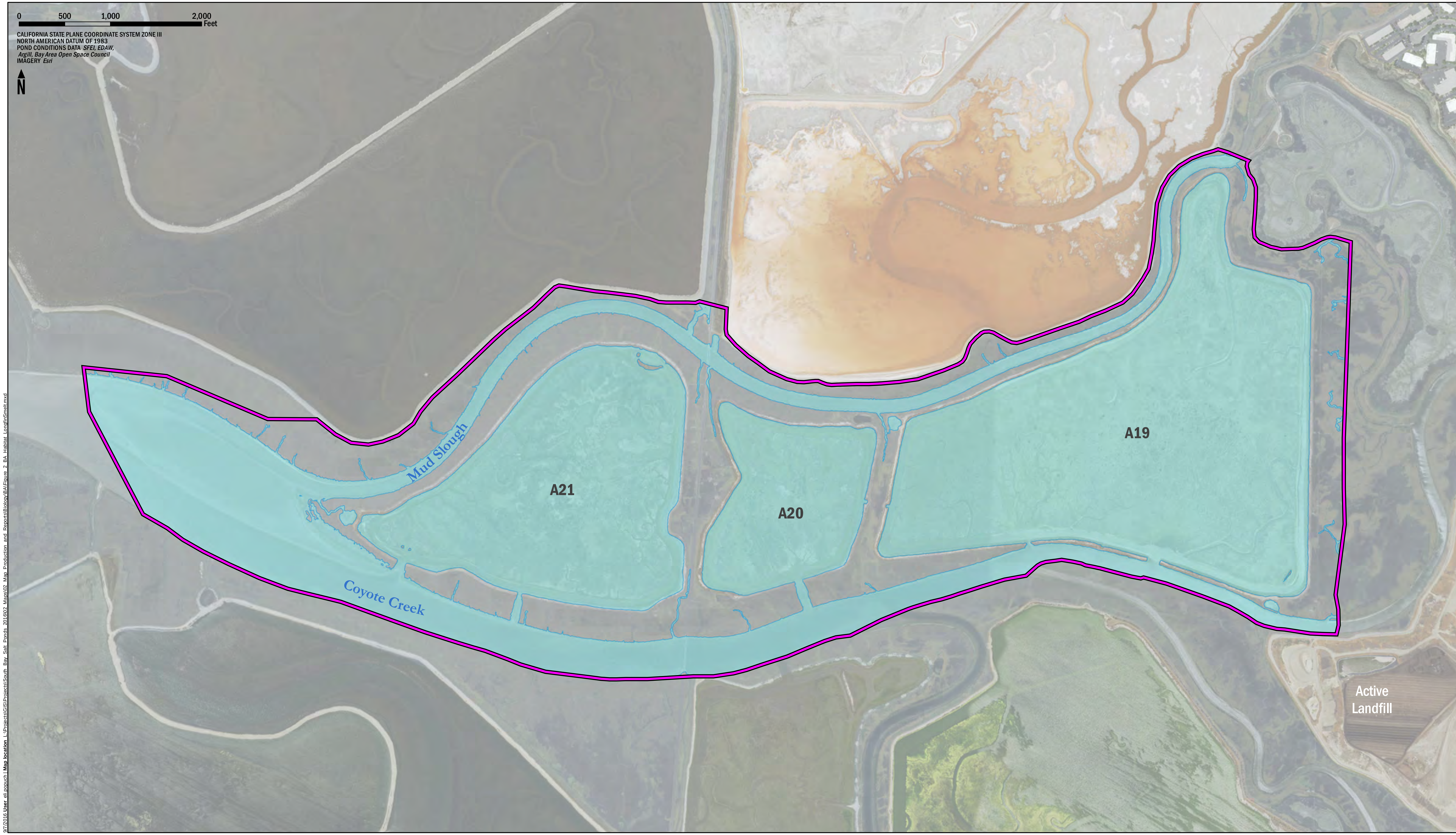
Green Sturgeon Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 8d

Green Sturgeon Habitat - Ravenswood Ponds



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Phase 2 BA Action Area

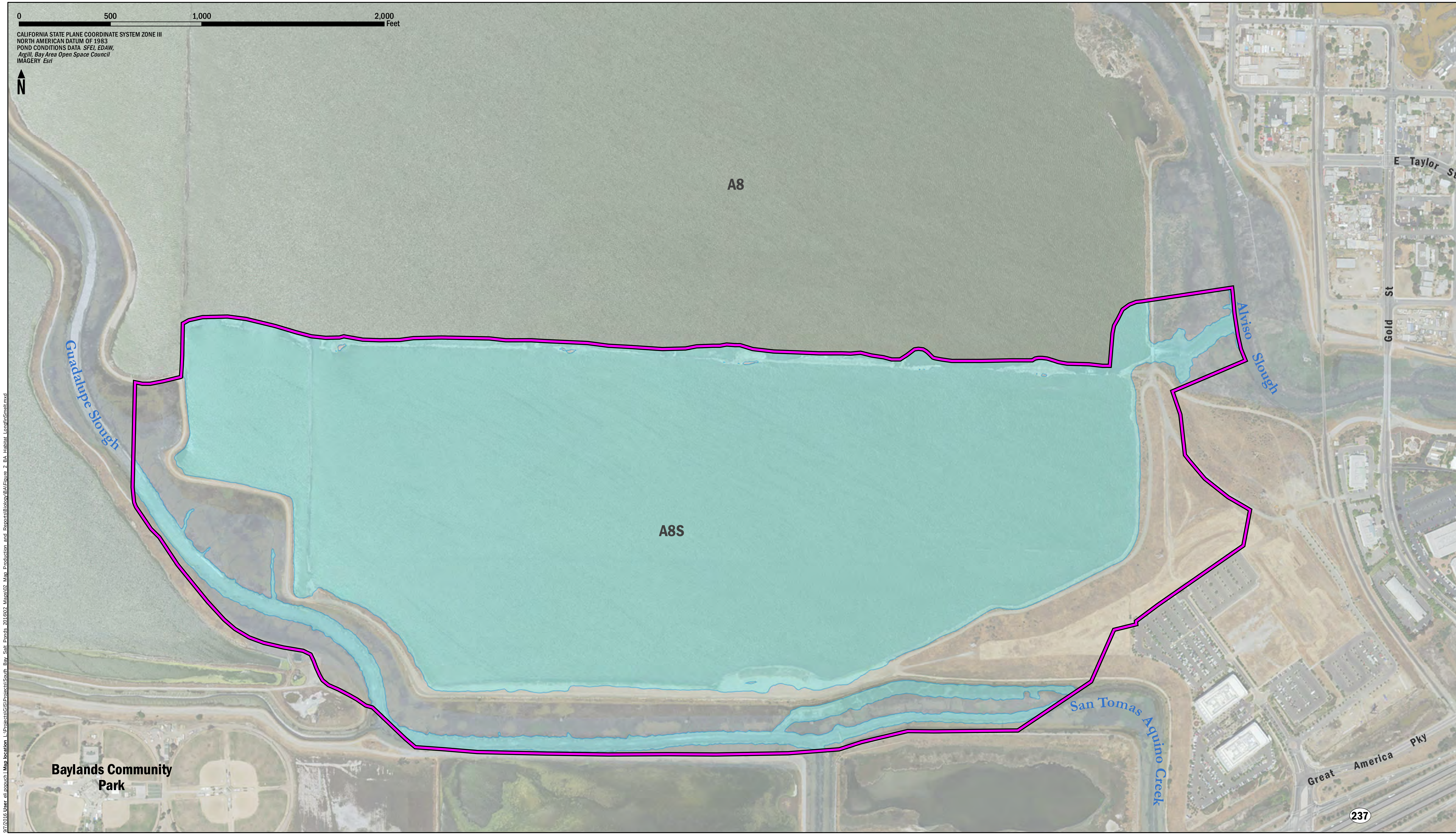
Essential Fish Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 9a

Essential Fish Habitat - Island Ponds



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Phase 2 BA Action Area

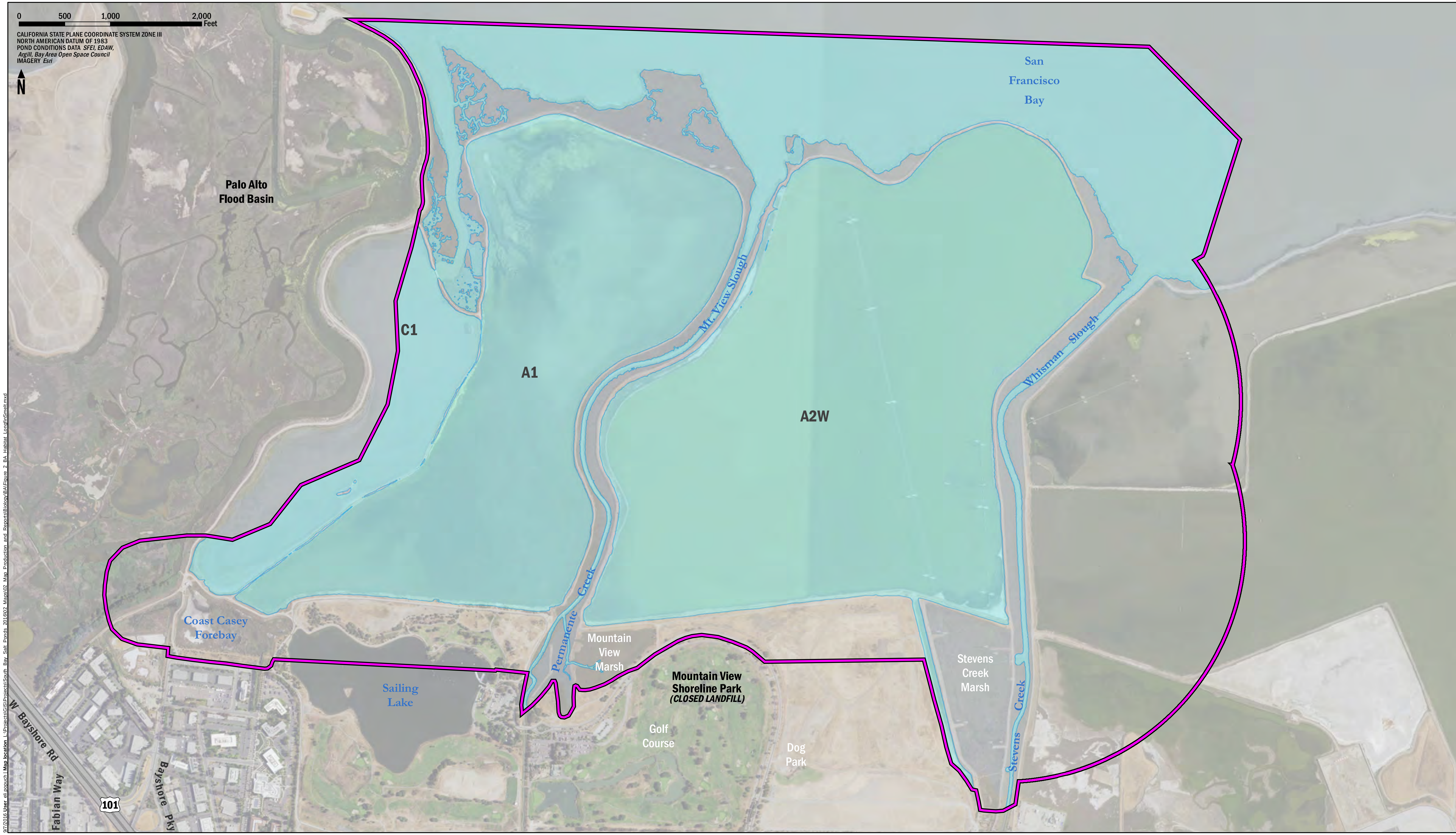
Essential Fish Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 9b

Essential Fish Habitat - A8 Ponds



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Phase 2 BA Action Area

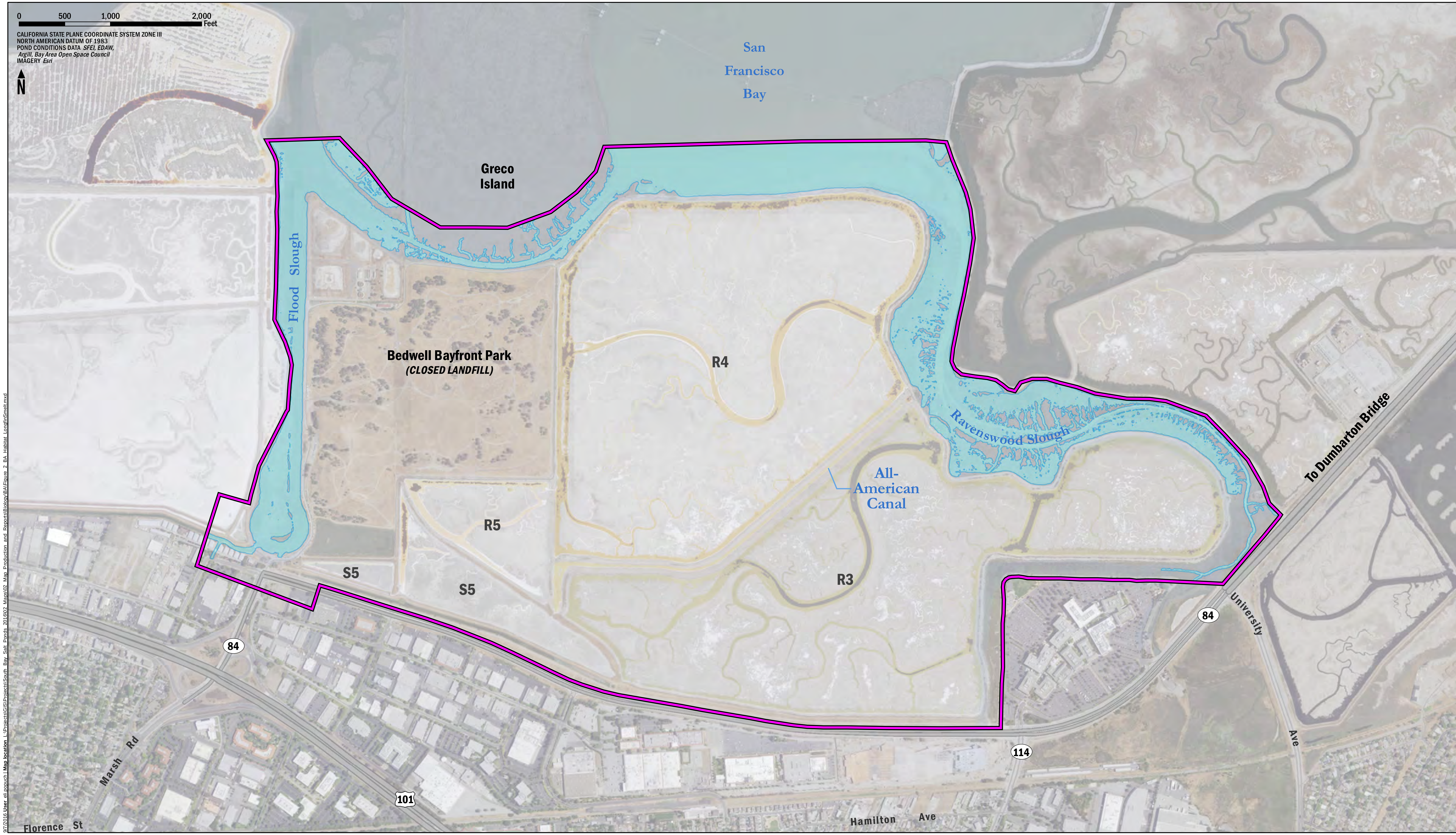
Essential Fish Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 9c

Essential Fish Habitat - Mountain View Ponds



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Phase 2 BA Action Area

Essential Fish Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 9d

Essential Fish Habitat - Ravenswood Ponds

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Appendix A. Construction Details for PG&E Infrastructure

1. Summary

As part of the SBSP Restoration Project Phase 2 work, Pacific Gas and Electric (PG&E) would restore existing access boardwalks, construct new boardwalks and raise concrete foundations on existing towers in the Alviso – Mountain View Ponds. The following summarizes the proposed PG&E work based on information provided to the Refuge by PG&E.

2. PG&E Access Boardwalks

All existing boardwalks would be raised a maximum of 4 feet, utilizing the existing boardwalk pillars. The existing boardwalks in Pond A2W are made of wooden planks on wooden frames that rest on concrete foundations set into the pond bottom. The decking is approximately 6,700 feet long, two to three feet wide, and only intermittently used by PG&E for pedestrian access to the towers. These boardwalks would be removed and replaced with higher ones to retain PG&E access to the towers. The replacement would increase the width of the boardwalks by approximately two feet and thus increase the shaded area of the Bay. The exact amount of added surface area would not exceed 13,500 square feet (0.31 acre). In addition to raising the boardwalks within the pond, a new section of boardwalk would be added to connect the end of the Pond A2W boardwalk with the end of an existing one that lies northwest of Pond A1. The additional boardwalk would be approximately 2,350 feet long and 3 feet wide (7,050 square feet [0.16 acre]). This area the area of new shade added to the Bay. The total cross-sectional area of the piles to support this new boardwalk is less than 700 square feet (under 0.15 acre). The total volume of the piles to support the new boardwalk would be approximately 280 cubic yards, of which approximately 186 cubic yards would be below the Bay floor (piles must be placed 12 vertical feet below the Bay floor), and the remaining 93 cubic yards would be in the water column. The various access points to the boardwalks would be gated to protect against unauthorized human entry and would be designed to exclude terrestrial predators of marsh wildlife species that may use them.

2.1 PG&E Boardwalk Improvement and Addition.

The new boardwalks would be placed within the existing PG&E right-of-way (ROW), adjacent to the towers. All new sections of boardwalk would be built approximately 4 feet above the height of the existing boardwalk. The boardwalk spans would be 3-foot-wide sections and would include a double handrail. The boardwalk spans would be built in 20-foot-long sections supported by 4-inch by 4-inch vertical plastic lumber posts, known as support footings, which would be spaced 10 feet apart along the boardwalk spans. The boardwalks would parallel the transmission line towers and would include additional lateral boardwalks, which would be used to access each tower from the main boardwalk. Construction details for PG&E operations can be found in the 2016 SBSP Restoration Project's Final Environmental Impact Statement/Report (2016 FEIS/R) Appendix D.

Using hand tools, PG&E crews would manually drive the support footings into the Bay floor to an approximate depth of 12 feet. A small amount of mud would be displaced by the support footings. PG&E is proposing to use only plastic lumber or untreated wood for boardwalk installation. Plastic lumber would last longer than wood, and the use of untreated wood would ensure that the least amount of potential long-term environmental impacts will result. All work would be conducted by hand, and equipment used to install the boardwalks, including generators and chainsaws, will be mobilized to the boardwalk locations on foot.

Working from the land-side end of the existing boardwalk at the southern end of Pond A2W, the decking/planks of the existing boardwalk would be removed, and the old piles pulled. Rebuilding each removed segment of the boardwalk would proceed before the next segment is removed, so that crews would be working from newly built segments. Some of this work may be done by a crew working from the existing boardwalk, but much of the demolition and removal would be done from a small boat and the use of an 8-foot by 10-foot floating device such as a raft. Some of the old piles and decking would be placed on the floating device and hauled out, and some would be transported on special hand-built and hand-powered dollies/wheelbarrows. In the areas closest to shore, where water may be too shallow for a barge, some work may also be done while standing on temporary trellises or other work platforms, which would be placed on the pond bottoms. This would involve some foot traffic on the pond bottom and along the edge of the pond.

Wooden safety railings would be added in a similar manner. As is the current condition, gates and fences with razor wire would be placed on each end of the boardwalk to prevent public access and entry to the boardwalks; it would also deter mammalian predators. All boardwalks would be constructed according to PG&E specifications.

The two replacement boardwalks inside of Pond A2W would extend approximately 6,700 feet combined, from the border with Mountain View Shoreline Park through the pond to the outer Bay-facing levee or to the levee bordering Stevens Creek. On the other side of the outer Bay-facing levee, the new length of boardwalk (approximately 2,350 feet long) would extend west-northwest from the Pond A2W levee to connect with the existing PG&E boardwalk to the north of Pond A1.

This boardwalk would be built in a similar, stepwise manner as the one inside of Pond A2W, with each new segment of boardwalk being built from the segment most recently constructed. This outer section of boardwalk would be in deeper water that is not expected to eventually become tidal marsh but rather to remain open Bay.

These tasks would require small crews, typically less than a dozen people. Construction monitoring will be conducted as directed by PG&E's Environmental Compliance Management Plan (ECMP).

3. Raise Concrete Foundations of PG&E Towers in Pond A2W

Sixteen (16) transmission towers are within Pond A2W. Conversion of this pond to tidal marsh habitat would require PG&E to upgrade the tower foundations to account for the introduced tidal flux and to raise the maintenance/service boardwalks that run under the power lines and provide PG&E access to the towers. The concrete pedestals on which the towers sit would be reinforced with additional concrete placed higher on the tower legs to protect the metal portions of the towers from the corrosive action of saltwater from the highest tides. The total combined area of the new concrete foundation is estimated to be 540 square feet (about 0.013 acre), and the total combined volume of that concrete is 2,160 cubic feet (80 cubic yards).

3.1 Adding Concrete for PG&E Tower Foundation Improvements

Boardwalk work would be completed first for worker safety and to more efficiently transport materials and tools to the towers. Following the completion of boardwalk replacement and construction, work would be performed on the footings of the towers in Pond A2W. Multiple towers will be worked at the same time from each side of the boardwalks. All structures would require adding additional concrete to existing concrete foundations to a greater height of up to 4 feet above existing structure footing.

Equipment required for this project would involve: wheel barrels, hand tools, drills, saws, jackhammers with air compressor, barge and pickup trucks. The material would be moved to each specific work site by hand or wheelbarrow. The new concrete would either be mixed at each tower location, or hauled in with a wheelbarrow to each location to the levee and removed in wheelbarrows for disposal. It is possible some concrete deliveries could be made by helicopter.

To upgrade the concrete foundations of the four legs of each tower, the following general steps would be taken: PG&E would construct a cofferdam around each of the footings, dewater the space between the cofferdam and the existing foundations, build a form for pouring additional concrete, pour the concrete, and remove the cofferdam.

The cofferdams would be installed at low tide to allow access to the foundation footing. The cofferdams would generally be plywood and wooden strongbacks. These would be placed around each footing. Mud would be removed by hand, and the dam pushed down to expose the solid piling, usually 3 feet below the mud line. The mud would be returned to the base of the footing after the cement is poured.

The dewatering would be done by pumping the enclosed pond water out of the cofferdam and per in accordance with the 2007 SBSP Program FEIS/R and 2016 SBSP Phase 2 Mitigation Measure 3.4-5a. Pumps would be gas- and diesel-powered. Each cofferdam could be dewatered in fewer than 6 hours of pumping. The pumps would be delivered to the towers via the boardwalks or by barge.

During the time that the tower foundations are exposed, new/replacement concrete footings would be poured between the reinforcements. Each footing would be chipped down to roughen concrete to accept the new concrete cap. Stockpiles would be necessary at each end of the boardwalks. Crews will use the existing boardwalk to transfer removed concrete to staging site located on the maintained outboard levee, loaded onto trucks, and transported to PG&E’s facility in Newark for disposal. Any necessary steel repairs would be performed before the new concrete cap is added to the existing footing.

New pins would be inserted to form a new rebar cage around the pile to act as the form, and the concrete would then be poured. All concrete will be mixed by hand at each tower site. The new concrete caps would be at elevations three to five feet higher than the existing footing height. The cofferdam would be removed once the concrete is dry.

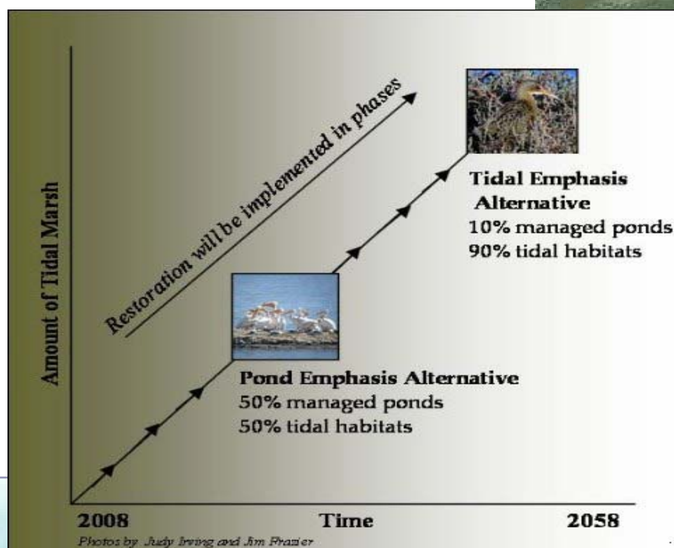
Footing repairs can be done within a work area extending approximately 2 feet from the footing. In very shallow water or at low tides, rubber mats could be used for short periods to gain temporary access to perform maintenance work and would be placed to help protect the vegetation around the boardwalk being built.

The duration of the tower foundation improvements would be 20 weeks, assuming PG&E crews would work 10-hour days, 7 days per week. These tasks would require 8 workers. Construction monitoring will be conducted as directed by PG&E's ECMP. If necessary for schedule compression, work on tower foundations near segments of boardwalk that have already been replaced or constructed could be implemented prior to the completion of all boardwalk work. However, this analysis assumes that these activities do not overlap.

Appendix B.
Adaptive Management Plan for the South Bay Salt Pond Restoration Project

SOUTH BAY SALT POND RESTORATION PROJECT

ADAPTIVE MANAGEMENT PLAN



November 14, 2007
Science Team Report for the South Bay Salt Pond Restoration Project

Lead Author: Lynne Trulio
With Assistance from: Deborah Clark, Steve Ritchie, Amy Hutzel, and the Science Team

SOUTH BAY SALT POND RESTORATION PROJECT
ADMINISTRATIVE DRAFT ADAPTIVE MANAGEMENT PLAN

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Executive Summary

This Adaptive Management Plan (AMP) is integral to the South Bay Salt Pond Restoration Project and is designed to help to guide the planning and implementation of each Project phase. Adaptive management provides a directed approach to achieving the Project Objectives through learning from restoration and management actions—actions for which many scientific and social uncertainties exist. The AMP lays out the background for adaptive management in Part 1, including the importance of adaptive management in the Project and how adaptive management will direct this long-term effort toward achieving the Project Objectives. Part 2 describes the foundations for adaptive management developed during the planning process, especially the key uncertainties, monitoring, applied studies, and modeling. The scientific approach to generating information and its use in decision-making for the long-term Project as well as the Phase 1 actions is described in Part 3. Part 4 discusses the institutional structures and processes for undertaking adaptive management. This AMP provides direction for the Project, especially Phase 1, based on the best current information. However, the Plan itself is designed to be adaptive and, therefore, many elements including the key uncertainties, applied studies, and the institutional structure may change and evolve over time.

In March 2003, state and federal agencies acquired 15,100 acres (>6100 hectares) of solar evaporation salt ponds in South San Francisco Bay from Cargill, Inc. These former salt ponds became the South Bay Salt Pond Restoration Project (the Project), which is managed collaboratively by the California State Coastal Conservancy (SCC), the U.S. Fish and Wildlife Service (FWS), and the California Department of Fish and Game (DFG). The Project is composed of three complexes; FWS owns and manages the Alviso and Ravenswood pond complexes and DFG owns and manages the Eden Landing pond complex. In 2003, the FWS and DFG began implementing the Initial Stewardship Plan (ISP), a management strategy to decouple the ponds from salt-making and prepare the ponds for restoration under the Project. From 2003-2007, the Project undertook a comprehensive planning process, in which the Project participants: 1. developed the Project's Objectives; 2. developed the scientific foundation; 3. engaged the public; 3. coordinated with the Army Corps of Engineers (ACOE) on the South San Francisco Bay Shoreline Study, a closely-related multi-objective study that includes the Project area; and 5. produced an EIS/R that evaluates the Project, as a whole, for 50 years as well as the Phase 1 actions, which are the first actions the Project Managers will implement as part of the 50-year program. The adaptive management approach described in this AMP is integrated into the *South Bay Salt Pond Restoration Project EIS/R*.

The overarching mission of the Project is the restoration and enhancement of wetlands in the South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation. The six Project Objectives (Table 1, see page 3), based on this mission, are central to Project planning and implementation. While much is known about the South Bay ecosystem, the Project participants identified eight key uncertainties that could make meeting the Project Objectives difficult. These uncertainties included sediment dynamics, bird response to changing habitats, non-avian species responses, mercury issues, invasive and non-native species, water quality, public access and wildlife, and social dynamics. The overarching uncertainty of global climate change is incorporated, defacto, into each of the specific key uncertainties.

The Project participants developed a number of visions for what the restored ecosystem could look like in 50 years. In particular, the EIS/R for the Project evaluated three alternatives: "No Project" in which ISP management continues for 50 years, a 50% tidal:50% managed pond alternative in which approximately 50% of the Project Area is returned to tidal action and 50% is managed as ponded habitat, and 90% tidal:10% managed pond. While NEPA may require the Project Managers to identify a "preferred alternative", the Project participants agree that, due to the many uncertainties, the mix of habitats that will optimally meet the Project Objectives—including the amount of tidal restoration and its location--cannot be predicted at this time. Given this, the Project will implement restoration and management in phases and will use adaptive management as the process for determining how far the system can move toward full tidal action and associated tidal habitats, while still meeting the Project Objectives.

For this Project to succeed, no phase can proceed without including adaptive management as an element of the design and implementation. The Adaptive Management Staircase in Figure 2 (see page 8) is a conceptual view of this process. Adaptive management will provide the information needed to determine how far to proceed along the staircase and at what pace. Implicit in the staircase and the Project's core mission is that the Project will continue to add tidal habitat to the system, so long as the other Project Objectives are met. Also implicit is the possibility, although unlikely, that the Project might stop adding tidal habitat before 50% of the Project Area is returned to tidal action, if substantial unanticipated problems are identified. However, taking that action would require a new NEPA/CEQA evaluation and reconsideration by all regulatory agencies.

The AMP describes how providing public access, one of the goals of the Project, is also subject to adaptive management. The Adaptive Management Approach for Recreation and Public Access (Figure 3, page 9) shows that the suite of public access features described in Phase 1 is the minimum level of public access the Project will provide. Whether additional recreation and access features are provided in the future will be determined through a process that weighs both effects of access on target species and public demand for particular features.

During the planning stage, the Project moved forward with monitoring, applied studies, and model development. Monitoring during Project planning began in 2003 and characterized baseline conditions in all 54 ponds as well as the associated sloughs, and, to some extent, the South Bay before and after ISP implementation. This program also included compliance monitoring, specifically to track water quality conditions before and after culverts connecting ponds to the Bay were opened for ISP operation. Applied studies were initiated during planning, including a research effort to establish baseline levels of mercury in indicator (sentinel) species, a study of the physical and vegetation changes in response to restored tidal actions at the Island Ponds, and studies of bird use of managed and unmanaged ponds. In addition, the Project developed two large-scale models to predict physical and biological changes in response to management, and tapped a team of modelers to begin developing a detailed predictive, landscape-scale model.

Adaptive management of the Project is based on restoration targets, monitoring, applied studies, and modeling that will be used to generate the science-based information managers will need for decision-making. Adaptive management begins with clear, measurable restoration targets that link directly to the Project Objectives. Appendix 3 lists 28 restoration targets for the Project, which should be monitored to determine if more tidal habitat will be restored, i.e., whether the Project will continue along the adaptive management staircase. Monitoring, using appropriate parameters, allows Project Managers to assess progress toward Project Objectives. The Project participants identified the most essential parameters and some potential methods for collecting the needed data. The monitoring parameters in Appendix 3 are all expected to be measured beginning with Phase 1. Applied studies are listed for each restoration target and, during Phase 1, they will provide data to reduce uncertainties related to achieving the Project Objectives. Each restoration target has a management trigger for action if the system is not performing well. For each management trigger there is a list of potential actions the Project Managers might take if a management trigger is reached.

Both simple and complex numerical models will be employed throughout the adaptive management process to integrate knowledge gained from monitoring and applied studies, allow improved interpretation and extrapolation of observed trends, test and refine hypotheses, and aid in identification of key uncertainties. While individual applied studies may contain some modeling aspects, the Project has need of an integrated model that simulates interactions among physical and biological processes. A successful model will integrate new information as it becomes available and will allow Project Managers to evaluate movement along the adaptive management staircase.

Phase 1 of the Project will be implemented beginning in 2008 and actions, including restoring tidal action to some ponds, managing other ponds, and integrating public access, are planned for each of the three pond complexes. In Phase 1, specific applied studies are coordinated with each restoration and management action and are designed to produce information to help manage the current Phase as well as plan up-coming phases of restoration. Studies in Phase 1 focus on bird response to changing habitats, mercury methylation, public access and wildlife interactions, and pond management effects on the Bay.

The Project will need an effective institutional structure to achieve these four basic adaptive management functions:

1. Generate and synthesize data from monitoring to track restoration progress and from applied studies and modeling to reduce key uncertainties;
2. Convert the synthesized data into effective short- and long-term management decisions;
3. Involve the public in decision-making and make management decisions transparent; and
4. Store and organize Project information for use by the decision-makers and the public.

The organizational structure that will be used to carry out these functions includes the Project Management Team (PMT), which is responsible for decision-making and taking action on those decisions, the Science Program, which will generate and interpret data, the Information Management Staff, which will organize, store and disseminate Project information, and the Stakeholder Forum plus Local Working Groups, which will provide perspectives from the public. The PMT will make decisions on what monitoring, applied studies, and modeling to fund; actions needed to modify current phases; and the design of future phases. In addition to decision-making, the PMT also has important fund-raising and public outreach functions. Regulatory and funding entities will be involved in the Project as members of the PMT, when appropriate.

The Science Program will be run by two science managers, who will be members of the PMT and will set the direction for and oversee the work of the Science Program. It is anticipated that an array of contractors will do the work required for the Science Program, including collecting and analyzing monitoring data, conducting applied studies, providing reports that analyze and synthesize monitoring and applied studies results, and peer-reviewing Program products and the Program itself. The science managers will use the information generated by the contractors to revise and prioritize monitoring and applied studies and to make recommendations to the full PMT on management actions for current phases and the design of future phases.

Public involvement as an especially important component of successful adaptive management. The public will have multiple avenues to learn about Project activities and provide input to the Project Managers, including through the website as well as Stakeholder Forum and Local Work Group meetings. Collaborative learning among scientists, managers, and the public, will allow for public comment and input on the decision-making process and ensure transparency through Project reporting.

Project participants will operate using processes that integrate their activities on a yearly and more frequent basis. The Project will use processes that coordinate Project participants for effective decision-making and restoration implementation. As with other aspects of the Project, the institutional structures and processes are designed to be flexible, allowing them to evolve to achieve effective adaptive management.

All Project reports mentioned in this document are available through the California State Coastal Conservancy, California Department of Fish and Game, Don Edwards San Francisco Bay National Wildlife Refuge or the Project's website (http://www.southbayrestoration.org).

PART 1. INTRODUCTION: Rationale for Adaptive Management

A. Purpose

This Adaptive Management Plan (AMP) is an integral part the South Bay Salt Pond Restoration Project implementation and provides a strategy for achieving the Project Objectives. Adaptive management provides a guided approach to learning from restoration and management actions—actions for which many scientific and social uncertainties exist. In Part 1, the AMP gives the rationale for adaptive management of the Project. Part 2 describes the monitoring, applied studies, and modeling conducted during planning, which laid the foundation for adaptive management of the Project. This work was used to develop a data collection approach based on restoration targets, monitoring, applied studies, and management targets, described in Part 3, that will provide data for management responses. Part 4 describes the institutional structures and processes by which Project Managers, scientists, and stakeholders will work together for effective adaptive management decision-making. This AMP provides direction for the Project, especially in Phase 1, based on the best current information. However, the Plan itself is designed to be adaptive and elements such as the key uncertainties, applied studies, and the institutional structure may change and evolve over time.

B. The Role of Adaptive Management

Project Background. In March 2003, state and federal agencies acquired 15,100 acres (>6100 hectares) of solar evaporation salt ponds in South San Francisco Bay from Cargill, Inc. This acquisition provides the opportunity to restore wetlands on a scale unprecedented on the west coast of North America. The South Bay Salt Pond Restoration Project (the Project) is managed collaboratively by the U.S. Fish and Wildlife Service (FWS), the California Department of Fish and Game (DFG), and the California State Coastal Conservancy (SCC). The overarching goal of the Project is the restoration and management of wetlands in the South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation. The Project Management Team (PMT) and the Stakeholders developed six Project Objectives, based on this goal (Table 1).

The Project Area consists of 54 ponds ranging from 30 to 680 acres in size in three distinct pond complexes bordering South San Francisco Bay: the Alviso complex (7,997 acres in 25 ponds), the Eden Landing complex (5,450 acres in 22 ponds), and the Ravenswood complex (1,618 acres in 7 ponds) (Figure 1). The entire Project Area is surrounded by the highly urbanized landscape of the South Bay, also known as Silicon Valley. In 2005, according to the U.S. Census Bureau, over 3.8 million people lived in San Mateo, Santa Clara, and Alameda Counties (see http://quickfacts.census.gov/qfd/states/06000.html), the counties that border the three pond complexes. This urban landscape brings a significant human dimension to the Project. Project Objectives that focus on flood management, public access, mosquito control, and infrastructure protection attest to the importance of social factors in the Project.

The pond complexes consist primarily of former wetlands that were diked off from the Bay as early as the 1860s (Siegel and Bachand 2002). Creation of the levees, extensive urbanization, and other actions in the Project region had large effects on the ecosystem of the South San Francisco Bay (south of the San Bruno Shoal) including:

- the loss of at least 85% of historic tidal wetlands;
- changes in sediment dynamics;
- changes in freshwater flows;

- introduction of pollutants, especially mercury;
- changes in species composition and distribution, and
- significant population changes for a number of key species.

The restoration of substantial tidal habitat in the South Bay to reduce or reverse these impacts has long been a goal of the public and agencies (Habitat Goals 2000). However, complete restoration of tidal habitat to historic acreages would eliminate the salt ponds, which are now used for foraging, roosting and nesting by a wide variety of resident and migratory bird species. To maintain these species' presence in the South Bay, restoration and management of the Project Area must balance tidal habitat restoration with preservation of current habitat uses.

As a condition of the purchase, Cargill, Inc. was responsible for reducing pond salinity to the "transfer level", a condition set by the Regional Water Quality Control Board (RWQCB). Cargill, Inc. transferred the Eden Landing and Alviso ponds (except Ponds A22 and A23, which had not yet met the salinity transfer standard) to the DFG and FWS, respectively, between 2004 and 2005. Upon transfer, the agencies began to manage the ponds under a strategy called the Initial Stewardship Plan (ISP). The ISP is designed to control water salinities and maintain the ponds as independent systems that no longer make salt. In other words, the ISP decouples the ponds from salt making. ISP management produces low to moderate salinity ponds prepared for restoration or other management action as determined by the Project. Pond management under the ISP is described in the *South Bay Salt Ponds Initial Stewardship Plan* (Life Science 2003a, b). As a result of ISP management, pond conditions, especially salinity, have changed since the purchase. These changes have been monitored by the USGS, whose monitoring program is summarized in Part 2.

Much is known about the South Bay ecosystem (Goals Project 1999, 2000). On the landscape level, the EcoAtlas Baylands Maps provide excellent historical information on the extent, configuration and bathymetry of South Bay habitats in the 1800s (SFEI, 1998) and today (Collins and Grossinger, 2005). Current pollutant levels are under study (Davis, 2005) and the USGS has collected 30 years of data on the water quality, phytoplankton community, and pollutant levels in the South Bay (www.sfbay.wr.usgs.gov/access/wqdata/index.html). On the habitat scale, researchers have collected significant data on the evolution of restoring tidal habitat (Orr, et al., 2003), sediment dynamics (Schoellhamer et al., 2005), hydrodynamics, and tidal habitat community composition (Josselyn, 1983; PWA and Faber, 2004). Many species have received research attention, including the endangered California clapper rail (*Rallus longirostris obsoletus*) and salt marsh harvest mouse (*Reithrodontomys raviventris*), as well as invasive and non-native species (Josselyn, et al. 2005). The FWS has good data sets on winter waterfowl abundances and Point Reyes Bird Observatory (PRBO) has documented shorebird use of salt ponds and other South Bay habitats (Warnock, et al., 2002).

Despite the information available, a number of uncertainties and knowledge gaps exist that could inhibit the Project's potential to reach its Objectives. Monitoring and applied studies conducted during the Project's planning stage provided data on some of the uncertainties. However, all the uncertainties cannot be resolved before restoration starts. In fact, many data gaps can only be addressed by implementing restoration actions and learning from the results. Given this, the Project participants agreed that restoration and management should be implemented in phases and use adaptive management as the process for determining how far the system can move toward full tidal action and associated tidal habitats, while still meeting the Project Objectives.

Rationale for Adaptive Management. The process of learning by doing and then using the results to improve management actions is called *adaptive management* (Walters and Holling, 1990) and this process is a critical component of South Bay Salt Pond Restoration Project implementation. For this Project to meet its Objectives (Table 1), no phase can proceed without including adaptive management as a design and implementation element. Adaptive management is essential to keeping the Project on track toward its Objectives and is the primary tool identified in the *South Bay Salt Pond Restoration Project EIS/R* (2007) for avoiding significant impacts from the Project. The information produced through adaptive management will permit effective changes to current phases and assist in the design of future phases. If information is not collected and applied to management decisions, aspects of the Project will fail or *appear* to fail. Monitoring and applied study information will inform Project Managers as to whether the Project is meeting its Objectives and if not, whether problems are due to the Project or to forces beyond the Project's control. Without adaptive management, Project Managers will not understand the restored system nor will they be able to explain their management actions to the public. Ignorance of the ecosystem may jeopardize public support and funding for future phases and may result in significant negative impacts to the South Bay system and beyond.

Restoration practitioners have found that, because knowledge of natural and social systems is incomplete, systems will respond in unexpected ways. Surprises are also inherent in restoration because nature is variable and unpredictable, especially at large spatial scales and over long time frames. Adaptive management allows managers to prepare for and respond to novel events, from unexpected changes in dissolved oxygen levels to vandalism. When and where such events occur may not be predictable, but part of the adaptive approach is to anticipate the range of events and system responses that might occur and develop a process for dealing with them if they do happen. Monitoring and applied studies can help to prevent unintended consequences of the Project or, when they occur, can help to minimize any negative impacts and address them before they become substantial. Adaptive management allows the Project to move forward in light of regulatory requirements (NEPA, CEQA, FESA) by providing a process for preventing significant negative environmental impacts, to the greatest extent feasible.

This Project has multiple objectives and there may be trade-offs or costs as well as benefits. For example, the planning for this Project balanced the ecological benefits of tidal habitat restoration with the reduction of benefits that the salt ponds provide to some species. The Project also balances other goals such as amounts and locations of tidal restoration with required flood protection and public access with wildlife protection. Monitoring, applied studies, and modeling will help Project Managers understand the trade-offs and their social implications in order to make informed decisions.

TABLE 1. South Bay Salt Pond Restoration Project Objectives

Objective 1. Create, restore, or enhance habitats of sufficient size, function, and appropriate structure to:

A. Promote restoration of native special-status plants and animals that depend on South San Francisco Bay habitat for all or part of their life cycles.
B. Maintain current migratory bird species that utilize existing salt ponds and associated structures such as levees.

C. Support increased abundance and diversity of native species in various South San Francisco Bay aquatic and terrestrial ecosystem components, including plants, invertebrates, fish, mammals, birds, reptiles and amphibians.

Objective 2. Maintain or improve existing levels of flood protection in the South Bay area.

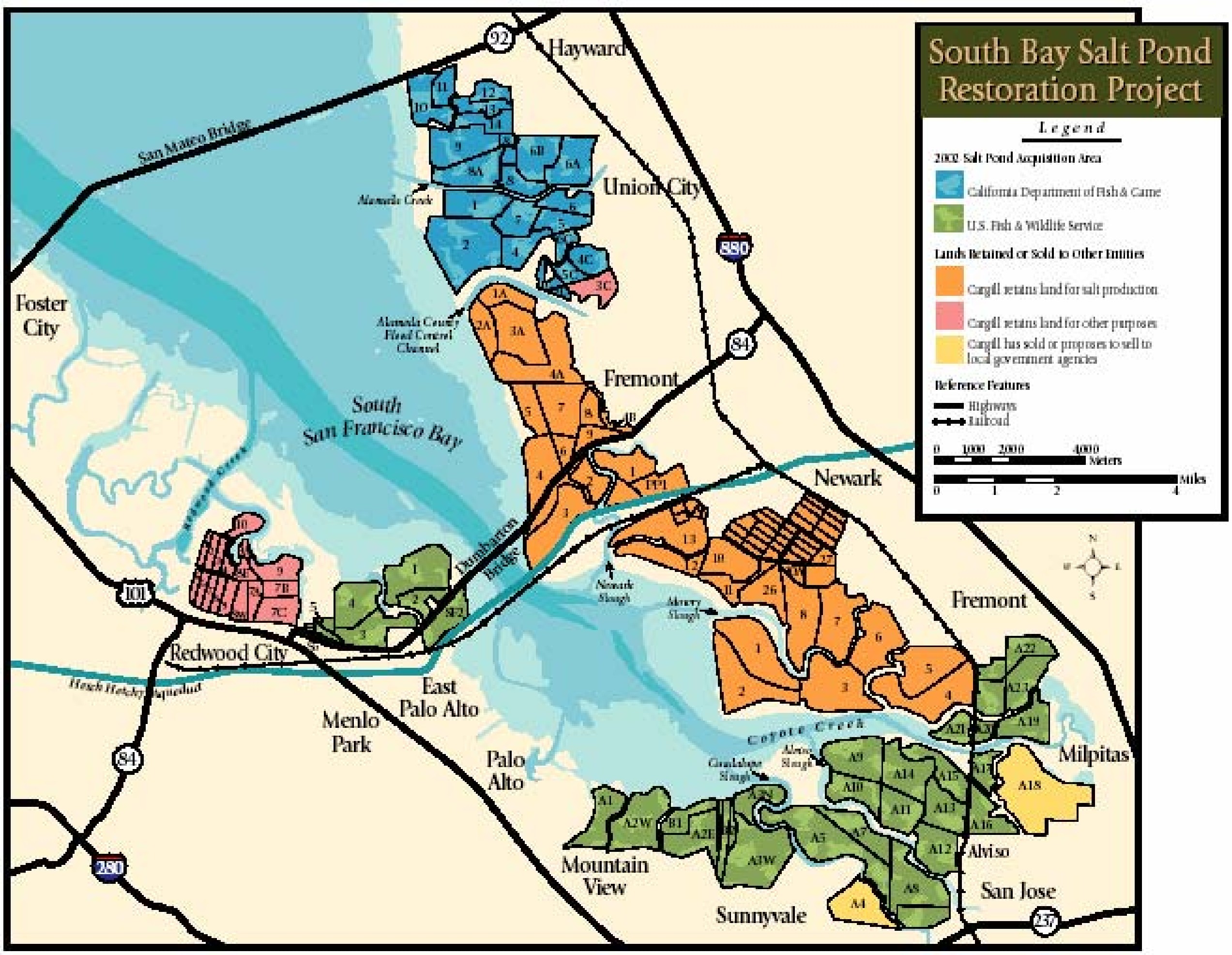
Objective 3. Provide public access opportunities compatible with wildlife and habitat goals.

Objective 4. Protect or improve existing levels of water and sediment quality in the South Bay and take into account ecological risks caused by restoration.

Objective 5. Implement design and management measures to maintain or improve current levels of vector management, control predation on special status species and manage the spread of non-native invasive species.

Objective 6. Protect the services provided by existing infrastructure (e.g. power lines).

FIGURE 1. The South Bay Salt Pond Restoration Project Area.
Blue ponds are the Eden Landing complex owned by the DFG; green ponds from Mountain View to Fremont are the Alviso Complex and those in Menlo Park are the Ravenswood complex, all owned by FWS. Cargill, Inc. retains ownership of the pink ponds. The orange ponds are mostly owned by the FWS, but Cargill continues to make salt there under an easement agreement. Yellow ponds are in the ownership of local government agencies.



C. Adaptive Management Defined

Adaptive management for natural resources was first described by Holling (1978). While there are many current definitions of adaptive management, one of the most applicable to this Project comes from Jacobson (2003) who states, "Adaptive management is a cyclic, learning-oriented approach to the management of complex environmental systems that are characterized by high levels of uncertainty about system processes and the potential ecological, social and economic impacts of different management options. As a generic approach, adaptive management is characterized by management that monitors the results of policies and/or management actions, and integrates this new learning, adapting policy and management actions as necessary."

In an adaptive management approach, resource management and restoration policies are viewed as scientific experiments. This concept is important because the environmental outcomes of management policies are often uncertain. Adaptive management encourages an ecosystem–level approach to resource management and encourages close collaboration among scientists, managers, and other stakeholders on key policy decisions (Jacobson 2003). To be effective, decision-making processes must be flexible and designed to be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.

Adaptive management is a "formal process for continually improving management policies and practices by learning from their outcomes" (Taylor et al. 1997) and it incorporates natural variability in evaluating the results of management actions. Effective adaptive management is not trial and error, which typically reflects an incomplete understanding of critical components of the system. It does not focus solely on tracking and reacting to the fast, immediate variables; this leads to perpetual reactive, crisis management. For fundamental change, adaptive management monitoring includes slow, driving variables. Light and Blann (2001) explain this approach by stating that, "adaptive management is a planned approach to reliably learn why policies (or critical components of policies) succeed or fail". Restoration fails when managers do not learn from actions and policies and, ultimately, miss restoration goals.

This Project will occur in phases over an expected 50-year implementation horizon. This Project's adaptive management approach will allow Project Managers to learn from their actions and will achieve these four functions:

1. Generate science-based information for managers;
2. Convert information into effective management decisions;
3. Involve the public to help provide management direction; and
4. Store and organize information for use by the decision-makers and the public.

To summarize the role of adaptive management in ecosystem restoration projects, the National Research Council (2003) has said, "The learning process that will guide the 'adaptive implementation' of the Restoration Plan will depend on a research strategy that effectively combines monitoring, modeling, and experimental research with a high level of attention to information management, data synthesis and periodic re-synthesis of information throughout the implementation and operation of the Restoration Plan." The National Research Council (2003) also notes that, "As with any long-term environmental project, but especially one committed to an adaptive approach, learning depends on the continuity of adequate funding." While this AMP does not specifically discuss sources of funding or funding mechanisms, the Project participants recognize this is a critical issue for the Project. Securing adequate, constant, long-term funding will be a primary activity of the Project Management Team throughout the life of the Project and its adaptive management.

D. Visions of South Bay Ecosystem Restoration

The Project's geographic scale, encompassing most of the "baylands" and associated species within the South Bay as well as the interconnectedness of all the components, makes this an ecosystem restoration project. An ecosystem is composed of interacting elements of the physical and biological world that produce large-scale processes. Carbon uptake and loss, energy exchange, nutrient cycling and the water balance are typical processes used to distinguish one ecosystem from another (Woodward 1994). Ecosystems have characteristic disturbance regimes, microclimates, successional processes, and species diversity and interactions that occur over the majority of the system (Woodward 1994). To promote a healthy ecosystem and to restore maximum ecological diversity, adaptive management information for the Project must include the entire South Bay ecosystem, the Bay itself, and factors beyond the Bay that are significant influences on South Bay conditions.

Ecosystem restoration is complex and scientific understanding of ecological systems is insufficient to the task of restoring fully-functional systems. There are major information gaps and poor predictive capabilities on long-term and large spatial scales. Given our incomplete knowledge, a basic goal of restoration is to manipulate the system as little as possible and allow natural processes to restore ecological structures and functions, to the greatest extent feasible (National Research Council, 1992). Allowing nature to do the work is often the most successful approach to restoration and in many cases requires less management and reduces project costs. However, the South Bay is a highly altered system in an urban setting; some Project Objectives may be reachable only through constant management. Adaptive management will be used to determine the minimum amount of human intervention needed. In addition, restoring sustainable habitats for rare and indicator species may require intervention that focuses on particular species, habitats, or habitat components. While species-specific management may be necessary, it should not replace the Project's ecosystem focus.

The Project participants conceived a range of visions for the restored ecosystem in 2050. Based on Project input, the Consultant Team evaluated a "No Project" scenario and two Project alternatives—50% tidal habitat:50% managed pond and 90% tidal habitat:10% managed pond—in the *South Bay Salt Pond Restoration Project EIS/R* (2007) for the NEPA/CEQA process (Figure 2). While NEPA may require the Project Managers to identify a "preferred alternative", the Project participants realize that, due to many uncertainties, the mix of habitats that will optimally meet the Project Objectives—including the amount of tidal restoration and its location--cannot be predicted at this time. Specifically, the Project's Science Team identified eight key uncertainties relative to the Project Objectives, which include sediment dynamics, water quality, bird response to changing habitats, mercury methylation, invasive and nuisance species issues, effects on non-avian species, public access and wildlife interactions and social dynamics (see Part 2, Section B). Given these uncertainties, the Project will use adaptive management as the process for determining how far the system can move toward restoring full tidal action and tidal habitats, while still meeting the Project Objectives. The visions for the 50-year landscape are arranged in Figure 2 along a gradient from the landscape with the most managed pond and least tidal habitat (Phase 1) to the system with the most tidal habitat.

The *South Bay Salt Pond Restoration Project EIS/R* (2007) describes the "No Project" alternative as one in which restoration is not implemented but, rather, the Project area is managed indefinitely under the ISP. Under this scenario, ponds would continue to be managed as they are under the ISP and the agencies would maintain critical levees for flood protection.

Other levees would fail, allowing some tidal habitat restoration. Public access features would not be implemented. They also analyzed a 50% tidal habitat:50% managed pond mix and a 90% tidal habitat:10% managed pond scenario. These two scenarios form the likely "bookends" for what the Project area would look like in 50 years. The EIS/R assumes that at least 50% of the Project area would be restored to tidal habitat, but recognizes that the final configuration at 50 years would be a tidal habitat/managed pond mix somewhere between 50:50 and 90:10, as depicted in Figure 2. The EIS/R used information from this AMP to describe how adaptive management will be used to determine the optimal mix of habitats and avoid significant environmental impacts and the AMP is included as an appendix to that document. In essence, the proposed 50-year program is an adaptive management approach to restoration.

In addition to habitat restoration, the EIS/R describes how the Project will meet the other two parts of its mission: preserving or improving on current levels of flood protection and providing high quality, wildlife-compatible public access. The flood protection strategy for the Project is integral to the restoration plan. It is a combination of three elements: 1) levees along the landward edges of ponds to prevent tidal flooding, 2) restoration of tidal habitats along sloughs to increase floodplain storage, and 3) restoration of tidal habitats along sloughs thereby increasing tidal exchange and slough scour for greater channel conveyance. For more detailed planning and implementation of restoration incorporating flood protection, the Project Managers are collaborating with the Army Corps of Engineers (Corps) on the South San Francisco Bay Shoreline Study. The Project Managers will work with the Corps to ensure flood protection is achieved, but adaptively managed as the Project progresses.

A program for high quality, diverse public access, including trails, overlooks, and interpretive features, will also be adaptively managed. Public access features are designed to meet wildlife compatibility requirements, based on current information. However, there is significant uncertainty about the effects of public access on sensitive species. Information from monitoring and applied studies will be used to adaptively manage public access based on: 1) public access effects on wildlife, and 2) public demand for access/recreation features. For example, wildlife managers currently assume that public access features, such as trails, will negatively affect California clapper rails and Western snowy plovers, which are listed species. Studies of trail effects on these species may confirm this suspicion, requiring protective measures; or data may refute this assumption, suggesting that agencies revisit the issue of public access adjacency to these species. Project Managers will also evaluate assumptions about what features the public wants and then adjust current and future Project actions to meet those desires, whenever possible. The Project's approach to adaptive management of public access is depicted in Figure 3, which shows that the public access features planned for the first phase of the Project are the minimum in public access the Project will provide. Whether additional recreation and access features are provided will be determined through a process that weighs both effects of access on target species and public demand for particular features.

Adaptive management will provide the information needed to determine how far to proceed along the tidal habitat staircase and at what pace; Project information may show that the Project should move more quickly or slowly along the staircase. Implicit in the adaptive management staircase and the Project's core mission is that the Project will continue to add tidal habitat to the system, so long as the other Project Objectives are achieved. It is also possible, although unlikely, that the Project Managers might stop adding tidal habitat before 50% of the Project area is returned to tidal action, if substantial problems are identified at that point. However, because the EIS/R evaluated the impacts of 50% tidal habitat as the minimum level of restoration, i.e. the lower "bookend", if Project Managers wish to restore less than that amount, they would need, at the very least, to revisit regulatory requirements with permitting agencies. For example, the FWS Endangered Species Office may undertake a jeopardy analysis for listed species.

In each Project phase, adaptive management will be most effective if Project Managers implement actions for which outcomes are most certain and include those actions that provide good opportunities to study uncertainties. In moving the Project along the adaptive management staircase (Figure 2), Project Managers should take care to avoid designing and implementing irreversible actions for which there is a moderate to high risk of not achieving Project Objectives, and they should avoid taking actions that preclude reaching more complete levels of tidal action. As Project Managers learn more about the system through adaptive management, more types of actions will become predictable and can be implemented.

FIGURE 2. Adaptive Management Staircase for Tidal Habitat Restoration
(MP=percent of managed ponded habitat; ISP=Initial Stewardship Plan)

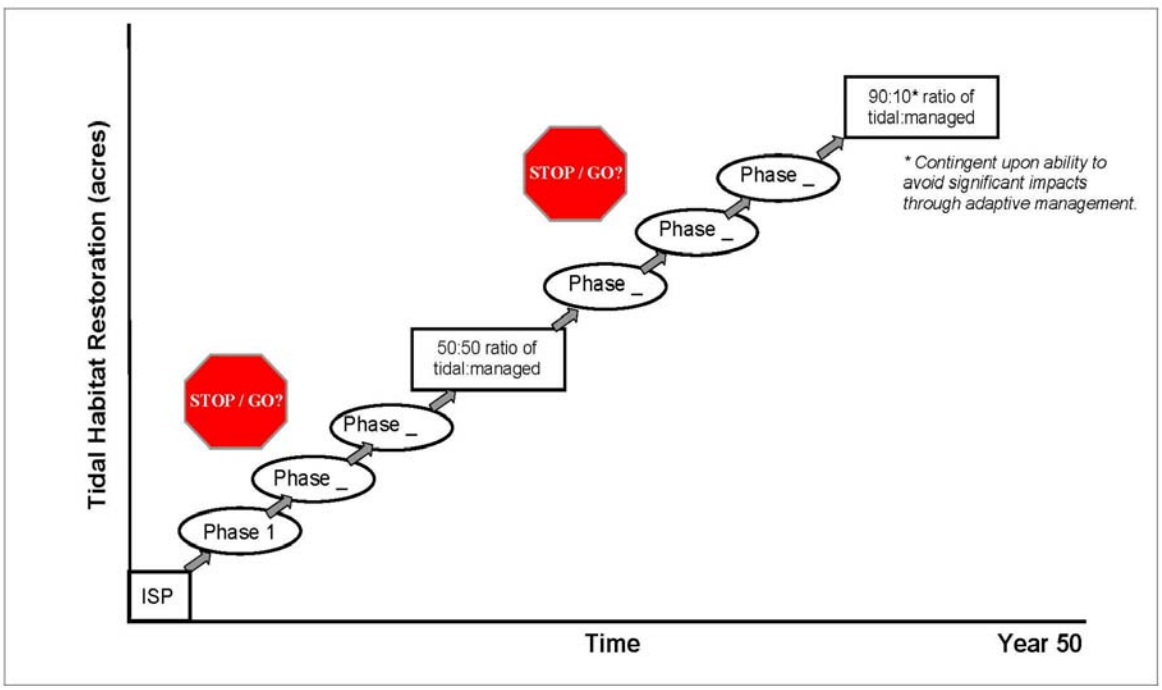
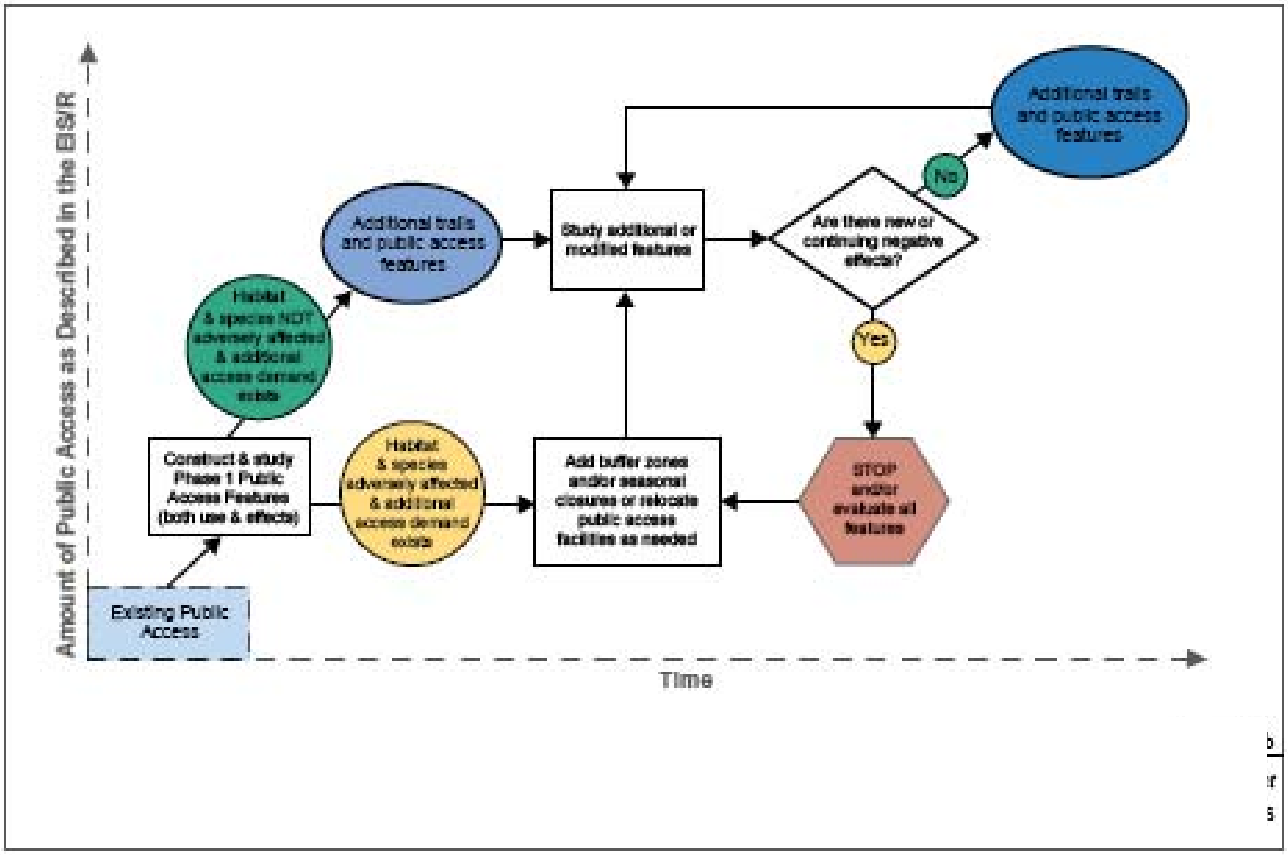


FIGURE 3. Adaptive Management Approach for Recreation and Public Access



PART 2. PLANNING: The Foundation for Adaptive Management

A. Key Uncertainties and Applied Studies

During the planning phase from 2003-2007, the Project participants worked together to lay the groundwork for adaptive management during Project implementation. The Science Team led the effort that developed the science foundation for the Project by writing a series of Science Syntheses (focused literature reviews), holding technical workshops on important Project issues, and identifying the Project's key uncertainties, which led to a list of applied studies for testing. The Project Management Team worked with USGS and the San Francisco Bay Bird Observatory (SFBBO) to develop a plan for baseline data collection that the USGS conducted for the Project. The Consultant Team developed significant amounts of information for the Project through its EIS/R research and, with review from some Science Team members, developed several large-scale predictive models. Given the uncertainties, the Project participants agreed that incorporating adaptive management into the Project was essential to success.

A primary task relevant to adaptive management was to determine where gaps in our knowledge about South Bay ecosystem functioning or restoration significantly hinder our ability to achieve the Project Objectives. The Science Team, with input from the other Project participants, identified the following list of key Project uncertainties:

- **Sediment dynamics**, especially the extent to which tidal habitat restoration might result in the loss of slough and Bay tidal mudflat habitat (links to Project Objective 1A and 1C).
- **Bird use of changing habitats**, especially the extent to which tidal habitat species can be recovered while maintaining the diversity and abundance of nesting and migratory waterbirds observed during pre-ISP conditions (links to Project Objective 1B).
- **Effects on non-avian species**, especially the extent to which restoration and management will affect fish and other critical species in the South Bay ecosystem (links to Project Objective 1C).
- **Mercury**, especially the extent to which Project restoration and management actions might result in an increase in bioavailable mercury in the food chain above pre-ISP levels (links to Project Objective 4).
- **Water quality**, especially the effects of pond management regimes on slough and Bay water quality and important species (links to Project Objective 4).
- **Invasive and nuisance species**, especially the invasive *Spartina* hybrids, red foxes, California gulls, and mosquitoes (links to Project Objective 5).
- **Public access and wildlife**, especially the extent to which various forms of public access and recreation can be integrated into the Project without significantly affecting wildlife (links to Project Objective 3).
- **Social dynamics**, especially the extent to which the local population in the South Bay will actively support the Restoration Project over time (links to all Project Objectives, but especially Project Objectives 2 and 3).

The Project's Science Syntheses (available from the managing agencies or on the Project website) provide more information on the connection between these uncertainties and the Project Objectives.

The Science Team then developed a list of the highest priority applied studies, to be researched through hypothesis testing and modeling, in order to reduce the eight key uncertainties. Table 2 lists the 21 applied studies questions and when research is expected to occur. Each of these questions will require multiple studies in order to develop adequate information for management. In addition, numerical modeling is essential to address questions and develop predictive power. Specifically, sediment dynamics questions, water quality, mercury transport, bird carrying capacity, and effects of human population dynamics all require modeling. Results from many of the applied studies and models are needed to proceed from Phase 1 into later phases. Appendix 1 describes the rationale for each most of the applied studies and gives likely hypotheses for testing or modeling, conceptual study designs, and management uses for the information. All applied studies research for this Project will undergo peer review an must employ well-designed, unbiased data collection and analysis methods, as accepted in their fields.

Several caveats about research are worth noting. First, some studies may require construction of features for isolating treatments or otherwise implementing the manipulation and may, in some cases, conflict with restoration goals (Walters, 1997). For example, providing tidal action into specific ponds to test mercury methylation may result in increased mercury in the system. Whenever possible, irreversible changes for study manipulations will be avoided. But, if they cannot, Project Managers will need to evaluate the trade-offs between the benefits the study provides and the costs to achieving a Project Objective. Second, although they are chosen to try to reduce unknowns and develop meaningful management information, some studies may not produce data that are immediately useful to the Project or may produce completely unexpected results. Project Managers will minimize these situations by regularly evaluating key uncertainties and *requiring that proposed studies link directly to management*. The Science Team during planning did an excellent job ??? of selecting the most critical uncertainties and studies.

It is absolutely critical, throughout the life of the Project, that the Project Managers and scientists continue to carefully select a targeted, short list of key applied studies for funding that are specifically linked to management needs and achieving the Project Objectives. Unless research needs are tightly defined, the Project can easily veer off in a direction of collecting large amounts of data that ultimately do little to help managers. This direction would be highly detrimental to the Project. Therefore, one of the most important on-going tasks of the science managers will be to tightly define the most critical applied studies and modeling efforts that provide the information managers need in a timely manner. The science managers will achieve this through regular review of the key uncertainties and applied studies, with direct input from the Project Managers.

During planning, the Project and other agencies initiated a number of applied studies to begin this component of adaptive management; they are listed in Table 3. Major study efforts included the research program developed by San Francisco Estuary Institute (SFEI), USGS, and the Santa Clara Valley Water District (SCVWD) to help establish baseline levels of mercury in indicator (sentinel) species and to assess whether restoring a managed pond, A8, to reversible muted tidal action will increase mercury levels in these species. The reversibility of this project will limit species' exposure. In addition, FWS and USGS undertook a multi-million dollar study of mercury levels in San Francisco Bay and Delta birds, funded through the CALFED process. This research included study of mercury levels in South Bay avocets, stilts, and terns. Another major research effort, this one funded by the Project, focused on the physical and vegetation changes at the Island Ponds, Ponds A19, A20, and A21, during the first year after they were breached. Research was initiated at these ponds just prior to breaching in March 2006. Other applied studies undertaken by PRBO Conservation Science (PRBO), San Francisco Bay Bird

Observatory (SFBBO), and San Jose State University (SJSU) focused on bird use of habitats and public access-wildlife interactions.

While each of the 21 applied studies is considered essential to reducing key uncertainties, studies should be sequenced in a way that takes advantage of ecosystem conditions as the Project progresses. Sequencing the studies ensures that critical path research is started when the timing is appropriate. From a funding standpoint, sequencing lists the studies that need to be funded immediately and those for which funding will not be needed until later. Appendix 2 gives the three-tiered approach and rationale for sequencing the studies that the Science Team identified during planning. Briefly, the three tiers are:

Sequence 1 includes studies to be implemented at the beginning of Phase 1 or before, either because they address a direct threat to our ability to achieve Project Objectives, because Phase 1 provides ideal conditions to study the question, or the findings are essential to implementing future actions. Studies focus on bird use of managed habitats, mercury methylation, pond management effects on the Bay, California gull impacts, public access and wildlife interactions, and assessing public support for the Project.

Sequence 2 includes studies to be initiated some time in Phase 1, but more fully in conjunction with future Project actions. Phase 1 conditions are not ideal for addressing these questions, but some data can begin to be collected in Phase 1. Studies focus on sediment dynamics in restored ponds and the Bay, *Spartina* and other invasive species, and boating effects on wildlife.

Sequence 3 includes studies to be initiated after Phase 1 actions have been implemented and habitat has evolved or data from Sequence 1 studies have been collected. Studies focus on tidal restoration effects on species, pond/panne habitat, costs/benefits of restoration on local communities, and effects of long-term population and demographic change.

TABLE 2. Key Scientific Uncertainties and Applied Studies

	Key Uncertainties, in italics, are followed by specific, high-priority Applied Study Questions (in bold) with a brief explanation of the importance of each question.	Where Studies are Planned
	Sediment Dynamics. Is there sufficient sediment available in the South Bay to support marsh development without causing unacceptable impacts to existing habitats?	
1	**Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal habitat ecosystems within the 50-yr projected time frame?** Sediment deposition has varied greatly over the last 150 years. Large-scale restoration occurring over decades will also affect sediment dynamics throughout the South Bay and regional study will be required to understand these changes.	Island Ponds, Phase 1 at A6 & E8A/9/8X
2	**Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance in the South Bay?** Sediment accretion into the restored ponds is expected to reduce the amount of mudflat in the South Bay, but it is not known whether mudflat loss will be significant in terms of acreage or its effect on South Bay ecology. Such changes are expected to occur over decades.	Phase 1 at A6, A8 & E8A/9/8X
3	**Will restoration activities always result in a net decrease in flood hazard?** Increased tidal prism will scour slough channels within a relative short time frame (months to years) and reduce flood hazard. Changes in tidal elevations and prism in sloughs occurring over months to years may potentially increase flood hazard.	Phase 1 at A6 & E8A/9/8X
	Bird Use of Changing Habitats. Can the existing number and diversity of migratory and breeding shorebirds and waterfowl be supported in a changing (reduced salt pond) habitat area?	
4	**Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions?** Overall ecosystem changes and effects must be measured and compiled over decades to understand the overall implication of South Bay restoration on migratory birds. Some factors that could affect bird numbers are changes in disease and predation rates, food availability, and nest competition.	During and after Phase 1
5	**Will shallowly flooded ponds or ponds constructed with islands or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds?** Simple changes to existing pond management or simple habitat alteration may significantly benefit nesting snowy plovers while still providing nesting and foraging habitat for other species, but the extent of potential benefits is not known.	ISP at E6A, E6B, E8, & E16

Key Uncertainties, in italics, are followed by specific, high-priority Applied Study Questions (in bold) with a brief explanation of the importance of each question.		Where Studies are Planned
Bird Use of Changing Habitats. (continued)		
6	**Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner?** Ponds managed as small-scale salt pond systems may provide enhanced benefits for wide range of birds. But, the extent to which they can improve the prey base and increase foraging shorebird densities in the short and long-term is not known.	Phase 1 at E12/13
7	**To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner?** Changing salt pond island configurations may result in significant increases in nesting and foraging bird densities but to what extent is not known.	Phase 1 at A16 & SF2
8	**Will pond and panne habitats in restoring tidal habitats provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term?** Naturally-maintained pond and panne habitat within marshes could potentially provide significant habitat for many species that currently use ponds. But, little is known about the extent of potential benefits to waterbird species on short or long timescales.	Phase 1 at E8A/9/8X
9	**How do California clapper rails and/or other key tidal habitat species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response?** Increased tidal habitat is expected to boost populations of California clapper rails and other key species, but the data on the conditions that produce high quality habitat for survival and reproduction are needed.	As appropriate habitat develops
Effects on Non-Avian Species. Can restoration actions be configured to maximize benefits to non-avian species both onsite and in adjacent waterways?		
10	**To what extent will increased tidal habitats increase survival, growth and reproduction of native species, especially fish and harbor seals?** The extent to which restoring tidal habitats will affect native species, including steelhead, harbor seals, native fish and oysters, is unknown. This question requires long-term study on local and regional scales relevant to the species examined.	During and after Phase 1

Key Uncertainties, in italics, are followed by specific, high-priority Applied Study Questions (in bold) with a brief explanation of the importance of each question.		Where Studies are Planned
Mercury. Will mercury be mobilized into the food web of the South Bay and beyond at a greater rate than prior to restoration?		
11	**Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species?** Restoration actions could increase the bioavailability of mercury in sediment and water. Bioavailable mercury becomes a problem when it leads to deleterious accumulation in wildlife and people. Sentinel species, such as some invertebrates, fish and birds, are a cost effective way to monitor this toxic pollutant.	ISP at A8 and Phase 1 at E8A/9/8X & A8
12	**Will pond management increase MeHg levels in ponds and pond-associated sentinel species?** Pond management could increase the bioavailability of mercury in sediment and water over pre-ISP conditions. Sentinel species, such as some invertebrates, fish and birds, are a cost effective way to monitor this pollutant.	Phase 1 as part of A8 study
Water quality: Will restoration adversely affect water quality and productivity?		
13	**What is the effect of a) pond management, including increased pond flows and associated managed pond effects, and b) increased tidal prism from tidal habitat restoration on water quality, phytoplankton and fish diversity and abundance, and food web dynamics in South Bay?** Pond management and resulting water discharges to the Bay have the potential to decrease slough and Bay water quality and affect Bay species, but little is known of the short or long-term effects of pond management on the South Bay ecosystem. Restoring tidal action to ponds will increase the tidal prism and tidal currents in South Bay. South Bay phytoplankton dynamics at the base of the food web are dependent on hydrodynamics and mixing.	Phase 1
Invasive and Nuisance Species. Can invasive and nuisance species such as Spartina alterniflora (or the invasive Spartina hybrid), corvids and the California gull and, if warranted, raptors such as the northern harrier, be controlled. I f not, how can the impacts of these species be reduced in future phases of the project?		
14	**Where not adequately eradicated, does invasive *Spartina* and hybrids significantly reduce aquatic species and shorebird uses?** The Invasive Spartina Project is a comprehensive program to control *Spartina alterniflora* hybrids to a level at which native species are not threatened. If this Project is not successful, this applied studies question would need investigation.	Depends on Invasive Spartina Project results
15	**Will California gulls, ravens, and crows adversely affect (through predation and encroachment on nesting areas) nesting birds in managed ponds?** Data indicate that a number of native predatory species are increasing in population and are negatively affecting native breeding birds, but the extent of the impacts are not known.	Phase 1 at A6, A16, & SF2

	Key Uncertainties, in italics, are followed by specific, high-priority Applied Study Questions (in bold) with a brief explanation of the importance of each question.	Where Studies are Planned
	Public Access and Wildlife. Will trails and other public access features / activities have significant negative effects on wildlife species?	
16	**Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales?** While there is a strong constituency for increased boating access, there is almost no information in the San Francisco Bay on the immediate or long-term effects of recreational boating on birds or other target species in different habitat types.	During and after Phase 1
17	**Will landside public access significantly affect birds or other target species on short or long timescales?** Information on the short and long-term effects of general and specific trail uses, such as dog walking, on birds and other key species in different habitat types (ponds, sloughs, tidal habitat) is mostly lacking, as is information on effective mitigation measures.	Phase 1 at E12/13, A16, & SF2
18	**Will public access features provide the recreation and access experiences visitors and the public want over short or long timescales?** The public's desire for recreational uses changes over time. Understanding and providing the opportunities people value, to the extent feasible, is essential for the Project engender stewardship and public support in the short and long-term.	Phase 1
	Social Dynamics. How can the Project gain support from the public now and into the future?	
19	**Will voters, advocacy groups, elected officials, and government agencies support the project (especially in terms of funding) over the short timescale at the local and regional spatial scales?** While the Project does not seem to generate opposition and habitat restoration seems popular in the Bay Area, there are factors that may impede public and political support, such as competing funding initiatives and very local community concerns.	Phase 1
20	**What are the benefits and costs associated with the project sites and will they be shared equitably among communities, businesses, municipalities, and/or government agencies at local and regional scales?** Cities/municipal governments may worry about economic costs and benefits attributable to the Project that will spill over into jurisdictions, especially concentrated costs, but also benefits attributable to the Project. The project will also generate regional benefits (and perhaps costs).	During and after Phase 1
21	**Will impacts associated with population growth and development adjacent to the project sites and beyond be successfully managed over the long timescale at the regional scale?** Population growth, densification, and development in the South Bay and the region as a whole will affect the ability of adaptive management to reach the project objectives. There is some information on population growth, but little information on how the particular patterns of growth and development will affect the project sites.	During and after Phase 1

TABLE 3. Monitoring, Applied Studies, and Modeling during Project Planning

	Project or Study*	Funded By*	Funding Amount
	Monitoring Project		
1	Pond and Project Area Monitoring—USGS, J. Takekawa, D. Schoellhamer, B. Jaffe (2003-05)	Project	~$600K/year (2003-05) ~$350K/year (2005-06)
2	LIDAR Survey of South Bay--TerraPoint	Project	$178K
3	Bathymetric Survey of the South Bay--Sea Surveyor, Inc.	Project	$380K
4	Urban Levee Flood Management Requirements--Moffat and Nichol	Project	$300K
5	ISP Water Quality Monitoring--USGS, J. Takekawa	FWS and DFG	
6	ISP Mercury Monitoring—USGS, K. Miles (2005-06)	FWS and DFG	~$50K
	Applied Study		
1	Island Ponds initial physical and vegetation change—UC Berkeley, M. Stacey; USF, J. Callaway; SFSU, T. Parker *Applied Studies Question*: Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal habitat ecosystems within the 50-yr projected time frame?	Project	~$100,000
2	Water Quality Data QC and Compilation—USGS, J. Cloern *Applied Study Question*: What is the effect of a) pond management, including increased pond flows and associated managed pond effects, and b) increased tidal prism from tidal habitat restoration on water quality, phytoplankton and fish diversity and abundance, and food web dynamics in South Bay?	USGS	In-kind
3	Pond A8/South Bay Mercury Study--SFEI, USGS, SCVWD *Applied Study Questions*: * Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species? * Will pond management increase MeHg levels in ponds and pond-associated sentinel species?	SCVWD, FWS, SFF, SCC, RMP	$750,000
4	Bird Diversity and Abundance on Newark Ponds—SFBBO *Applied Study Question*: Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions?	SFF and FWS	$80K for 2 years

	Project or Study*	Funded By*	Funding Amount
5	Bird Use of Mature and Restored Marshes—PRBO *Applied Study Questions*: * Will pond and panne habitats in restored tidal habitats provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term? * How do California clapper rails and/or other key tidal habitat species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response?	SFF	$60K for 2 years
6	Snowy Plover use of Managed Ponds; Harbor Seal Response to Watercraft; CA Gull Impacts to Nesting Birds—SJSU, L. Trulio *Applied Study Questions*: * Will shallowly flooded ponds or ponds constructed with islands or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds? * Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales? * Will California gulls, ravens, and crows adversely affect (through predation and encroachment) nesting birds in managed ponds?	SJSU	In-kind
7	Hg in SF Bay-Delta Birds: Trophic pathways, bioaccumulations, and ecotoxicological risk to avian reproduction—USGS, J. Ackerman; FWS personnel *Applied Study Questions*: * Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species? * Will pond management increase MeHg levels in ponds and pond-associated sentinel species?	CALFED	$2 million total (not all in South Bay)
8	Native Oyster Establishment Study—Save the Bay, M. Latta *Applied Study Question*: Will increased tidal habitats increase survival, growth and reproduction of native species, especially fish and harbor seals?	Save the Bay, NOAA, SJSU	
	Modeling Project		
1	Small and Large-Scale 3-D Integrative model	SCC	Approximately $3 million
2	South Bay Geomorphic Assessment—PWA	Project	
3	Habitat Conversion Model—PRBO	Project	$215K
4	NOAA/URS Fish Model	NOAA Fisheries	In-kind

* Acronyms: FWS=US Fish and Wildlife Service; DFG=California Department of Fish and Game; SCVWD=Santa Clara Valley Water District; SFF=San Francisco Foundation; SCC=Coastal Conservancy; SJSU=San Jose State University

B. Baseline Monitoring

Data Collection. Monitoring during Project planning began in 2003 to characterize conditions in the ponds, sloughs, and, to some extent, the Bay before and after ISP implementation (Table 3). This extensive monitoring effort provided both baseline data and a foundation for long-term, adaptive management monitoring. Reports are available through the California State Coastal Conservancy, California Department of Fish and Game, Don Edwards National Wildlife Refuge, or the Project's website (http://www.southbayrestoration.org).

USGS was contracted to do intensive and wide-spread baseline monitoring. USGS staff collected data on all 54 ponds and the data set from 2003-2005 included these parameters:

- bathymetry (depth and topography) of the ponds, sloughs, and South Bay;
- monthly bird abundance and diversity in the ponds;
- water salinity, pH, temperature, turbidity, DO, nitrogen (NH_4-N and NO_3-N), total and soluable phosphorus, and sulfur concentrations;
- chlorophyll 'a' (primary productivity);
- sediment salt content, particle size, and bulk density;
- invertebrate composition in sediment cores and from the water column (collected once);
- monthly fish abundance and diversity, and habitat characteristics at capture locations;
- Hg and MeHg levels in sediment in the Alviso and Eden Landing ponds, MeHg levels in invertebrates; bacteria community analysis at high and low MeHg production sites in Eden Landing ponds.

In 2005-2006, the USGS continued data collection at the 54 ponds with these exceptions:

1. No collection of benthic organisms;
2. No fish collection in ponds;
3. Bi-monthly bird surveys on all ponds, instead of monthly; and
4. Bi-monthly bird surveys on tidal flats in the Bay and sloughs were added.

In addition to pond bathymetry, bathymetry of the tidal flats and topography of levees was measured by LiDAR; subtidal bathymetry with some sediment surface classification was collected by Sea Surveyor, Inc. In fall 2005, SFBBO began a two-year study of bird use of the Refuge ponds in the South Bay that are still operated by Cargill for salt production. These data add to the baseline information on bird use of South Bay habitats.

Little data on pond conditions prior to the acquisition in 2003 were collected, although USGS collected data from 2001-2003 on selected Alviso salt ponds regarding water quality, nutrient concentrations, the structure of pelagic and benthic invertebrate communities, and waterbird abundance and distribution. Other information on South Bay conditions prior to the acquisition have been collected over the years by many different groups and agencies. There are many USGS reports (including those from 30-year monitoring programs), SFEI reports such as those for the Regional Monitoring Program and the EcoAtlas, agency monitoring programs (DFG South Bay fish monitoring), and graduate student theses. Some of these data were useful in planning and may be valuable in the future.

One source of multi-source data is the comprehensive catalog of water quality data sets compiled by the USGS (accurate through October 2006). South Bay Salt Pond Restoration Program Water Quality Data Inventory is an overview of the water quality information--chemical, physical, and biological—collected by many groups in and around South San Francisco Bay and the salt ponds. This Inventory is designed to help Project participants and other researchers find water quality data sets and ancillary environmental information from other groups working in the region (see http://www.southbayrestoration.org).

Pond Conditions. Data from the Project's monitoring efforts showed that pond conditions changed during the 2003 to 2005 monitoring period compared to conditions during Cargill's salt pond operation. During 2003 to 2004, Cargill reduced pond salinities to meet the transfer standard. In 2004, water control structures (gated culverts) were installed in Ponds A1 through A3W (Charleston Slough to Guadalupe Slough) in the Alviso complex and, in July 2004, the culverts were opened allowing Bay waters to flow into these ponds for the first time in many decades. Gated culverts were installed and opened to the Bay in 2004 in Ponds B2 and B10 at Eden Landing and in 2005 at Ponds A5 through A17 (Guadalupe Slough to Coyote Creek) in the Alviso complex. Then, in March 2006, the three Island Ponds, between Coyote Creek and Mud Slough, were opened to unrestricted tidal action. Thus, the monitoring that began in 2003 occurred when Cargill was reducing salinities and included approximately a year of data before ISP operation began in 2004.

The USGS summarized its data on water quality, water and sediment mercury levels, biotics, and bathymetry, for use during planning. Initial data showed some interesting findings. In the first migratory season after the ISP was implemented, shorebird numbers increased at both the Eden Landing and Alviso Complexes by at least 100% from pre-ISP conditions (Takekawa pers. comm.). FWS data for waterfowl showed similar increases in the Alviso complex (Morris pers. comm.). However, in the Eden Landing complex, water level draw-downs reduced habitat and bird use by piscivores, diving ducks, and grebes substantially from pre-ISP levels. Continued monitoring will determine whether these changes actually resulted from changing pond conditions as a result of the ISP or from inter-annual variation, and whether species responses will continue over time.

The USGS also conducted compliance monitoring, specifically to track water quality conditions before and after culverts were opened for ISP operation. One year of monitoring has shown that salinity, which Project Managers worried would not meet requirements set by the Regional Water Quality Control Board (RWQCB), has not been a problem. However, low dissolved oxygen (DO) levels, which were anticipated to a degree, have plagued a number of ponds during the summers of 2004 and 2005. These early findings show that management actions in the Project area are already causing changes in the system, some of which are not easily predictable and require study to fully understand.

C. Modeling During Planning

Models that integrate data and are able to predict system response to management actions will be invaluable to Project Managers as they deal with changing conditions and design future phases. During planning, several modeling approaches were developed to help predict changes to the system (Table 3). Philip Williams and Associates used the South Bay Geomorphic Assessment to predict large-scale habitat changes under various restoration scenarios. This general model used existing information on pond, slough and Bay bathymetry, sediment/hydrodynamics, sediment accretion rates, and a number of other factors to predict tidal habitat evolution and habitat acreages under different tidal habitat to pond ratios. Estimates of sea level rise, based on the predictions from the Intergovernmental Panel on Climate Change that were available during model development, were included in the South Bay Geomorphic Assessment to assess whether sediment accretion in restoring marshes would keep pace with sea-level rise due to global climate change. The results of this assessment were used in the EIS/R to evaluate the impacts of the “No Project”, 50% tidal:50% managed pond, and 90% tidal:10% managed pond alternatives. The Consultant Team also conducted hydrodynamic modeling, coastal flooding analyses and fluvial flooding analyses to further evaluate the three scenarios for the EIS/R.

A second model set, the Habitat Conversion Model, was developed by PRBO to predict bird population response to the restoration alternatives. Using the habitat change results predicted by the South Bay Geomorphic Assessment, PRBO used its model to estimate how bird populations currently using the South Bay might change in response to different tidal to pond ratios. These results were also used in the EIS/R to evaluate the impacts of different alternatives. The model will continue to be refined and used in the future as part of the monitoring analysis for migratory waterbirds.

Formal and informal reviews of these models by other scientists revealed limitations in their predictive power. The time line for Project planning did not allow further refinement of these models before implementation. Thus, model refinement and development will be part of long-term adaptive management. In particular, the Project is in need of modeling tools for predicting large-scale and long-term geomorphic and ecological changes to the system. While some tools do exist in the public domain, a concerted research effort is needed to identify and adapt an appropriate model to the South Bay system. For the long-term success of this Project, a 3-D model that integrates key physical parameters over small and large-scales and multiple timescales is needed to predict sediment dynamics, contaminant transport, salinity gradients and other factors in response to management actions and to external factors such as climate change. A research team associated with the Project developed a proposal for this type of model and the Project sought funding for it (Appendix 1). Research at the Island Ponds initiated during planning produced data and small-scale modeling that will be used as inputs into the larger model.

The uses of landscape-scale predictive models are varied:

1. To forecast the response of the system and parts of the system to different restoration and/or management actions, and thereby function as a design tool;

2. To predict certain types of conditions, such as low dissolved oxygen areas; for example, models can be used to identify areas of the Project that are likely to have problems meeting water quality requirements;

3. To indicate where applied studies are needed by showing key gaps in knowledge of the system;

4. To inform monitoring programs and allow spatial and temporal interpolation among monitoring data;

5. To explain trends and act as a diagnostic tool to determine system response to hypothetical cases or alternative scenarios. For example, if *Spartina alterniflora* hybrids cannot be controlled and studies indicate this invader will have a significant effect on the South Bay ecosystem, then modeling alternative scenarios will be required to predict ecosystem response to this new state and predict how the system might respond to new management actions; and

6. To provide the public with real-time information and analysis of system conditions.

All of these uses will help Project Managers adaptively manage the South Bay while allowing the public and researchers access to Project information.

D. Conceptual Models Illustrating Adaptive Management

During the planning process, the Project participants learned that some aspects of the South Bay ecosystem are fairly well understood and the outcomes of management actions for these parts of the system are relatively certain. For example, there are good data for the rate of marsh development in South Bay marshes. Tracking relatively predictable restoration responses requires one data collection approach, while reducing uncertainty in restoration outcomes requires another. Predictable outcomes are assessed through monitoring, which is repeated data collection to assess system progress. Monitoring tracks system responses through time to allow Project Managers to assess whether expected changes are, in fact, occurring. Uncertainties are reduced through applied studies (Table 2), in which hypotheses are tested to develop cause-and-effect knowledge about the environment.

The relationship between monitoring and applied studies in the South Bay Salt Pond Restoration Project is depicted in Figures 4-6 using conceptual models that illustrate ecosystem processes and outcomes. These figures are based on conceptual models, for tidal habitat, managed pond, and landscape levels, described in the *South Bay Salt Pond Restoration Project Conceptual Models* (Trulio, et al. 2004). These conceptual models link different restoration and management actions to anticipated responses in the South Bay ponds and the overall ecosystem.

In Figures 4-6, current conditions under ISP management are changed through the Project's management and restoration actions ("Project Actions"), and these actions result in expected, and desired, effects on the system ("Results"). Monitoring topics are aspects of the environment that the Project will measure to assess progress toward the desired "results" and detect possible problems. The applied studies are questions whose answers will help reduce uncertainty in reaching the "results". Look along the top of the figures to see the changes the Project expects to occur and will monitor at tidal habitat, pond, and landscape levels. Actual changes will be compared to the expected results to assess restoration progress. Along the bottom of each diagram are corresponding lists of applied study questions that will be answered to reduce uncertainty and offer insight into why the system is responding in a particular way. A complete listing of all the monitoring parameters, applied studies, and modeling that the Project plans to undertake is found in Part 3 and Appendix 3, the Adaptive Management Summary Table.

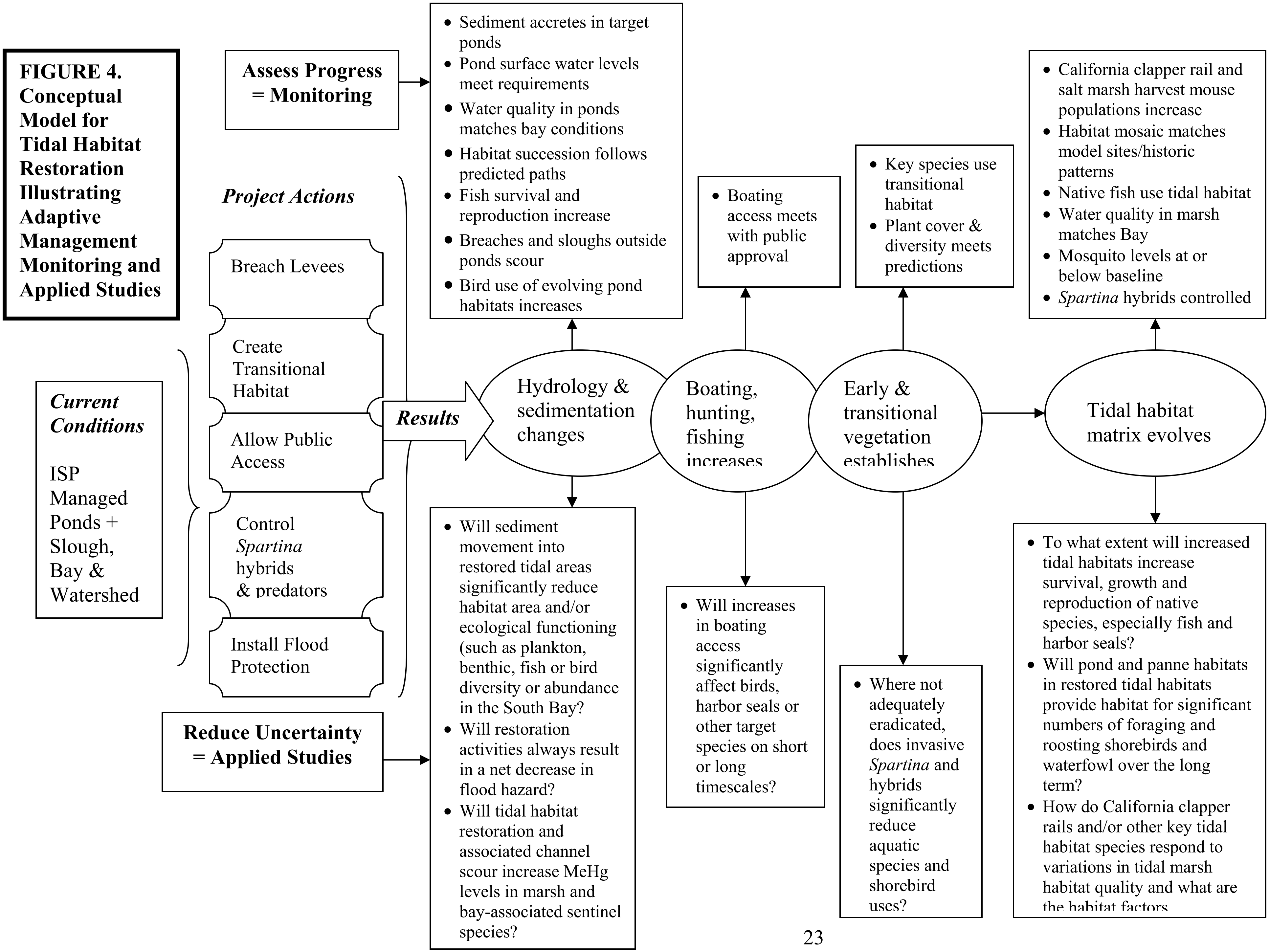


FIGURE 4. Conceptual Model for Tidal Habitat Restoration Illustrating Adaptive Management Monitoring and Applied Studies

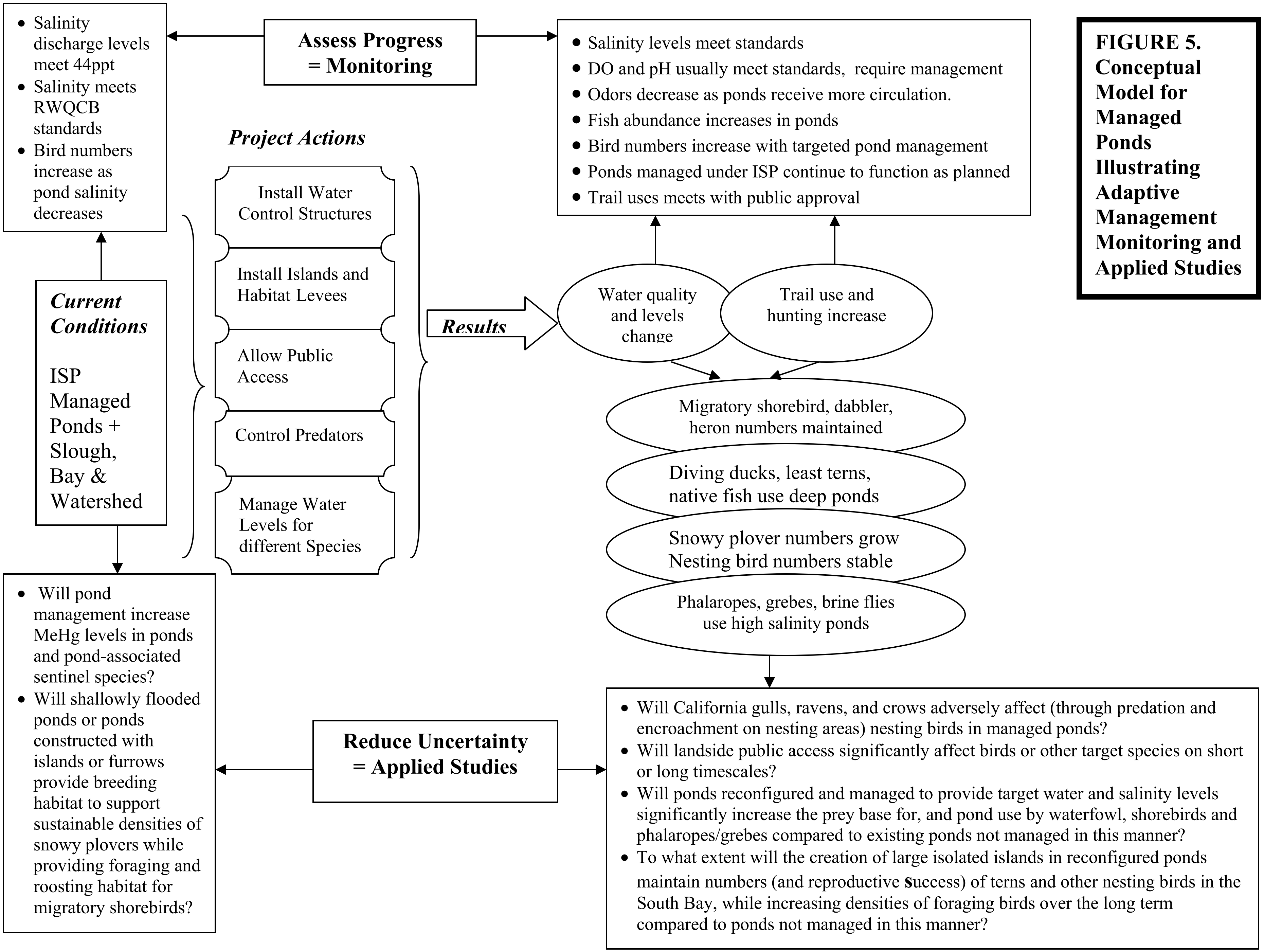


FIGURE 5. Conceptual Model for Managed Ponds Illustrating Adaptive Management Monitoring and Applied Studies

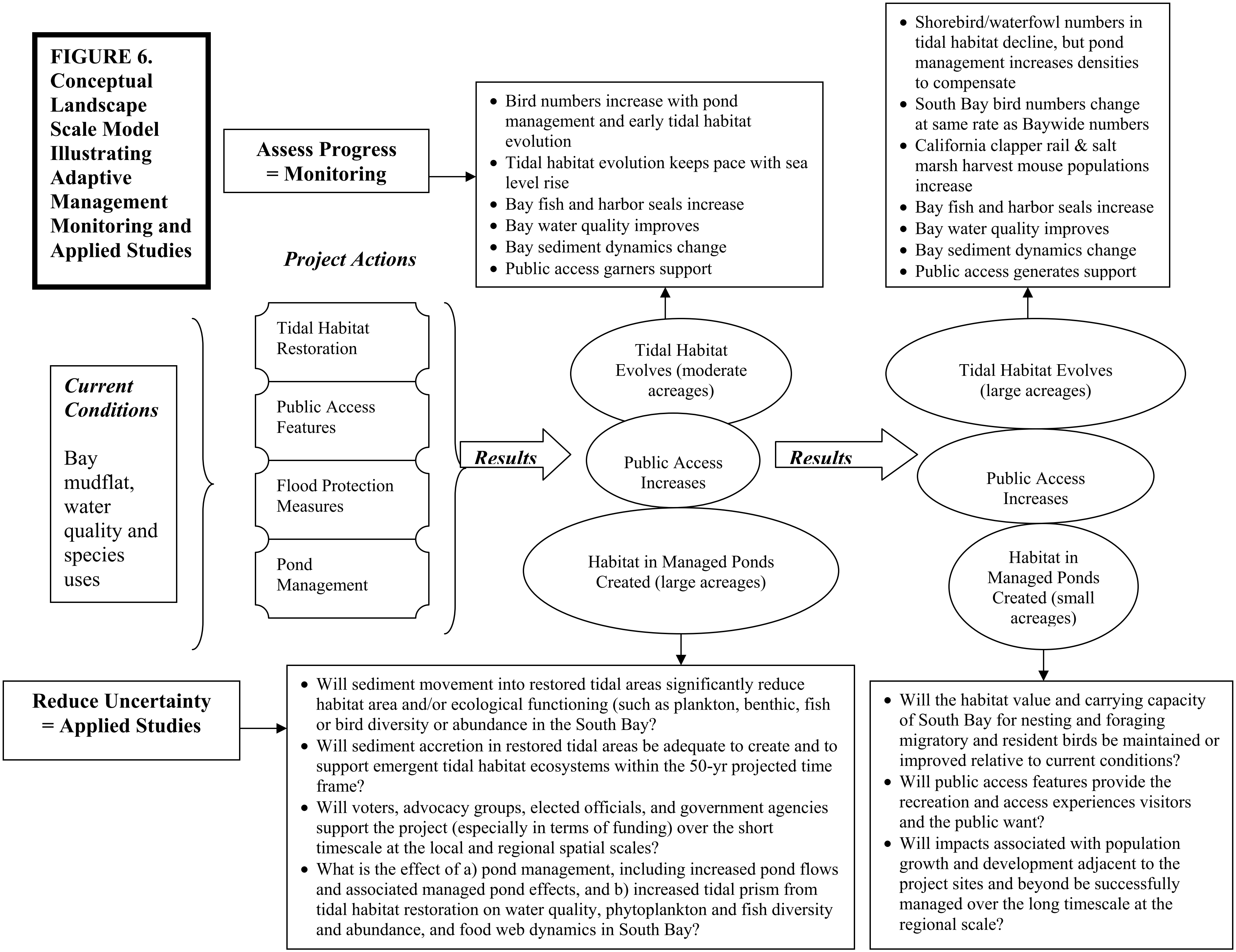


FIGURE 6. Conceptual Landscape Scale Model Illustrating Adaptive Management Monitoring and Applied Studies

Part 3. IMPLEMENTATION SCIENCE: Information for Decision-Making

A. Elements of Adaptive Management Science

Work done during the planning phase established the foundation for the adaptive management data collection and analysis approach described here. This section describes the scientific approach--based on restoration targets, monitoring, applied studies, and modeling--for providing the information that managers will need for decision-making. Appendix 3, the Adaptive Management Summary Table, integrates data collection and management, and ties them to the Project Objectives.

This adaptive management approach begins with a limited set of quantitative restoration targets for the Project Objectives that allow restoration progress to be tracked. We chose only targets that must be assessed to determine whether or not Project Managers can implement more tidal action while continuing to achieve the Project Objectives, in other words whether the Project can move further along the adaptive management staircase depicted in Figure 2. Thus, benefits or impacts from the Project that would not affect the decision to add more tidal habitat are not included. This restriction is important. While there are many factors that could be monitored, a feasible monitoring program can include only the most critical elements.

In Phase 1, Project Managers expect to implement all the monitoring and applied studies listed in the Adaptive Management Summary Table in Appendix 3. However, parameters will be monitored with different levels of effort based on management needs. While all applied studies in the Table will be undertaken, complete results to some questions, especially sediment dynamics, may not be possible until other action, such as restoration of more acres to tidal action, is initiated. The Adaptive Management Summary Table links the data collection needed for adaptive management with decision-making. Here is a summary of the role of each column in the Table:

Category. Categories are the basic elements of the ecosystem that must be monitored to determine whether the Project Objectives are being met or are likely to be met in the future and, therefore, whether the Project can move forward with more tidal restoration. The applicable Project Objectives are listed for each category.

Restoration Target. Each restoration target is a direct measure of a Category and each gives measurable goals for what the Project should achieve to successfully meet each of the Project Objectives. Typical data sources for developing these targets are the literature, quantitative baseline data (such as that collected by USGS, PRBO or SFBBO), or requirements set by a regulatory agency, such as standards for dissolved oxygen levels or population levels for California clapper rail recovery. Targets include both long-term goals (50-year horizon) and intermediate conditions as the ecosystem changes. Restoration targets are expected to evolve as more information about the system is collected.

Monitoring Parameter. The Project participants chose monitoring parameters they believe are the most effective and efficient way to assess change with respect to the restoration targets. This column gives the variables to be measured and a basic monitoring approach. Specific methods are given only when needed to make the approach clear. The parameter, method, spatial scale, and timing of monitoring must be adequate to detect change. For example, the first restoration target under sediment dynamics is “no significant decrease in South Bay intertidal and subtidal habitat”. Assessing this target requires calculating the areas of restored pond, outboard mudflat, and subtidal shallows. A combination of monitoring methods might be used, such as: 1) bathymetry and LiDAR survey every 5 years; 2) survey of sediment accumulation annually in ponds opened to tidal action; and 3) a limited number of localized bathymetry surveys in certain priority areas. This column lists appropriate monitoring parameters, but cannot fully describe the monitoring regime. A monitoring plan—giving methods, protocols, timing and responsible parties—will be developed by the Project for implementation in Phase 1.

Spatial Scale for Monitoring Results. This column gives the spatial scale at which monitoring should occur to detect results usable by Project Managers.

Expected Time frame for Decision-making. This is the time frame in which change could realistically be detected leading to management actions to adjust the restoration actions.

Management Trigger. While the restoration targets identify the desired outcomes relative to the Project Objectives, the management triggers identify the point at which technical analysts believe the system may not be performing as expected, i.e., potentially moving away from achieving a restoration target. At this point, Project Managers should evaluate the status of the Project and consider management actions. Triggers have been set intentionally at a low threshold to ensure early evaluation and potential action, rather than waiting until substantial problems have developed. The threshold is also designed to avoid significant environmental impacts as identified in the *South Bay Salt Pond Restoration Project EIS/R* (2007).

Applied Studies. The relevant Applied Studies from Table 2 are listed for each restoration target. Descriptions of each applied study appear in Appendix 1.

Potential Management Actions. In the event that a management trigger is tripped, the Project Management Team will need to take action based on the available information. This column lists typical classes of management actions available to Project Managers and some examples of those actions. The exact management action will depend on the nature of the problem and the appropriate remedies available. Typically, the first management action will be to conduct a thorough review of the available information that can inform management on the trigger. Often, Project Managers will ask experts, both associated with and external to the Project, to analyze the relevant information and provide a range of appropriate management actions, including their risks and costs.

B. Linking Science-generated Information

Restoration Targets. The Project’s restoration targets, monitoring, applied studies, and modeling are integrated to generate the scientific information managers need for decision-making. In a nutshell, adaptive management relies on clear, measurable restoration targets that directly track the Project Objectives; monitoring is used to assess progress toward those targets; applied studies help Project Managers understand why the system is performing the way it is, relative to the targets, and help reduce uncertainty; modeling is used to try to predict the effects of management actions and to integrate and analyze information for analysis.

The Society of Wetland Scientists (2003) recommends that restoration planning materials clearly state science-based restoration targets (also known as success criteria or performance standards) that are indicators of habitat structure and function. These targets should be "measurable attributes of restored or created wetlands that, when measured over an appropriate period, can be used to judge whether project objectives have been met" (Society of Wetland Scientists, 2003). Typically, they are quantitative benchmarks that are used for measuring progress toward restoration objectives and for determining when the system is diverging from the desired restoration trajectory. Restoration targets should be set for final Project conditions, as well as the interim conditions expected as the Project develops. Restoration targets are a temporary set of expectations that will change as our knowledge of the system increases (National Research Council, 2003).

The targets in the Adaptive Management Summary Table (Appendix 3) were developed cooperatively by the Project Managers, Science Team, Consultant Team, Stakeholders, and appropriate regulatory agencies. Quantitative targets, such as minimum numbers, or ranges of variability, do not yet exist for all restoration targets. Restoration targets will be developed using existing data, such as that collected by the USGS for the Project, or other data sources outside the Project. Some restoration targets will be set by regulatory agencies. For example, water quality standards are determined by the RWQCB, and the FWS will set restoration targets for the California clapper rail and salt marsh harvest mouse through the Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California, which is expected to be released in 2008. Maintaining consistency with the Recovery Plan is especially important for the Project because the South Bay is a significant restoration area for these endangered species.

During planning, the Project participants began developing measurable restoration targets and they will continue to refine them early in Phase 1. The task of setting restoration targets is often difficult. For example, the Project Managers will set population levels as restoration targets for many species, including migratory shorebirds. Setting population targets for these birds is difficult because pre-ISP data are often spotty; in some cases new data will need to be collected over time. In addition, population numbers are often highly variable from year to year, which will make it a challenge to know if the Project is either positively or negatively affecting bird numbers. Despite these difficulties, it is important to try to set and meet target species levels. Although there is significant uncertainty in many population numbers, if monitoring is complete, it will be possible to determine whether species numbers in the South Bay are meeting a baseline level and/or changing at the same rate as the larger Bay-wide or flyway population.

Some restoration targets may be difficult to meet. For example, it is not likely that the Project will be able to meet water quality standards in all ponds all the time. However, these situations will result in studies providing more information on why ponds do or do not meet the standards and what can be done. Restoration targets should hold the Project to levels of performance that are under the Project's control and not to levels that are controlled by external factors. For example, one Project Objective is to maintain the current levels of migratory bird species using the Project Area. If this number declines due to Project activities, Project managers are expected to take action to reverse the decline. However, if the decline is due to other factors, such as loss of arctic nesting habitat, then this is not due to the Project actions and managers will not be expected to (and will probably not be able to) reverse this decline. The Project Managers and scientists have tried to anticipate external factors that will need to be tracked and have included them in monitoring or applied studies for the Project. Project participants will continue to identify important external factors throughout the life of the Project as part of adaptive management. Even with this work, the causes of decline or change may not always be apparent and Project Managers may have to make decisions given the information they have. Advice from experts should always be sought in these cases and Project Managers should carefully document the reasoning and data that went into their final decision.

The Adaptive Management Summary Table lists specific restoration targets for all Project Objectives except for Objective 5, implementing measures to control invasive and nuisance species, and Objective 6, protecting infrastructure. Achieving invasive and nuisance species control is measured with respect to impacts on target species or communities. Thus, targets relative to Objective 5 are given under the Tidal Habitat Establishment, California Clapper Rail, Breeding Birds, and Western Snowy Plover categories in the Table. Protecting infrastructure is a design issue that will not alone determine whether the Project proceeds along the adaptive management staircase. Infrastructure evaluation will be part of the operations and maintenance plans that DFG and FWS will develop for their pond complexes.

Even with the best research, restoration targets may not be entirely accurate, and ranges of certainty and natural variation may not be known. Careful monitoring and applied studies will reveal whether the target should be revised and, if so, how. While the Project Objectives themselves are expected to remain unchanged throughout the life of the Project, restoration targets are very likely to change as knowledge of the system increases (National Research Council 2003). Each year, in their evaluation of the Project's performance, Project scientists and managers will review the restoration targets in light of adaptive management monitoring and study results to determine if they are still appropriate and accurate measures of progress toward the Project Objectives.

Monitoring Parameters. Callaway, et al. (2001) state that, "Assessment is the quantitative evaluation of selected ecosystem attributes, and monitoring is the systematic repetition of the assessment process, that is, measurement of the same attributes in the same way, on a regular schedule. The placement and timing of samples are tailored to the spatial and temporal variability… A one-time sample does not constitute monitoring, nor does the haphazard timing of repeated assessments or repeated measurement…using different sampling methods. The essence of monitoring is consistency. At the same time, monitoring programs must be able to evolve." The purposes of monitoring are to:

- assess progress toward Project Objectives;
- evaluate effects of a specified management action;
- characterize baseline/reference conditions;
- track regulatory compliance; and
- detect early signs of potential problems and anticipated changes.

To achieve these purposes, the Project will measure a large number of monitoring parameters. The Project's 50-year horizon necessitates measuring short- and long-term characteristics. For example, we expect that large-scale changes in the area of mudflat (the first restoration target in the table) will not be detected for 10-20 years. In contrast, breeding birds are likely to respond to restoration changes in the next breeding season. In addition to varying time scales, the Project will track structures and functions at these spatial and ecological scales:

- Beyond the Ecosystem Scale (Entire Bay Area and Beyond): Parameters at this level measure large-scale processes, often external to the ecosystem, that will affect the Project. Three such metrics relevant to the Project are:
    - Pacific flyway species composition and abundances;
    - Sea-level rise, especially effects on tidal habitat evolution and flood protection;

- California and Bay Area human population change.

If information on these parameters is needed, Project Managers will seek out the data from other entities. If data are not being collected by others, the Project may initiate its own data collection efforts.

- Ecosystem Scale (South Bay and Multiple Pond Complexes): Ecosystems are large-scale phenomena driven by water, carbon, energy, and nutrient dynamics. Parameters proposed to measure physical aspects include sediment measures (sediment deposition or erosion and suspended sediment concentrations), water quality conditions, and mercury-level changes in populations in the food web. Ecological parameters will include the extent and distribution of habitats in the South Bay ecosystem, landscape-level marsh development, habitat connectivity, bird species diversity in the Project Area, fish community changes, and plankton community changes.
- Community Scale (Pond level): Ecological communities are characterized by the diversity and interaction of species in a particular area. Major communities in the Project Area are tidal marsh habitats, managed pond, tidal mudflat, and subtidal/deep water communities. Parameters will include nutrient levels, vegetation composition and cover, succession, bird/fish/benthic community composition, food chain development, water quality measures, predator-prey dynamics, mercury levels, and interaction of non-native/invasive with target native species.
- Population Scale (Species level): The Project will monitor population changes in a number of listed and indicator species, as well as specific non-native species, such as *Spartina alterniflora* (and hybrids), and nuisance species, especially mosquitoes and California gulls (*Larus californicus*). Typical population parameters are distribution, abundance, breeding success, predation impacts, habitat quality, and quantity.

The Adaptive Management Summary Table lays out the monitoring for the Project, beginning in Phase 1. For these parameters, the Project will develop monitoring plans, which will be peer-reviewed. Plans should include these elements:

- protocols for measuring parameters including the location of measurements, timing and frequency of monitoring, monitoring methods and a schedule for rapid review of data to compare to management targets;
- construction-related monitoring parameters and protocols;
- roles and responsibilities for monitoring, including who will do what, when, and where;
- specific instructions for data analysis, interpretation, presentation, and storage;
- protocols for ensuring QA/QC;
- report requirements and deadlines; and
- funding approach for monitoring.

The Project Managers will develop monitoring plans for implementation beginning in Phase 1. Whenever possible, monitoring methods should be designed to collect data for multiple parameters. For example, aerial photo and satellite data collection methods can be very economical and can provide information on a range of parameters (Table 4). More labor-intensive field data collection once a month may be needed, but a wide range of sampling can be done in one visit. Collecting sediment cores and topographic elevations, perhaps done once a year, will provide valuable data for a number of parameters. Volunteers may be able to collect a range of data using simple assessment methods. Collecting some data may not even be necessary if that information is already being collected by other organizations. For example, the Regional Monitoring Program (RMP), a program of the San Francisco Estuary Institute, may already be collecting some of the pollutant data the Project will need. Finally, some time-consuming and expensive methods, such as call counts for California clapper rails, may be the only way to assess some parameters.

Well-implemented operations and maintenance (O & M) programs are important to supporting accurate monitoring results. Simply stated, O & M activities are those tasks required to keep the Project running as designed. These activities include a wide range of tasks such as operating and maintaining tide gates as required, checking and repairing infrastructure protections (such as riprap or other armoring), and fixing damage due to vandalism. When O & M activities are current and the Project is functioning as designed, monitoring will track how the system is performing based on the effects of management actions. Without up-to-date O & M, monitoring results may detect problems in the system stemming from the effects of poor maintenance rather than from the management actions themselves.

The Project's science program during implementation will be responsible for collecting and interpreting monitoring data for the Project Managers to use in adjusting current actions and designing future Project actions. In particular, Project Managers and scientists will look for evidence that the system is diverging from restoration targets and for evidence of unexpected outcomes--both of which may require management action. These situations may also require additional or new applied studies to understand system responses. Project science managers will make recommendations to the Project Managers on appropriate monitoring parameters, methods, and emerging applied study needs. Data and analyses will be made available to the public via the Project's website and other outreach mechanisms.

TABLE 4. Efficient Monitoring Methods and Parameters they Measure

Monitoring Method	**Examples of Parameters Measured**
Aerial Photos or satellite Images	• Aerial extent of tidal habitat • Connectivity of habitats • Form, location, density of channels • Primary productivity • Location, extent of invasive plants, where appropriate
Photo monitoring	• Use of levees by predators, especially red fox, cats, etc. • Nest activities
Monthly site visits	• Waterbird abundance & diversity • Counts of trail users • Water samples for nutrients, productivity, pollutants
Water quality data sondes	• DO, salinity, temperature, sediment concentrations, currents • Water level elevations
Sediment Cores	• Benthic species diversity • Accretion/erosion rates • Presence of contaminants

Applied Studies. Monitoring indicates what is happening, but typically not why it is happening. Applied studies will help close the gaps in our knowledge about how to reach restoration targets and will help managers understand why the system is responding as it is. The applied studies listed in Table 2 were identified by the Science Team during planning as most critical to achieving the Project Objectives. However, not all the applied studies listed in the table can be thoroughly investigated in Phase 1. For example, Phase 1 actions will not allow study of large-scale sediment movement. Thus, the applied studies for the Project should be sequenced and undertaken when conditions permit (Appendix 2).

The Project will generally use competitive proposal processes (Appendix 4) to identify researchers for applied studies, although a directed solicitation process may be used from time to time. The Project's science managers will review the list of priority applied studies each year, or more often if needed, and will make recommendations to the Project Managers as to which studies should be undertaken and when. Individual contractors, as part of the Project's science program, will be responsible for synthesizing and interpreting the information from these studies, which will be used to revise the monitoring program, adjust current actions, and design future Project actions. Research through applied studies is expected to be published in peer-reviewed publications and the applied studies program will be peer-reviewed periodically as part of the Project's external review. Part 4 gives more detail on the process for identification and review of applied studies.

While the applied studies listed in Table 2 are those most critical to informing movement along the adaptive management staircases (Figure 2 and 3), there are many other areas of research, not related directly to adding more tidal habitat, that could benefit the Project. The Project Managers and scientists will encourage researchers interested in other relevant studies to undertake this work. Such areas of study include restoration of native oyster populations, habitat requirements of western pond turtles, and habitat requirements of native rare plants, and basic or theoretical research into South Bay ecosystem processes. Certainly, researchers will present Project Managers with a wide array of research ideas. The Project will not be able to provide funding for all such studies, but Project Managers should assist to the extent they can with permits, letters of support, and other in-kind services, for valuable studies when appropriate. If demand is great for this type of research, the Project's science managers may develop a review system to help managers select research most likely to assist the Project.

Modeling. The development and application of numerical models is an important component of the Adaptive Management Plan. While some applied studies may contain modeling components, the primary modeling endeavor will be the development and application of an integrated model that captures "understanding of system processes based on information currently available, to identify important areas of uncertainty where additional information is needed, and to predict system outcomes under different scenarios" (National Science Panel, 2005). The development, revision, and application of the model will require continual effort during implementation.

This model will be used to integrate and analyze applied studies, monitoring, and other Project information for use by the Project Managers. In particular, the model should allow managers to predict how the system is likely to respond to management actions and also to external factors such as sea-level rise and other consequences of climate change. This forecasting function will be especially valuable for designing future Project phases. The model will also inform applied studies by allowing preliminary testing and refinement of hypotheses and improve monitoring programs by identifying areas of variability that should be resolved by monitoring. A state-of-the-art numerical model will also be useful for many additional restoration projects and other environmental studies in South San Francisco Bay.

The scope of the mechanistic model will be large given the many physical and ecological processes relevant to the Project, and the model's development will likely be incremental with early efforts focusing on hydrodynamics, water quality, sediment transport and geomorphic change. While model development is expected to be a multi-million project, this effort will be less expensive and more productive than funding parallel development of models by multiple consulting and research teams. This should be a public domain, open source model so that it is available to all researchers and consultants for continued development, testing and application to the Project and other restoration efforts in the South Bay. All data used in model applications will be made available on a website. Data will include initial conditions and boundary condition data, other model inputs, and calibration and validation data.

The model formulation and calibration should be documented and published in peer-reviewed literature to ensure that any important shortcoming of the model formation or degree of calibration is quickly identified. As additional refinement and calibration of the model is performed, this information will be provided on the website in a timely manner. As with monitoring and applied studies, the Project's modeling efforts will be peer-reviewed as part of external Project review.

C. Linking Information and Management Actions

Adaptive management cycle. Figure 7 illustrates the cyclic, adaptive management process of information generation and decision-making. As earlier described, the restoration targets are the expected Project outcomes and management triggers are the thresholds that indicate the Project may be diverging from a restoration target. These triggers are set to trip well in advance of significant impacts to the system and, if reached, signal the Project Managers will take steps to understand what is happening and, if necessary, take action to put the system back on track toward the restoration target (Figure 8). As Figure 7 shows, the PMT and science managers will review and regularly update the restoration targets and management triggers with new information as part of adaptive project management. The adaptive management process also allows for review the Project's six primary Objectives if the Project is not able to achieve one or more of them. However, any changes to these Objectives will require consultation with the Stakeholders, as they were central in developing these goals. The adaptive management cycle is a continual process of updating restoration targets and triggers, appraising applied studies and monitoring needs, designing current and future phases, and generating information to determine if the Project is meeting its Objectives.

Responses to management triggers. What will the Project Managers' responses be when data show a management trigger is reached? The Adaptive Management Summary Table (Appendix 3) lists a suite of potential management actions Project Managers could take. In each case, one of the first actions will be for the Project Managers and scientists to study the information more thoroughly to understand what may be happening with the system. This analysis may be achieved through a meeting of Project participants, or workshops, and/or written evaluation from a panel of experts, when time allows. The exact management actions taken will depend on the nature of the problem, the results of the in-depth analysis, and the management options available. Management actions available for some triggers will be diverse, but others will be proscribed, especially those in response to triggers linked to regulatory standards.

Project Managers will be prepared for situations requiring rapid response as well as those allowing slow response. In some cases, a tripped management trigger must result in rapid action by the Project participants. In the rapid-response scenario, monitoring data are reviewed in a timely manner by the Project scientists, especially the Monitoring Director (see Part 4), and reported to the Project Managers. If Project Managers and scientists determine that a threshold has been reached, they will confer with other experts and Project participants to determine the best course of action. Action may be quickly taken to prevent or minimize damage to the system. Rapid action is essential in the case, for example, of low dissolved oxygen levels, which can cause fish die-offs and other ecological problems within days. Such situations allow little time for public interaction at the time of the event and Project Managers may have to take action without public input. In all such cases, the public will be informed of actions taken and invited to comment on the events to help managers improve their actions in these rapid-response situations.

For other management triggers, responses will be slower, allowing more time for study and stakeholder involvement before corrective action is taken. An ideal example of this is the population trigger for migratory shorebirds. The entire "restoration target-monitoring-trigger-management response" scenario for shorebirds will be a long-term process. First, the restoration target for shorebird population numbers will take several years to produce and will continue to be refined for many years. This target development process is lengthy because there is very little information on shorebird numbers in the South Bay prior to the Project monitoring. In addition, shorebird numbers are extremely variable from year to year and, therefore, the target will be designed to include the natural variation shown by Bay-wide populations. South Bay and Bay-wide populations will be monitored and compared to the target to determine whether South Bay population change is different from Bay-wide shorebird population trends. Gathering enough data to statistically assess these trends will, most likely, take a number of years. While the management trigger will be set recognizing the wide natural variation inherent in shorebird numbers, it is meant to trip very early to prevent problems from becoming too great. Thus, if the trigger is reached, the Project Managers will begin by convening experts to determine if shorebirds are declining and, if so, is the Project responsible in a substantive way. There will be time for significant scientific and public input to assess the information and determine appropriate corrective actions, if they are necessary.

Public access decisions will also be adaptively managed using the same rapid and slow response processes. For example, a rapid response scenario could occur if, hypothetically, a listed species were to establish nesting sites adjacent to a public access, spur trail. Since nesting birds are very sensitive to human disturbance (Carney and Sydeman, 1999; Trulio, 2005) and listed species are protected by law, Project managers and scientists would rapidly evaluate whether the trail was likely to be a significant disturbance to the animals. If so, they might take action to seasonally close or reroute the trail. The public, especially stakeholders, would be informed of the management actions, but as with most rapid response scenarios, there would be little time for public input before action was needed. Managers would receive public input at follow-up meetings to help improve responses in the future. There will also be many slow-response scenarios. For example, information from public access applied studies may show that some species are more sensitive to trails, i.e. experience more disturbance, than others. Project managers, scientists, and other experts would assess whether a trigger had been tripped. If so, the process of holding workshops with experts, meeting with stakeholders, and assessing potential management actions would be initiated.

Action not initiated by management triggers. The Adaptive Management Summary Table and the previous discussion have focused on what the Project Managers should do to get the system back on track if the targets are *not being reached*. This risk-averse approach is designed to prevent the Project from harming the South Bay system. Not only is this approach essential from an ecosystem health standpoint, but it is required by NEPA/CEQA as well as regulatory agencies that require that the Project avoid or mitigate significant impacts of the implemented restoration and management actions (Figure 8). Finally, this approach provides the best assurance possible that the Project Managers will meet the Project Objectives--goals that are important to the funders, agencies, legislators, and all the members of the public who were involved in helping make this Project possible.

While it is important to be cautious, Project information may indicate that, instead of things going awry, they may be going very well, even exceeding the targets expected. For example, data may show that California clapper rails are responding very quickly and positively to new tidal habitat with population numbers and densities exceeding targets. Or, foraging shorebird numbers in tidal habitat may be greater than expected, showing these habitats are supporting more birds than predicted. Or, assumptions that public access has impacts on one or more listed species may not be supported. These Project results, in which restoration targets are exceeded, will also be evaluated by Project Managers and scientists for management action. Exceeding expected outcomes will have implications for how fast and how much tidal habitat is restored, the locations and amounts of public access, and movement along the adaptive management staircase, in general. Since the monitoring parameters in the Adaptive Management Summary Table are set up to track progress toward the targets, they will function well to show when the Project is advancing quickly and exceeding expectations, as well as the when the Project is diverging from expected outcomes.

FIGURE 7. Adaptive Management Process

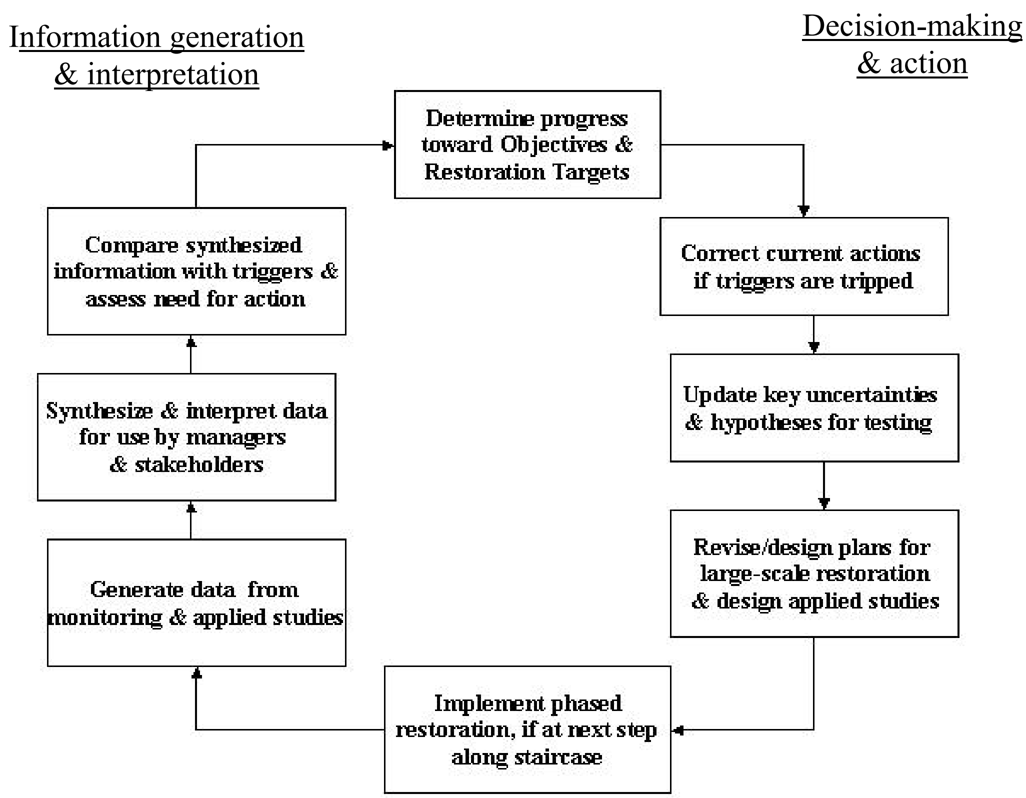
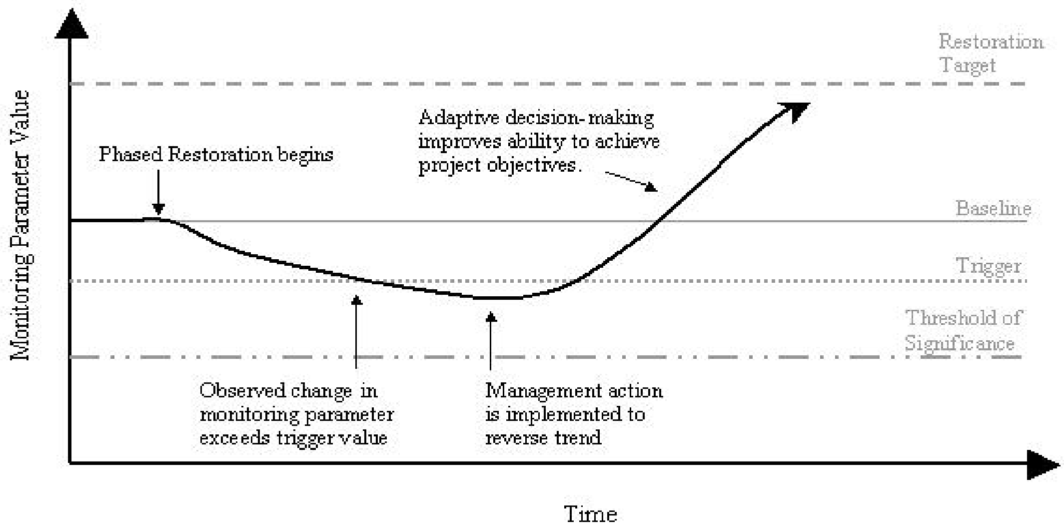


FIGURE 8. Linking Restoration Targets to Management Triggers



D. Phase 1 Applied Studies, Modeling, and Restoration Techniques

In 2008, planning for the Restoration Project will be complete and the Project Managers will begin implementing a set of Phase 1 actions. The Phase 1 actions were chosen because they are visible to the public, are expected to provide early successes in meeting Project Objectives, and allow testing for a series of applied studies to reduce key uncertainties. Table 5 lists the Phase 1 actions evaluated in the *South Bay Salt Pond Restoration Project EIS/R* (2007) and Figure 9 shows the locations. Table 5 also shows the applied studies associated with each action.

Phase 1 applied studies are coordinated with each restoration and management action. These studies are predominately focused on questions related to bird use of changing habitats, mercury issues, and public access-wildlife interactions. Project Managers need information on these uncertainties before they can determine how much tidal action to restore in future phases. Two large-scale experiments are planned to test key questions (see descriptions in Appendix 5). Ponds A16 and SF2 will be engineered with a large number of islands of different shapes, sizes and densities to assess the applied studies question: Will ponds that are reconfigured to create large isolated islands for nesting and foraging significantly increase reproductive success for terns and other nesting birds and also increase the numbers and densities of foraging birds over the long term compared to existing ponds not managed in this manner? At ponds E12/13, the Project will assess the extent to which ponds reconfigured and managed to provide specific water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds, and phalaropes/grebes; these ponds will be reconfigured as a small-scale salt pond system. Public access-wildlife interaction studies will be included in both these experiments. Studies of mercury methylation in response to management actions will continue into Phase 1, especially at Pond A8, which will be constructed as a reversible, muted tidal system used to assess mercury methylation changes in response to restoring tidal action. This action will also allow study of the extent to which salmon are able to enter and leave A8 through the water control structure.

Another issue for the Project during Phase 1 will be the effect on the Bay of ponds that are reconfigured or still managed as described in the ISP. Under the ISP, groups of ponds were linked together for circulation in a coordinated design of water intake and outflow to prevent salt making. Operation under this system quickly revealed unexpected changes in water quality and bird use. Changes due to Phase 1 actions will further affect pond ecology, requiring that they are monitored and studied to understand how ponds are functioning within the restoration project and with respect to the Bay.

As described earlier, Phase 1 efforts will include development and application of a numerical model that integrates physical and biological processes of the system to identify uncertainties and to predict system responses to potential management actions or external factors, such as climate change. This core model will be focused on predicting physical processes and changes in the far South Bay, below the Dumbarton Bridge, over 50 years. Model development will likely be incremental with early efforts focusing on hydrodynamics, water quality, sediment transport and geomorphic change. Small-scale model development and calibration began during planning at the Island Ponds. The Habitat Conversion Model for predicting bird response to changing habitats should be refined in Phase 1 to provide more predictive power. Ultimately, the Project would benefit from developing models to predict how human population and demographic changes will affect the Bay and restoration potential.

In addition to applied studies, the Phase 1 actions will include design features and pond operations whose feasibility and effectiveness deserve study. These "restoration techniques" (Table 5) do not require hypothesis testing, but their effectiveness requires documentation. Monitoring the effectiveness and sustainability of these techniques will inform the future planning, and possibly indicate changes to Phase 1. These restoration techniques have been identified for inclusion in Phase 1:

- Vegetation Management on Islands and in Managed Ponds. While some vegetation on nesting islands may be acceptable, design features and/or management is necessary to prevent dense, tall vegetation from substantially encroaching on the islands and to maintain habitat for species averse to nesting in vegetation. Vegetation management may also be required in areas of ponds managed for shallow water habitat. Phase 1 provides an early opportunity to learn about which methods are most effective at preventing vegetation growth and, if needed, controlling vegetation.
- Water Management for Discharge Requirements. The shallow water environment of managed ponds provides valuable habitat that supports various species of invertebrates and fish, many of which serve as food for nesting birds. However, compliance with water quality discharge requirements for discharge to Bay sloughs, particularly dissolved oxygen (DO), has been problematic during ISP operations. Reconfigured Phase 1 ponds will include approaches to determine cost-effective strategies to meet regulatory standards while simultaneously providing high quality bird habitat.

- Predator Control at Managed Ponds. Islands within managed ponds provide nesting habitat for a variety of birds. The proposed Phase 1 includes tidal restoration and pond reconfiguration to add nesting islands to managed ponds. These actions will displace predatory California gulls currently nesting in Pond A6, increase wetland nesting habitat for predatory northern harriers in restored marshes, create island nesting habitat that may attract breeding California gulls, and concentrate nesting islands for terns and other birds into fewer locations. As a result, predation pressure by avian (and possibly mammalian) predators on birds nesting on the islands could increase, potentially limiting the number and success of nesting birds utilizing the islands. Phase 1 management actions will include approaches to examine the most efficient and cost-effective methods for preventing and/or controlling predation.
- Sustainability of Constructed Marsh Pond/Panne Habitat. Pannes and ponds were typical, but not ubiquitous, features of historic salt marshes that provided important habitat for certain bird species. These features have rarely formed naturally in restored marshes, and constructed marsh ponds and pannes have been difficult to maintain due to vegetation colonization and erosion of the topographic elements that control tidal inundation. Phase 1 actions include restoration techniques to evaluate if constructed pond and panne habitat can be maintained through natural processes over the long-term.
- Ditch Blocks and Interior Channel Development. Re-establishment of the relict tidal drainage network is typically preferable since channel complexity provides a variety of microhabitats that support many marsh-dependent species. However, during channel formation within former salt ponds, borrow ditches tend to capture and dominate the evolution of the tidal drainage system. Phase 1 actions include restoration techniques to evaluate the extent to which ditch blocks enhance the re-establishment of relict dendritic channel networks within restored marshes. Information from the Island Pond restoration will also be used in this evaluation.
- Gypsum Pre-Treatment and Vegetation Establishment. The plant community is central to the biological functions of a wetland ecosystem, although the presence of gypsum may inhibit vegetation establishment by blocking root growth, preventing full drainage at low tide, or other factors. Phase 1 action at Pond E8A includes mechanically disturbing the existing gypsum layers prior to tidal restoration to examine the effectiveness of pre-treatment. Vegetation establishment (overall and by species) in treated areas will be compared with monitoring data from areas where the gypsum layers are intact.
- Wave-Break Berms and Pond Sedimentation. Wind blowing across open expanses of water, such as low restoration sites at high water, can generate waves that are sufficient to inhibit sediment deposition and re-suspend previously deposited material. These effects can slow or possibly prevent marsh plain formation. Monitoring elements associated with Phase 1 tidal habitat restoration has been included to assess the effectiveness of wave breaks at increasing pond sedimentation rates, and inform fetch spacing.

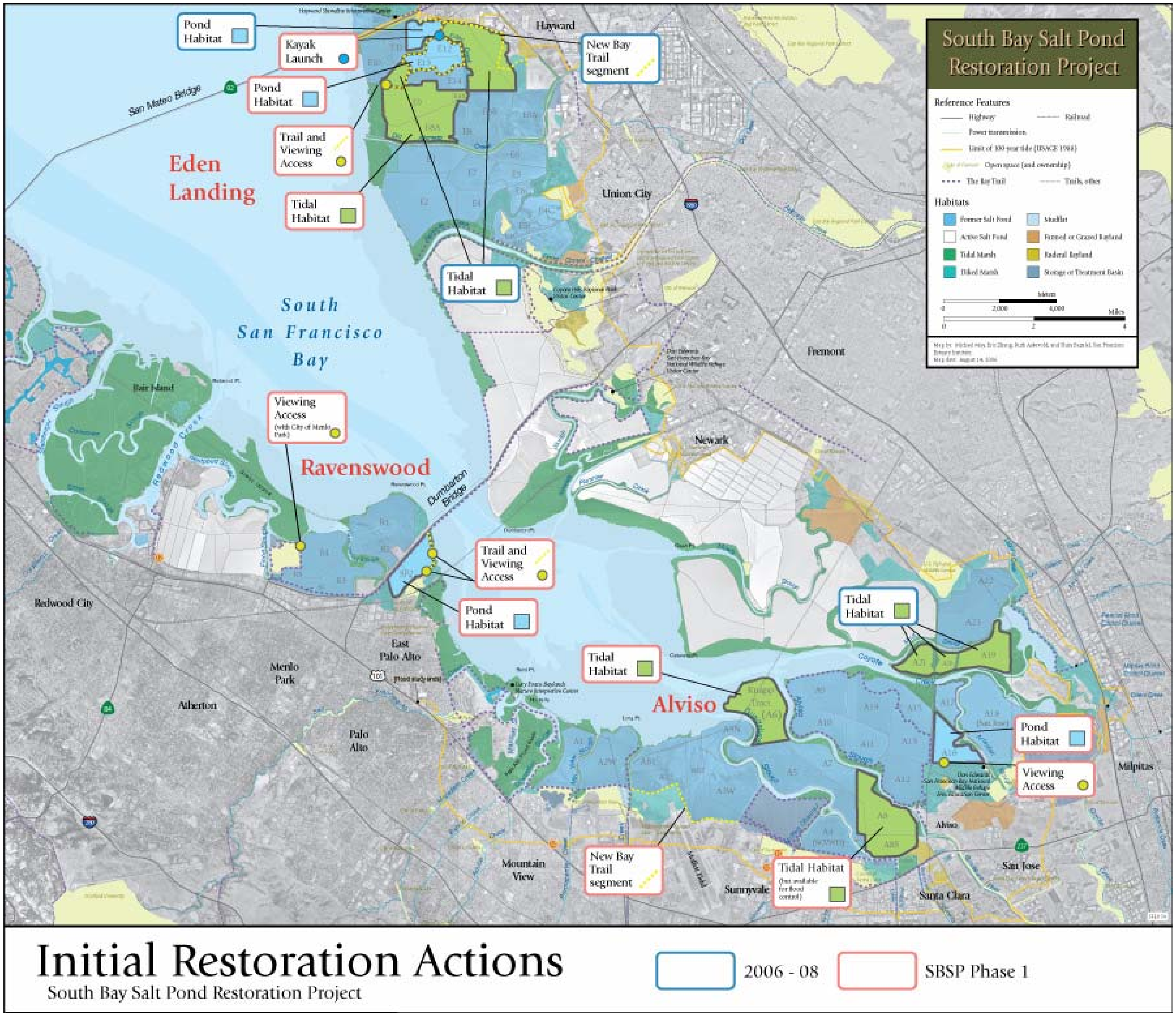
TABLE 5. Phase 1 Applied Studies and Restoration Techniques Questions

Action Type	Phase 1 Action	Applied Studies and Restoration Techniques Questions
Tidal habitat restoration	A6 (Perimeter breaches to mouth of Alviso Slough and Guadalupe Slough.) E8A/9/8X (Restoration plan developed in coordination with Alameda County Flood Control and Water Conservation District. Perimeter levee breaches connect ponds to Old Alameda Creek, North Creek, and Mt Eden Creek)	<u>Applied Studies</u> • Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal habitat ecosystems within the 50-yr projected time frame? (Modeling required) • Will sediment movement into restored tidal areas significantly reduce shallow water habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance) in the South Bay? • E8: Will restoration activities always result in a net decrease in flood hazard? • E8: Will pond and panne habitats in restored tidal habitats provide long-term habitat for significant numbers of foraging & roosting shorebirds & waterfowl? • To what extent will increased tidal habitat increase fish and harbor seal survival, growth and reproduction? • Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species? • A6: Will California gulls, ravens, and crows adversely affect (through predation and encroachment on nesting areas) nesting birds in managed ponds? <u>Restoration Techniques</u> • E8: Will gypsum inhibit the re-establishment of vegetation and relict tidal channels within the ponds? If so, what cost-effective treatments are available for treating gypsum? • E8: Can effective pond and panne habitat be constructed and, if so, can it be maintained through natural processes over the long-term? • A6: To what extent do wave breaks increase pond sedimentation rates? • A6: To what extent do ditch blocks enhance the re-establishment of relict dendritic channel networks within restored marshes?
Reversible muted tidal deepwater ponds	A8 (Limited exchange of tidal water through an armored notch in the perimeter levee between A8 and upper Alviso Slough provided muted tidal action and deep (>2 ft) water depths in Ponds A8, A5 and A7).	<u>Applied Studies</u> • Will sediment movement into restored tidal areas significantly reduce shallow water habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance) in the South Bay? • Will restoration activities always result in a net decrease in flood hazard? • Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species? • To what extent will increased tidal habitats affect survival, growth and reproduction of native species, especially fish and harbor seals?

Action Type	Phase 1 Action	Applied Studies and Restoration Techniques Questions
Reconfigured managed pond with islands with public access	SF2, A16 (Pond reconfigured to include shallowly flooded cells with isolated islands.)	<u>Applied Studies</u> • To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner? Specifically, what are the effects of island density and shape on bird nesting use and reproductive success? How do vegetation types, density and distribution affect island use by nesting birds? • Will landside public access significantly affect birds or other target species on short or long timescales? • Will public access features provide the recreation and access experiences the public wants over short or long timescales? <u>Restoration Techniques</u> • Which management methods are most effective and cost-effective for controlling vegetation? • Can we feasibly (cost-effectively) manage water for discharge requirements and create high quality bird habitat? • Which management methods are most effective and cost-effective for controlling predation?
Reconfigured managed pond to sustain a salt pond system with public access	E12/13 (Ponds reconfigured into cells that provide a gradient of salinities and water depths.)	<u>Applied Studies</u> • Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner? • Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales? • Will landside public access significantly affect birds or other target species on short or long timescales? • Will public access features provide the recreation and access experiences the public wants over short or long timescales? <u>Restoration Techniques</u> • Which management methods are most effective and cost-effective for controlling vegetation? How effective is high salinity in discouraging vegetation growth? • Can we feasibly (cost-effectively) manage water for discharge requirements and create high quality bird habitat?

Action Type	Phase 1 Action	Applied Studies and Restoration Techniques Questions
Public access	Bay Trail spine from Sunnyvale to Stevens Creek Viewing opportunity and interpretive display at Bayfront Park	Applied Studies • Will landside public access significantly affect birds or other target species on short or long timescales? • Will public access features provide the recreation and access experiences the public wants over short and long timescales?
Regional effects	Regional ecological and social impacts associated with implementing the South Bay Salt Pond Restoration Project	Applied Studies • Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? (Modeling required) • What is the effect of pond management, including increased pond flows and associated managed pond effects, on water quality, phytoplankton and fish diversity and abundance, and food web dynamics in South Bay? • Will voters, advocacy groups, elected officials, and government agencies support the project (especially in terms of funding) over the short timescale at the local and regional spatial scales? • What are the costs and benefits associated with the project sites and will they be shared equitably among communities, businesses, municipalities, and/or government agencies at local and regional scales?

FIGURE 9. Phase 1 Actions



E. Future Actions and Long-term Uncertainties

Future Actions. Future phases of the South Bay Salt Pond Restoration Project will integrate habitat restoration and management with flood protection and wildlife-compatible public access, which is the mission of the Project. Future actions will be based, in part, on the evaluation of adaptive management information collected in previous phases. Information collected in Phase 1 from monitoring and applied studies on bird response to management, methyl mercury, and public access-wildlife interactions will be instrumental in determining the extent and location of future tidal restoration.

Ultimately, future actions will be determined by evaluating this information in light of a number of decision criteria. Many of these criteria will be the same as those used in developing Phase 1, which were:

- Availability of funding
- Likelihood of success
- Ease of implementation
- Visibility and accessibility
- Opportunities for adaptive management
- Value in building Project support
- Certainty of investment
- Flood protection

For actions after Phase 1, the same criteria will be applicable, but others will be relevant as well, including the following:

<u>Readiness to proceed</u>
This criterion is similar to ease of implementation. Under this criterion, actions would be favored that are most timely for the particular implementing agency in completing the necessary planning and design. This criterion would not outweigh certain others, particularly those described below.

<u>Ability to utilize results from earlier applied studies and other new knowledge</u>
Under this criterion, projects that utilize the results of earlier applied studies would be favored, either in applying new design concepts based on earlier results or developing new information or knowledge to add to the knowledge base from earlier results. Also, it would take into account any other new knowledge that becomes available to the Project.

<u>Dependency on precedent actions</u>
Some actions cannot be implemented until specific precedent actions occur. A good example is that many ponds cannot be opened to unrestricted tidal action until a suitable flood protection levee is constructed. In fact, after Phase 1, there are few opportunities to open ponds to unrestricted tidal action without precedent flood protection actions.

<u>Dependency on adaptive management progress</u>
The basic layout of tidal and pond habitats in the 50% tidal:50% managed pond and 90% tidal:10% managed pond alternatives presumes a progressive conversion of ponds to tidal

habitats over time. The two alternatives are laid out to represent a continuum, a progression over time from 50%:50% to 90%:10% provided that monitoring results confirm that the Project Objectives are being achieved. The implicit assumption in this construct is that ponds that are managed ponds would not be converted to tidal action until after:

a) the 50:50 mix of tidal and pond habitats is achieved, and
b) monitoring has confirmed that further conversion of ponds to unrestricted tidal action is acceptable.

Flood Management Requirements

Many flood management actions proposed as part of the Salt Pond Project, such as levee construction, may wait for completion of the South San Francisco Bay Shoreline Study. The Shoreline Study process will be used to determine the specific elements of one or more projects that may be authorized for construction under by the federal government. The advantage of the Shoreline Study process to the Salt Pond Project is that it will carry the analysis to project-level detail and may result in a substantial Federal cost share for those elements contained within the federally-authorized project(s).

However, the Shoreline Study is not expected to be complete for several years. As a result, the Project partners are evaluating candidate actions for early implementation in the Alviso Pond complex by the Santa Clara Valley Water District in cooperation with the FWS and the State of California. The value to the Project of early implementation in this manner is that it provides necessary flood protection coupled with further tidal habitat restoration actions. In fact, the opportunities for creating additional tidal habitats after Phase 1 are severely limited until adjacent flood protection levees are constructed.

For the Ravenswood Pond complex, tidal habitat restoration will be closely linked to flood protection. In particular, the Highway 84 approach from the west to the Dumbarton Bridge and the PG&E substation are potentially at risk from flooding if outboard levees are breached, as well as the Belle Haven neighborhood of Menlo Park.

For the Eden Landing complex, the southern area (between Old Alameda Creek and the Alameda County Flood Control Channel) will be evaluated for a combined tidal habitat restoration and flood protection project led by the Alameda County Flood Control and Water Conservation District.

Public Access Needs

A number of the public access projects that are included in Phase 1, such as completion of Bay Trail spine segments, can proceed independently of changes in habitat. Many of the Bay Trail spine segments can and will be built when funds are available on existing or temporary levees that are ultimately proposed to be replaced with well-engineered flood protection levees. When the flood protection levees are constructed, it is the Project's intention that new and improved trail segments will be constructed on the levees, either on top of the levee or on a bench along one of the levee side slopes. Spur trails into the habitat areas or looped around managed ponds will be considered for construction as habitat development occurs and as additional information becomes available regarding the compatibility of trail uses with species use of the developed habitats.

The resulting application of these criteria will make implementation of actions in the future a varied mixture of activities at different times. A good example would be the set of actions following Phase 1. One may be the construction of a flood protection levee, another could be the development of an additional viewing area, and a third could be refinement of a Phase 1 applied study. These could be somewhat separated in time and space across the Project Area and be unrelated to each other, yet for other valid considerations they could be the most desirable set of actions to follow Phase 1.

Future actions are expected to open significant acreages of pond to tidal action in order to initiate development of significant areas of tidal habitat for California clapper rail and salt marsh harvest mouse and to allow large-scale testing of sediment dynamics and supply questions. These goals argue for restoring tidal action to an entire slough complex. The location of these ponds will depend on results with respect to the factors listed, above, as well as where flood protection work occurs. Possible locations include:

* Ponds along Old Alameda Creek in the Eden Landing complex
* Ponds along Alviso Slough in the Alviso complex
* Ponds along Guadalupe Slough in the Alviso complex
* Ponds along Ravenswood Slough in the Ravenswood complex

Long-term Uncertainties. As the Project moves into the future, understanding external factors affecting the Project will be extremely important. Climate change may be one on which all others hinge. The range and magnitude of climate change effects are not easy to predict. However, it is certain that change will occur. Some of the expected effects of climate change that are relevant to the Project include:

- sea-level rise, which will affect marsh development and flood risk;
- increasing air temperatures, which will influence insect populations, such as mosquitoes;
- changes in ocean and bay surface temperatures, which will affect primary productivity and plankton communities, the basis of the Bay food web;
- changes in freshwater storage and flow, which could change freshwater flow amounts and rates into the South Bay;
- melting permafrost in the arctic, which will affect the nesting success of many migratory birds and could reduce the number of birds migrating to the San Francisco Bay; and
- changes in storm patterns and intensity, which along with sea level rise, flood risk changes and freshwater flow changes, may impact the amount and location of urban settlement around the Bay.

While current estimates of sea-level rise have been factored into the evaluation of the Project alternatives in the *EIS/R* (2007), new model results based on revised sea-level estimates will be important throughout the Project's life. Model predictions of sediment dynamics, marsh development, primary productivity, bird use of South Bay habitats and human demography will all be affected by climate change. And, there are likely to be other significant forces that will impact the Project. One obvious factor is increasing urbanization and changes in human demographic patterns around the Bay. Others are the impact of earthquakes and oil spills. In addition to these, there will be factors that are currently not anticipated.

How will the Project deal with these changes? The adaptive management approach provides a process for continually examining the system, anticipating change, and responding to changes, if, when, and where they occur, based on thorough evaluation of the information and options available. Using information collected and well-developed models, Project Managers can assess, not only system response to Project activities, but can detect changes not resulting from Project actions and can predict changes to the system. Applied studies can be used to assess the causes of these responses and help Project managers understand when the corrective actions can and cannot effectively change or mitigate a negative trend. Evaluating the Project's performance includes trying to anticipate factors that may affect the Project, putting monitoring, applied studies, and modeling in place to try to detect changes due to those factors, and developing potential management responses if unacceptable changes occur. For example, although Project Managers cannot stop sea-level rise, based on estimates they may decide to restore tidal action only to certain parts of the Project area that can be armored with flood protection appropriate to protect against expected storm surges.

The future is uncertain and the direction and extent of change is often unpredictable. Project data and modeling will be employed to improve predictive and response capacities. Ultimately, the adaptive management process will be the way that the Project Managers will learn of and deal with changes to the system due to their actions or due to factors beyond their control.

Part 4. IMPLEMENTATION MANAGEMENT: Institutional Structure and Procedures

A. Organizational Structure

Adaptive management cannot be implemented without an effective decision-making structure that completes the loop between information development and the use of that information in decision-making. The institutional structure for decision-making described here is designed to achieve these four functions:

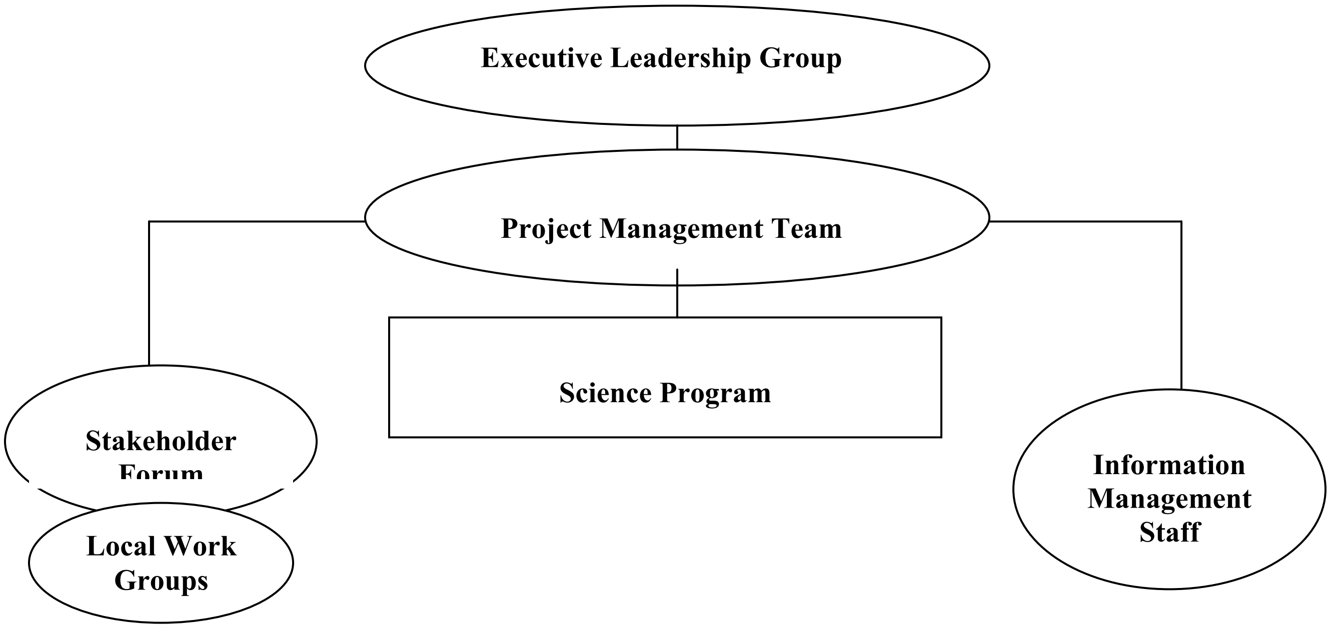
1. Generate science-based information for managers (from monitoring and studies);
2. Convert information into effective management decisions;
3. Involve the public to help provide management direction; and
4. Store and organize information for use by the decision-makers and the public.

Figure 10 shows the organizational structure that will be used to carry out these functions. This structure includes two primary elements, the Project Management Team (PMT), comprised of the USFWS, DFG, SCC, and other involved organizations, which is responsible for decision-making and taking action on those decisions, and the Science Program, comprised of science directors and contractors, which is responsible for data generation and interpretation. The science managers that direct the Science Program will be members of the PMT. Collectively, the PMT and the Science Program managers will evaluate: a) progress toward Project Objectives and restoration targets, b) monitoring and applied study priorities, c) corrections needed to current phases, and d) design of future phases. The PMT is ultimately responsible for all decisions that are implemented.

This structure evolved through a collaborative effort by the Project participants involved during the planning phase and is designed to allow a smooth transition from planning to implementation. The Project scientists and managers reviewed adaptive management programs in other ecosystem restoration projects (CERP, 2004, Flanigan, 2004; Glen Canyon Adaptive Management Plan, 2001) and found that every adaptive management program is structured differently to address the unique ecological and social features of the system. Society has not yet perfected the social, economic, and institutional components of adaptive management needed in specific contexts (Gunderson et al., 1995; Holling, 1978; Walters, 1997). However, one clear lesson from other ecosystem restoration projects is that institutional arrangements themselves need to be flexible and adaptive, as most attempts to institutionalize adaptive management into a standard template have failed (Walters, 1997). The structure and processes described here are expected to evolve over time to meet the Project's needs.

Another lesson is that adaptive management cannot succeed unless participants in the decision-making structure communicate effectively with each other to share information and take action in a timely manner. When different groups or functions remain in "boxes" or "silos" separated from other parts of the structure, decision-making breaks down. Mechanisms to ensure communication include integration of the science managers into the PMT, regular meetings of the Stakeholders attended by PMT members, transparent peer-review procedures, and vehicles for providing information to all project participants and the public, including regular reports from the PMT and Science Program, newsletters, and a Project website.

FIGURE 10. Adaptive Management Organizational Structure and Functions



Executive Leadership Group Functions:
* Provide decisions on overall direction of the Project and use of funds
* Make final decisions on issues involving competing interests between agencies or other big picture issues

Project Management Team Functions:
* Determine changes to current Project phases
* Determine movement along tidal action continuum
* Review and approve Applied Studies and Monitoring recommended by the Science Program
* Determine management actions relative to Triggers
* Evaluate and make changes to Targets and Triggers
* Issue RFPs for research and monitoring
* Set up and respond to Project reviews
* Develop and let contracts for all Project work
* Direct public outreach
* Develop/provide Project funding
* Report Project progress to funders and public

Stakeholder Forum and Working Group Functions:
* Provide community feedback to PMT
* Comment on recommendations from SMT
* Comment on draft decisions from PMT

Science Program Functions:
* In conjunction with the ELG and PMT, generate funds for Science Program implementation
* Interpret results from studies and monitoring for PMT
* Recommend and prioritize Applied Studies, Modeling, and Monitoring needs
* Assess movement along tidal action continuum and recommend actions for future phases and changes to current phases
* Implement adaptive management process when Management Triggers are reached
* Recommend changes to Targets and Triggers
* Set up peer-review for studies, monitoring, RFP, and associated reports
* Develop RFPs for studies, modeling, and monitoring
* Integrate with Information Management Staff
* Hold Science Symposia
* Coordinate research groups ("Science Consortium")
* Produce science reports and publications

Information Management Staff Functions:
* Store and manage data
* Conduct simple data analysis
* Provide data to PMT, the public, and others
* Prepare annual trends reports

B. Roles and Responsibilities
Each group in the Organizational Structure in Figure 10 has multiple functions in developing the information for decision-making, providing information to Project Managers and the public, and making and implementing decisions based on that information.

Executive Leadership Group. The Executive Leadership Group (ELG) is comprised of the heads of the Project Management Team agencies, consisting of the State Coastal Conservancy, the landowning and management agencies, local flood control districts, the Army Corps of Engineers, and Project funders. This group has overall authority for how funds are spent in Project implementation. The ELG coordinates directly with the PMT on high-level decisions. The ELG will meet one or possibly two times per year, depending on the need, to discuss current and proposed management actions and activities in future Project phases.

Project Management Team. The Project Management Team (PMT) will be the decision-making body for implementation and adaptive management. The PMT will be led by an Executive Project Manager and will include representatives from the FWS and the California DFG (the land management agencies), the State Coastal Conservancy (SCC), the local flood control districts (especially the Santa Clara Valley Water District and the Alameda County Flood Control and Water Conservation District), the ACOE, and the Lead Scientist and Monitoring Director. It will operate on a consensus basis, as it has during the planning process. Regulatory agency staff will be invited to participate in PMT meetings; they will be kept apprised of Project activities and will be contacted directly when their attendance is essential. Agencies should include staff involved with issuing and overseeing regulatory approval who can provide "early warnings" to the PMT on regulatory issues. If necessary, decisions will be elevated to the Executive Leadership Group.

The PMT provides leadership for the implementation process and is responsible for many components of the effort, especially determining the management and restoration activities required to meet the Project Objectives. The land management agencies will use the PMT as a forum to coordinate and cooperate for the benefit of the overall Project, but will retain their independent land management authority. A Memorandum of Understanding (MOU) among the PMT agency members will define the roles and responsibilities of the members with respect to achieving the Project Objectives and implementing adaptive management. The Executive Project Manager will assist the PMT in achieving their goals.

Two additional functions of the Project Management Team are obtaining funding for implementation and adaptive management, including funding for the Project including the Science Program, and providing for public participation and outreach. Funding is critical to ensuring that adequate long-term, stable financial support is provided to achieve the Project Objectives. This work includes researching and developing close and long-term relationships with potential funders and incorporating a rigorous proposal and reporting process. To achieve these goals, Project Management Team members will work with other stakeholders, including representatives from environmental or community groups, public works agencies, private foundations, and local businesses or industry, to conduct public outreach and development.

The PMT will lead the effort to identify and secure funding for implementation, including funds for science (applied studies, monitoring, and modeling), adaptive management, and management of the organizational structure. In 2007, the Project Managers and scientists estimated the cost of the program of monitoring, applied studies, and modeling laid out in the Adaptive Management Summary Table at approximately $3 million/year. This figure does not include administrative costs, such as funding the science managers. It is likely that the Project will need to budget at least 10% of its funds for the Science Program, although costs will change depending on the Project's science needs. There are several opportunities for funding that will be pursued including, but not limited to, state bond money, local benefit assessment districts or other local funding devices, federal appropriations to the FWS or ACOE, funds from private foundations, corporations, and individuals, and funds for mitigation or in lieu of fines from public and private entities. Funding for applied studies can, in part, be achieved through coordination with universities and research groups. The SCC will work with its non-profit arm, the Coastal Conservancy Association, to manage private funds. In addition, the Conservancy has the authority to accept and disburse public and private funds.

Outreach efforts to bring the public into the Project will engender support and long-term stewardship and increase the public's overall awareness of their role in protecting the environment. Outreach may include a quarterly or semi-annual newsletter in English and other important languages summarizing the Project's work, field trips, and opportunities for public involvement. Television and radio spots may also be useful in informing the public-at-large about the Project. Getting people actively involved in the Project will require a number of techniques. For example, tours of the Project area are popular but, also, "virtual public access" available on the Project website will allow people to "visit" the site even if they cannot travel. Virtual access can also let people see things that are normally inaccessible; for example, "nest cams", video cameras set up at nest sites that broadcast to the website, are popular ways to see nature in action. Technical workshops and/or public science talks will be popular with some. Many restoration projects also have active volunteer organizations that help publicize and manage aspects of the Project or collaborate with other local organizations to do this. While managing volunteers takes staff and money, the good will they convey and actual work they do can be very beneficial for the Project. The PMT will define geographic sub-areas in the South Bay, establish local Work Groups for those areas, and involve these groups and the Stakeholder Forum in the design, implementation, and monitoring of on-the-ground activities.

Key activities of the PMT include:

- Planning and implementing overall restoration and management, flood protection, and public access design;
- Making decisions about changing current Project phases/actions, determining future actions, revising restoration targets and triggers, meeting regulatory requirements, and all other operations of the Project, based on Science Program findings, Stakeholder input, and other relevant information;
- Providing regular reports to the Stakeholder on Project progress and future plans, and to regulatory agencies on compliance requirements;
- Overseeing budgeting and funding;
- Managing and implementing the contracting and RFP processes;
- Maintaining relations among state and federal legislative and local governments, communities, business, agencies, NGOs, and others;
- Developing community restoration and monitoring participatory activities;

- Conducting Stakeholder Forum and Work Group meetings;
- Coordinating with the Information Management Team to provide information to the public via the Project website and other methods; and
- Conducting outreach activities to raise the visibility of the Project.

In addition, the PMT should facilitate these important tasks as early as possible in Phase 1:

- Quantify restoration targets, as needed.
- Develop monitoring plans.
- Develop methods for resolving disputes about technical and social issues, and disagreements about potential management actions; and
- Develop a schedule and procedures for external review and assessment of the Project's decision-making and information generation systems to improve the effectiveness of adaptive management.

As part of the decision-making process, the PMT will be apprised of current results of studies and monitoring carried out by or related to the Project. The Science Program managers and the Executive Project Manager will be responsible for making sure that results and their interpretation are presented to the PMT in a timely fashion. The PMT will use the results to make four types of decisions:

- *Day-to-day decisions*: These are operational decisions made primarily by the landowners that will be consistent with the EIR/S, AMP, other restoration plans, regulatory requirements, and any operations and maintenance plans that are developed.
- "*Emergency Action" decisions*: These are actions, often related to operations and maintenance, requiring quick response, such as an unanticipated levee failure or unexpected violation of a regulatory requirement.
- *Decisions regarding management triggers*: These are decisions based on PMT agreement that a management trigger has been tripped and would be the initiation of the process to evaluate all existing information and subsequent evaluation of potential management actions.
- *Future action decisions*: These are decisions to initiate a future action, either a restoration plan action or a new or modified applied study. These decisions would incorporate review of existing information, consideration of potential modification of the actions consistent with that review, and in the case of restoration actions, would require environmental review tiered off of the programmatic EIS/R. The PMT will develop guidelines for how to make decisions based on the totality of the South Bay response to Project actions.

Whenever appropriate, the Stakeholder Forum and Local Work Groups will provide input to the PMT before decisions are made (other than day-to-day and "Emergency Action" decisions). They will participate in annual meetings and reviews of the Project's progress as delineated in Section C, below. PMT decisions will be documented in the Project's annual report and in action summaries of its meetings.

The PMT's decisions will be based primarily on the following factors:

- Available information as provided by the Science Program and other sources;
- Status of progress towards achieving the Project Objectives;
- Available funding and any institutional constraints associated with the funding source;
- Input from Stakeholders;
- Assessment of the risks of taking various actions as well as not taking action; and
- Regulatory considerations and constraints.

Science Program. The Science Program will be directed by two science managers, the Lead Scientist and Monitoring Director, and will include an array of contractors hired to complete specific tasks. The Lead Scientist and Monitoring Director, supported by a Program assistant, will determine and manage the work to be done by the Program. They will be members of the PMT and will ensure long-term continuity in the Science Program. The contractors will be hired to conduct all work identified by the science managers, including collecting and analyzing monitoring data, conducting applied studies, writing reports that analyze and synthesize monitoring and applied studies information for use by the PMT, and conducting peer-reviews of science products and the Science Program itself.

The goal of the Science Program is to bring the best and most relevant science to decision-makers and the public in a timely fashion. The Science Program will provide the PMT with a scientific basis for adaptive management decisions on current and future Project actions as well as assisting with the development of restoration targets, and measuring Project success. The primary objectives of this Program are to develop priorities for applied studies and monitoring for the Project; to ensure that information from the Project's applied studies and monitoring is synthesized, interpreted, and published in appropriate media for use by the PMT, other scientists, and the public; to develop, implement adaptive management processes; and to implement peer-review processes for Science Program projects and products as well as for the overall Project. The science managers will need to ensure that the best research organizations and qualified researchers are engaged in order for the Project to be successful.

The Lead Scientist is the overall science manager for the Science Program and will perform these functions:

- Generate local, national and international interest, and local and regional investment in the Science Program;
- Ensure Science Program efforts are credible, legitimate and relevant;
- Encourage the best scientists available to work on issues of interest to the Project;
- In concert with the ELG and PMT, identify and foster funding opportunities to support the Science Program.

Specific responsibilities of this position are to:

- Promote and build the visibility of the Science Program and the Project;
- Represent the Science Program to funders, academic institutions, at meetings, and other public venues;

- Seek funding and research opportunities to support the Science Program, including opportunities for formal partnerships with local Bay area academic institutions and researchers as well as opportunities through federal and state programs, e.g. Sea Grant and others
- As a member of the PMT, provide updates on Science Program activities and advise the PMT on all aspects of the Project connected to science, especially adaptive management decision making, changes needed in current Project phases, and design of future actions;
- Oversee the applied studies process, including the generation of syntheses of information and the production of peer-reviewed products/reports;
- Oversee adaptive management processes, such as when management triggers are tripped;
- Set up and oversee peer-review and expert panels/processes for Science Program products and the Program itself, as well as other aspects of the Project needing expert input, such as refining restoration targets, adaptive management workshops, and Project reviews;
- Develop competitive proposal processes for applied studies and synthesis reports, and establish peer-review panels to evaluate study proposals and reports;
- Convene scientists and research institutions ("Science Consortium") and encourage them to undertake research in the South Bay that cannot be funded by the Project;
- Hold Science Symposia, or other such venues, to highlight South Bay research;
- Attend Stakeholder Forum and Local Work Group meetings;
- Report on Science Program progress to the ELG and funders.

The Monitoring Director is responsible for developing and overseeing the operation of a system-wide monitoring program, including identifying monitoring parameters, developing monitoring protocols, and overseeing a competitive proposal process to hire consultants or research teams to collect the data. Specific responsibilities of this manager are to:

- Implement the process for identifying monitoring parameters and developing protocols;
- Ensure data are collected, analyzed, and published in useful peer-reviewed formats in a credible and timely fashion;
- Develop competitive proposal processes for monitoring work;
- Evaluate the monitoring data, as required (monthly to yearly), to determine progress toward restoration targets and management triggers;
- Ensure that those collecting data provide, on an established schedule, information and advice about data collection results and system conditions;
- Coordinate with the Information Management Staff on monitoring data storage, analysis, reporting, and presentation for the public and the Project Managers;
- Provide findings and recommendations to the PMT;
- Attend funder, stakeholder, and other meetings as needed;
- Help generate funds for the science program;
- Prioritize and recommend monitoring programs;
- Coordinate with other monitoring programs;
- Achieve a balance between time needed for contractor QA/QC and delivery of timely and accurate data.

These two science managers will work together in a cooperative effort to integrate their tasks. Together they will set the direction for the Science Program and assess whether the cumulative data collected are adequate to meet the Project's needs. They will determine what products need to be produced by the Science Program and ensure that contractors provide those products. This oversight will require they review the quality of work produced by contractors. Joint tasks will also include assessing whether management triggers have been tripped; prioritizing research questions and monitoring needs; providing recommendations for adaptive management and Project implementation to the PMT; ensuring reports that interpret the results of studies and monitoring are prepared, peer reviewed, and published in appropriate formats for all audiences. Advising the PMT will require that the science managers synthesize the reports produced by the Science Program in a form usable by the PMT.

The Science Program will be supported by a Program Assistant who will be responsible for various administrative and research tasks. In particular, this assistant will help set up meetings, coordinate the peer-review process, and organize workshops, and symposia. Other tasks will include helping the science managers establish contacts with researchers and consultants, assisting with RFP production and collecting information from other restoration and management projects to ensure that the Project has the most up-to-date and comprehensive information available. Other relevant projects, especially those around the Bay, must be included in the on-going information synthesis. Examples of such projects include the Napa Salt Ponds Restoration Project, CALFED Restoration Program, and the Hamilton Army Airfield Restoration.

The job of the science managers is to direct the work of the Science Program. The actual work--including collecting and analyzing monitoring data, undertaking applied studies, synthesizing the data generated, preparing peer-reviewed reports, and peer-review itself—will be conducted by contractors, especially research scientists and consultants. The contractors will be chosen on the basis of demonstrated skills and relevant experience through competitive proposal processes designed to bring the best scientists and experts to the Project for the specific tasks at hand (Appendix 4). The contractors associated with the Project at any one time will be determined by the particular work that needs to be done; a wide range of experts will contribute to the Project over time. On occasion, directed or sole-source contracts will be let (Appendix 4), but typically work will be subject to an open and fully competitive process.

The science managers are responsible for implementing peer review of the Science Program and its products. This process ensures that the work meets standards of scientific rigor. Most large restoration programs incorporate independent review panels, comprised of qualified individuals who are not participants in the long-term monitoring and research studies. These panels include peer reviewers and science advisors, and also protocol evaluation panels to assess the quality of research, monitoring, and science being conducted through the adaptive management program; they provide recommendations for further improvement. The entire Project, including the science and decision-making arms, will undergo review by experts external to the Project on a regular basis. For the first few years, the Project may be reviewed every other year. After that, 5-year reviews may be adequate.

In addition to peer review, monitoring and research will also require review and permitting by the landowners (DFG and FWS) and, in some cases, by regulatory agencies, such as the FWS Endangered Species Office. Work done through universities will require authorizations from human and animal care committees, when appropriate.

Stakeholder Forum and Local Work Groups. Substantial public involvement is essential for support and stewardship of long-term restoration projects and is one of the four functions of the AMP institutional structure. The Stakeholder Forum and Work Groups are designed to provide ongoing, publicly-derived input to the PMT on major components of the restoration plan and adaptive management actions. This input will be used by the PMT to help guide management direction. The Stakeholder Forum will remain as it was constituted in the planning process, composed of approximately 30 core stakeholders with demonstrated, ongoing interest in South Bay ecosystem restoration, representing the following sectors:

- Local Business and Adjacent Landowners;
- Environmental Organizations;
- Public Access /Recreation Interests;
- Public Infrastructure;
- Community Advocates and Institutions;
- Flood Management;
- Public Works/Public Health; and
- Local or State Elected Officials.

Local government staff and elected officials will be invited to join the Stakeholder Forum. Each year, one meeting of the Forum will be dedicated to an Annual Report from the PMT focusing on project accomplishments, progress toward Project Objectives, updates to restoration targets and triggers, lessons learned, progress on local projects, and plans for the upcoming year. Additional Stakeholder Forum meetings will be held as needed for topics such as the Shoreline Study progress, implementation of the Adaptive Management Plan, significant scientific findings, and when unusual monitoring activity results in a management trigger.

Local Work Groups, associated with each pond complex, will be established and will meet two to three times per year at Project milestones. Additional Work Group meetings may be held as needed. These Work Groups will be open to everyone, including Stakeholder Forum members, with a special emphasis on inclusion of local elected officials or staff. The local land managers and flood control districts will participate and a State Coastal Conservancy representative will chair the meetings. The Project Management Team will also make use of other existing groups. For example, the Lower Alameda Creek Task Force could be asked for feedback on plans for the southern half of Eden Landing, and the Alviso Water Task Force could provide feedback regarding the areas around Alviso.

A significant, but often overlooked component of adaptive management is social learning, in which all players interact with and learn from each other (Van Cleve, et al. 2003). One obvious avenue for social learning is educating the public about the science and policy of the restoration project (Parson and Clark, 1995). Providing Stakeholders with clear summaries of monitoring and research information will help them understand the ecosystem. Social learning also means that the PMT will respond to concerns voiced by the diverse population comprising the South Bay area, and will incorporate transparent and genuine ways of responding to public comments. Sincere efforts by the PMT to listen and respond to concerns raised by the

Stakeholder Forum, Local Work Groups, and individuals and groups not already involved in the Project will help to build trust and provide a solid foundation for decision-making over the 50-year lifespan of the Project.

Information Management Staff. This group will be responsible for data storage and access, including monitoring and/or GIS data and is the link among the data collection groups, the PMT, and the public. The Information Management Staff will work with the Science Program managers to provide data and reports to the PMT and to ensure that data from monitoring efforts are made widely available. This group will organize and maintain an Information Repository, which will store and archive the Project's documentation, including decisions, agendas, reports, and monitoring data. To support the Project's mission to distribute information, the Information Management Staff will manage the Project's website. This group will coordinate with other agencies and organizations involved in data management in the South Bay. The Information Repository and management systems should include:

- clear data and metadata transfer and input policies and standards;
- policies and procedures for data validation;
- mechanisms to ensure data integrity and security;
- policies and procedures for public information access and outreach;
- database software and database models to facilitate storage and retrieval; and
- tools to facilitate basic data analysis as determined by the PMT.

Resources in the Information Repository will be organized in a manner that makes clear the level to which the data have been analyzed. One archive approach might categorize information as follows:

- general information—press releases, fact sheets, information summaries, abstracts;
- publications—reports, agreements, printed materials; peer-reviewed articles;
- status and trends—high-level interpretations, graphs, charts;
- maps—watershed profiles, bay atlas; and
- raw data—real-time monitoring, preliminary studies, raw monitoring data.

Documentation would make clear that raw data are high-quality, but have not been interpreted; they will not generally be useful to the public or PMT. One exception is real-time monitoring data, which come from systems that provide easily understood data for immediate dissemination on a website. Data converted to maps they are more easily interpreted and some of this graphical work may be conducted by the Information Management Staff. Complete analysis occurs at the publication level in reports generated by the Science Program. General information is the most accessible level, providing information from previous levels in forms that are clear and understandable to the public and the PMT.

C. Interactive Processes

The Project participants will use a number of methods to coordinate their activities to provide information in a timely manner to the PMT.

Direct Connections. The PMT and Science Program will be integrated, as the Lead Scientist and Monitoring Director will be members of the PMT. When appropriate, regulatory representatives will attend PMT meetings to have direct dialog on regulatory issues. The PMT members, including the science directors, will attend Stakeholder Forum and Work Group meetings to give updates on Project progress and listen to public input. The Science Program managers and other PMT members will work directly with the Information Management Staff to design data storage, analysis, and display methods, as well as public outreach tools.

Reports and Meetings. At a yearly meeting, the PMT will present the Project's progress to the Stakeholder Forum and Local Work Groups and will solicit comments on management directions, when appropriate. This information will go into a yearly report to the public. It is also the task of the PMT to generate reports, as required, by regulatory agencies such as the Regional Water Quality Control Board and the FWS Endangered Species Program.

Science Program reports, for use by the PMT in developing management direction, will be produced through a transparent peer-review process. Specifically, approximately once per year, the Science Program will ensure that summary reports presenting and interpreting the information generated since the last review are generated. Reports will make recommendations for future applied studies, monitoring, and management. At a Project meeting separate from the one between the PMT and the Stakeholders, contractors and the Science Program managers, to the extent they are involved, will present their findings and management interpretations to a peer-review panel. The Stakeholders and Work Group members will be encouraged to attend this meeting. This mechanism accomplishes peer review of Science Program products while providing transparency. It allows the public to learn about the work the Project has produced and the hear comment from peer-reviewers on that work.

Perhaps once or twice a year the Lead Scientist will convene a "science consortium", bringing together researchers and institutions to encourage them to undertake research in the South Bay that the Project cannot fund. These consortiums would inform scientists about research opportunities relevant to the Project, encourage scientific collaborations, and identify ways that the Project might assist researchers, such as by providing letters of support or helping to secure permits. Every two to three years the Science Program managers will host a Science Symposium designed to highlight results of current research relevant to the Project.

Some of the data for the Science Program reports will come from the Information Management Staff, which will provide a yearly summary, and perhaps more frequent mini-reports, describing the data available (old and new), giving basic analysis of monitoring and research data, and reporting on public outreach systems and outcomes.

Stakeholders and other members of the public will have multiple opportunities during the year to provide feedback to the PMT. In addition to the PMT and Science Program meetings described above, the Stakeholder Forum will meet additional times during the year, as required. Additional meetings will occur only if an issue requires comment from the full range of

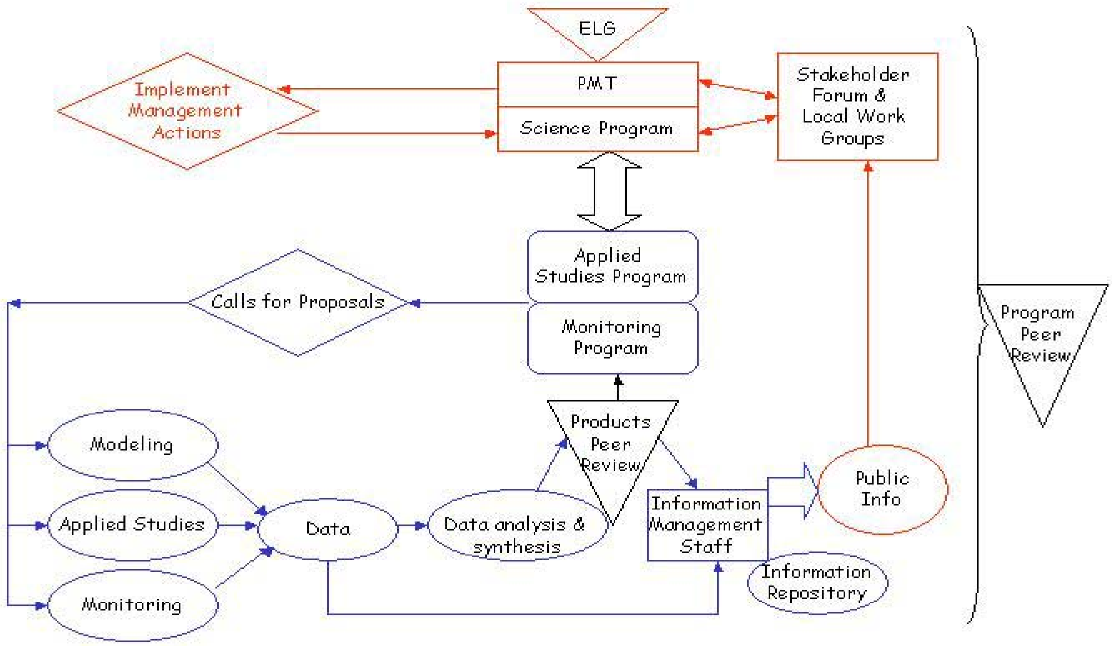
Stakeholders. The Project managers expect Local Work Groups to meet more frequently than the full Forum during the year to talk with the PMT about local Project activities.

Activity Cycles. The public will be informed of Project activities, such as management actions related to management triggers, and invited to provide input, when possible. As described in Part 3, there will be rapid- and slow-response processes in response to management triggers. For slow-response management triggers, the Stakeholders will be involved, through meetings, reports, and email, before management actions are taken. However, for rapid-response management triggers and unanticipated events, decisions and actions will need to occur quickly. The PMT will have developed a suite of responses, in advance, to deal with such issues and typically actions will be chosen from this suite. For other triggers, such as those associated with listed species, the management actions will be prescribed in advance by the regulatory agencies. Stakeholders will be informed through the Project website and email alerts when the PMT has taken rapid action on a trigger. Stakeholders will have the opportunity to discuss what occurred and provide input to the PMT on potential changes to future situations. When a suite of actions is predetermined, the Stakeholders will be informed of these and will be involved in their development, to the extent possible.

Within the Science Program, there are also different cycles of activity. Yearly, the science managers will determine whether the data collected are adequate to meet the Project's monitoring needs and will refine the Project's applied studies and monitoring needs. Calls for proposals for applied studies and monitoring will typically be posted on a yearly basis. Also yearly, the Science Program managers will evaluate the monitoring, modeling, and applied studies reports from the contractors to determine progress toward restoration targets. Applied studies and overall monitoring findings will be evaluated and reported approximately yearly at the public Science Program meeting, as described above. Figure 11 shows how data collection and decision-making are integrated.

Some monitoring data must be screened more regularly to assess whether management triggers are reached. To provide information in a timely manner to the PMT, the Monitoring Director will have an evaluation schedule for different parameters. For example, dissolved oxygen data may need to be reviewed monthly for problems, bird data may need evaluation seasonally, and sediment changes data every 5 years. The data collectors, Monitoring Director, and appropriate PMT members will review the data as required. If warranted, the Monitoring Director and Lead Scientist will meet with the rest of the PMT to determine whether a management trigger has been reached.

FIGURE 11. Adaptive Management Data Collection Processes



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APPENDIX 1: Descriptions for Applied Studies Design

In this Appendix, the Science Team members give detailed guidance to Project Managers and future researchers on potential hypotheses and study designs that could be used to address the Applied Study questions listed in Table 2. These descriptions should serve as a starting point for researchers preparing proposals in response to calls for proposals or designing research for the Project that they will fund through means separate from the Project. Descriptions for Applied Study Questions 6 and 7, on bird use of saline habitats and islands, are given in Appendix 5. Descriptions for Applied Studies 9 (California clapper rail use of tidal habitats), 13 (pond management effects), and 14 (non-native *Spartina* effects) are not included as questions 9 and 13 did not have Science Syntheses to draw upon and research approaches to question 14 will be dependent on other agencies, such as the Invasive *Spartina* Project.

Applied Studies Question 1: Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal marsh ecosystems within the 50-yr project time frame?
David Schoellhamer, Science Team Member

Background/Rationale

Project objective 1 is to create, restore, or enhance habitats of sufficient size, function, and appropriate structure to promote restoration and support increased abundance and diversity of native species in South San Francisco Bay. Desired species primarily utilize either tidally-influenced aquatic habitats or vegetated marsh habitats. In order to create these habitats, the Project must introduce tidal action to existing nontidal submerged salt ponds. The levees around the ponds will be breached to connect the ponds to the estuary and allow the water level in the ponds to vary with the tides. Pond volume below mean tide level, the approximate elevation needed for vegetation colonization, is 31 to 33 million m^3, over 99% within the Alviso ponds. The five most subsided ponds contain one-half of this volume. Thus, the bed elevation of subsided ponds must be raised before it can be colonized by marsh vegetation. Natural deposition of sediment is the most cost effective method to accomplish this. Placement of dredged sediment is a faster alternative but increases costs and regulatory impediments. Once established, vegetation helps the marsh develop by trapping additional sediment and providing organic material. As land subsides and sea level rises, sedimentation is needed to maintain the elevation of the marsh relative to sea level. The net rate of sedimentation will determine whether and when some project objectives will be met.

Natural sedimentation within the ponds will be dependent upon:

- Sediment supply from local tributaries and Bay waters.
- Transport of sediment from the Bay and sloughs into the ponds by tidal currents.
- Deposition and retention of sediment in the ponds.

The rate of sediment supply from local tributaries and Bay waters to the ponds and sediment demand of restored ponds must be known to answer the question. USGS has measured the existing bathymetry of the ponds, so the highest priorities are to gain a better understanding of sediment supply and deposition and retention within restored ponds. Of immediate importance is to continue tributary sediment load measurements because annual variability is large and recent data are scant which can lead to inaccurate estimates of sediment supply. The null hypothesis is that sediment supply is not sufficient to create and to support emergent tidal marsh ecosystems within the 50-year project time frame.

Applied Study Design Concepts
The goal of these studies should be to develop predictive capabilities that can be used by the Project for evaluating how far up the adaptive management staircase the project can go and the likelihood of success of future restoration phases. This would essentially improve upon the South Bay Geomorphic Assessment undertaken at the beginning of the Project. The following major elements are likely to be needed:
1) Measurement of sediment supply from the watershed and Bay waters to the Project area.
2) Analysis of measurements to develop simple algorithms of how precipitation, tributary discharge, tides, and wind affect sediment supply. Estimated cost for the USGS to operate 6 riverine stations and 3 tidal stations and analyze the data is $750,000 per year.
3) Measurement of accretion and vegetation colonization in ponds restored by the ISP and early Project phases.
4) Analysis of pond measurements to develop algorithms or models of deposition and vegetation colonization of restored ponds. Estimated ballpark costs of items 3 and 4 ranges from $100,000 for a graduate student or post doc, involvement of advising professor, and supplies, up to $300,000 per year for a larger University or agency effort.
5) Development of numerical models of watershed sediment supply, Bay sediment supply, and restored pond evolution. A key component is developing hydrologic and climate scenarios to drive the models. The models would use the algorithms from steps 2 and 4 and would be calibrated and verified by hindcasting pond evolution using data collected in steps 1 and 3. Estimated ballpark cost is $200,000 per year for 3 graduate students and involvement of advising professor up to $410,000 per year for a larger University, agency, or 2005 ECOFORE proposal effort.

Because of uncertainties in the models and in developing future hydrologic and climate scenarios, the Project may find that comparing the difference in model results between different restoration scenarios is more useful than evaluating the result of a single restoration scenario.

Sediment supply from tributaries is affected by watershed hydrology and sediment supply from South Bay is affected by suspended sediment concentrations and salinity in Central Bay, which are determined by flows from the Central Valley. Thus, the spatial scale of the study is the watershed of San Francisco Bay and Bay waters. It may be possible to represent processes outside of the Project area by parameterization, surrogates, or algorithms.

Measurements of sediment supply, pond accretion, and vegetation colonization are needed to develop robust predictive models and should be undertaken during the ISP and phase 1. As more data and analyses of the data become available over years to decades, the accuracy of models will improve.

Management Response
Progress up the adaptive management staircase can continue if sediment supply is sufficient for colonization of desired vegetation. If sediment supply is insufficient, then use of fill, perhaps dredged material, is required to continue progress up the staircase. Another alternative may be to alter design of restored ponds to increase deposition. Otherwise progress up the staircase is impossible and unrestored ponds will have to be operated as managed ponds. If results are inconclusive, managers will have to decide whether to stop restoration or to continue restoration and monitor and evaluate pond evolution to determine if an additional restoration phase is desired.

Applied Studies Question 2: Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance) in the South Bay?
David Schoellhamer, Science Team Member

Background/Rationale
Although restoration actions are designed to increase habitat quantity and quality, they also have the potential to destroy valuable existing habitat. For example, one effect of breaching a pond to a tidal slough or Bay is to increase the tidal prism of South Bay and the slough. Tidal prism is the change in water volume between low and high tide for a given region. Restoration essentially undoes what the original diking of tidal marsh did: reduce tidal prism and allow remaining tidal channels to fill with sediment. If tides were reintroduced to an area equal to the area of the Alviso ponds (9.4 km^2), the tidal prism south of the San Mateo Bridge would increase by about 10%. When the tidal prism increases, tidal velocities must increase to accommodate the new prism. Increased velocity can cause erosion of existing marsh or tidal flats and scour of subtidal channels. Marsh and tidal flats are critical habitat for shorebirds and waterfowl, are integral in nutrient cycling and food web dynamics, and protect the shoreline from erosion. Indirect impacts from restoration actions are also possible, including changing plankton dynamics through changes in vertical and horizontal mixing in the water column.

For geomorphic responses, the null hypothesis is that restoration does not alter the geomorphology of existing South Bay tidal habitats and adjacent subtidal channels. Studies would measure change of the area and characteristics of existing habitats.

For ecological responses, the null hypothesis is that restoration does not alter the ecological functions of existing South Bay tidal and subtidal habitats. Studies would measure change in the diversity and abundance of species that use these habitats in South Bay.

Applied Study Design Concepts
Geomorphic studies would measure change of the area of tidal marsh in the slough providing tidal connection to restored ponds and in South Bay, change of slough channel bathymetry, change of mudflat bathymetry in South Bay, and change of subtidal bathymetry in South Bay. Geomorphic response to breaching can not be accurately predicted so studies will require flexibility. The most likely scour location is at or adjacent to the breach. Scour may start at the breach and progress through the slough toward the Bay or the slough and mudflats may scour uniformly. It may take years to decades for a new dynamic equilibrium to emerge or scour may never be measurable away from the breach. A cause and effect relation may be difficult to establish between restoration and scour far from a breach, especially if part of the path to the breach is not scouring. In addition to scour, coarsening of bed material and deposition where currents are unable to support increased sediment in suspension are possible. Initially, bathymetry and bed material size should be measured before breaching and annually. Frequency and specific location of measurements can be refined in response to initial data analysis. Recent LIDAR and bathymetry surveys cost the Project $558,000, so with analysis the estimated cost is $650,000 to $750,000 per survey.

The geomorphic studies would provide a measure of the transformation of existing habitat caused by restoration. The effect of habitat change on ecological function would be determined by studies of species that use these habitats and of other functions of interest, e.g., nutrient cycling. Use of habitats should be measured before breaching and if a habitat is being lost to determine if density increases or remains constant. Species that utilize habitats that are likely to diminish or are diminishing as well as target resident species should be the priority for measurement. Establishing cause and effect will probably be more difficult than for geomorphic studies. Measurements at control sites not affected by restoration will be necessary.

Habitat quality may also be affected by changes in geomorphology and suspended sediment concentrations. For example, a habitat quality change not necessarily indicated by geomorphic studies are increased vertical and horizontal mixing in South Bay caused by increased tidal prism and decreased turbidity. Phytoplankton dynamics in South Bay are dependent on mixing; increased vertical mixing would remove them from the photic zone and expose them to benthic grazing and increased horizontal mixing would transport more phytoplankton from shallow water where there is net production to deeper channels where there is a net loss of phytoplankton. Restoration areas are sediment sinks that may reduce turbidity and increase the depth of the photic zone. Studies of mixing and plankton production in areas with and without breaches or before and after breaching would be appropriate. Estimated ballpark costs range from $100,000 per year for a graduate student or post doc, involvement of advising professor, and supplies, up to $1,000,000 for a large University or agency study, depending on the scope.

Management Response

Progress up the adaptive management staircase can continue if the null hypotheses are upheld. If the null hypotheses are refuted, possible management responses are to:

- Evaluate whether the Project causes a net loss of habitat or whether local loss is offset by habitat gain elsewhere.
- Place dredged materials to accelerate restoration and reduce new tidal prism
- Place dredged materials to maintain mudflats
- Time breaches (seasonal, wet years) for maximum initial deposition
- Phased breaches to increase tidal prism more slowly
- Locate breaches to minimize damage to sloughs most susceptible to erosion
- Limit additional tidal prism by keeping ponds isolated or developing muted tidal ponds
- Construct temporary or permanent barriers to control which channels have increased tidal prism
- Connect adjacent sloughs to create a zone of flow convergence and sediment deposition
- Slow or stop progress up the staircase

If results are inconclusive, managers will have to decide whether to stop restoration or to continue restoration and monitor and evaluate habitat evolution to determine if an additional restoration phase is desired. Given that the geomorphic and ecological response may take decades, this is a likely outcome.

Applied Studies Question 3: Flood Hazard Uncertainty (part of Sediment Dynamics)

Dilip Trivedi, South Bay Salt Pond Restoration Project, Science Team Member

Introduction

The Science Team identified three Applied Studies questions to address Sediment Dynamics, a Key Uncertainty in achieving the Project Objectives for the South Bay Salt Pond Restoration Project. One primary Project Objective (PO# 2) is to *"Maintain Or Improve Existing Levels Of Flood Protection In The South Bay Area."* To achieve this, we must first identify the existing level of flood protection, and then analyze post-restoration conditions to assess the effects of the project. Since the primary metric of flood hazard is elevation of water levels in the vicinity, predictions of future water levels is necessary. Both, short-term as well as long-term, water levels need to be determined to assess flood hazard potential.

The specific uncertainty, as developed by the Science Team (Applied Studies Question #3), along with a brief explanation of the importance, is described as follows:

> ***Will restoration activities always result in a net decrease in flood hazard ?*** *Increased tidal prism will scour slough channels within a relatively short time frame (months to years) and reduce flood hazard. Changes in tidal elevations and prism in sloughs occurring over months to years may potentially increase flood hazard.*

Background/Rationale

The restoration project envisions opening up some of the diked salt ponds to tidal action. This implies that the levee along the landward edge of those salt ponds will be improved/rehabilitated to sustain tidal as well as wind-induced wave action, such that flood hazard to local communities will not increase. The subject of this Applied Studies discussion is flood hazard resulting from changes in flow within the sloughs and channels which connect to the Bay through the project area. It is important to quantify the impacts of the restoration project on tidal hydrology and water quality in these lower reaches of the creeks. Both, short- and long-term changes need to be considered because the creeks will most likely have a delayed morphologic response to significant changes in tidal prism such as those expected from the restoration project.

Most of the creeks in the project area offer just enough conveyance capacity to convey the design flood flows (100-year in most cases). This was documented in earlier reports (Moffatt & Nichol 2003a, SCVWD 2002). Some creeks, which do not offer this protection, are being modified to contain the design flood flows and the projects are in various stages of development. Changes in tidal water levels in these creeks, even minor, will change the amount of conveyance and may affect the level of flood protection to adjacent communities. Since water levels in the vicinity are a function of fluvial flows from upstream watersheds, astronomical tides, bathymetry, and bed characteristics, each of these elements need to be known for existing as well as future conditions.

<u>Uncertainties</u>

The Project Key Issues document authored by the Science Team had already recognized that the following questions needed to be answered to assess the hydrological impacts of the restoration project:

- what is the hydrology and current pattern in the South Bay as they exist today, and how have they changed over time ? ;
- how will South Bay hydrology change over 50 years in response to human activities and natural processes ? ;
- how will the hydrology in ponds, sloughs and South Bay react to natural changes, as well as human-induced changes (such as ISP, restoration and other changes), over the next 50 years ?

Some of this is already being conducted as part of the environmental review phase. The flood hazard related uncertainties are tied in to hydrological modifications that will occur as a result of the restoration project, primarily due to the combination of fluvial flows and tidal stage. Moving the edge of the Bay farther landward (upstream within the local creeks), as envisioned for the restoration project, may affect the hydrology of the creeks and stability of the levees due to higher currents, scour, and changes in "backwater" elevation. Since the restoration will be phased over several years, assessing the impact of each phase, as well as cumulative impact is necessary.

Applied Study Concepts

Determining the backwater effect within the creeks and potential scour at the base of the flood control levees requires analyzing existing and future hydrological conditions. This is a deterministic effort which can be completed utilizing hydraulic models. Simulations should be conducted for all creeks draining through the project area (Coyote Creek, Guadalupe River, Stevens Creek, Mountain View Slough).

Work should be coordinated with local flood control districts which have conducted Flood Insurance Studies. Output from ongoing SBSP model studies will be needed to model flood stages within the creeks. These parameters include future tidal water levels and allowable future channel dimensions to simulate future conditions. Water levels and velocities should be determined for existing and future conditions, with the emphasis being on storm conditions.

For budgeting purposes, this kind of analysis could be performed using models similar to the existing Flood Insurance Studies models. An allowance of about $200,000 may be sufficient to run the different simulations, assuming that channel surveys and model results from the SBSP restoration project hydrodynamic analysis is available.

Management Options

If it is determined that the backwater elevation increases upstream of the pond levees, due to breaches through slough levees, project design features may have to investigate alternatives for breach locations/dimensions. If it is determined that the base of the flood control levees will scour sufficiently to affect the stability of the levees, mitigation schemes may have to be developed to prevent channel headcutting.

Applied Studies Question #4: Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? Ecosystem changes and effects must be measured and compiled over time to understand the overall implication of South Bay restoration on migratory birds. Some factors that could affect bird numbers are changes in suitable habitat for particular species, disease and predation rates, food availability, and nest competition.
Nils Warnock, PRBO Conservation Science, South Bay Salt Pond Restoration Project Science Team Member

Background/Rationale
The Science Team identified six Applied Studies questions to address Bird Use of Changing Habitats, a key uncertainty in achieving the Project Objectives for the South Bay Salt Pond Restoration Project. One primary Project Objective is to provide adequate habitat to support pre-ISP numbers and diversity of waterbirds using the South Bay while increasing numbers of tidal marsh birds such as California clapper rails that have historically used the Bay.

Bird use of San Francisco Bay, particularly in the South Bay is high. Birds counts on San Francisco Bay from 1964-1966, showed highest densities of birds in salt ponds, followed by tidal flats, open water, and tidal marshes (Bollman and Thelin 1970). Single day counts of waterbirds in the salt ponds during winter months can exceed 200,000 individuals (Harvey *et al.* 1992), and single day counts during peak spring migration have exceeded 200,000 shorebirds in a single salt evaporation pond (Stenzel and Page 1988). Takekawa et al. (2000) reported that the South Bay salt ponds supported up to 76,000 waterfowl (up to 27% of the Bay's total waterfowl population) including 90% of the Bay's Northern Shovelers, 67% of the Ruddy Ducks, and 17% of the Canvasbacks. Depending on the year, 5-13% of the federally threatened U.S. Snowy Plover Pacific Coast population breeds at San Francisco Bay, mainly in the South Bay salt ponds (Page *et al.* 1991, Strong et al. 2004). In some years, >20% (1,500 – 2,500 pairs) of the Pacific Coast Forster's Terns may nest in the salt ponds of the South Bay (Strong et al. 2004b).

However, various modeling efforts and expert opinion have suggested that there is the potential for significant declines in some bird populations, particularly waterbirds, if significant amounts of salt pond habitat are converted to vegetated tidal marsh habitat (Takekawa et al. 2000, Stralberg et al. 2003). For instance, Takekawa et al. (2000) estimated that if 50% of the South Bay's salt ponds were converted to tidal marsh, that 15% of the 76,000 waterfowl that use those salt ponds could be lost. Despite the documented importance of San Francisco Bay salt ponds to populations of Pacific Flyway waterbirds, few guidelines exist for state and federal wildlife agencies on how to actively manage a significantly smaller amount of salt pond habitat in the South Bay than currently exists to achieve the maximum abundance and diversity of birds using the habitat while keeping maintenance costs and efforts to a minimum. Answers to these questions rely in part on understanding bird use patterns in and around the salt ponds.

This description gives background to one (Applied Study Question #4) of the six key applied studies identified for the key uncertainty, Bird Use of Changing Habitat - "Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions?"

Study Design Concepts

Applied studies to this key uncertainty will primarily be addressed in the other five applied studies questions (ASQ #5-9):

5) Will shallowly flooded ponds or ponds constructed with island or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds compared to existing ponds not managed in this manner?
6) Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner?
7) Will ponds that are reconfigured to create large isolated islands for nesting and foraging significantly increase reproductive success for terns and other nesting birds and also increase the numbers and densities of foraging birds over the long term compared to existing ponds not managed in this manner?
8) Will inter-marsh pond and panne habitats in restoring tidal marshes provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term?

9) How do California clapper rails 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?

Answering AS Questions 5-9 will go a long way in addressing AS Question #4, whether the restoration will be able to maintain and improve the carrying capacity of birds in the South Bay. However, key to answering AS Question #4 will be to having an adequate bird monitoring program in place for the restoration project.

Monitoring bird populations in the South Bay

- Study Population: all bird species using the restoration area
- Study Sites: This monitoring will need to encompass several spatial scales including a) the restoration area, b) the South Bay, and c) San Francisco Bay.
- Parameters Measured: Numbers, species diversity, reproductive success, survival; predicted densities (these densities will be generated from modeling exercises on what numbers and diversity of birds are predicted in different restored habitats)
- Study Design: various monitoring designs depending on parameter being measured; Modeling of predicted bird densities in restored habitats to follow methods established by Stralberg et al. (2003).
- Time Frame for Study: monitoring of restoration area should be conducted monthly for the foreseeable future; efforts should be expanded to South Bay and whole Bay scales at some annual interval (every 1-3 years).
- Estimated Study Cost: Monitoring efforts to be split by various organizations and agencies but critical to compile to a central data base including centralized, periodic synthesis of data. Costs - $100,000-250,000/year

Management Options

The results of this monitoring will provide specific data to land managers and other interested parties on trends and predicted densities of focal bird species in the restored area. These data will be compared with trends of bird populations in the South Bay and the entire Bay. These data will serve as triggers for applied management actions. If targets are not met, specific information gathered from AS questions 5-9, can be used to increase carrying capacity of specific habitats to help species of concern.

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Applied studies Question 5: Will shallowly flooded ponds or ponds constructed with island or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds compared to existing ponds not managed in this manner?

Cheryl Strong, San Francisco Bay Bird Observatory, Science Team Member
Caitlin Robinson, San Jose State University, MS Graduate Student
Lynne Trulio, South Bay Salt Pond Restoration Project, Lead Scientist/Science Team Member

Background/Rationale

Project Objective 1 states that the South Bay Salt Pond Restoration Project will maintain current migratory bird species that utilize existing salt ponds and associated structures such as levees. One of the main concerns of the restoration plan is how to maintain the current numbers of migratory and wintering waterbirds that utilize the salt ponds for foraging and roosting within a smaller number of managed ponds. If ponds can be managed specifically for wildlife habitat such as bird use, then less acreage of managed ponds may need to be maintained. This would: 1) allow for more tidal marsh acreage to be restored, 2) minimize the amount of human intervention and maximize the amount of natural processes within the system, and 3) reduce the cost of long-term management in the project area.

San Francisco Bay salt ponds support hundreds of thousands of shorebirds during the winter and migratory months, the largest numbers of which are found on South Bay mudflats and shallow salt ponds (Goals Project 2000). Yet dry salt ponds have also become important nesting habitat for the federally threatened Western Snowy Plover. Plovers require a unique set of habitat characteristics: they lay their eggs on dry or drying salt ponds, and feed on the high concentrations of brine flies that swarm along the edge of these ponds in highly saline water (Goals Project 2000). If a set of ponds could be managed for shorebirds September to March, then for nesting plovers April to August, we could reduce the footprint of ponds necessary to maintain numbers.

To collect reliable information on this question, we recommend testing the following three null hypotheses. These hypotheses for Western Snowy Plovers and migratory shorebirds can be tested together in one carefully designed experiment:

Ho_1: Ponds managed for Western Snowy Plover by lowering water levels in the spring and summer will not increase the plover nesting density and hatching success.

Ho_2: There is no relationship between ponds constructed with islands or furrows and Western Snowy Plover nest site selection.

Ho_3: The same ponds above (Ho_1) will not support the pre-ISP diversity and abundance of shorebirds when flooded during the winter/migrating period.

- Time Frame for Study: At least three years of data are required to detect significant results for all of the hypotheses above. SFBBO will monitor plover nest success (Ho_1) least through 2007. Plover nest site selection (Ho_1) study currently underway in 2006 (C. Robinson under direction of L. Trulio and with SFFBO); data collection expected through summer 2007. Shorebird surveys (Ho_3) are currently conducted bi-monthly by USGS through 2006.
- Ballpark cost estimate: $25,000-50,000/year (not including USGS surveys or maintenance of furrows and islands).
- Study Sites: Ho_1 and Ho_3: Managed ponds: E6A, E6B, E8 E8A and E8X;
- Control ponds: E1C, E4C, E5C, E11, E12 and E14. No ponds have been selected for Ho_2 as of yet, but could include E16B, E15B.

Study Design

Objective 1: Locate snowy plover nests and determine productivity in managed and control ponds. March-August, all snowy plover activity on the pond will be identified to determine foraging and nesting use of the ponds. Surveys will take place approximately once/week and all foraging and nesting birds marked on maps. Nesting birds will be followed as per SFBBO/FWS protocols: nests identified and return visits at approximate 1-2 times/week to determine nest fate.

Objective 2: Locate snowy plover nests and determine productivity in ponds with and without created islands or furrows. March-August, all snowy plover activity on the pond will be identified to determine foraging and nesting use of the ponds. Surveys will take place approximately once/week and all foraging and nesting birds marked on maps. Nesting birds will be followed as per SFBBO/FWS protocols: nests identified and return visits at approximate 1-2 times/week to determine nest fate. All nests will be located with GPS and distance to (or location one) furrow or island will be determined.

Objective 3: Identify shorebird diversity and abundance, and percentage of birds feeding in pond. Using existing survey protocols, ponds will be divided into 250m x 250m grids for mapping in ArcView. All birds will be counted August-April, within 3 hours of high tide, identified to species, determined to be foraging or roosting, and recorded in a grid square. Data will be entered into spreadsheets and added into the grid coverage by abundance. Low water levels must be maintained (5-15 cm) in order to create foraging habitat for small to medium shorebirds. The same ponds will be used as stated in Objective 1. These ponds have been monitored for shorebird use by USGS; these data can be used as "pre-management" data to compare.

Management Responses:
If fewer ponds can support large numbers of wintering/migrating shorebirds as well as successfully nesting plovers, then the PMT can consider movement up the Adaptive Management staircase. Local land managers will need to balance water quality issues with the drying of ponds for the summer months. Pond intakes may need to be closed to prevent flooding of plover nests and/or broods. If this is the case, then these ponds may not be able to reopen to discharge into the bay waters without significant fresh or bay water input after the nesting season has ended. We assume that mammalian predator management will continue in order to help maintain nesting success for plovers. If ponds cannot be managed to successfully maintain habitat for both wintering/migrating shorebirds and nesting plovers, then the Project Management Team will need to reassess the area of dry/seasonal wetlands created within the South Bay landscape before movement up the staircase can be considered.

Citations
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Applied Studies Question #8: Will inter-marsh pond and panne habitats in restoring tidal marshes provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term?
John Takekawa, South Bay Salt Pond Restoration Project, Science Team Member

Background/Rationale
To meet the South Bay Salt Pond Restoration Project goal of "no net loss" of waterbirds, adequate habitat must be available within and outside the project site to meet their needs. As ponds become vegetated and change to marsh, birds that currently use ponds heavily could face a population-limiting decline in suitable habitat. Ponded areas and panne habitats within transitional or mature marshes could provide interim or even long-term habitat for some salt pond species. However, not all species may use inter-marsh and panne habitats equally. Furthermore, because such habitat is likely to be less abundant than existing salt pond habitat, waterbird densities comparable to those on salt ponds would be necessary to have a significant impact on local populations. To determine whether these habitats could supplement pond habitat, we need to know the potential total area of these habitats as well as:

1. What species or foraging guilds most use inter-marsh pond and panne habitat and how does the species composition of these habitats compare to that of salt ponds?
2. What are the mean seasonal densities of birds using inter-marsh pond and panne habitat?

We recommend specific hypotheses or research questions be designed to address these two questions.

Study Design Concept
Both these questions could be addressed with surveys of developing and developed marsh habitats. Bird surveys should use data collection methods similar to those used on salt ponds so that the data are comparable.

- Study Sites: Developed and developing marshes around San Francisco and San Pablo Bays, including Tolay Creek and Napa-Sonoma Marshes pond 2A.
- Parameters Measured: Complete area counts of birds, identified to species and placed within 250-m survey grids. Behavior and microhabitat data recorded.
- Study Design: Complete counts divided by high and low tide at each site.
- Time Frame for Study: At least one year of monthly counts are needed to assess seasonal variation in site use by migratory birds.
- Estimated Study Cost: Dependent upon the number of sites and frequency of monitoring. Two biological science technicians working half to full-time could survey several sites monthly. Ballpark cost estimate: $40,000-$80,000

Management Options
The results of this study will provide important information to land managers on habitat value of inter-marsh ponded areas and panne habitats to waterbirds that currently use salt ponds. This information can be used to assess habitat needs of waterbirds and determine which ponds should be managed as open water areas and at what depth and salinity.

Applied Studies Question 10: *Will increased tidal habitats improve survival, growth and reproduction of native species, especially fish and harbor seals?* The extent to which restoring the dominant tidal marsh habitat will affect native fish, including the steelhead, and harbor seals, who feed on them, is unknown.
Gillian O'Doherty, NOAA Restoration Center, South Bay Salt Pond Restoration Project, Science Team Member

Introduction
One of the Project Objectives (PO) of the South Bay Salt Pond Restoration Project (Project) is to restore and manage habitats for the benefit of species and ecosystem functioning. As part of the Adaptive Management approach the Science Team has identified Key Uncertainties associated with the Project and has formulated Applied Studies Questions to guide research and management. The Science Team identified a single Key Uncertainty/ Applied Studies question for all of the effects of the on non-avian species, specifically identified as estuarine fish, anadromous fish and marine mammals. Restoring tidal access and saltmarsh is predicted to be of net benefit to these species, however human activities, including changes to physical habitat, hydrology, and increased public access, can also have negative effects on species and habitats. The potential impacts of some of the proposed restoration activities on the fish and marine mammals are unknown and must be studied to reduce the uncertainties involved with achieving the PO. The results of these studies will be used to guide actions as the Project progresses.

The following description for the "Effects on Non-Avian Species" Key Uncertainty gives some background as well as general study design concepts and potential management responses to the information generated by the studies.

Although the Applied Studies Question asks about effects on fish survival, growth and reproduction we recommend focusing on diversity and abundance, distribution, growth rates and some limited aspects of reproduction. Effects on survival will be logistically impossible to measure. The Applied Studies Question also refers exclusively to tidal marsh while fish can be expected to benefit from all increased access to tidal areas, marsh channels, bays or shallow open water habitats. Finally the Applied Studies Question refers to estuarine fish, anadromous fish and marine mammals as one but for clarity the effects on estuarine fish, salmonids and marine mammals will be addressed separately.

Estuarine fish

Background/Rationale

Project Objective #1 states that the South Bay Salt Pond Restoration Project will restore and manage habitats for the benefit of species and ecosystem functioning. A primary step in achieving this objective is to identify the effects of the proposed changes to physical habitat of the species that use the area currently and will likely use the restored area. Fish populations in the South Bay are currently not well understood and the impacts of some restoration and management activities are unknown.

The major information gaps relative to the Project are:

1. What native estuarine fish species can be expected to use the project area before, during and after restoration?

2. Will an increase in available tidal habitat increase the abundance of native fish?
3. Will water control structures significantly impact the ability of fish to benefit from managed ponds and muted tidal areas?
4. Is restored habitat of similar value to fish assemblages in terms of growth, feeding and reproduction as reference habitats?
5. Will there be significant negative impacts from Project activities or increased public access?

Study Design Concepts

Some specific ideas on study designs for each question are as follows.

<u>What is the abundance and diversity of native estuarine fish in the project area before, during and after the restoration? Will there be significant negative impacts from Project activities?</u>

- ❑ <u>Study Population:</u> Fish populations using the Bay south of the Dumbarton Bridge for all or part of the year, particularly fish that use the marshes and shallow water areas adjacent to the Project.
- ❑ <u>Study Sites</u>: Previously restored and undisturbed native marshes; salt ponds; sloughs in the South Bay including Eden Landing 49 acre mitigation marsh, Cogswell Marsh, Faber Tract and Bair Island. Former salt ponds that have been restored to full tidal action and former salt ponds that are accessible only via water control structures.
- ❑ <u>Parameters Measured</u>: Seasonal abundance and diversity; length and/or size in order to determine life-stage.
- ❑ <u>Study Design</u>: Sampling during the spring, summer and fall in shallow open water, un-vegetated tidal areas and salt marsh channels. Standardized sampling methods need to be

developed from current work for all future work. Ideally, sampling would occur monthly from spring through fall, at least four sampling dates are suggested with emphasis on spring and summer to capture juvenile use of shallow water habitats. In previous studies sampling has occurred in March, June, July and September.
In addition a large amount of data form the Marine Science Institute exists and could be digitized and analyzed to provide a more complete picture of fish assemblages and trends in the South Bay.

- Time Frame for Study: The initial work to establish a baseline is ongoing. Monitoring should continue throughout the Project life.
- Estimated Study Cost: Ballpark cost estimate: $30- 75K/ year for data collection and basic analysis. Cost of digitizing MSI records $10-30K.
- Comments: NOAA Fish Model Study in previously restored marshes is underway as is USGS study of salt ponds and adjacent sloughs. Future studies should build on this work and concentrate on developing standardized sampling methods; identifying areas of special concern, particularly nursery habitats; identifying limiting factors to fish populations and identifying fish assemblages that use discrete habitat types.

Are the growth rates of fish within the project area within normal limits and do they change over time?

- Study Population: Surfperch and native flatfish; other indicator species as identified by USGS and NOAA studies.
- Study Sites: Former salt ponds that have been restored to full tidal action and former salt ponds that are accessible only via water control structures.
- Parameters Measured: length to weight ratio, age.
- Study Design: Collect length and weight data from fish captured in the abundance and diversity studies. Collect otoliths and/or scales from a subset of fish. Data would be compared to literature or previous studies to determine if growth rates were within normal limits. Trends would be monitored
- Time Frame for Study: Starting immediately and continue through the life of the Project.
- Estimated Study Cost: $40K/ year. This study could be carried out by a graduate student with appropriate input.

Is the fecundity of fish within the project area within normal limits and does it change over time?

- Study Population: Surfperch and native flatfish; other indicator species as identified by USGS and NOAA studies.
- Study Sites: Former salt ponds that have been restored to full tidal action and former salt ponds that are accessible only via water control structures..
- Parameters Measured: Fecundity.
- Study Design: Collect target species during spawning periods to determine fecundity. Data would be compared to literature or other studies to determine if fecundity is within normal limits.
- Time Frame for Study: Once yearly sampling for each species indefinitely.
- Estimated Study Cost: $20K/ year. This study could be carried out by a graduate student with appropriate input.

Are the restored areas functioning similarly to natural areas in terms of prey availability?

- Study Population: Surfperch and native flatfish; other indicator species as identified by USGS and NOAA studies.
- Study Sites: 1) Former salt ponds that have been restored to full tidal action within the project area 2) former salt ponds that have been restored to muted tidal action or otherwise utilize water control structures and 3) natural salt marsh areas in SF Bay (or data from literature)
- Parameters Measured: prey composition and prey availability.
- Study Design: Sample invertebrate populations and collect and gut contents from fish captured within the Project area and compare to data from historical salt marsh or long term restoration projects or data from the literature.
- Time Frame for Study: Study would be carried out periodically in newly restored areas and as salt marsh becomes fully vegetated.
- Estimated Study Cost: $25K. This study could be carried out by a graduate student with appropriate input.

What is the effect of increased public access on recreational fishery species?

- Study Population: fish targeted by recreational anglers in the Project Area.
- Study Sites: Fishing areas that are currently legally accessible and new fishing areas that are made accessible during the Project.
- Parameters Measured: Composition and size of catch.
- Study Design: Identify angling spots and conduct creel surveys to determine fishing pressure.
- Time Frame for Study: Creel surveys could be conducted every 2-3 years to track general trends in angler usage and catch.
- Estimated Study Cost: $15K for several study dates.

Management Options

The results of the first study will provide information that can be used to gauge the success of the Project in enhancing native fish species and ecosystem functioning and protecting existing populations. It will provide data on fish use of restored and managed areas and can be used to improve management of these areas to maximize benefits and reduce impacts to fish.

The second, third and fourth studies will provide more data on how various species use the marsh and what kind of benefits the newly restored habitat is providing to native fish species. The final study will provide data on the impact of an increased recreational fishery and may lead to management changes in terms of access.

Salmonids:

Background/Rationale

Steelhead and fall run Chinook salmon are present in the Project area. Threatened steelhead in the Project Area belong to the Central California Coast Distinct Population Segment. An increase in saltmarsh habitat is expected to benefit steelhead and Chinook populations in the area by providing improved estuarine rearing habitat for juveniles and improved migratory conditions for juveniles and adults. However, some management or restoration activities have the potential to negatively affect steelhead populations including water discharges from managed ponds,

increased fishing pressure, or incidental take associated with restoration activities and monitoring. The major information gaps relative to the Project are:
1. To what extent will salmonids use the newly restored tidal marsh?

Study Design Concepts.

To what extent will salmonids use the newly restored tidal marsh?

- Study Population: The steelhead and Chinook salmon that spawn and rear in streams flowing into south San Francisco Bay, which might use the marshes and shallow water areas adjacent to the Project as they migrate to and from the Pacific Ocean.
- Study Sites: Coyote, Guadalupe, and Alameda creeks.
- Parameters Measured: Spatial and temporal distribution of salmonids through the Project area.
- Study Design: Apply acoustic tags to salmonid smolts migrating from tributaries flowing into south San Francisco Bay. The tags should be compatible with those currently being used to tag salmonids in a large multi-agency study to determine the spatial and temporal distribution of juvenile salmonids migrating from the Sacramento River. The dredging community is part of that study and has not only indicated interest in tagging salmonid smolt from south San Francisco Bay, but also has already purchased a large number of monitors which could be used as part of this proposal. By using similar equipment, the movement of the tagged smolts through the Project area and out of the bay could be monitored.
- Time Frame for Study: The larger salmonid study that is currently underway in the San Francisco Bay region is planned for the spring of 2007-2009. Therefore, if it is essential to tap into their expertise as well as potential access to their equipment, it would not be until the late winter/early spring of 2010. However, if adequate funds could be obtained, then it is possible that a consultant or student (UC Davis is part of the study) could conduct the proposed study, realistically beginning in the spring of 2008. Continued studies would be based on adequate funding.
- Estimated Study Cost: Each monitor cost ~$1,100 and has a range (radius) of 200 meters. Each tag costs ~$300. Some acoustic tags can be tracked with a mobile tracking unit (boat mounted). Otherwise the monitors are stationary and must be downloaded periodically. The tags that can be placed inside juvenile salmonids have a battery life of ~30-60 days, depending on the ping rate.
- Comments: Tagging of ESA-listed species will have to be in compliance with Federal and State permits (NMFS and CDFG).

Management Options
This study would be part of a larger, San Francisco Bay wide look at smolt movement and survival. It would allow smolts to be tracked as they moved through the Project area and migrated out of the Bay. It would provide improved data on migration timing and residence time in the Project Area and would improve the ability of managers to plan activities so that they do not negatively impact salmonids.

Marine Mammals:

Background/Rationale

Harbor seals are present throughout the South Bay, which they use to haul out, for reproduction and for feeding. An increase in tidal habitat is expected to benefit harbor seals by increasing the fish populations on which they feed. There is also the potential for restoration activities such as increased public access and changes in tidal prism to negatively impact populations. The major information gaps relative to the Project are:

1. Do restoration activities negatively affect harbor seals from growth, reproduction or survival, in particular use of historical haulouts and pupping areas?

At this point in the Project, we recommend specific hypotheses or research questions be designed to address these two questions.

Study Design Concepts

This work should be coordinated with research conducted on potential public access impacts on harbor seals, which is Applied Studies Question #16. Some specific ideas on study designs for each question are as follows.

Do restoration activities displace harbor seals from feeding, resting or pupping areas?

- ❑ Study Population: Harbor seals in the restoration area or that use adjacent areas to rest, feed or reproduce.
- ❑ Study Sites: Mowry Slough and adjacent pupping and haulout areas
- ❑ Parameters Measured: Numbers of seals using the haulouts for resting. Annual pup production.
- ❑ Study Design: Surveys in the spring and during pupping and rearing seasons.
- ❑ Time Frame for Study: Counts should begin immediately to establish a baseline for population and should continue annually for 10-15 years to monitor potential long-term effects of mercury contamination.
- ❑ Estimated Study Cost: $15K/ year.

Management Options

The results of the study will determine if the Project may be negatively impacting harbor seal numbers through disturbance or changes to the larger ecosystem. Further studies have been proposed as management actions if this is determined to be the case.

Applied Question # 11: Will the scour of Alviso Slough resulting from tidal marsh restoration of associated salt ponds increase the bioavailability of methymercury?
Josh Collins, SFEI Wetland Scientist and Science Team Member

Background and Rationale
The cross-section area of a tidal marsh channel at any point along its length is a function of the volume of water (i.e., the tidal prism) that usually passes that point in the channel during ebb tide (Dyer 1995). If the tidal prism decreases, the channel will get smaller. If the tidal prism increases, the channel will get larger (Dedrick 1979). A change in cross-section area can result from a change in channel width, depth, or both (Collins et al 1987; Coates et al.1989; Leopold et al. 1993).

The reclamation of tidal marshland (i.e., the construction of levees and other structures to isolate the marshland from the tides) represents a loss of tidal prism for the channels that drained the marshlands before they were reclaimed. One result of large-scale reclamation of tidal marshland is therefore a major decrease in the size of the remaining tidal channels. For example, the reclamation of tidal marshland along Alviso Slough in South Bay to create salt ponds caused the slough to narrow and shoal (Dedrick 1993). Conversely, the proposed restoration of these lands as tidal marsh will increase the tidal prism of Alviso Slough, causing it to scour and enlarge. The amount of scour can be predicted from empirically-derived correlations between tidal channel size and tidal prism (Orr and Williams 2002), and from models that relate increases in tidal prism to increases in shear stress against the channel bed, which causes scour.

Sometime during the first quarter of the 20th century, the Guadalupe River was diverted into Alviso Slough (Collins and Grossinger 2005). The Guadalupe watershed contains abundant mercury ore (cinnabar of HgS) that was mined intensively within the watershed as the tidal marshes were being reclaimed. It is likely that the sediments that have accumulated in Alviso Slough during and since the period of mining and reclamation bear large amounts of mercury (Beutel and Abu-Saba 2004).

Mercury (Hg) is dangerously toxic to wildlife and people. The organic form of mercury (methylmercury or MeHg) is an especially powerful neurotoxin that readily accumulates in food chains. Minamata disease, or methyl mercury poisoning, is characterized by peripheral sensory loss, tremors, and loss of memory, hearing, and vision (NRC 2000). Methymercury can be created from elemental mercury under low levels of oxygen (anoxia) in the presence of organic carbon and sulfate-reducing bacteria (NRC 2000, Wiener et al. 2003). These conditions exist in the sediments of tidal marshes and other estuarine environments.

The scour of Alviso Slough can increase habitat for aquatic resources, decrease the need for dredging (Goals Project 1999), and help sustain the adjoining tidal marsh. But the circulation of mercury-bearing sediments in Alviso Slough due to its scour might increase the risk of mercury accumulation in associated food webs. A study of the distribution of mercury within the predicted scour zone of Alviso Slough is therefore warranted.

Study Design Concepts

- □ <u>Study Population:</u> The sediments of the tidal reach of Alviso Slough that are likely to be scoured due to the restoration of adjoining tidal marshland, based on scour predictions provided by the Project Consultant Team.
- □ Study Site: Alviso Slough between the Alviso Yacht Club and San Francisco Bay.
- □ <u>Parameters Measured:</u> depth below sediment surface, total mercury, methylmercury, reactive mercury, total carbon, sulfur, Ph, conductivity, magnetic susceptibility, soil density, grain size.
- □ <u>Study Design:</u> The measured parameters will be profiled over depth in each of 15 5-cm diameter sediment cores 2-m long taken with a piston-corer; one core is taken at each of three stations for each of five cross-channel transects evenly spaced along the Study Site; the stations at each transect represent the left bank, mid-channel, and right bank of the scour zone. All cores will be photographed and x-rayed. Half of each core will be archived for further study if needed.
- □ <u>Time Frame for Study:</u> One-time study conducted in fall-winter 2005-06.
- □ <u>Estimated Study Costs:</u> $60,000-$70,000

Management Options

This study will determine whether or not the scour of Alvisio Slough due to the restoration of adjoining tidal marshland is likely to increase the bioavailability of mercury. If large loads of mercury are discovered within the zone of predicted scour, then the managers of the slough and adjacent lands will have alternative responses, including:

(a) conduct additional studies to further elucidate the extent of the potential problem (this might involve taking more cores to better describe the distribution and quantities of legacy mercury, and/or linking the core studies to sediment transport studies to assess the fate of any mobilized mercury);

(b) Adjust the amount of tidal marsh restoration to prevent the amount of scour that might mobilize the legacy mercury (the mercury may be concentrated at great enough depths that some marsh restoration and concomitant scour is allowable);

(c) remove the mercury-bearing sediment that is likely to scour and place it away from the biosphere (it may be possible to use the sediment with a safety cap to help fill deeply subsided salt ponds slated for tidal marsh restoration);

(d) proceed with tidal marsh restoration and monitor for increased bioaccumulation in sentinel species (provides no preventive measures, however);

(e) not restore tidal marsh along Alviso Slough (precludes major land use objective).

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Applied Question # 12: Will tidal marsh restoration increase MeHg levels in indicative wildlife of managed ponds and tidal marsh?
Josh Collins, SFEI Wetland Scientist and Science Team Member

Background and Rationale

Mercury (Hg) is dangerously toxic to wildlife and people. The organic form of mercury (methylmercury or MeHg) is a neurotoxin that readily accumulates in food chains. Minamata disease, or methylmercury poisoning, is characterized by peripheral sensory loss, tremors, and loss of memory, hearing, and vision (NRC 2000). Methymercury can be created from elemental mercury under low levels of oxygen (anoxia) in the presence of organic carbon and sulfate-reducing bacteria (NRC 2000, Wiener et al.2003). These conditions exist in the sediments of tidal marshes and other estuarine environments (Marvin-DiPasquale et al. 2000, Marvin-DiPasquale and Agee. 2003).

The potential exists to inadvertently increase the risk of mercury (Hg) accumulating in South Bay fish and wildlife through hydrological modification of salt ponds as part of the South Bay Salt Pond Restoration Project (Project). Concentrations of Hg in sediment and water tend to be greater in South Bay due to past local mercury mining (Beutel and Abu-Saba 2004). The Alviso Pond and Slough Complex are especially worrisome because they contain more Hg than most other areas of South Bay (Conway et al. 2004, SFEI 2005) and because they are slated for early hydrologic modification by the Project.

Bayland managers need to know how their actions affect the risk of mercury bioavailability and toxicity. The risk can be assessed most directly by monitoring Hg in 'biosentinel' wildlife species that represent habitat conditions that typically result from the planned management actions. Coupling such a monitoring effort to studies of MeHg production and biological uptake is essential to understand how management actions can be adjusted to reduce the risk of Hg toxicity.

Study Design Concepts

- Study Population: Selected "biosentinel" species of invertebrates, fish, and birds that indicate local bioaccumulation of mercury. The candidate species must have a small home range, be easily collected, and be residential within a habitat type or feature that is targeted for restoration or enhancement by the Project.
- Study Site: The geographic scope of the study changes over three phases. Phase 1 is restricted to the major habitat types of Pond A8 and Alviso Slough plus ambient sites of these same habitat types. Phase 2 expands to encompass a survey of these habitat types in the South Bay. Phase 3 focuses on South bay locales of special interest identified during Phase 2.
- Parameters Measured: Phase 1 involves sampling mercury in selected sentinel species and characterizing the mercury in their habitats. The parameters for wetland habitats include total mercury, methylmercury, reactive mercury, total carbon, sulfur, Ph, conductivity, soil density, and grain size. The parameters for aquatic habitats include unfiltered total mercury, methylmercury, TSS, dissolved carbon, temperature, Ph, sulfur, and conductivity. Maps will be made of all habitat types surveyed.
- Study Design: The regional strategy for solving the mercury problem calls for an integrated program of monitoring plus focused research driven by questions and hypotheses that explicitly reflect the information needs of resource managers (Wiener et al. 2002). The proposed work would start by helping the Project Management Team define the mercury problem in practical terms, The work would then proceed to develop cost-effective indicators of the problem, survey its magnitude and extent (beginning with Pond A8 and its adjacent tidal habitats), test for correlations between the problem and manageable environmental factors, initiate research to understand the primary environmental factors most strongly influencing the observed correlations, and help translate these findings into recommended actions to either prevent or correct the problem.

  The work would be conducted in three phases over three years. The approach is scalable, however, and could be used to monitor any management action at any spatial scale from one local habitat patch to the South Baylands as a whole.

The conditions of existing pond and tidal habitat types will be surveyed as analogues for what could be maintained or restored in the pond complexes based on different management scenarios. For example, the tidal habitats to be surveyed in Phase 1 represent the habitats predicted for PondA8 restoration. The existing pond habitats to be surveyed represent the expected future conditions of Pond A8 if it is not restored to tidal marsh. The comparisons are based on sentinel species that are common to tidal and non-tidal habitats. For example, the same sentinel fish species will be sampled in Alviso Slough and Pond A8.

Phase 1 would:

- Develop sentinel species indicators of Hg exposure for Alviso Slough water column, pond water column, slough bottom, pond bottom, tidal marsh panne/pond margin, tidal marsh channels, tidal marsh vegetated plain;
- Assess the mercury problem for the habitat types listed above based on Hg concentrations in the associated sentinel species;
- Characterize the habitats in terms of their propensity to produce MeHg.

Phase 2 would:

- Expand the sentinel species survey to encompass more of the South Baylands. This phase provides a picture of the spatial variability in mercury problem within and between bayland habitats in South Bay.

Phase 3 would:

- Initiate focused research to better understand the linkages between Hg contamination in sentinel species and bio-goechemical indicators for specific habitat types in selected areas, based upon the results of Phase 2;
- Help translate the scientific understanding of the Hg problem into habitat designs and management options that minimize the problem.

□ <u>Time Frame for Study:</u> fall 2005 through winter 2008.

□ <u>Estimated Study Costs:</u> $750,000

Management Questions

Phase 1 of this study will initially determine the relative risks of mercury toxicity represented by different habitat types resulting from different management options for Pond A8. For example, if the ratio between the ambient slough benthic risk and the Alviso Slough benthic risk (based on the benthic sentinel species) is less than the ratio between the ambient slough benthic risk and the Pond A8 benthic risk, then the managers could assume that sampling breaching the pond would not result in a net increase in benthic risk. The same analyses will proceed for the other habitat types. If the restoration of Pond A8 is indicated to increase the net risk of mercury toxicity, then the managers might consider other options than simply breaching the pond, including:

(a) not breaching the pond;

(b) capping the sediments in the pond or removing them before restoring the pond to tidal action (this pertains to the condition that existing benthic conditions in the pond represent relatively high risk due to legacy mercury loads in the pond);

(c) breaching the pond but excluding any tidal habitats, such as marsh panes, small channels, or densely vegetated marsh plains, if their ambient conditions tend to represent relatively high risk;

(d) dredge Alviso Slough (this pertains to the condition that a relatively high risk of mercury toxicity in Alviso Slough is due to its legacy mercury load, and that the scour of these sediments and their possible transport into Pond A8 after it is breached represents a net increase in risk for restored tidal habitats in Pond A8).

Phase 2 of this study will profile the relative risk of mercury toxicity among the habitat types resulting from different planned management actions throughout the South Bay. This profile will provide the managers with a number of options, including:

(a) Assessing the importance of the risk of mercury toxicity relative to other stressors, such as gull predation, flood hazards, biological invasions, and accelerated sea level rise;

(b) Prioritizing the restoration or maintenance of habitat types and habitat features based on their relative contributions to the local and regional risk of mercury toxicity;

(c) Targeting research to explain the conditions of highest risk, and/or to establish threshold of mercury concentration among the sentinel species that correspond to significant biological harm

This option would be translated into Phase 3 of the study, which is designed to address the primary information needs of the managers based on the Phase 2 profile of South Bay conditions.

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Applied Studies Question 15: Will California gulls, ravens, crows, and native raptors adversely affect (through predation and/or encroaching on nesting areas) nesting birds in managed ponds?

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Background/Rationale

Project Objective 1 states that the South Bay Salt Pond Restoration Project will maintain current migratory bird species that utilize existing salt ponds and levees as well as support increased abundance and diversity of native species. Without adequate control and prevention measures, nuisance species such as the California Gull could hamper these objectives through displacement or predation of desired species. California Gulls are opportunistic feeders; their numbers have exponentially increased in the Bay area since first nesting in the early 1980's; over 30,000 now nest in the South Bay (Strong *et al*. 2004, and SFBBO unpub. data). Other species such as Common Ravens and American Crows have also increased in the Bay area in the last few decades largely due to their ability to exploit human-dominated landscapes in general and their ability to successfully nest in power towers and other structures above or adjacent to salt ponds (Josselyn *et al*. 2005, SFBBO unpub. data). Native raptors such as the Northern Harrier are expected to increase with tidal marsh restoration (MacWhirter and Bildstein 1996) and are known predators of the endangered Western Snowy Plover (Page *et al.* 1995). All of these species can be difficult to control in the environment and are likely to impact nesting birds within the restoration project to some extent. Although some level of predation and displacement occurs in all ecosystems, the consolidation of nesting gulls, shorebirds and terns into fewer ponds may increase levels within the restoration landscape to unacceptable levels.

To collect reliable information on this question, we recommend testing the following null hypotheses. Because of differences between the species, there are three hypotheses listed, one for each species or group below.

Ho_1: California Gull colony changes during tidal marsh restoration will not displace or reduce nesting shorebirds and terns.

> Ho_{1A}: Displacement of the California Gull colony at the Knapp pond will not reduce the number and/or location of other nesting bird species in the South Bay.
>
> Ho_{1B}: The movement and diet of California Gulls during the nesting season does not change, and therefore has no effect on the number and/or location of other nesting bird species in the South Bay.

Ho_2: Increased tidal marsh restoration will not increase predation of shorebirds and terns by corvids or other tower nesting species.

Ho_3: Increased tidal marsh restoration will not increase predation of shorebirds and terns by Northern Harriers or other marsh nesting raptors.

Ho_1: California Gull colony changes during tidal marsh restoration will not displace or reduce nesting shorebirds and terns.

> **Ho_{1A}: Displacement of the California Gull colony at the Knapp pond will not reduce the number and/or location of other nesting bird species in the South Bay.**

Relocation Dynamics of the Knapp Pond California Gull Colony

Background:
The largest California Gull colony in the Bay, ~20,000 birds, is located on a dried salt pond known as the Knapp pond (Pond A6), located near Alviso. Restoration of tidal action to the Knapp pond is currently proposed in Phase I, and is likely to cause the displacement of all or part of this colony. Nesting space may be available on salt pond levees elsewhere within the South Bay (where some gull colonies already exist), but nesting space in the long term will be limited by future tidal restoration, and at least some of the Knapp California Gulls may relocate to islands or levees currently used for nesting by other species. Relocation of 20,000 California Gulls to nesting sites elsewhere in the South Bay areas could potentially have a serious effect on terns and shorebirds as a result of their exclusion from nesting locations and an increase in predation. Given the imminent breaching of the Knapp pond, it is important to identify: (1) where the Knapp pond gulls will relocate; (2) approximate numbers expected to relocate to various parts of the estuary; and (3) the proximity of these sites to those of important nesting areas of Forster's Terns, Caspian Terns, American Avocets, Black-necked Stilts, and Western Snowy Plovers.

Applied Study Design:
1. The first step would be to color band a large sample of the Knapp gulls (>500 birds) in one part of the colony in one year. Color banding will require boom netting before egg-laying has begun so that we will not cause relocation of many banded birds in the initial year of banding.

2. In the year following banding, all gulls with territories in the boom netted section of the Knapp colony will be excluded from their site using wire or repellant over that area of the colony, preventing landing and nesting. Wire/repellant will be installed before the gulls have begun to reoccupy nest sites.

3. During normal colony reoccupation (March-April), a team of biologists will survey for color banded Knapp gulls that have relocated to other suitable nesting habitat in the Bay.

4. Using data on the locations of nesting terns, recurvirostrids, and plovers collected by SFBBO, PRBO, and USGS, the proximity of the relocated Knapp gulls to important breeding areas of other species (and thus, the potential threat to these species) will be determined.

5. We expect an immediate response from gulls within the second year of the study if enough are displaced from the Knapp colony. The banding/displacement may be expanded in subsequent years to bolster predictions of the effects of gull displacement on other South Bay nesting birds.
Management Responses:
If the displacement of the Knapp colony does not reduce the number and/or location of other nesting bird species in the South Bay, then the PMT should consider movement up the Adaptive Management staircase. Monitoring should continue to determine that gulls do not begin to affect other nesting species.

If the displacement of the Knapp colony does reduce other nesting bird species in the South Bay, then the Project Management Team may need to think about reducing the number of gulls or consider not moving up the Adaptive Management staircase. Various methods have been used to reduce the size of gull colonies, including allowing vegetation to cover over nesting and roosting sites, limiting roosting near landfills, using monofilament to cover the nesting site, scaring tactics, oiling eggs, and lethal control. All of the tactics may need to be used over a period of time (even years) to reduce the number of gulls and/or limit their nesting success. Limiting the amount of garbage at dumpsters, in parking lots, and at landfills may also help. Some of these methods would require permits from the USFWS that may be difficult to obtain.

Estimated Budget: $100,000

Ho_1: California Gull colony changes during tidal marsh restoration will not displace or reduce nesting shorebirds and terns.

Ho_{1B}: The movement and diet of California Gulls during the nesting season does not change, and therefore has no effect on the number and/or location of other nesting bird species in the South Bay.

<u>California Gull foraging and breeding dynamics in the South Bay</u>

Background:
We will examine the breeding and foraging movements, distributions, and abundance of California Gulls throughout the South Bay salt ponds and associated landfills and determine the relative contribution of landfills to gull diet. These results will facilitate management decisions regarding colony placement, active gull management, and restoration of specific salt ponds for the South Bay Salt Pond Restoration Project.

Applied Study Design:
The study area will be the salt ponds in the San Francisco Bay National Wildlife Refuge complex and surrounding landfills. Radio-tracking will occur primarily in pond A6 (Knapp). Gull surveys will occur throughout the salt pond complex, including primary nesting sites in ponds A6, A9, 3A, M2, B2, and A1 and landfill foraging sites at Newby Island, Palo Alto, and Tri-Cities.

Objective 1. Monitor the current nesting and foraging distributions and abundance of California Gulls throughout the South Bay salt ponds and associated landfills.

We will conduct monthly gull surveys from March 1 to September 1 at each gull colony and landfill following existing protocols (Takekawa *et al.* 2001a,b; Strong *et al*. 2004). We will identify gulls to species, enumerate, and record gull activity as breeding, roosting, or foraging. Nesting gull surveys will be conducted once yearly during peak nesting (Strong *et al.* 2004). Gull distribution and densities will then be mapped using ArcView GIS (ESRI 1996). <u>This study is in progress through SFBBO and USGS.</u>

Objective2. Examine the movements of California Gulls from nesting to foraging sites using telemetry to determine their relative use of landfills and other habitats as foraging sites.

We will use radio or satellite telemetry to track the movements of California Gulls from nesting sites to foraging areas. In early spring, we will capture gulls using rocket nets (Dill and Thornsberry 1950) or nest traps set at colony sites. We will mark 30 California Gulls with U.S. Fish and Wildlife Service leg bands and a transmitter either attached to the leg or to a backpack harness (Belant *et al.* 1993, Takekawa *et al.* 2002, Ackerman 2004). We will then track gulls daily (if radio-tagged) using trucks equipped with dual 4-element Yagi antenna systems (Gilmer *et al.* 1982) or download locations on a regular basis (if using satellite transmitters).

Objective 3. Examine California Gull diet using stable isotope analysis of eggs and chicks, assess how the diet changes throughout the breeding season, and determine the relative contribution of landfills to sustaining gull populations as well as gull predation on locally breeding waterbirds.

We will use stable nitrogen, carbon, and sulfur isotope analyses to assess the relative contribution of anthropogenic food items (i.e. landfills) to gull diets (Hebert *et al.* 1999). Up to 45 eggs and 200 feather samples from chicks will be collected from California Gull colonies. Up to 50 reference samples will be collected to represent available diet items. We will establish baseline isotopic signatures of prey from the most likely foraging habitats, including food items common to landfills (chicken, beef, pork), and the bay and saltponds (fish [e.g., topsmelt and gobies], invertebrates [e.g., brine shrimp, snails], and nesting bird eggs and chicks [e.g., American Avocets]). We will also assess how diet changes over the course of a breeding season (Belant *et al*. 1993, Duhem *et al.* 2005) by examining differences in nitrogen, carbon, and sulfur values between eggs and chicks. We expect that shorebird eggs and chicks may become a more important component of gull diets later in the season (Ackerman, USGS, unpublished data), thus the isotope values would reflect a greater degree of marine nutrient input. <u>This study is partially funded for 2007 through USGS.</u>

Management Responses:
If the movement and diet of California Gulls during the nesting season does not change, and has no effect on the number and/or location of other nesting bird species in the South Bay the PMT can consider movement up the Adaptive Management staircase. Monitoring should continue to determine that gulls do not begin to negatively impact other nesting species.

If the movement and diet of California Gulls does change during the nesting season in a way that negatively affects other nesting species, then the PMT may need to think about reducing the number of gulls in the South Bay. (See above.)

Estimated budget: $85,000-150,000

Ho_2: Increased tidal marsh restoration will not increase predation of shorebirds and terns by corvids or other tower nesting species.

Ho_3: Increased tidal marsh restoration will not increase predation of shorebirds and terns by Northern Harriers or other marsh-nesting raptors.

American Crows, Common Ravens, and Native Raptor Management

If numbers of gulls, corvids, and native raptors negatively impact other nesting birds to a significant degree then a bay-wide avian predator control program will need to be implemented and likely maintained in perpetuity. Mammal control is contracted with Wildlife Services in the South Bay overall, but avian control currently exists only in the CDFG property of Eden Landing Ecological Reserve.
Various landscape-level factors may also reduce the impact of these species on nesting plovers and other birds if enacted on a broad scale.

Landscape level control:

1. limiting open food and water access, including landfills and dumpsters
2. power tower modification within pond and marsh areas
3. business park/housing development modifications to limit trees near the edge of ponds and marsh
4. removing perches within the pond and marsh areas
5. restoration design to limit Northern Harrier nesting habitat (tidal marsh channels) adjacent to plover or other shorebird nesting habitat (Note that this might conflict with recommendations to have vegetated areas near shorebird and tern nesting sites to give chicks a place to hide from gulls.)

If in the likely event that avian predator management becomes necessary on a large scale, there are various management techniques that can be used in addition to or in place of lethal control. For corvids, these include behavior modification (repellents, sterilants, conditioned taste aversion), and habitat modification (tower modification or removal, perch site removal, modification of anthropogenic food and water sources). While short-term solutions such as lethal removal and behavior modification may be necessary in some circumstances to avoid local population declines of threatened or endangered species, more effective methods for controlling corvid populations in the long run, and that may also benefit entire ecosystem function, are habitat restoration and modification of anthropogenic food and water sources. Because a number of landfills in the South Bay are in close proximity to restoration locations, management actions that deter corvids from eating garbage including installation of overhead wiring, use of chemical repellents, scare tactics, and covering waste with at least 15 cm of soil or a synthetic cover, could help reduce corvid population levels (Josselyn *et al.* 2005).

Because Northern Harriers are included in the "support increased abundance and diversity of native species" restoration design should be attempted before lethal control is implemented.

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Applied Studies 16, 17, and 18: Descriptions for the Public Access Key Uncertainty
Lynne Trulio, South Bay Salt Pond Restoration Project, Lead Scientist/Science Team Member

Introduction
The Science Team identified three Applied Studies questions to address Public Access, a Key Uncertainty in achieving the Project Objectives for the South Bay Salt Pond Restoration Project. One primary Project Objective (PO# 3) is to provide adequate, high quality access for visitors to the restoration area. To achieve this, we must understand the local public's recreational interests and, currently, there is little information of local origin. To anticipate public access demand, it is important to track the public's interests and needs, as these will change over time.

The Project also has the primary objective to restore and manage habitats for the benefit of species and ecosystem functioning (PO #1). Research indicates that human disturbance, including public access, can have negative effects on species and habitats (see Trulio, 2005 for a review of this literature). Thus, the public access and ecological Project Objectives may, to some extent, be in conflict. The potential impacts of public access on many important South Bay species and habitats are unknown and must be studied to reduce the uncertainties involved with achieving both Project Objectives.

The following descriptions for the three Public Access Applied Studies questions give a background for each question as well as general study design concepts and potential management responses to the information generated by the studies.

Applied Studies Question #16: Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales?
Lynne Trulio, South Bay Salt Pond Restoration Project, Lead Scientist/Science Team Member

Background
Project Objective #3 states that the South Bay Salt Pond Restoration Project will provide public access opportunities compatible with wildlife and habitat goals. The Project plans boating oriented features such as kayak and small boat launches, which are expected to increase recreational boating traffic. In addition, the Water Trail, a designated water route for recreational boaters, is being developed and sites within the Project will be destination points along this route. Personal watercraft, such as jet skis and wave runners, with their shallow drafts, can access "wilderness areas" previously inaccessible to motorboats (National Park Service 1998). Boating generated by the Project has the potential to negatively affect waterbirds and harbor seals.

There is a very large body of literature on the effects of human disturbance on species. Researchers agree that breeding birds are very sensitive to human disturbance, whether the disturbance is from trail use, boats, or research (Carney and Sydeman 1999, Burger and Gochfeld 1993, Keller 1991, Burger 1981). Studies of watercraft effect found that disturbances from boats can result in nest abandonment and reproduction failure of breeding adult waterbirds (Burger 1998; Erwin, et al. 1995). In general, nesting birds exhibit abnormal behavioral, growth, or reproductive effects (Mikola et al. 1994; Rodgers and Smith 1997), while foraging birds move away from areas of high boating activity with varying degrees of habituation (Burger 1998; Kaiser and Fritzell 1984). Due to high-density nesting habits, colonial breeding birds are particularly susceptible to boating disturbances. Rodgers and Smith (1995, 1997) studied the impacts of outboard boating, canoeing, and walking on several species of colonial waterbirds in Florida. The distance at which the birds flushed depended on the species, disturbance source, habituation, and colony type.

As with breeding birds, researchers found watercraft type affects non-breeding birds in different ways. Rodgers and Schwikert (2002, 2003) showed that waterbirds flushed at significantly longer distances when approached by faster and noisier propeller-driven airboats compared to slower, quieter outboard motorboats. In addition, larger birds flushed sooner than smaller species, no matter what the boat type, probably due to their slower take-off times. In general, the faster and louder the approach, the sooner birds will flush and the larger the waterbird the sooner it will flush. A study at Aquatic Park in Berkeley, CA found ducks, flushed in response to a kayak in the 30-70 m range, depending on species and size of group (Avocet Research Associates 2005). Rodgers and Schwikert (2003) also found that there was high variation in flushing distances within species; habituation may be one reason for this variation.

In San Francisco Bay, recreational boating is a major source of behavioral changes, particularly haul-out patterns, in the Pacific harbor seal (Farallones Marine Sanctuary Association 2000). The effects of disturbance range from mild to severe, from a hauled-out seal raising its head at the sound of a disturbance to being struck and killed by boats. Harbor seals are vulnerable to "harassment by persons on shore and boaters and kayakers from [San Francisco] Bay" and "will flush from haul-out sites at 300 meters" (Lidicker and Ainley 2000). Kayakers can cause greater disturbance to resting seals than powerboat operators because of their tendency to travel close to the shoreline. Kayakers also create disturbances at a greater distance from the seals than do powerboat operators (Suryan and Harvey 1999). Subsequent disturbances, however, have a greater rate of recovery. Suryan and Harvey (1999) suggest two possible explanations: 1) seals become more tolerant of boating disturbances; or 2) seals that are most affected by the initial harassment have already moved on to another haul-out site. Females will remain in the water until the danger passes before returning to their pups. This is important where haul-out sites, and particularly pupping sites, are few in number (Suryan and Harvey 1999). Because harassment increases seals' energy expenditure by decreasing haul-out period, harassment has the greatest impact on nursing pups and molting adults, when haul-out is most critical (Suryan and Harvey 1999).

The literature indicates the need for two studies of boating effects on wildlife:

1. What is the effect of boating generated by the Project on waterbirds, especially non-nesting birds?
2. What is the effect of boating generated by the Project on harbor seals during pupping and non-pupping seasons? (This research should be coordinated with research on harbor seals connected with Applied Studies Question #10.)

Study Design Concepts

At this point in the Project, we recommend specific hypotheses or research questions be designed to address these two questions.
These two studies are very different from each other and will require different research methods.

<u>1. What is the effect of boating generated by the Project on waterbirds, especially non-nesting birds?</u>

Study Design Concepts

- ❑ <u>Study Population</u>: Study boaters both within and near the Project area. Study waterbirds, especially migratory species—both shorebirds and waterfowl--found in the Project area.
- ❑ <u>Study Sites</u>: Compare areas frequented by boaters to control sites, where boaters are absent or rare. Study both open bay and slough sites.
- ❑ <u>Parameters Measured</u>: Flight initiation distance in response to boaters; species richness and abundance in boater and non-boater areas; effects on nesting birds, such as nest success rates (if boaters are approaching nesting areas).
- ❑ <u>Study Design</u>: Choose at least 3 boater-use and 3 control sites within or near the Project area, south of the San Mateo Bridge, in each habitat type (open Bay, slough). Collect data 2 or more times per month for two full years. Some control data should be taken at area planned for facilities before the facilities are put in, to do a Before-After-Control-Impact (BACI) study. Analyze data by species, bird group size, season, etc. in response to boater group size and activity.
- ❑ <u>Time Frame for Study</u>: Baseline data collection should begin before boating facilities are constructed and before the Water Trail is officially designated. Some or all of this data may have been collected by USGS. Then, begin the two-year boater site-Control study approximately a year after boating features are installed.
- ❑ <u>Estimated Study Cost</u>: Study will require a team effort by experienced researchers. Tentative cost estimate: $100,000 for entire study.

2. <u>What is the effect of boating generated by the Project on harbor seals during pupping and non-pupping seasons?</u>

- ❑ <u>Study Population</u>: Study harbor seal population south of the San Mateo Bridge, which is typically divided into groups that haul at known locations, including Bair Island, Alviso Slough and Mowry Slough. Study boaters and seals using these areas.
- ❑ <u>Study Sites</u>: Harbor seal haul-out and pupping sites in the South Bay.
- ❑ <u>Parameters Measured</u>: Immediate behavioral responses to boaters; number of seals in boat-use versus Control areas; movement of seals around the South Bay in response to boaters; tidal cycle and seasonal responses to boaters.
- ❑ <u>Study Design</u>: Some parameters, such as immediate behavioral responses, can be achieved with an observational study of unmarked animals. Capturing, marking and using radio-telemetry will be needed for other studies, such as movements around the South Bay.

- Time Frame for Study: Study can begin now to provide basic locational and behavioral information; study for 2-3 years. Repeat this work after boating facilities are completed. Conduct marking/radio-telemetry after boating facilities completed; study for 1-2 years.
- Estimated Study Cost: Observational study of immediate behavioral responses has been initiated by Kathy Fox, Master of Science student, Department of Environmental Study, San Jose State University. Tentative cost estimate: $20,000. Radio-telemetry study tentative estimated cost: $100,000.

Management Options

The effect of public access on wildlife is one of the most contentious aspects of the Project. Providing high-quality public access and recreation is critical to the goals of the Project and also for general public support. But, managers must be sure access is designed and provided in such a way that species are protected. Research is needed to give managers relevant information to achieve both goals.

Both studies will give managers information on the extent of boating effects on sensitive species. Information on flush/response distances will allow managers to estimate the amount of habitat that is compromised by boating activities. Managers may seek to limit the area of impact and/or ensure that enough undisturbed habitat is provided. Information on seasonal sensitivities will allow managers to protect wildlife at sensitive times of the year, through education and seasonal area closures.

The waterbird study will give managers valuable information on different responses of species and guilds in roosting and foraging habitat, which can be used to protect specific areas and in educational materials. Harbor seal telemetry will fill a major data gap—How do seals move about and use the Bay and do they move in response to human disturbance? This critical information will give managers insight into the overall habitat needs of the harbor seal population, once again for protecting habitat, directing boating to minimize impact and educating the public.

Findings will be used to design public access so that it does not have significant impacts on the target species. Design may include keeping public at an appropriate distance from wildlife, permitting only certain recreational activities, excluding public access with significant impacts altogether, or allowing public access with significant impacts in certain proscribed areas while maintaining large refuges with no public access.

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Applied Studies Question #17: Will landside public access significantly affect birds or other target species on short or long timescales?
Lynne Trulio, South Bay Salt Pond Restoration Project, Lead Scientist/Science Team Member

Background

Project Objective #3 states that the South Bay Salt Pond Restoration Project will provide public access opportunities compatible with wildlife and habitat goals. The FWS and DFG are dedicated to providing high-quality recreational opportunities as part of the Restoration Project. However, the potential for conflict exists between the goals of restoring and managing habitat for wildlife (Objective 1) and providing public access (Objective 3) (Delong 2002). Researchers agree that breeding birds are very sensitive to human disturbance, whether the disturbance is from trail use, boats, or research (Carney and Sydeman 1999). In their review of human disturbance of nesting colonial waterbirds, Carney and Sydeman (1999) found scientific research and visitors (recreationists and ecotourists) had a range of impacts on a number of nesting species. Studies of landside recreational activities and non-breeding shorebirds, waterfowl and colonial waterbirds show that bird responses vary based on a number of factors, such as proximity of approach, directness of approach, species, time of year, habituation, location, speed of movement, and type of recreational activity. Direct approaches by people on foot are very disruptive causing flight and reduced foraging times in a many shorebird species compared with undisturbed birds (Thomas, et al. 2003, Burger and Gochfeld 1993). Burger and Gochfeld (1991) also found that pedestrians always disturbed shorebirds if they approached birds directly, but there was no significant disturbance from walkers a path. Some species are more sensitive than others. Pease et al. (2005) and Klein, et al. (1995) found that ducks exhibited significant negative responses to birding, walking and bicycling. Other studies (Josselyn et al., 1989; Rodgers and Schwikert, 2003) have found that larger birds flush at much greater distances in response to human presence than smaller birds. Gill et al. (2001) studied the abundance of black-tailed godwits (*Limosa limosa*) at four coastal estuaries in England and found no effect of human activities, including footpath use, on bird numbers. Habituation is also an important factor. For example, Ikuta and Blumstein (2003) found birds were significantly more sensitive to disturbance at the low human use sites, suggesting birds became habituated to humans in the high traffic areas. In their study of trail use effects around the San Francisco Bay, Trulio and Sokale (in review) found, overall, no consistent difference in bird numbers, species richness or foraging behavior of between trail and non-trail sites dominated by shorebirds at three locations around the San Francisco Bay. Tangential trails with no fast or loud vehicles and the dominance of small shorebirds may have contributed to these results.

The literature indicates a need for these specific studies:

1. What is the effect of trail use on waterfowl? Many trails are planned adjacent to ponded habitat, but we have no information on how waterfowl might respond to those trails.

2. What is the effect of trail use on California clapper rails? We also have no data on the effects of trail use on California clapper rail habitat use and breeding. Wildlife agencies assume the effect is negative, but there are no data to support that assumption.

3. At what distance should nesting islands must be placed from trails for various species to avoid impacts? Nesting birds are very sensitive to human disturbance, but the distance at which that impact is negligible is unknown.

4. What is the response of shorebirds at sites before trails exist compared to after they are opened? Studies of shorebird response to trails before and after trails are introduced would add to our knowledge of trail effects on shorebirds.

Study Design Concepts

1. What is the effect of trail use on waterfowl?
   - ❑ Study Population and Sites: Waterfowl in the South Bay, especially those in ponds designated for public access, as well as at non-public access sites.
   - ❑ Parameters Measured: Bird buffer distances, sustained changes in abundance and/or species richness, impacts to bird survival, availability and quality of impacted and non-impacted habitat
   - ❑ Study Design: For buffer distances, study the distances birds are distributed from levees not used for public access and those that are. Calculate the amount of area that is impacted, i.e. from which birds are excluded, when disturbed by people.
   - ❑ Time Frame for Study: 1-2 years

- ❑ Estimated Study Cost: Tentative cost estimate: $20,000. This study is underway by Heather White, Master of Science Student, Environmental Studies Department, San Jose State University.

2. What is the effect of trail use on California clapper rails? This study would need to be designed in conjunction with US Fish and Wildlife Service Refuge and Endangered Species staff.

3. At what distance should nesting islands must be placed from trails for various species to avoid impacts? See Pond A16/SF2 experiment for this design.

4. What is the response of shorebirds at sites before trails exist compared to after they are opened? See Pond E12/13 experiment for this design.

Management Options

Findings will be used to design public access so that it does not have significant impacts on the target species. Design may include keeping public at an appropriate distance from wildlife, permitting only certain recreational activities, excluding public access with significant impacts altogether, or allowing public access with significant impacts in certain proscribed areas while maintaining large refuges with no public access.

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Applied Studies Question #18: Will public access features provide the recreation and access experiences visitors and the public want over short or long timescales?
Lynne Trulio, South Bay Salt Pond Restoration Project, Lead Scientist/Science Team Member

Background/Rationale

Project Objective #3 states that the South Bay Salt Pond Restoration Project will provide public access opportunities compatible with wildlife and habitat goals. A primary step in achieving this objective is to clearly understand the public's needs and wants for visitor access to the restoration area. The Project's land managers, US Fish and Wildlife Service and the California Department of Fish and Game, allow a range of recreational activity on their lands including hunting, fishing, wildlife viewing, research, photography, environmental education, and interpretation. The Restoration Project is planning to provide a range of public access opportunities in its Phase 1 Project, such as hunting, non-motorized trails, kayak launches, interpretive stations at the Eden Landing salt works and other sites, and overlooks.

Many recent studies of recreational pursuits show increased interest in some activities and declines in others. The 2001 report of National Survey of Fishing, Hunting, and Wildlife-Associated Recreation shows that by 2001 the popularity of these activities had increased from 1996 levels (US Department of the Interior 2003). In California, public survey polls conducted in 1987 showed that outdoor recreation was important to 44% of Californians. This percentage increased to 62% in 1997 (California Department of Parks and Recreation 2002).

In California, participation in all trail activities increased significantly in the last 15 years; bicycling doubled and hiking increased by 50% from 1987 to 1992 (California Department of Parks and Recreation 2002). California's population is expected to grow from its current level of 34 million to 45 million by 2020, further fueling the demand for recreational opportunities. California Department of Parks and Recreation (2002) reports that popular recreational activities of significance to the Restoration Project include recreational walking, driving for pleasure, trail hiking, general nature and wildlife study, bicycling on paved surfaces, visiting historic sites, attending outdoor cultural events, and picnicking at developed sites. Recreational trends show increasing interest in nature study and wildlife viewing, especially among two growing demographic groups, Hispanics and seniors, and a general continued interest in motorized recreation, such as "all terrain vehicles" (ATVs) and personal watercraft. Two traditional recreational uses, hunting and fishing, continue to decline in popularity.

While many questions about public access demand could be studied, two information gaps relative to the Project stand out:

6. What are the public access interests of San Francisco Bay Area residents and visitors?
7. Do the features that the Project provides meet the public's needs in the short and long-term?

At this point in the Project, we recommend specific hypotheses or research questions be designed to address these two questions.

Study Design Concepts

Both these questions could be addressed with well-designed public surveys. The two studies should use compatible data collection methods so that the data compliment each other. Some specific ideas on study designs for each question are as follows.

<u>1. What are the public access interests of San Francisco Bay Area residents and visitors?</u>

- ❑ <u>Study Population</u>: Regional scale needed. Sample the population south of the San Mateo Bridge, but could expand to the greater Bay area. Randomly sample overall population and recreationists; sample residents and tourists/visitors
- ❑ <u>Study Sites</u>: Recreational and non-recreational facilities
- ❑ <u>Parameters Measured</u>: Demographic parameters (age, ethnicity, residence, etc.); Types of recreation/public access engaged in, where and how often; Types of recreation/public access desired; Knowledge of restoration and the Project, in particular; Willingness to support restoration and associated public access
- ❑ <u>Study Design</u>: Survey administered to study population; stratified random sample design
- ❑ <u>Time Frame for Study</u>: Can be administered any time; a year or less of data collection should be adequate. Should be repeated every 5-10 years
- ❑ <u>Estimated Study Cost</u>: Could be undertaken by a qualified graduate student with direct involvement of major professor. Tentative cost estimate: $30,000-50,000

<u>2. Do the features the that Project provides meet the public's needs in the short and long-term?</u>

- ❑ <u>Study Population</u>: Sample visitors to the Project's different public access features.
- ❑ <u>Study Sites</u>: Recreational and non-recreational facilities within the Project area
- ❑ <u>Parameters Measured</u>: Demographic parameters (age, ethnicity, residence, etc.); Project public access features used most often and why; Opinions of the public access provided by the Project; Types of recreation/public access desired; Types of recreation/public access engaged in, where and how often; Willingness to support restoration and associated public access

- ❑ <u>Study Design</u>: Survey administered to study population; include weekdays and weekends
- ❑ <u>Time Frame for Study</u>: Administer during Phase 1, after public access features have been available for at least a year; collect data over all four seasons and during weekdays, weekends and holidays. Should be repeated with each new Project phase and after major changes, of any sort, to existing phases.

- ❑ Estimated Study Cost: Could be undertaken by a qualified graduate student with direct involvement of major professor. Tentative cost estimate: $30,000-50,000

Management Options

The results of the first study will provide specific and local information to the land managers on recreational trends and desires of Bay Area residents. This information should be used to adjust existing public access opportunities in the Project area and for designing valued public access features into future Project phases that *anticipates* demand.

The second study will give managers information on how visitors to the Project's public access amenities might use and view those features. Specifically, if some features are not well-used or of interest to the public, they might be converted to features that are attractive. Features that are popular should be increased, if wildlife impacts and funding make this possible. Of course, this information will be very valuable in designing the public access features of future phases.

The information collected by these studies must be acted upon in a *public manner*. If the public is happy with the access that the Project is providing, the Project should celebrate this achievement in public outreach tools, such as newsletters, the website, press releases, and the like. If the public seeks changes, the Project should make those public access changes if possible, based on wildlife needs, funding, etc.; if the changes are not possible, the PMT should make efforts, though meetings and public outreach tools, to explain why requested changes cannot be made. Public responses to people's needs and interests will promote support of the Project and for future phases. Not to address public access demands is to risk negative public sentiment that could prevent movement of the Project up the Adaptive Management staircase.

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Applied Studies 19, 20, and 21: Descriptions for the Social Dynamics Key Uncertainty
Lois M. Takahashi, South Bay Salt Pond Restoration Project, Science Team Member

Introduction
The overall goal of the South Bay Salt Pond Restoration Project's planning process is to develop a scientifically-sound, publicly-supported plan. Clearly, an effective planning process requires an understanding of the public's needs and attitudes toward restoration, particularly of this project's proposed improvements. But in addition what is also necessary is an understanding of the ways in which population change, urban development, and political shifts interact with ecological restoration to affect management decisions. Current public attitudes and the potential influence of longer term social, political, and economic shifts on the restoration project comprise key uncertainties that challenge the potential effectiveness of adaptive management and proposed restoration.[1]

Though the uncertainties stemming from social dynamics are most clearly related to the Project Objective focused on human interactions (PO#3), all the Project Objectives have political, economic, or social aspects that may make adaptive management difficult and challenging. Indeed, some have argued that without an understanding and incorporation of social elements, ecosystem management projects may be "even worse than doing nothing."[2] In terms of public access (PO#3), rapid growth and change in population near the project sites may affect public satisfaction with the project because of added demand for access, or in contrast because of changes in public interest associated with the restoration project, public support may wane or increase.

The Project Objectives associated with public service delivery (PO #2, 5, 6) have clear political and economic elements, related to jurisdictional governance issues (such as responsibility and accountability) and the distribution of costs and benefits associated with restoration efforts. Even the more ecological Project Objectives (PO #1, 4) are significantly affected by social dynamics, particularly in terms of the pressures brought by population growth in the region (e.g., groundwater demand, stormwater run-off, solid waste creation and services, and degraded air quality associated with increased traffic congestion), global economic forces (e.g., cargo ship traffic) and climate change (e.g., increasing urbanization and deforestation world-wide).

Though many researchers are assessing the possible influence of varying social dynamics on habitats and environments, the particular character of social, political, and economic change in the South Bay, and its relationship to environmental quality and management remain largely unclear. These uncertainties should be studied and clarified to ensure that adaptive management will be able to respond to what are likely to be significant shifts in population and politics over the 50-year project timeline.

Three Social Dynamics questions have been identified as needing in-depth scientific investigation for the project to meet its objectives. The following descriptions provide a background for each question, general study design concepts and potential management responses that address the study results.

Applied Studies Question 19: Will voters, advocacy groups, elected officials, and government agencies support the project (especially in terms of funding) over the short timescale at the local and regional spatial scales?
Lois M. Takahashi, South Bay Salt Pond Restoration Project, Science Team Member

Background/Rationale
Stated public support for the restoration project is a necessary, though not sufficient, requirement for successful passage of ballot initiatives associated with new public funding sources such as tax assessments and bonds. Stated support is not sufficient since behavior (such as voting for an initiative or bond measure) and stated attitudes are not necessarily directly linked. Attitudes and behavior have been shown in many cases to have weak correlations, but research building on the

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[1] Young, T.P. (2000), "Restoration ecology and conservation biology," in Biological Conservation 92: 73-83 makes the argument that habitat degradation is significantly defined by global population growth rates, land use and abandonment, and public awareness of the importance of biodiversity.
[2] Carpenter, S., W. Brock, and P. Hanson (1999). "Ecological and social dynamics in simple models of ecosystem management," Conservation Ecology 3(2): 4. [online] URL: http://www.consecol.org/vol3/iss2/art4/ (last accessed 6 February 2006).

Theory of Reasoned Action[3] has suggested that those with stronger opinions and attitudes (compared to neutral or weak attitudes) tend to behave in line with their stated attitudes.[4]

Some researchers have argued that an environmentalist ideology is the most important predictor of support for environmental regulations or laws.[5] Others have argued in contrast that environmentalist ideologies are less important than income and occupation in explaining voting for ballot initiatives associated with environmental regulations. In one study,[6] individuals who were lower income and employed in the construction, extractive industries (farming, forestry), and manufacturing were usually opposed to environmental ballot initiatives. This suggests that voting behavior for environmental ballot initiatives might be driven by a "'self-interest' theory of environmental demand"[7] rather than primarily by a collectivist view on environmental protection. In other words, though restoration projects tend to be communicated to various stakeholders and interest groups through an environmentalist ideological framework, what might be as important if these results hold for initiatives proposing funding for restoration projects, are the income and occupational characteristics of potential voters and other important stakeholders.

Part of the challenge in gaining and sustaining public support is the very long time span of the restoration project. One issue related to this challenge is the relative lack of evidence clearly indicating the effectiveness of an adaptive management approach. There are few examples of adaptive management projects that have been in place long enough or been systematic enough to provide evidence. One adaptive management project in northwest Australia on ground fisheries, to show "practical results in fisheries management" required a decade of implementation – US examples (e.g., U.S. Forest Service's consensus management plan for coastal forests in California, Oregon, and Washington; Plum Creek Timber Company's habitat conservation plan; US Department of Interior's Glen Canyon Dam habitat project in the Grand Canyon) have tended to not be as systematic as the Australian case.[8]

Communicating the importance and benefits of the project to various interests requires that there is trust both in the information used to describe the project and in the institutions relaying the information.[9] Barriers to building and sustaining trust include intergovernmental conflict (such as specific agencies' desire to control data, and efforts to maximize "biological or economic yield" through single species management) and the "domination" of policy surrounding the project by single/few stakeholders, clients, or funders.[10] Trust and credibility might be enhanced by shifting "from traditional, expert-driven" processes to more community-based assessment and monitoring efforts.[11]

To determine what strategies might be most effective in promoting public support of the project, what is needed is a clearer understanding of the degree of support for the project, the characteristics (e.g., demographic, ideological, etc.) associated with support, and possible competing issues or needs dominating public discourse and voting behavior.

Study Design Concepts

The study measures the degree of support (both stated and behavioral) by relevant individuals, communities, and groups critical to successful planning (e.g., vocal support during public

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[3] Ajzen, Icek and Martin Fishbein (1980). Understanding Attitudes and Predicting Social Behavior, Englewood Cliffs, N: Prentice Hall.

[4] See review in Takahashi, Lois M. (1998). Homelessness, AIDS, and Stigmatization: The NIMBY Syndrome at the end of the Twentieth Century. Oxford, England: Oxford University Press.

[5] Samdahl, Diane M. and Robert Robertson (1989). "Social Determinants of Environmental Concern: Specification and Test of the Model," Environment and Behavior 21(1): 57-81.

[6] Kahn, Matthew E. and John G. Matsusaka (1997). "Demand for Environmental Goods: Evidence from Voting Patterns on California Initiatives," Journal of Law and Economics 40(1): 137-173.

[7] Ibid, p. 140.

[8] Lee, K. N. (1999). "Appraising adaptive management," Conservation Ecology 3(2): 3. [online] URL: http://www.consecol.org/vol3/iss2/art3/ (last accessed 6 February 2006).

[9] Kunreuther, Howard, Fitzgerald, Kevin, and Aarts, Thomas D. (1993). "Siting Noxious Facilities: A Test of the Facility Siting Credo," Risk Analysis 13(3): 301-318.

[10] Pinkerton, E. (1999). "Factors in overcoming barriers to implementing co-management in British Columbia salmon fisheries," Conservation Ecology 3(2): 2. [online] URL: http://www.consecol.org/vol3/iss2/art2/ (last accessed 6 February 2006), pp. 6-8.

[11] Corburn, Jason (2002). "Environmental Justice, Local Knowledge, and Risk: The Discourse of a Community-Based Cumulative Exposure Assessment," Environmental Management 29(4): 451–466; quote on p. 464.

hearings), funding (e.g., voters for assessment or bond measures), and implementation (e.g., sustained support through initial and later phases of the project). The most important issue is the degree of public support (where public is broadly defined, including residents, businesses, advocacy groups, but with a focus on likely voters) for funding for implementation.

- Study Population: Scale depends on funding mechanism, likely cities and counties, with special focus on jurisdictions adjacent to project sites. Two populations are appropriate given resources for study. For very limited resources, focus on South Bay state legislators/aides and local elected officials. If larger pool of available resources, population would consist of South Bay residents, especially likely voters.
- Study Sites: For elected officials, conduct short telephone interview; for likely voters, conduct focus groups (if limited resources) or telephone/web-based survey.
- Parameters Measured: For elected officials, assess perception of public support for restoration project. For focus groups and/or survey, measure demographic parameters (age, ethnicity, gender, residence, occupation, income categories, etc.); environmental ideology; knowledge about restoration and location/ecological condition of specific project sites; perception about benefits and costs of project.
- Study Design: For elected officials, semi-structured interview with interview guide. For focus groups, selection of 8-12 unrelated individuals for discussion, semi-structured discussion facilitated by trained researcher, taped for further analysis. For telephone survey, questionnaire administered via telephone or Internet (though this will bias the sample toward better educated, wealthier voters), stratified random sample design.
- Time Frame for Study: Should be conducted at several points prior to funding mechanism's critical juncture (e.g., election day for ballot measure, public comment period for plan, etc.). Several points in time will provide opportunities for developing public education, social marketing, or advocacy campaign for public support of project. Data collection should be limited to relatively short time frame (2-3 weeks for focus groups or survey) to reduce external influences on measures (i.e., a longer time frame runs the risk of having important social, political, or economic events occur during data collection, which would reduce the comparability of data for the sample portion contacted prior to and after the significant event).
- Estimated Study Cost: For elected officials, requires individual familiar with elected officials and their aides who could access these individuals in a timely manner. Ballpark cost estimate: $50,000. For focus groups, requires facilitator/analyst, transcriber (of audiotapes), cash incentives for participants ($50-$100 each), incidentals (food, transportation, childcare, etc.); assuming between 3-5 focus groups conducted twice prior to the critical funding mechanism, ballpark cost estimate: $50,000. For the telephone/web-based survey, which is the most expensive option, a very rough estimate would be $150,000-$200,000.

Management Response
While the project generally does not seem to be a hot-button issue in terms of opposition and there seems to be general support for habitat restoration in the Bay Area, there are factors that may impede public and political support, such as competing funding initiatives and very local community concerns. Researchers have also cautioned that even if opposition or conflict are not encountered in planning phase, care should be taken to ensure that controversies and concerns are investigated as conflict can flare during implementation and management phases.

The results of this study would provide managers with current information on the level of support, the characteristics of supporters and non-supporters, and the potential reasons for lack of support. With this information, project managers will be better able to craft public education, social marketing, or advocacy campaigns to increase public support (both stated and behavioral) of the project.

Applied Studies Question 20: What are the benefits and costs associated with the project sites and will they be shared equitably among communities, businesses, municipalities, and/or government agencies at local and regional scales?
Lois M. Takahashi, South Bay Salt Pond Restoration Project, Science Team Member

Background/Rationale
For management decisions to be made and for public support to be attained, in addition to the ecological and biotic dimensions of restoration, science will likely need to also focus on the political, social, and particularly the economic value of the project. Clarifying the economic

dimensions places this project in the context of and in comparison to other public concerns (i.e., the trade-offs involved in focusing public and private resources on this project versus other noteworthy issues).

Researchers tend to view the environment as a collective or public good, and efforts to restore sites are seen as collective or communal activities.[12] But if the potential benefits and costs are to be measured and communicated to the public and specific interest groups, one necessary step is to take a more pragmatic approach by clarifying the value of the restoration project. Determining the value of the restoration project, however, is a complex endeavor. Cost-benefit analysis provides a quantitative means of assessing the appropriateness or feasibility of options by comparing the costs (including opportunity costs) with benefits accruing to specific actions. Benefits accrue to individuals/communities/businesses (private benefits) or to the public at large (public benefits); the same is true for costs.

> It [cost-benefit analysis] attempts to express all beneficial consequences of an action ($B) and all costs or detrimental consequences ($C) in monetary terms, usually discounted to net present values. Alternative actions are then ranked according to the ratios ($B/$C) or the differences ($B - $C) of benefits and costs. Cost-benefit analysis has the advantages of appealing to a widely-held goal, financial efficiency, and of incorporating different parties' assessments of costs and benefits. It has the disadvantages of not dealing with uncertainty, of obscuring rather than illuminating trade-offs among non-financial objectives, and of offering little help in structuring negotiations.[13]

As this quote indicates, this approach should be used with caution because cost-benefit analysis steers managers and decisionmakers "to adopt only those limited investments in environmental practices which can yield monetary [and by extension programmatic, political, or biotic] benefits within an economic time frame."[14]

Productive activities (e.g., building a bridge or transportation system) as well as publicly perceived negative actions (e.g., polluting) have been assessed using cost-benefit analysis. In one cost-benefit analysis of the private and public benefits and costs associated with conservation programs, for example, the largest benefits were "increases in the value of market sales of farm commodities and reductions in commodity deficiency payments from the Commodity Credit Corporation (CCC)" while the largest costs were "direct CRP [Conservation Reserve Program] costs and increased consumer food costs."[15] Another study analyzed the trade-offs between the costs and benefits of lake pollution (over-enrichment of lakes), and found that the potential benefits from polluting included the profits gained by farmers or developers, while costs included not being able to use the lake's water as a source for drinking water, farming or manufacturing, or for recreation.[16]

While cost-benefit analysis can help to identify the varied economic dimensions of ecologically-focused projects, it does not eliminate issues of inequity or different values concerning the environment, nor does it necessarily make conflicting values more transparent. As one researcher found in an analysis of watershed management in the Pacific Northwest:

> there are also obvious (although generally unacknowledged) asymmetries in the distribution of the costs and benefits of environmental protection between these various constituencies – between, for example, different types of users of resources at the local

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[12] Light, Andrew and Eric Higgs (1996). "The Politics of Ecological Restoration," Environmental Ethics 18: 227-247.

[13] Maguire, Lynn A. and Lindsley G. Boiney (1994). "Resolving Environmental Disputes: A Framework Incorporating Decision Analysis and Dispute Resolution Techniques," Journal of Environmental Management 42: 31-48; quote on p. 32.

[14] Sharma, Sanjay and Harrie Vredenburg (1998). "Proactive Corporate Environmental Strategy and the Development of Competitively Valuable Organizational Capabilities," Strategic Management Journal 19: 729-753; quote on p. 730.

[15] Feather, Peter, Daniel Hellerstein, and LeRoy Hansen (1999). "Economic Valuation of Environmental Benefits and the Targeting of Conservation Programs: The Case of the CRP," Report prepared for the Economic Research Service of the US Department of Agriculture. Washington, DC: US Department of Agriculture; quote on p. 6.

[16] Carpenter, S., W. Brock, and P. Hanson (1999). "Ecological and social dynamics in simple models of ecosystem management," Conservation Ecology 3(2): 4. [online] URL: http://www.consecol.org/vol3/iss2/art4/ (last accessed 6 February 2006).

level, and local and more distant 'publics'.[17]

Consequently, cost-benefit analysis must be conducted in a rigorous and transparent manner, but should not be used in lieu of a larger and inclusive process of discussion, negotiation, and management of varied interests.

Study Design Concepts
The study measures the local and regional costs and benefits, in monetary terms, associated with the project sites. The costs and benefits should include biotic and habitat dimensions, as well as impacts on local and regional economies, air and water quality, and potential effects on transportation and infrastructure.

- Study Population: Local and regional scales. Study would include local and regional economies, ecosystems, infrastructure and transportation systems, and other relevant factors.
- Study Sites: South Bay region, with an emphasis on municipalities and jurisdictions adjacent to the project sites.
- Parameters Measured: Costs and benefits should include biotic and habitat dimensions, as well as impacts on local and regional economies, air and water quality, and potential effects on transportation and infrastructure.
- Study Design: Secondary analysis of existing data (demographic, transportation, infrastructure, etc.) using appropriate projections (e.g., population, industrial sector change, etc.) and econometric modeling techniques. Potential primary data collection for important factors with limited existing information. May require integration of multiple distinct models.
- Time Frame for Study: Study relies primarily on secondary analysis, but may require primary data collection and analysis (and incorporation of model results into larger integrated model). Could probably be completed within 12 months. Should be completed prior to implementation of project, preferably initiated during planning process.
- Estimated Study Cost: Economic analyses are generally quite expensive. Because this study may also require primary data collection and integrated model development and analysis, a ballpark cost estimate has a wide range: $200,000 - $300,000 (if no data collection, only secondary analysis, projections, and integrated model development); $400,000+ if primary data collection needed.

Management Response
Cost-benefit analysis would provide an economic valuation of the project, and would help to clarify the benefits and costs locally and regionally so that varying stakeholders could better understand the short- and medium-term impacts of the project. The results of a cost-benefit analysis using an integrated model (e.g.,, with population projections, monetary valuation of biotic and habitat restoration, etc.) would clarify to cities, government agencies, advocacy organizations, and residents the trade-offs involved in the project in monetary terms (making comparisons to other proposals and projects more feasible). Though cost-benefit analysis has inherent within it biases (see above discussion), such analysis also provides a solid baseline from which discussions and negotiations can be initiated.

Applied Studies Question 21: Will negative impacts associated with population growth and development adjacent to the project sites and beyond be successfully managed over the long timescale at the regional scale?
Lois M. Takahashi, South Bay Salt Pond Restoration Project, Science Team Member

Background/Rationale
The project's 50-year time frame means that a myriad of complex and challenging issues will affect the ability of project managers to adapt to changing circumstances. Population size, the activities associated with human presence (such as agriculture, recreation, and economic activities such as local, regional, and international commerce), and the transformation of land use/cover associated with population growth and human activities are all elements that will affect

[17] Singleton, Sara (2002). "Collaborative Environmental Planning in the American West: The Good, the Bad, and the Ugly," Environmental Politics 11(3): 54-75; quote on p. 68.

the project in significant ways.[18] Human settlement and population growth constitute primary challenges to effective management of the project – "urbanization has been identified as a primary cause, singly or in association with other factors, for declines in more than half of the species listed as threatened or endangered under the U.S. Endangered Species Act."[19]

Planning and implementation of ecosystem restoration projects, however, tend not to engage with planning and action associated with urban and regional development, creating a large level of uncertainty for the project's longer-term outcomes.[20] In addition, researchers still know little about ecosystem restoration challenges in urban, suburban, and exurban locations – the focus of researchers has instead largely been on "lands with a relatively small human presence, often dominated by resource extraction and agriculture."[21]

There are two conceptual approaches to understanding the impacts of human presence on the environment. The first approach assumes that population growth has negative impacts on environmental conditions. Those who advocate such a neo-Malthusian approach believe, simply put, that more people use more resources. From this perspective, population growth is part of a larger system where "materials and energy" flow through "the chain of extraction, production, consumption, and disposal of modern industrial society."[22] Population growth globally is consequently seen as associated with increasing energy demand, which, in turn, increases air pollution from fossil fuel combustion, local and transboundary water and ocean pollution due to effluents, and climate change resulting from "greenhouse" gases.[23] The second approach begins with the argument that neither population nor poverty alone is the most important cause for environmental impacts from human presence. Instead, a "land use/land-cover change" approach focuses on "the alteration of the land surface and its biotic cover,"[24] combining social science through a focus on land use and with natural science through a focus on the physical landscape and biota. Sources of land cover change should be seen as the result of "peoples' responses to economic opportunities, as mediated by institutional factors,"[25] or in other words, "changing consumption and behavioral patterns."[26]

No matter the perspective used to think about the potential long-term environmental impacts associated with development in the South Bay, what is clear is that adaptive management of the restoration project will require information and analysis about the size, composition, and density of populations and development and their impacts on the project sites over the 50-year time frame. The South Bay is no exception to global trends toward land cover change and environmental degradation. For example, economic growth in the region associated

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[18] Vitousek, Peter M., Harold A. Mooney, Jane Lubchenco, Jerry M. Melillo (1997). "Human Domination of Earth's Ecosystems," Science 277(25 July): 494-499.
[19] Miller, James R. and Richard J. Hobbs (2002). "Conservation Where People Live and Work," Conservation Biology 16(2): 330-337; quote on p. 332.
[20] Slocombe, D. Scott (1993). "Environmental Planning, Ecosystem Science, and Ecosystem Approaches for Integrating Environment and Development," Environmental Management 17(3): 289-303.
[21] Miller, James R. and Richard J. Hobbs (2002). "Conservation Where People Live and Work," Conservation Biology 16(2): 330-337; quote on p. 330.
[22] Meyer, William B. and B. L. Turner II (1992). "Human Population Growth and Global Land-Use/Cover Change," Annual Review of Ecology and Systematics 23: 39-61; quote on p. 39.
[23] Holdren, John P. (1991). "Population and the Energy Problem," Population and Environment 12(3): 231-255.
[24] Meyer, William B. and B. L. Turner II (1992). "Human Population Growth and Global Land-Use/Cover Change," Annual Review of Ecology and Systematics 23: 39-61; quote on p. 39.
[25] Lambin, Eric F., B.L. Turner, Helmut J. Geist, Samuel B. Agbola, Arild Angelsen, John W. Bruce, Oliver T. Coomes, Rodolfo Dirzo, Gunther Fischer, Carl Folke, P.S. George, Katherine Homewood, Jacques Imbernon, Rik Leemans, Xiubin Li, Emilio F. Moran, Michael Mortimore, P.S. Ramakrishnan, John F. Richards, Helle Skanes, Will Steffen, Glenn D. Stone, Uno Svedin, Tom A. Veldkamp, Coleen Vogel, Jianchu Xu (2001). "The causes of land-use and land-cover change: moving beyond the myths," Global Environmental Change 11: 261–269; quote on p. 261.
[26] Lambin, Eric F., B.L. Turner, Helmut J. Geist, Samuel B. Agbola, Arild Angelsen, John W. Bruce, Oliver T. Coomes, Rodolfo Dirzo, Gunther Fischer, Carl Folke, P.S. George, Katherine Homewood, Jacques Imbernon, Rik Leemans, Xiubin Li, Emilio F. Moran, Michael Mortimore, P.S. Ramakrishnan, John F. Richards, Helle Skanes, Will Steffen, Glenn D. Stone, Uno Svedin, Tom A. Veldkamp, Coleen Vogel, Jianchu Xu (2001). "The causes of land-use and land-cover change: moving beyond the myths," Global Environmental Change 11: 261–269; quote on p. 266.

with global trade will bring continued environmental change. For example, nonnative species associated with ballast water discharge from cargo ships[27] will likely increase given increased activities at Bay Area ports and economic development and trade with Pacific Rim nations, especially China. Land use patterns, such as urbanization (and in the South Bay, suburbanization and densification), and changes in land cover, such as intensification of agriculture or densification of housing development, contribute to local, regional, and global environmental degradation in various ways, including reducing biotic diversity, exacerbating climate change at the local, regional, and global levels, worsening soil degradation, and reducing the ability of ecosystems to provide services that benefit populations.[28]

Study Design Concepts

The study develops long-term (50-year time frame) projections of population, employment, and development in the South Bay, and potential effects on habitat and biota at the project sites. The projections and evaluation of environmental impacts should include biotic and habitat dimensions, stemming from population change (e.g., projections of population size, composition, and density), the activities associated with population change (e.g., projections of employment centers, housing, retail/commercial, and industrial development), and the negative environmental impacts of population change and human behavior (e.g., air and water pollution, land cover change). The study will develop an integrated model using projections of human settlement and public service/infrastructure system change, and provide scenarios or potential portraits of impacts on the project's habitat and biota (given projections, estimates, or targets of the restoration project).

- Study Population: South Bay region (human settlement, economic activity, and habitat/biota).
- Study Sites: South Bay region, with an emphasis on municipalities and jurisdictions adjacent to the project sites.
- Parameters Measured: Projections of population size, composition, and density; projections of change in employment, housing, and commercial markets; change in transportation, infrastructure, and other public systems important to the quality of the project's habitat and biota; impacts on biota and habitat associated with these changes.
- Study Design: Goal is to develop projections of impacts for 50-year project time frame. Secondary analysis of existing data (demographic, transportation, infrastructure, etc.) using appropriate projections (e.g., population, industrial sector change, etc.). Primary field data collection for habitat and biota (using data collected through monitoring proposed for adaptive management. Simulation models of impacts from population, market activity, industrial sector shifts on habitat and biotic quality/health.
- Time Frame for Study: Study relies primarily on secondary analysis, and large integrated model should be updated every 5-10 years. The first model could probably be completed within 24 months. Updates of the model will probably take less time, perhaps 10-12 months. Initial study results would be most useful prior to implementation, but would also provide useful information for ongoing evaluation of project.
- Estimated Study Cost: This is a complex study, requiring an interdisciplinary team (ecologists – especially specialists on biota and habitat impacts from human presence, and social scientists – especially demographers, economists, geographers). Ballpark cost estimate: $300,000+.

Management Response

Because ecosystem restoration projects (and other environmental policies and programs) are long-term in nature, there are a multitude of political, economic, and social uncertainties along with the ecological uncertainties that will continue to affect long-term outcomes. Though there have been some efforts to use socio-demographic projections as background for environmental

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[27] Drake, John M. and Reuben P. Keller (2004). "Environmental Justice Alert: Do Developing Nations Bear the Burden of Risk for Invasive Species?," BioScience 54(8): 718-719.

[28] Lambin, Eric F., B.L. Turner, Helmut J. Geist, Samuel B. Agbola, Arild Angelsen, John W. Bruce, Oliver T. Coomes, Rodolfo Dirzo, Gunther Fischer, Carl Folke, P.S. George, Katherine Homewood, Jacques Imbernon, Rik Leemans, Xiubin Li, Emilio F. Moran, Michael Mortimore, P.S. Ramakrishnan, John F. Richards, Helle Skanes, Will Steffen, Glenn D. Stone, Uno Svedin, Tom A. Veldkamp, Coleen Vogel, Jianchu Xu (2001). "The causes of land-use and land-cover change: moving beyond the myths," Global Environmental Change 11: 261–269.

management,[29] conceptual and empirical models of the interactions between urban development and ecosystem restoration are rare. The results from this study are quite important to show stakeholders, decisionmakers, and the public at large the potential interactions between ongoing development and the Project Objectives. Though the results of this study would be largely based on projections and simulations, this study would still provide a tangible portrait of the project's potential impacts and an opportunity to clarify ecological interactions with social dynamics at the local and regional scales.

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[29] For example, see Struglia, Rachel, Patricia L. Winter, and Andrea Meyer (2003). "Southern California socioeconomic assessment: Sociodemographic conditions, projections, and quality of life indices." Gen. Tech. Rep. PSW-GTR-187. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Integrative, Mechanistic Model (Proposal for Model Development)

Tidal Marsh Restoration in San Francisco Bay: Evaluating External Effects under Uncertainty

Investigators:
Mark Stacey, University of California-Berkeley
Thomas Powell, University of California-Berkeley
Oliver Fringer, Stanford University
Jeff Koseff, Stanford University

Historically, marshlands were ubiquitous around the San Francisco Bay estuary, with large portions of South San Francisco Bay, San Pablo Bay and Suisun Bay fringed by tidal marsh habitat. Over the past century, these marshes have been "reclaimed" for development, mostly having been put into production as salt ponds. Recently, restoration of these habitats to recover ecosystem function is being pursued at an accelerating pace. The largest single effort in this regard is the South Bay Salt Pond Restoration Project (SBSPRP), which involves the acquisition of more than 15,000 acres of salt ponds by the state of California and the federal government. In the North Bay, the CALFED process has established momentum for marsh restoration in the Sacramento-San Joaquin Delta, with restorations being discussed for tracts along Dutch Slough, Van Sickle Island and many others. Other examples of restoration projects throughout the estuary include Bair Island near Redwood City, and several projects around the perimeter of San Pablo Bay including the Napa Salt Ponds, Cullinan Ranch and Hamilton Field. In each case, the restoration of tidal wetlands will be coupled with the physical and ecosystem dynamics of the adjoining estuary, and the success of the restoration project, as well as the condition of existing estuarine ecosystems, will be shaped by that interaction.

While the goal of restoring native habitats and associated ecosystem function is certainly laudable and carries great benefits, restoration of tidal marsh habitat at the scale that is being pursued is not without its risks. These risks include effects both within the project domains and external effects of the projects on other, existing, habitats. Within the project domain, negative outcomes would include an incomplete recovery of marsh habitat (due to, say, insufficient sediment supply or a lack of vegetation recruitment) or poor quality habitat, which could be due to the detailed spatial structures of the restored habitat and its connection with adjoining habitats, the mobilization of contaminants at the site or other perturbations to the habitat that reduce its ecosystem function.

The uncertainty that surrounds the prospects for restoration success is compounded by uncertainties in the driving natural and anthropogenic processes, particularly at the decadal timescales of interest. Climate change (and variability) is likely to alter oceanic conditions, both through sea level rise and changes in the temperature and biota associated with oceanic waters. Further, the hydrology of the watersheds surrounding the estuary is likely to adjust in response to climate change, including the amount and timing of freshwater flows and the associated sediment supply. In an urban setting like San Francisco Bay, sediment supply will also be altered due to shifts in land use over the decadal timescale of interest. Finally, policies that govern how humans interact with the restored habitats will be dynamic, and create additional uncertainty for the success of the projects.

While much of the analysis to date has focused on the uncertainties associated with the success of the restoration projects, of equal, if not greater, importance are the risks to exterior habitats (beyond the project boundaries) that are created by the restoration process. Due to subsidence of much of the land considered for restoration, the restored areas are expected to accrete sediment for an extended period as they build themselves up to approach marsh elevations. As a result, during the restoration process, the overall sediment budget for the estuarine system will be altered by the presence of large "sinks" of sediments along the perimeter (at the restoration sites). To assess the impact of restoration on existing habitats, sediment transport pathways must be evaluated, including the prospects for scour or accretion in existing habitats. This consideration is also important in evaluating the quality of the restored habitats, due to the presence of sequestered contaminants at depth in many existing habitats (e.g., Mercury in San Pablo Bay). The movement of these sediment-associated contaminants into marshes may lead to increases in their transformation to bio-available forms, due to effects of vegetation on the level of oxidation of marsh sediments (Marvin-DiPasquale et al. 2000, 2003). In order to effectively analyze and predict sediment transport in the system, including the perturbation created by restoration, the adjustment of the system, including tidal forcing and salinity transport in addition to sediment suspension and deposition patterns, must be critically evaluated.

While changes to the patterns of suspended sediment concentration and transport are likely to be relatively quick to appear, other external impacts are more likely to develop over time. For example, the creation of extensive marsh habitat along the estuarine perimeter constitutes a major ecological change for the system. Already, the interaction of salt pond habitats with the estuary has led to the introduction of new species not traditionally associated with South San Francisco Bay (Cloern, 2006). The eventual adjustment of the estuarine ecosystem to the presence of fringing wetlands may not be complete for decades and is filled with tremendous uncertainty. Any predictive analysis of this trajectory, however, will require a basic understanding of transport and turbidity in the estuary, which are the emphasis of the work we are describing here.

In order to accurately analyze and predict the progression of habitat restoration in the face of both internal and external uncertainties, as well as the external impacts of the restoration activity, a modeling tool must be developed and applied that can accurately resolve tidal dynamics, transport and sediment suspension and deposition. These processes force us to consider a wide range of spatial scales. At the small scale, the interactions of tidal and wind-forced motions with the local bathymetry are likely to dominate the analysis of the net sediment movement into the restoration site (Ralston and Stacey 2006), as well as the scour and deposition of sediments in existing habitats in the vicinity. At the same time, though, the analysis must be able to address the estuary-scale dynamics, including exchange between the major subembayments in the estuary (South Bay, Central Bay, San Pablo Bay, Suisun Bay) and between the estuary and the coastal ocean. This combination of requirements necessitates the use of a numerical tool that can provide great detail (high resolution) at local scales of interest, but can also address questions and concerns at the scale of the estuary as a whole. Temporally, while the primary concerns and uncertainties involve the procession of restoration and the adjustment of the estuary at the timescale of years to decades, short timescale processes due to tidal and wind forcing dominate the net sediment and salinity transport that will determine the longer timescale trajectory of the system. Together, we require a flexible numerical tool that can accurately and efficiently simulate tidal and wind motions at the local scale of the restoration projects, but can also expand to the estuary as a whole.

On its own, however, a numerical tool does not constitute a modeling system. To be clear, observations of the system, including the local topography and the local influence of tides and winds on flows, mixing and transport of sediment and other scalars, are required to both calibrate the numerical tool and to confirm our physical understanding of the processes being simulated. To make this description of an integrated modeling system more specific we can consider the question of how Coyote Creek and the intertidal habitats along its perimeter are scoured (or otherwise modified) by the activities of the SBSPRP. In this case, any modeling efforts must be certain to accurately capture shear stresses and sediment transport at the scale of Coyote Creek and the adjoining Sloughs. At the same time, if we were interested in how the SBSPRP as a whole modifies the annual sediment budget for the San Francisco Bay Estuary, the detailed tidal dynamics of perimeter sloughs become less important. This example illustrates the need for careful calibration and verification of a modeling tool *at the spatial and temporal scales of interest.* The distinction here is between a *numerical* modeling exercise and an *approach* to modeling an environmental system. Numerically, a model can be expanded to include any domain or the grid can be reduced to resolve any feature; this does not make it an effective model for all processes being simulated.

The modeling system that we aim to develop relies on a flexible three-dimensional hydrodynamic and sediment transport model (SUNTANS, see Fringer et al. 2006) to predict how restoration actions will interact with the existing estuarine system, including changes in local tidal dynamics, salinity and suspended sediment concentrations. The flexibility in the numerical approach allows for highly resolved studies in and around particular restoration sites, while not compromising complete Bay coverage (through a variable grid spacing). While our initial modeling efforts will focus on the tidal and wind-forced dynamics, and their influence on transport of salinity and suspended sediments, this modeling approach provides a necessary foundation on which other, cross-disciplinary modeling efforts can be built. For example, modeling the mobilization of metals and their transformation into bioavailable forms would rely heavily on an understanding of how sediment moves through the system due to the strong association of these contaminants with sediments. Ecologically, primary productivity in the estuary is sensitive to the extent of penetration of light into the water column, so understanding and predicting how the turbidity (suspended sediment concentration) will adjust following restoration activity is a necessary first step. In each case, we aim to provide the physical "infrastructure" on which interdisciplinary models can be layered.

At the same time, it is critical that the numerical analysis be coupled with observations of physical processes (forcing and resulting flows and transport) and bathymetry at the scales of interest. The observational needs will vary between projects due to the existence of other observational efforts. In the far South Bay, for example, detailed studies of lower Coyote Creek (March-May 2006) and the flows through an Island Pond Breach (September-November 2006) are likely to provide an excellent foundation for calibrating and verifying a numerical model for the interaction of the region south of the Dumbarton Narrows with the SBSPRP. At a larger scale, the development of an ocean observing system, which is expected to extend into the Bay (CeNCOOS, see http://www.cencoos.org/), along with previous transect observations (Fram et al. 2006), provide an important foundation for considering ocean-estuary exchange. During the early stages of development, these observations will need to be somewhat extensive, as the details of slough-mudflat exchange and other small-scale, local, processes have not really been explored sufficiently to establish our physical understanding. With each successive application of the modeling system, however, fewer physical process-based observations will be required, perhaps only involving a detailed survey of the local bathymetry and a few basic calibration-oriented data sets.

While the mechanistic details of the development of this modeling system are beyond the scope of this short summary, we would like to note a few of the applications that the model will allow us to consider. First, the interannual variability in the sediment supply for the restoration projects can be considered by resolving the annual cycle of sediment deposition and redistribution, with consideration of the potentially important influence of extreme events. Secondly, long-term shifts in climatic forcing and land use can be addressed by considering how changes in oceanic conditions (rising sea level as well as shifts in oceanic conditions) and hydrologic forcing (riverflow timing and magnitude as well as sediment loading) affect the restoration projects and interact with those projects to define the long-term adjustment of the estuarine ecosystem.

Detailed Description of Activities and Associated Budget

Considering a three-year research time horizon, we now describe briefly a specific set of research activities that are motivated by the general discussion in this document. First, we will pursue an analysis of sediment transport in the region south of the Dumbarton Narrows (the Far South Bay) and the influence of annual variability in sediment supply. This activity would consist of both numerical development as described in this document and continued analysis of data sets collected in conjunction with the SBSPRP; the first examines the detailed dynamics of Coyote Creek adjacent to early breaches in the project (the Island Ponds) and the second data set examines flows and transport through a breach in detail. The data analysis would be focused on both developing an understanding of the basic physical processes that dominate sediment transport and establishing a reliable calibration and verification data set for the numerical activity at the scale of interest. Next, we will pursue modeling and analysis of a second site of similar scale to the Far South Bay modeling exercise. The specific choice of a site would be based on what data is available for calibration and verification purposes, most likely a San Pablo Bay restoration site. Finally, in both of these modeling exercises, we will evaluate the performance of the model in Central Bay using existing measurements of currents, salinity, temperature and suspended sediment (Fram et al. 2006). This final exercise is motivated by our interest in using our modeling approach to examine the effects of restoration at the scale of the entire estuary; the Central Bay data sets provide a rigorous test of the model's ability to extend to those spatial scales. To summarize these activities:

- Transport analysis and modeling South of the Dumbarton Narrows, including annual variability
- Transport modeling at a second restoration site to be determined (likely to be San Pablo Bay)
- Evaluation of model performance in Central Bay near the Golden Gate.

A rough budget for these activities, based on a three-year time horizon is $750,000 or about $125,000 per year for each institution (UC-Berkeley and Stanford). This estimate of the budget includes 1 graduate student researcher at each institution, salary support for each PI to contribute during summer months, and allowance for miscellaneous supplies and expenses related to computational facilities, publications and travel.

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APPENDIX 2. Sequencing of Applied Studies, South Bay Salt Pond Restoration Project
Authors: Lynne Trulio, Lead Scientist, and Science Team
Dated: July 24, 2007

This memo provides an approach and rationale to sequencing the Applied Studies the Science Team has developed during the planning phase of the South Bay Salt Pond Restoration Project. Sequencing is important because, although all the studies we have identified are essential to the Project, some are on the critical path for research. This approach has three tiers:

Sequence 1 includes studies to be implemented at the beginning of Phase 1 or before, either because they address a direct threat to our ability to achieve Project Objectives, because Phase 1 provides ideal conditions to study the question, or the findings are essential to implementing future actions.

Sequence 2 includes studies to be initiated some time in Phase 1, but more fully in conjunction with future Project actions. Phase 1 conditions are not ideal for addressing these questions, but some data can begin to be collected in Phase 1.

Sequence 3 includes studies to be initiated after Phase 1 actions have been implemented and habitat has evolved or data from Sequence 1 studies have been collected.

Sequence 1: Studies to be implemented at the beginning of Phase 1 or before, as Phase 1 actions are conducive to answering these questions.

AS 5: **Will shallowly flooded ponds or ponds constructed with islands or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds?**

AS 6: **Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner?**

AS 7: **To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner?**

Rationale for AS 5, 6 and 7:

- The extent to which the current diversity and abundance of birds can be supported in a smaller footprint of actively managed ponds will be an important determinant in how much tidal marsh can be restored while still meeting Project Objectives. This information is critical for designing future Project actions.
- Conditions in Phase 1 are conducive to answering these questions as much of the Project area will still be managed ponds that can be manipulated to test the importance of different factors in attracting and supporting different bird species.

AS 11: **Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species?**

AS 12: **Will pond management increase MeHg levels in ponds and pond-associated sentinel species?**

Rationale for AS 11 and 12:

- Since the early stages of planning, the Project proponents have realized that Project actions have the potential to increase bioavailable mercury in the Bay. This issue has the potential to hinder the Project's ability to meet Project Objectives for sediment and water quality, and ecosystem health.
- There are major gaps in our understanding of this human and ecosystem-related issue and, as a result, research began in the planning stage. Studies continuing into Phase 1 will assess the effects of Project actions, both pond management and tidal restoration, on mercury uptake to the food web. Tidal restoration in A8 is being designed specifically to assess tidal restoration on mercury uptake.
- As part of the MeHg studies, data collection should begin on AS 2 (see Sequence 2 below). Pond A8 provides an ideal opportunity to study this question in sloughs.

AS 13a: **What is the effect of pond management on water quality and species both inside the ponds and outside in the sloughs and bay adjacent to pond discharge points?**

Rationale for AS 13a:

- Potential effects of operating the ponds under the Initial Stewardship Plan (ISP) have not been studied and little is known about the effects of pond management on conditions inside the ponds and directly outside. As a result, managers have had to deal with water quality problems since ISP management began. Lack of research on this topic could impede meeting Project Objectives for water quality and overall ecosystem health.
- Potential effects of pond management on entrainment of salmonids in ponds, pond discharges on receiving water species, and harbor seal populations, which are relevant to AS 10, should be studied in Phase 1.
- Understanding conditions created by pond management is of immediate importance in Phase 1 as most of the Project area will continue to be managed as ponds.

AS 15: **Will California gulls, ravens and crows adversely affect (through predation and encroachment on nesting areas) nesting birds in managed ponds and restored areas?**

Rationale for AS 15:

- The exponential increase in the California gull population in the South Bay is an immediate threat to Project Objectives focused on preserving nesting species and protecting listed species.
- An Adaptive Management Working Group for this issue has identified a number of studies that must be implemented before Phase 1 begins, as the Phase 1 actions will evict approximately 24,000 gulls from pond A6.

AS 17: **Will landside public access significantly affect birds or other target species on short or long timescales?**

AS 18: **Will public access features provide the recreation and access experiences visitors and the public want over short or long timescales?**

Rationale for AS 17 and 18:

- Two of the Project's missions to protect wildlife and enhance public access may be in conflict for some species and some types of access, and this issue is of great concern to stakeholders. Phase 1 includes an array of land-side public access elements, especially trails, near a range of habitats, which facilitates the study of land-side public access effects on wildlife.
- Adaptive Management for the Project includes a process for collecting and analyzing data on public access and wildlife interactions as well as on public satisfaction with access features. Collection of data is critical in Phase 1 since conclusions from the analysis will guide the type and amount of public access that could occur in Phase 1 and future phases.

AS 19: **Will voters, advocacy groups, elected officials, and government agencies support the project (especially in terms of funding) over the short timescale at the local and regional spatial scales?**

Rationale for AS 19:

- Funding is now, and will continue to be, a major challenge to implementing the Project and its adaptive management process. Money will need to come from a wide range of sources, including local residents, but we have little information on how to reach a range of constituents and secure their support. This may be one of the greatest threats to achieving the Project Objectives.
- By collecting this information in Phase 1, Project managers can design fund-seeking approaches that will provide money for future phases. Some approaches, such as ballot measures, will need significant time to develop and should be started as soon as possible.

Sequence 2: Studies to be initiated some time in Phase 1, but implemented more fully in conjunction with future Project Actions that better support addressing the questions.

AS 1: **Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal habitat ecosystems within the 50-yr projected time frame?**

AS 2: **Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance in the South Bay?**

AS 3: **Will restoration activities always result in a net decrease in flood hazard?**

Rationale for AS 1, 2, and 3:

- Relatively little area will be opened to tidal action in Phase 1, which does not afford much opportunity to study these questions. One exception is opening A8 to tidal action, which affords an opportunity to collect data on AS 2 in sloughs. Future actions are expected to open large numbers of ponds along specific sloughs, which will provide optimal conditions for answering these questions, especially AS1 and 3.
- However, the Island Ponds and ponds open to tidal action in Phase 1 do allow initial study of these questions and research has begun, especially on AS1 and 3. Research conducted in Phase 1 will form the basis for research in future phases.

AS 14: **Where not adequately eradicated, does invasive *Spartina* and hybrids significantly reduce aquatic species and shorebird uses?**

Rationale for AS 14:

- This research depends on the results of the Invasive Spartina Project, which is currently in process. The results may not be known for some time. If the Invasive Spartina Project cannot control invasive *Spartina*, AS 14would become necessary.
- However, even now, the USGS is conducting research on the response of clapper rails to invasive and native *Spartina*. Any research conducted now will provide a basis for understanding species' responses to different types of habitats.

AS 16: **Will increases in boating access and boating behavior significantly affect birds, harbor seals, or other target species on short or long timescales?**

Rationale for AS 16:

- Relatively little in the way of improved boating access is planned in Phase 1, so this phase does not afford much opportunity to study this question.
- There is one kayak launch planned in Eden Landing that could be used, in combination with other South Bay kayak launches, as part of an initial study on this question.

Sequence 3: Studies to be initiated after Phase 1 actions have been implemented and habitat has evolved or data from Sequence 1 studies have been collected.

AS 4: **Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions?**

Rationale for AS 4:

- This question requires analysis of data collected from other studies, especially AS 5, 6, and 7, but also AS 8 and 9. Thus, this question cannot be addressed until a number of years of data have been collected, during Phase 1 and after.
- This question should be analyzed at regular intervals during the Project's lifetime, beginning in Phase 1, to determine the overall effect of the Project on South Bay birds.

AS 8: **Will pond and panne habitats in restored tidal habitats provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term?**

AS 9: **How do clapper rails and other key tidal marsh species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response?**

Rationale for AS 8 and 9:

- Both questions involve determining species responses to vegetated tidal marsh conditions, which will take some time to evolve after Phase 1 tidal marsh actions are implemented.

- However, baseline data at appropriate reference sites can be collected in advance of tidal marsh evolving at the Phase 1 sites.

AS 10: **To what extent will increased tidal habitats increase survival, growth and reproduction of native species, especially fish and harbor seals?**

Rationale for AS 10:

- Response of non-avian species depends on tidal marsh evolution, which will take some time. During Phase 1, conditions will eventually change enough to potentially benefit native species survival, growth and reproduction. This study should be linked to the evolution of tidal habitat.
- However, even before marsh develops, baseline data on species use of managed ponds and the South Bay should be collected via Project monitoring and studied specifically as part of AS 13a.

AS 13b: **What are the effects of tidal habitat restoration on water quality, food web dynamics, and key components of the ecosystem such as phytoplankton, benthic invertebrates, or fish diversity and abundance in the South Bay and what factors result in these effects?**

Rationale for AS 13b:

- Response of the ecosystem and its components to restoration will depend on significant tidal marsh evolution. During Phase 1, conditions will eventually change enough to potentially affect ecosystem level components.
- However, even before marsh develops, baseline data on conditions in the South Bay ecosystem should be collected in order to assess the effects of restoration changes.

AS 20: **What are the costs and benefits associated with the Project sites and will they be shared equitably among communities, businesses, municipalities, and/or government agencies at local and regional scales?**

Rationale for AS 20:

- Monetizing Project actions standardizes the value of Project effects for clearer understanding by businesses, government agencies, and advocacy organizations (i.e., a dollar value is placed on the Project and its outcomes). The study would consist of analysis of current and projected economic conditions, estimates of Project costs (including actual construction and monitoring costs, but also potential social or health impacts), and projections of the economic benefits associated with Project activities.
- This study may be best implemented after some Project actions have occurred, allowing for public reaction. This study will provide data for Project Managers to educate the public about the benefits/needs/trade-offs associated with particular activities.

AS 21: **Will impacts associated with population growth and development adjacent to the Project sites and beyond be successfully managed over the long timescale at the regional scale**?

Rationale: for AS 21:

- Answering this question requires modeling to forecast social conditions around the Bay and the impacts of those conditions on the Project. This information will be most beneficial in later Project phases when landscape scale changes to the ponds occur. Those changes should occur in the context of predictions about impacts of future conditions, whether they be associated with climate change or the social fabric adjacent to the Project.
- However, developing this model should begin in conjunction with developing landscape scale hydrodynamic models, with the expectation of ultimately linking their predictions.

APPENDIX 3. Adaptive Management Summary Table

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Sediment Dynamics Project Objective 1 (Preserve existing estuarine habitat areas)	No significant decrease in South Bay intertidal and subtidal habitats (south of San Bruno shoal), including restored pond mudflat, intertidal mudflat, subtidal shallow and subtidal channel areas.	▪ Area of restored mudflat. ▪ Area of outboard mudflat. ▪ Area of subtidal shallows and channel. Methods: Bathymetry and LiDAR surveys will be performed periodically, initially every 3–5 years and then less frequently if data suggest slower rates of changes over time.	▪ Change in tidal mudflat and subtidal shallows expected to vary at the pond complex scales. Areas will be estimated and reported on the pond complex scale. ▪ Changes in South Bay need to be placed within system-wide (San Francisco Estuary) context to assess influence of external factors.	▪ Change in tidal mudflat & subtidal shallow: 10–20 years, assuming significant tidal habitat restoration continues beyond Phase 1. ▪ Subtidal channel change: 0–5 years.	▪ Outboard mudflat decreases greater than the range of natural variability + observational variability/error.	▪ Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance) in the South Bay? ▪ Development of a 2- and 3-D South Bay tidal habitats evolution model.	▪ Convene study session to review and interpret findings to assess if observed changes are due to restoration actions or system-wide changes in the sediment budget (*e.g.*, effects of sea level rise). ▪ Study biological effects of loss of mudflat, subtidal shallows, and/or subtidal channel habitat. ▪ Adjust restoration phasing and design to reduce net loss of tidal mudflats. Potential actions include remove bayfront levees to increase wind fetch and sustain tidal mudflat, phase breaching to match demand and supply, and/or breach only high-elevation ponds to limit sediment demand ▪ Reconsider movement up staircase
Sediment Dynamics Project Objective 1 (Rate of accretion indicates trajectory toward vegetated marsh)	Accretion rate of the restored ponds is sufficient to reach vegetation colonization elevations.	▪ Areas of inboard mudflat and pioneer marsh inside ponds ▪ Sedimentation rate inside breached ponds. Methods: Transects or SET in breached ponds, annually at first and then less frequently as rates of accretion slow. LiDAR surveys (see above).	▪ Pond scale	▪ 2–10 years depending on initial pond elevation	▪ Projections based on the rate of inboard mudflat accretion suggest vegetation colonization elevations are not likely to be achieved within the planning time frame.	▪ Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal marsh ecosystems within the 50-yr projected time frame?	▪ Convene study session to review findings to assess if observed changes are due to restoration actions and whether colonization is compromised. ▪ Study biological effects of slower tidal flat evolution. ▪ Adjust phasing and design to increase inboard mudflat accretion. Potential management actions include adding wave breaks or adding fill. ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Sediment Dynamics Project Objective 1 (Maintenance or increase of current vegetated marsh is essential to key species)	▪ No long-term net loss of vegetated tidal marsh throughout the South Bay.	Total area of tidal salt marsh Methods: Bathymetry and LiDAR surveys and/or Iconos satellite data and/or aerial photography and ground truthing	Pond Complex and South Bay	10 to 20 years	▪ Observed net loss of tidal salt marsh (area of outboard fringe marsh losses > greater area of tidal marsh in restored ponds) than the range of natural variability + observational variability/error.	▪ Will sediment accretion in restored tidal areas be adequate to create and to support net increase in emergent tidal marsh habitat within the 50-yr projected time frame? ▪ Development of a 2- and 3-D South Bay tidal habitats evolution model	▪ Convene study session to review findings to assess if observed changes are due to restoration actions. ▪ If tidal marsh area is not meeting projections, assess biological significance of long-term loss of tidal marsh. ▪ Adjust phasing and design to accelerate marsh development. Potential management actions include filling to colonization elevations, adding wave breaks and/or preserving bayfront levees ▪ Adjust phasing and design to reduce erosion of existing marsh. For example, phase tidal restoration to match sediment demand and supply.
Flood Protection Project Objective 2	▪ No increase in tidal or fluvial flood risk at any project phase and improve tidal and fluvial flood protection in the South Bay in specific areas	▪ Survey slough channel cross-sections (scour) in the vicinity of breaches; ▪ Survey marshplain accretion in the ponds; initially frequently, then less often ▪ Measure water surface elevations inside the ponds and in the sloughs in the vicinity of breaches; initially annually, then less frequently ▪ Collect high water mark elevations in the vicinity of breaches and upstream, following large flood events ▪ Inspect for levee erosion initially monthly, then annually, and after major rainfall and/or tidal events ▪ Monitor relative sea level rise (sea level rise and land subsidence) every few years ▪ Water levels and cross-sections upstream in flood-prone channels	Slough (drainage) scale	▪ Slough channel cross-sections, marshplain accretion, and water levels: rapid initial response (within approximately five years) followed by slower changes over decades. ▪ Flood high waters: approximately every ten years (depends on timing of large events) ▪ Levee erosion: same timeframe as channel cross-section and marshplain accretion responses above, or as dictated by rainfall, tidal, and other events. ▪ Relative sea level rise: approximately ten years or longer	▪ Flood modeling predicts a current or future increase in flood risk (*e.g.*, decrease in levee freeboard). ▪ Significant levee erosion observed ▪ Elevated water surface elevations projected by modeling effort and/or observed in the field ▪ Field data collection and/or observation indicates that flood risk is greater than that predicted by models (*e.g.*, water surface elevation is higher)	Will restoration activities always result in a net decrease in flood hazard?	▪ Adjust phasing and design to provide fluvial flood protection. For example, set back or lower additional levees to increase flood conveyance or dredge channels. ▪ Adjust phasing and design to protect levees. For example, adjust levee maintenance or implement levee improvements (*e.g.* widen shoulder, raise, armor, set back levee)

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Water Quality Project Objective 4	▪ Water quality parameters in ponds will meet RWQCB standards ▪ South Bay water quality will not decline from baseline levels ▪ DO levels meet Basin Plan Water Quality Objectives	▪ Water quality parameters (DO, pH, suspended sediment and turbidity, trace contaminants other than mercury, etc.) set by RWCQB in ponds and Bay (methods as per Takekawa, et al. 2005). ▪ Sediment oxygen demand ▪ Continue as is under regulatory requirements for managed ponds. ▪ Relate to RMP for conventional pollutants (Use RMP infrastructure for Far South Bay main water mass.) ▪ Relate to RMP for trace contaminants (Use RMP process for determining frequency and methods for Far South Bay main water mass. Also use RMP process for determining need for and frequency of tidal habitat special studies.)	Ponds, receiving waters, and entire South Bay	Ongoing	▪ Annual data review to determine variation from past trends ▪ Review of RMP results indicate abnormal conditions ▪ Other indication of abnormal conditions such as fish kills ▪ Increases in chlorophyll-a to levels indicating eutrophic conditions ▪ Increases in sediment oxygen demand to levels indicating risk of low DO ▪ Low dissolved oxygen in ponds or receiving waters	▪ What is the effect of a) pond management, including increased pond flows and associated managed pond effects, and b) increased tidal prism from tidal marsh restoration on water quality, phytoplankton and fish diversity and abundance, and food web dynamics in South Bay? ▪ Can residence time be altered to prevent low dissolved oxygen? ▪ Is it possible to re-aerate water prior to discharging to the Bay? ▪ What effect would progress all the way to 90/10 (Alternative C) have on the BOD loading to the Bay?	▪ Applied studies to find causes of water quality problems in ponds (need salinity, temperature, wind speed, solar radiation, sediment oxygen demand, and net primary production) ▪ Applied studies of Bay-wide conditions ▪ Applied studies of WQ effects on pond/Bay species (plankton, shrimp, fish, birds) ▪ Active management such as baffles, aerators, etc. ▪ Decrease number of ponds monitored as conversion away from managed ponds to full tidal occurs. Focus on managed ponds with compliance issues. ▪ Review all available data. ▪ Reduce pond residence times. ▪ Accelerate conversion from managed ponds to tidal habitat. ▪ Eliminate managed pond discharges by converting to seasonal wetlands. ▪ Decrease pond residence time ▪ Introduce re-aeration mechanisms at discharge points ▪ Reconsider movement up staircase
Mercury Project Objective 4	▪ Levels of Hg in sentinel species do not show significant increases over baseline conditions ▪ Levels of Hg in sentinel species are not higher in target restoration habitats than in existing habitats	Hg levels in sediment, water column and sentinel species (methods as per Collins, et al. 2005)	Ponds and pond complexes	1–3 years depending on specific data and overall geographic scope	▪ One or more sentinel species show higher levels of Hg in target habitats than existing habitats ▪ One or more sentinel species show higher than ambient levels of Hg in Pond A8 or Alviso Slough.	▪ Will tidal marsh restoration and associated channel scour increase methylmercury (MeHg) levels in marsh and bay-associated sentinel species? ▪ Will pond management increase MeHg levels in ponds and pond-associated sentinel species?	▪ Applied study of sources of Hg and causes of increases ▪ Applied study of sediment capping methods (if relevant) ▪ Applied study of methylation processes (*e.g.*, photo-degradation, microbial methylation) ▪ Adjust phasing and design; for example, undertake preventative dredging or prevent draining of interstitial spaces or pore water. ▪ Reconsider opening more Alviso ponds to tidal action.

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Algal composition and abundance	▪ Nuisance and invasive species of algae are not released from the Project Area to the Bay. ▪ Algal blooms do not cause low DO within managed ponds	Algal species – visual observations of macrophytes and plankton tows Chlorophyll-a Sediment oxygen demand (SOD)	Ponds (visual), Bay (plankton tows) Ponds	Annually Annually	▪ Nuisance macrophytes are observed ▪ Harmful exotic species of phytoplankton are characterized in Bay	▪ Does pond configuration affect algal composition and abundance? ▪ Do harmful exotic species of algae persist in the Bay?	▪ Alter pond configuration ▪ Introduce artificial shading ▪ Stop progression towards Alternative C
Tidal Marsh Habitat Establishment Project Objective 1A	▪ Tidal marsh vegetation/habitat mosaic (including vegetation acreage and density, species composition, acreage of mudflat, channels, marsh ponds and transition area) is on a trajectory toward a reference marsh and/or other successful marsh restoration sites in South San Francisco Bay.	▪ Tidal marsh habitat acreage (*e.g.*, vegetation, mudflat, channel, pan, transition zones, etc.; collected via remote imagery with limited ground-truthing) as a percent of the total restoration area; plant species composition, including abundance of non-natives such as non-native *Spartina* spp. (qualitative assessments for invasive species will occur annually, quadrant or transect sampling once marsh has 20% vegetation cover); habitat trajectory toward a reference marsh and other restoration sites ▪ Tidal marsh habitat quality rated as high, medium, or low based on usefulness to clapper rail and salt marsh harvest mouse, determined every 2-3 years using aerial photos and ground-truthing ▪ Habitat mapping will take place every 5 years, beginning 5 years after the restored area has reached vegetation colonization elevation. Once 40% native vegetation cover has been achieved, species composition will be collected (in years corresponding to the habitat mapping) in a variety of zones (low marsh, high marsh, upland transition) within each restored marsh. (It would be beneficial to have increased frequency of	Entire South Bay	Establishment depends on initial pond elevation, vegetation colonization anticipated to be detectable within 5 years (or less) of reaching appropriate elevations, while habitat development trajectory anticipated to be detectable within 15 years (and possibly less) of the onset of vegetation colonization	▪ Vegetation deviates significantly (30–50%) from projected trajectory after colonization elevations are achieved. ▪ Channel and marsh pond formation does not occur as predicted. ▪ Non-native *Spartina* present on the site.		▪ Review sediment dynamics ▪ Study causes of slow vegetation establishment and channel development (ex: gypsum) ▪ Active revegetation ▪ Increased non-native invasive species control ▪ If invasive species cannot be controlled, study biotic response to non-native vegetation ▪ Continue to re-evaluate what is meant by "control" of invasive species and adjust monitoring and management triggers based on the latest scientific consensus ▪ Adjust phasing and design ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
		monitoring in the early Project phases.)					
Vector Control Project Objective 5	▪ The need for mosquito control does not exceed NEPA/CEQA baseline as determined by the Vector Control agencies	▪ Presence/absence of mosquitoes in former salt ponds ▪ Number of acres of breeding mosquitoes ▪ Number of larvae/dip in potential breeding habitat ▪ Number of acres within the Project Area treated for mosquitoes ▪ Costs/level of effort (*e.g.*, hours spent in treatment, amount of material applied, helicopter cost, etc.) to control mosquitoes	Focal areas that may support mosquito sources throughout the South Bay	Ongoing	▪ Detection of breeding mosquitoes in a former salt pond ▪ Detectable increase in monitoring parameters (relative to NEPA/CEQA baseline), particularly in areas with human activity/exposure ▪ Detection of mosquitoes that are known disease vectors and/or are of particular concern (*i.e.*, *Aedes squamiger*, *A. dorsalis*) in the Project Area		▪ Adjust design to enhance drainage or tidal flushing, control vegetation in ponded areas, and/or facilitate access (for control) to marsh ponds ▪ Increase level of vector control (preferably only as an interim measure while design issues are addressed to reduce mosquito breeding habitat) ▪ Study relationships of fish abundance and community composition and mosquito larval abundance in marsh features (*e.g.*, ponds and pannes) and managed ponds ▪ Ensure management actions are consistent with Refuge mosquito management policies
Clapper Rails Project Objective 1A	▪ Meet recovery plan criteria for clapper rail habitat within the SBSP Restoration Project Area	Clapper rail tidal salt marsh habitat acreage, quality (see Tidal Marsh Habitat Establishment above)	Entire South Bay	Likely decades for high-quality tidal marsh development (10-year targets)	See triggers for *Sediment Dynamics*, *Vegetation Establishment* above	▪ How do clapper rails 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?	▪ See *Vegetation Establishment* above ▪ Reconsider movement up staircase
	▪ Meet recovery plan criteria for clapper rail numbers (0.25 birds/ac over 10-year period) within the SBSP Restoration Project Area	Winter numbers, censused during high-tide airboat surveys, and breeding-season numbers, censused at representative locations	Entire South Bay	Monitoring not expected to show substantial results until 5–10 years after cordgrass establishment in 300 acres or more (10-year targets)	▪ Numbers drop below 0.20 birds/ac in any given year for Project Area as a whole ▪ Rate of increase in clapper rail numbers deviates significantly from projection		▪ See *Vegetation Establishment* above ▪ Applied studies of habitat parameters, contaminant levels, and predation pressure related to rail densities and productivity (and implement related management actions as appropriate) ▪ Reconsider movement up staircase
Salt Marsh Harvest Mice Project Objective 1A	▪ Meet recovery plan criteria for salt marsh harvest mouse habitat within the SBSP Restoration Project Area	Salt marsh harvest mouse tidal salt marsh habitat acreage, quality (see Tidal Marsh Habitat Establishment above)	Entire South Bay	Likely decades for high-quality tidal marsh development (10-year targets)	See triggers for *Sediment Dynamics*, *Vegetation Establishment* above	▪ 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?	▪ See *Vegetation Establishment* above ▪ Adjust phasing and design; for example, add or enhance upland transition habitat within and between restored marshes ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
	▪ 75% of viable habitat areas within each large marsh complex with a capture efficiency level of 5.0 or better in five consecutive years	Capture efficiency (targeting multiple areas with a CE of at least 5.0)	Entire South Bay	Monitoring not expected to begin for 5–10 years after pickleweed establishment in 300 acres or more	Rate of increase deviates significantly from projection		▪ See *Vegetation Establishment* above ▪ Adjust phasing and design; for example, add or enhance upland transition habitat within and between restored marshes ▪ Reconsider movement up staircase
Migratory Shorebirds Project Objective 1B	▪ Maintain numbers of migratory shorebirds at pre-ISP baseline numbers, if known, or as close to that baseline as can be determined.	▪ Use previously collected data (USGS, PRBO, SFBBO) on foraging shorebird densities, as well as modeled densities, to set targets for densities of foraging shorebirds for each restored/managed habitat type (*e.g.*, reconfigured ponds and restored mudflats) by season. Targets would be based on densities (by habitat type and/or geographic area) necessary to maintain pre-ISP numbers. Conduct limited surveys in a sample of habitats/locations within the SBSP Restoration Project Area to estimate foraging densities. ▪ Use existing data from Flyway Project surveys and data from initial few years of window surveys to determine the percentage of small migratory shorebirds that occur in the South Bay compared to the entire Bay. Monitor abundance in fall, winter, and spring via high-tide, baywide "window" surveys (in which multiple observers census a number of locations in a brief [*e.g.*, 3-day] period) conducted throughout San Francisco Bay. SBSP Restoration Project would provide for the coordination of these surveys.	▪ Monitoring stations in a sample of habitats/locations within the SBSP Restoration Project Area (for collection of data on shorebird densities in various habitats) and throughout the Bay Area (for collection of data on the percentage of small migratory shorebirds that occur in the South Bay compared to the entire Bay)	▪ Changes in shorebird foraging densities are expected to be immediate upon changes in management (*e.g.*, reconfiguration and management of a pond for optimal foraging depths, or conversion of a salt pond bottom to intertidal mudflat upon breaching of levees), although any changes in densities within a given habitat type will be slower. ▪ May take years or decades for the percentage of S.F. Bay birds using the South Bay to change in response to SBSP Restoration Project.	▪ 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 S.F. Bay small migratory shorebirds that use the South Bay is below the baseline (as determined using window survey data).	▪ Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? ▪ Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner? ▪ To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner? (including studies of mudflats and managed ponds invertebrate productivity, time-energy budgets for foraging birds, relative importance of and prey use in ponds with different salinities) ▪ Will intramarsh pond and panne habitats in restoring tidal marshes provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl?	▪ Analyze all available monitoring data for South Bay, Bay Area, and entire Pacific Flyway to determine whether declines are likely the result of SBSP Restoration Project, or the result of external factors. Coordinate with other Pacific Flyway studies; develop the larger structure for a centralized flyway monitoring network. ▪ Conduct Bay-wide survey to determine whether Project has displaced birds to other areas ▪ If declines are likely the result of SBSP Restoration Project: – Adjust design, for example reconfigure more ponds for use by foraging shorebirds – Adjust management, for example, manage more ponds for optimal water levels and salinities for foraging shorebirds ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Breeding Avocets, Stilts, and Terns Project Objective 1B	▪ Maintain numbers and breeding success of breeding avocets, stilts, and terns using the South Bay at pre-ISP baseline numbers, if known, or as close to that baseline as can be determined.	▪ Monitor total numbers of nesting Forster's and Caspian terns in the South Bay via comprehensive breeding-season surveys (per methods currently employed by SFBBO). Baseline has been established through past/ongoing monitoring conducted by SFBBO. ▪ Sample selected areas within the South Bay during the breeding season to determine the numbers of stilt/avocet nests in those areas. ▪ Estimate reproductive success by sampling a subset of breeding locations/colonies.	▪ Local (pond-level) scale for management actions, such as island creation, at specific ponds ▪ Entire South Bay for estimates of numbers (with estimates of breeding success in a few representative areas)	▪ Immediate response (increase) expected due to Phase 1 actions ▪ Longer-term trends monitored annually	▪ Decline in numbers (in the South Bay as a whole) or reproductive success of breeding stilts, avocets, and Forster's and Caspian terns below baseline for two consecutive years	▪ Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? ▪ To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner? (including predation and predator control studies, vegetation management approaches and Hg uptake in eggs, and related toxicity studies) ▪ Will California gulls, ravens, and crows adversely affect (through predation and encroachment on nesting areas) nesting birds in managed ponds?	▪ Analyze all available monitoring data for South Bay, Bay Area, and entire Pacific Flyway to determine whether declines are likely the result of SBSP Restoration Project, or the result of external factors (taking into account the downward trends in abundance of Forster's terns over last few decades, which are unrelated to salt pond conversion). ▪ If declines are likely the result of SBSP Restoration Project: – Undertake applied studies of habitat parameters, contaminant levels, prey availability and type, juxtaposition of nesting and brood rearing/foraging areas, predation pressure, and disturbance to determine appropriate design/management adjustments – Conduct Bay-wide survey to determine whether SBSP Restoration Project has simply displaced birds to other Bay-area locations. – Adjust design to construct more, or more optimal, nesting islands – Adjust design to reduce Hg uptake – Adjust management. For example, manage more ponds for optimal water levels and salinities for breeding and foraging stilts and avocets, manage more ponds for optimal water depths and salinities for foraging terns and/or control predation, vegetation, human disturbance. ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Diving Ducks Project Objective 1C	▪ Maintain numbers of diving ducks using the South Bay at pre-ISP baseline numbers	Use mid-winter waterfowl survey data to monitor winter numbers of diving ducks in the South Bay. Baseline has been set by previous mid-winter surveys and Accurso's studies.	Entire South Bay	Local changes in abundance are expected to be immediate upon changes in management (*e.g.*, reconfiguration and management of a pond, or conversion of a salt pond bottom to intertidal mudflat upon breaching of levees). Larger-scale changes in abundance will likely be slower (on the order of years to decades).	Decline in South Bay numbers below baseline conditions for two consecutive years	▪ Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance in the South Bay? ▪ Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? ▪ Will intramarsh pond and panne habitats in restoring tidal marshes provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term?	▪ Analyze all available monitoring data for South Bay, Bay Area, and entire Pacific Flyway to determine whether declines are likely the result of SBSP Restoration Project, or the result of external factors ▪ If declines are likely the result of SBSP Restoration Project: - Undertake applied studies of habitat use and effects of human disturbance to determine appropriate design/management adjustments - Adjust design to increase the restoration of shallow subtidal habitat - Adjust management. For example, manage more ponds for optimal water depths and salinities for foraging diving ducks and/or control human disturbance ▪ Reconsider movement up staircase
Salt Pond Associated Migratory Birds (Wilson's and Red-necked Phalaropes, Eared Grebes, Bonaparte's Gulls) Project Objective 1B	▪ Maintain these species' use of SBSP Restoration Project Area ▪ Minimize declines in the South Bay relative to pre-ISP baseline	Focused surveys would be conducted targeting seasonal peaks (*i.e.*, late summer/early fall for phalaropes, fall and winter for Eared Grebes and Bonaparte's gulls) and geographic concentrations (*e.g.*, high-salinity ponds and other areas known to support large proportions of South Bay numbers of these species) to determine the numbers of these species using the South Bay.	Entire South Bay (as determined by surveys in areas where these species are concentrated)	Local changes in abundance are expected to be immediate upon changes in management (*e.g.*, reconfiguration and management of a pond, or conversion of a salt pond bottom to intertidal mudflat upon breaching of levees). Larger-scale changes in abundance will likely be slower (on the order of years to decades).	Three consecutive years in which numbers are more than 25% below the NEPA/CEQA baseline, or any single year in which numbers are more than 50% below NEPA/CEQA baseline	▪ Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? ▪ Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner?	▪ Analyze all available monitoring data for South Bay, Bay Area, and entire Pacific Flyway to determine whether declines are likely the result of SBSP Restoration Project, or the result of external factors (taking into account declines that have already occurred due to ISP). ▪ If declines are likely the result of SBSP Restoration Project: - Adjust management to have more ponds with optimal water levels and salinities for foraging pond-associated birds ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Western Snowy Plovers Project Objective 1A	▪ Contribute to the recovery of the western snowy plover by providing habitat to support 250 breeding birds within SBSP Restoration Project Area, and maintain a 5-year average productivity level as required by the Recovery Plan.	Snowy plover numbers and estimated nest success, determined through comprehensive, annual South Bay surveys and monitoring during the breeding season	Entire South Bay for estimates of numbers (with estimates of breeding success in a few representative areas)	Local changes in abundance are expected to be immediate upon changes in management (*e.g.*, reconfiguration and water level/prey management of ponds). Longer-term trends will be monitored annually.	▪ Rate of population change declines substantially from projected trajectory toward target ▪ South Bay population declines in any given year below 2006 baseline	Will shallowly flooded ponds or ponds constructed with islands or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds compared to existing ponds not managed in this manner? (including predation studies and predator control studies, vegetation management approaches, and Hg- related toxicity studies	▪ Analyze all available monitoring data for South Bay, Bay Area, and entire Pacific Flyway to determine whether declines are likely the result of SBSP Restoration Project, or the result of external factors (taking into account the downward trends in abundance of plovers over last few decades, which are unrelated to salt pond conversion). ▪ If declines are likely the result of SBSP Restoration Project: – Undertake applied studies of habitat parameters, contaminant levels, prey levels/type, juxtaposition of nesting and brood rearing/foraging areas, predation pressure, and disturbance to determine appropriate design/management adjustments – Adjust design to construct more, or more optimal, nesting habitat, create more open salt panne habitat, and/or to reduce Hg uptake – Adjust management of water levels and salinities in more ponds for optimal breeding and foraging habitat and/or control predation, vegetation, human disturbance ▪ Reconsider movement up staircase
California Least Terns	▪ Maintain numbers of post-breeding California least terns in the Project Area at multi-year average levels including natural variation in numbers; avoid negative effect of SBSP Restoration Project on Bay-area least tern breeding bird numbers (multi-year average	Counts of birds using the South Bay as a post-breeding foraging area (or breeding area, if that occurs) and breeding pairs at Bay-area nesting colonies	Post-breeding foraging sites and breeding colonies	Local changes in abundance may be immediate upon changes in management (*e.g.*, reconfiguration and management of a pond, or conversion of a salt pond bottom to intertidal mudflat upon breaching of levees). Larger-scale changes in abundance will likely be slower (on the order of years to decades).	Decline in total number of birds using the South Bay as a post-breeding foraging area or breeding pairs in the S.F. Bay Area below 2006 baseline levels, in any given year		▪ If numbers decline, first use available information to attempt to determine whether declines are resulting from SBSP Restoration Project or other factors (*e.g.*, the impact of South Bay California gulls on nesting colonies or changes in Bay fisheries). ▪ Conduct applied study of post-breeding habitat use and diet, especially in the South Bay. ▪ Implement management or adjust design (*e.g.*, if applied study finds

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
	levels with natural variation)						more foraging occurs in ponds than Bay, manage more ponds for suitable least tern foraging conditions). ▪ Reconsider movement up staircase.
Steelhead Project Objective 1C	▪ Enhance numbers of salmonids and juvenile in rearing and foraging habitats relative to NEPA/CEQA baseline numbers	Counts of upstream-migrating salmonids to monitor spawning populations in South Bay streams	South Bay spawning streams	5–10 years likely for effects of restoration on salmonids to be detectable	Reduction in number of upstream-migrating salmonids	Will increased tidal habitat increase native fish and harbor seal survival, growth and reproduction? (including specific study of steelhead)	▪ If numbers decline, first use available information to attempt to determine whether declines are resulting from SBSP Restoration Project or other factors (*e.g.*, factors associated with spawning streams). ▪ Conduct applied study of constraints to population growth (ex: Hg, water quality, food chain). ▪ Conduct applied study of condition of salmonids seaward of restoration site (sample Chinook using minnow net upstream from, at, and downstream from restoration sites before and after restoration; determine whether fish are larger and healthier after than before restoration). ▪ If numbers decline, conduct diet studies on piscivorous birds (to determine whether increased bird predation is responsible). ▪ Implement management or adjust design (*e.g.*, restore more tidal habitat adjacent to spawning streams). ▪ Reconsider movement up staircase.
Estuarine Fish Project Objective 1C	• Enhance numbers of native adult and juvenile fish in foraging and rearing habitats relative to NEPA/CEQA baseline numbers	▪ Presence/abundance of surfperch in restored marshes (as measured in permanent monitoring locations with pilings installed to facilitate monitoring) ▪ Presence/ absence of native flatfish, such as starry flounder, in restored un-vegetated shallow water areas ▪ Species richness and	Monitoring results will reflect conditions at monitoring stations scattered throughout the SBSP Restoration Project Area, in tidal habitat, ponds, and sloughs	Varies by trigger – ▪ fish are expected to move into newly restored areas almost immediately but assemblages will change as habitat matures ▪ surfperch not expected to use restored marshes until vegetation is established ▪ negative impacts may be immediate if poor water quality from a pond	▪ Detection of a fish die-off ▪ Absence of detections of surfperch using restored tidal marsh ▪ Increase in percent of individuals sampled in restored marshes that are non-native ▪ Detectable reduction in water quality (as determined by monitoring described under “Water Quality” Key	Will increased tidal habitat increase native fish abundance and will restored habitat support healthy populations? (including specific study of native estuarine fish)	▪ Use available information to attempt to determine whether declines are resulting from SBSP Restoration Project or other factors (*e.g.*, factors associated with spawning streams). ▪ Applied study of constraints to population growth (ex: Hg, water quality, food chain) ▪ If fish populations decline, conduct diet studies on piscivorous birds (to determine whether increased bird predation

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
		abundance of native fish species in a range of habitats including restored marshes and associated unvegetated shallow water areas, major and minor sloughs, and deep and shallow-water ponds ▪ Water quality parameters (see "Water Quality" Key Category)		discharge causes a die-off	Category) ▪ Deviation from expected trajectory of native fish use of restored marshes and associated unvegetated shallow water areas		is responsible). ▪ Consider possible effects of recreational angling pressure. ▪ Implement management or adjust design (*e.g.*, remove more levees to increase connectivity in restored ponds) based on study results ▪ Reconsider movement up staircase
Harbor Seals Project Objective 1C	▪ Maintain or enhance numbers of harbor seals using the South Bay	▪ Conduct periodic monitoring at known South Bay haul-out sites (*e.g.*, Mowry, Newark & Alviso Sloughs, and expand to include haul-out site in Corkscrew Slough) to determine trends in productivity and abundance, and changes in distribution. If incidental sightings at other areas are not adequate to determine if new haul-out sites are established, periodically survey other locations as well. Existing data include over 5 years of weekly survey data for Mowry and Newark sloughs, and 5 years of monthly survey data for Alviso Slough. ▪ Mercury parameters (see "Mercury" Key Category)	Focal areas (*i.e.*, known haul-out sites) throughout South Bay	Negative response to human disturbance from improved public access may be immediate; response to habitat restoration or increased mercury availability may be longer-term (a decade or more)	▪ Decline in overall South Bay numbers and pup production, if known, at haul-out sites below 2006 baseline levels for 2 consecutive years ▪ Reduction in frequency of use and pup production, if known, of Mowry Slough and adjacent haul-out/pupping areas	▪ Will increased tidal habitat increase native fish and harbor seal survival, growth and reproduction? ▪ Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales?	▪ See management actions under "Mercury" and "Public Access" Key Categories ▪ Other potential management actions may include: - Restrict public access and/or improve public education near seal haul-out sites - Create seasonal closure in areas that might be appropriate for seal protection during pupping season, including buoys restricting access to sloughs to boats and land-based trails. - Enforce protective measures such as increased patrolling etc. ▪ If seal populations decline or pupping rates decline, conduct studies on seal health (pollutant exposure), potential disturbance changes, habitat/prey alternations (fish declines or fish community changes), or reduced access to sites due to steep gradient, tidal restrictions, or insufficient deep water
Public Access Project Objective 3	▪ High quality visitor experience is maintained ▪ Facilities are not degraded by over usage	▪ Visitor use surveys (numbers, activities, demographics, overall experience and peak use (surveys yearly) ▪ Staff observations ▪ Complaints or compliments registered with land managers ▪ Cost of maintaining facilities	Within the Project Area.	Based on construction of facilities and public use (5+ years of usage)	▪ Survey results show dissatisfaction ▪ Overcrowding at staging areas ▪ Conflicts between users (recorded incidences) ▪ Maintenance costs exceed budget	▪ Will public access features provide the recreation and access experiences visitors and the public want over short or long timescales? (Study visitor traits and use patterns, visitor satisfaction with experience, public demand for other uses, facility degradation)	▪ Adjust design. For example, limit number of visitors to a given area, provide alternate use times for certain activities and/or reduce development of some uses, increase others, based on demand. ▪ Hold public meetings/workshops to inform the public of applied studies findings to determine how best to meet public recreation

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
							desires given specific problems ▪ Hold charrette (group design process over 1-day)
Public Access Project Objective 1A, B, C	▪ Public use does not prevent reaching restoration targets as measured by significant impacts to target species.	Numbers, species richness and behavior of target species in public access areas	Within the Project Area, except as noted in restoration targets for shorebirds, diving ducks, breeding birds, California clapper rail, Western snowy plovers, and harbor seals.	Some parameters are immediate (*i.e.*, behavior); others may take 3 years or much more	▪ For species or guilds without specific population targets: statistically significant abundance, species richness or behavioral changes compared to control sites ▪ For species with population targets: reduction in abundance or density of breeding and/or non-breeding animals due to public access	▪ Will landside public access significantly affect birds or other target species on short or long timescales? (including studies of waterfowl, clapper rail and snowy plover responses to public access, and roosting bird response to public access) ▪ Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales? (including studies of waterbird response to boaters)	▪ Adjust design. For example, provide edge condition to prevent visitors from moving off-trail (*e.g.*, fencing). change design to reduce wildlife disturbance based on study findings, or, in sensitive areas, restrict public access and redirect. ▪ Increase public access if species goals are met, but continue to monitor species' response ▪ Evaluate changes in population or density of species with population targets in light of restoration targets and other impacts on the species ▪ Design future phases to avoid significant impacts to species and optimize public access in areas of little or no species impact

APPENDIX 4.
Suggested Proposal Solicitation and Directed Studies Processes

PART 1. PROPOSAL SOLICITATION

Calls for Proposals

The Science Program managers will direct the process for developing questions for study. When the list of approved applied study questions has been developed, the science managers and PMT will develop one or more competitive calls for proposals designed to solicit proposals from as wide a pool of respondents as possible. The call for proposals will be reviewed by the appropriate management and technical oversight bodies. The sponsoring agencies will also publicize the criteria to be used in proposal evaluation (see draft list below).

Pre-Proposals. In order to reduce the necessity for a large number of proponents to expend much effort in developing proposals that are eventually not funded, the Project's science managers will require that all proposals be preceded by a brief pre-proposal. Pre-proposals will be reviewed by the sponsoring agency staff, PMT, and the Science Program managers to ensure that the proposed work is responsive to the call for proposals, that the proposed work has apparent scientific merit, and that the funding request seems reasonable.

Proposals. For those selected pre-proposals, researchers will submit a proposal study plan that contains sufficient information to allow for technical and statistical evaluation by peer reviewers, including details about experimental design, field and laboratory procedures, data collection, and quantitative methods. The following format is recommended:

1. *Cover sheet* – A transmittal document that includes the call for proposals number and date; the title of the proposal; a brief statement of the purpose and objectives of the proposed study; the total funding requested by year; the name and home institution(s) of the PIs and Co-PIs; the name of the institution's Grant Administrator; the applicant's tax status; and dated signature lines for the Principal Investigator(s) and the institutional representative.
2. *Abstract* – A brief, topical abstract (200 words or less).
3. *Background and justification* – Statement of the problem(s) being addressed, hypotheses being tested, information needed, and relationship/relevance of the problem(s) being addressed to other South Bay Salt Pond Restoration Project projects or sponsoring agency projects and programs, with reference to appropriate literature citations regarding the problem(s).
4. *Study Objectives* – Description of the planned outcome of the study
5. *Study area(s)* – Description of the study location, i.e., whether it is a field and/or laboratory study. A field study proposal should include clear identification and description of the study sites, with a map.
6. *Approach* – Description of the study approach, with sampling and analytical procedures clearly described for each objective. Include details on methods/techniques, equipment and facilities, data collection, statistical analysis and quality assurance procedures, and describe the criteria to be used in hypothesis testing.

7. *Data archiving procedures* – Description of how the data will be handled, stored, and made accessible. All data collected under the auspices and funding of the South Bay Salt Pond Restoration Project will be made accessible through a Project database and website.
8. *Work Schedule* – An annual time line with expected start and stop dates, and accomplishment of major milestones.
9. *Hazard assessment/safety certification* – Identification of anticipated hazard or safety concerns affecting project personnel (e.g. aircraft, off-road vehicles, chemicals, and extreme environmental conditions).
10. *Permission to access CA Department of Fish & Game and US Fish & Wildlife Service lands* – Documentation of permission to access government property for purposes of conducting research and monitoring, or documentation that permission will be granted if funding is provided.
11. *Animal care and use certification* – Discussion of anticipated uses of animals in the research, including copies of approved forms for animal care and use. If animals are not to be used, collected, manipulated, or experimented upon, include a specific statement to the fact that no animals will be used in the research.
12. *Expected product(s)* – List of planned publications, reports, presentations, advances in technology, information transfer at workshops, seminars, or other meetings.
13. *Qualifications of Investigators, partnerships, and cooperators* – Brief resumes (two pages) of the principle investigators that include descriptions of the qualifications of principal personnel, identification of affiliations, expected contributions to the effort, including logistical support, and relevant bibliographic citations.
14. *Budget and staff allocations* – Detailed budget including salaries and benefits for each participant and costs for travel, equipment, supplies, contracted services, vehicles, and necessary overhead.
15. *Literature cited* – List of all of the publications cited in the text of the proposal.
16. *List of potential reviewers* – Names (minimum of three) and addresses of research scientists with subject area expertise who could serve as peer reviewers for the proposal.

Proposal Review Process

The South Bay Salt Pond Project will award research grants that are selected competitively on the basis of technical merit and relevance of the proposed work to South Bay Salt Pond Restoration Project goals and objectives. To do this, the Science Program managers will institute an objective process for the anonymous peer evaluation of proposals that is efficient and achieves broadest acceptance of the process within the scientific and resource management communities. Peer-review panels will consist of experts external to the Project. The PMT will select the projects to be funded based on the results of the peer review and the Project priorities.

Peer Review. Peer-review panels should include enough technical experts to thoroughly evaluate all topical areas of the proposals. The panel members should be active estuarine, freshwater or watershed research scientists/engineers who have a high degree of stature, are well connected with other scientists in their respective fields, represent different specialties within these fields, and have some familiarity with the San Francisco Bay estuarine system. Science Program managers will ensure that panel members have no conflicts of interest (e.g., current or pending support from the Program). Reviewers will score the proposals, based on their scientific merit and the relevance to the call for proposals, with numerical ratings from 1 (Poor) to 5 (Excellent) using the following criteria:

- Technical merit including (a) research scope, justification, and importance of expected results; (b) reasonableness of the hypotheses and experimental design; (c) soundness of proposed steps for data collection, analysis and synthesis
- The appropriateness of the proposed study to the South Bay Salt Pond Restoration Project goals and objectives and responsiveness to the call for proposals.
- Qualifications of the investigators and adequacy of the facilities for carrying out the proposed research
- Reasonableness of costs
- Likelihood of success

In the case of continuing projects, consideration will also be given to the level of progress achieved to date.

When all reviews have been received, the proposals will be ranked by the peer-review panel. The panel will develop an overall prioritization of the proposals and will transmit its funding recommendations to the Science Program managers and the PMT.

PMT Review. The PMT will provide its review and approval of the new proposals to be funded based on the funding available for support of the proposals under each call for proposal. In its deliberations, the PMT, guided by the Science Program managers, will give most serious consideration to those proposals having been rated 4 or 5 by the Peer Review Panel, and will not select proposals rated 1 or 2. The PMT will also evaluate renewal proposals for continuation beyond the first year.

PART 2. DIRECTED STUDIES PROGRAM

In the course of developing the focused research questions, it will probably become apparent that a specific, sustained research effort may be necessary to resolve one or more of the areas of uncertainty regarding the important resources of the bay-delta-watershed critical to the Restoration Project's goals and objectives. Examples of such needs might include the following:

- Developing an understanding of a specific ecological phenomenon over long temporal and/or large spatial scales
- Conducting major synthetic and theoretical efforts
- Providing information for the identification and solution of specific salt pond management or restoration problems
- Quantifying the linkages between potential stressors and the abundance of species populations

Addressing such needs may require interdisciplinary research coordinated among investigators, experimental studies across a range of appropriate spatial and temporal scales, and development of analytical and numerical models of critical ecosystem functions and responses to management actions.

Given the scope and complexity of some of the issues facing the Restoration Project, it may be necessary to support such sustained commitments of effort irrespective of the responses of scientists/engineers to the annual requests for proposals. In such cases, the PMT may wish to contract with specific individuals or entities, because of recognized expertise, accomplishment, and past responsiveness, to carry out a program of directed research that is not well accommodated in the year-to-year call for proposals process.

Such questions, identified by the Science Program managers and PMT, will become the subject of contractual arrangements with specific individuals or entities. In each case, the individual/entity will develop a research proposal, using the call for proposals format described above, that will be subject to review and concurrence (or rejection) by the Science Program managers and other additional subject-matter referees as necessary, with revisions being made accordingly.

In recognition of the need in these instances for sustained study effort, funding will be provided to successful proponents for specified periods up to 5 years. It is expected, therefore that the Directed Research Program proposals will incorporate a detailed multi-year strategy and budget. It will also be understood that the Principal Investigator(s) will be expected to make a long-term commitment to meeting the critical South Bay Salt Pond Restoration Project research need(s) described in the contract.

The sustained research efforts under the Directed Research Program will be subject to frequent, vigorous peer review, i.e., at the proposal stage, during the conduct of the research, and upon the conclusion of the study. Written progress reports will be required at the end of each year, or sooner if needed, with a full review of project progress and accomplishment by the Science Review Board at least every three years. Contract renewals will be contingent upon the successful demonstration of progress toward meeting project goals and Restoration Project needs and the submittal of meritorious renewal proposals.

APPENDIX 5.
Descriptions of Phase 1 Applied Studies at Ponds E12/13 and A16/SF2

Experiments designed to address selected key uncertainties regarding bird use of managed ponds will be conducted as part of the Phase 1 actions. Specifically, these experiments address two key uncertainties: the extent to which managing ponds for target depths and salinities will increase pond use by waterbirds compared to existing ponds and the extent to which reconfiguring ponds to provide numerous nesting islands will increase the densities of nesting and foraging birds compared to existing ponds. The results of these experiments will inform adaptive management approaches to management of ponds throughout the SBSP Project area for selected bird species or groups of species.

Phase 1 Applied Studies at Ponds E12/E13

Key uncertainty: Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner? Ponds managed as small-scale salt pond systems may provide enhanced benefits for wide range of birds. But, the extent to which they can improve the prey base and increase foraging shorebird densities in the short and long-term is not known.

Background/Rationale
Eden Landing Ponds E12 and E13 would be reconfigured to create shallow-water foraging habitat for migratory shorebirds, with a range of salinities, and a limited number of islands for nesting bird habitat (Figure 1). The restoration action would help maintain populations of bird species breeding at the salt ponds (project objective 1B.1) through the creation of nesting island and berm habitat; maintain habitat for salt pond-specialized birds (project objective 1B.2) by creating cells with elevated salinities; and maintain population levels of foraging shorebirds (projective objective 1B.3) by managing water levels and salinities to maximize foraging potential. These reconfigured ponds would test the extent to which focused management of shallow water habitats can increase migratory shorebird densities, the importance of salinity on the density of foraging shorebirds and their prey as applied studies, and techniques for vegetation management, predator management, and water and salinity management. The specific studies described below will address the following hypotheses:

- To what the extent will focused management of shallow-water habitats increase the densities of foraging shorebirds?
- What is the importance of salinity to the density of foraging shorebirds and their prey?

Applied Study Design Concepts
Several shorebird species, particularly Wilson's and Red-necked Phalaropes, have long been known to occur in the South Bay primarily within higher-salinity ponds. These species generally forage in high-salinity ponds throughout the tidal cycle. In addition, studies by PRBO and others have demonstrated that some species that typically forage on intertidal habitats during low tide, such as Western Sandpipers and Dunlin, show an affinity for higher-salinity (vs. lower-salinity) ponds at high tide, and that many individuals of these species forage in higher-salinity ponds at high tide. However, very high densities of shorebirds have also been observed foraging in South

Bay ponds that do not have high salinities, but do have optimal foraging depths for small shorebirds. The experiment at Ponds E12 and E13 would assess whether foraging shorebirds prefer low, moderate, or high salinity levels (and the associated prey types) in cells with similar shallow water depth habitat. The results of this experiment would determine the need for ponds with elevated salinity levels for foraging by migratory shorebirds in future phases of the project within the Adaptive Management Plan. Monitoring of the use of the constructed islands by nesting birds may provide some information regarding nesting bird use at the different salinity levels in the pond; however, this would not be the focus of the Ponds E12 and E13 applied study.

Study Methodology

Shorebird monitoring. Shorebirds in all cells would be monitored every other week from mid-July through April by observers walking or driving along the perimeter of the ponds (using spotting scopes). During each survey, the number of individuals of each species roosting and foraging in each cell during a two-hour period at high tide and a two-hour period at low tide (on the same day) would be recorded.

For an additional two hours during high tide, individual birds would be observed while foraging in an attempt to determine prey species. For a two-minute period, a single foraging individual would be watched. The foraging habitat, water depth, foraging method, and number of prey items taken by prey type (if determined) and foraging method would be recorded. If the bird spends time foraging in different habitat types (*e.g.*, mud vs. water) or using different methods, the proportion of the two-minute focal period spent using different habitats or methods would be recorded. After two minutes, a different bird would be observed, and so on, so that all the major species foraging in the ponds are represented by observations. Equal time observing foraging behavior would be spent in each of the three salinity treatments. The purpose of these observations would be to collect data that can be used to determine the optimal foraging conditions for birds within these ponds, and to attempt to relate foraging behavior and success to prey type and abundance (based on foraging habitat, water depth, foraging method, and in the case of larger prey items, observation of the prey items).

Prey monitoring. Invertebrates would be sampled at 10 locations within each salinity treatment during every other survey (*i.e.*, once/four weeks). Prey abundance would be estimated from these samples, including samples from both the water column and substrate, by prey type. Water depth, salinity, and temperature would be recorded at each sampling location.

Timeframe. The study would commence immediately following construction when water level management is underway. It is anticipated that a response to the reconfigured habitat will be discernable in the first season. However, meaningful results should be available after 5 years of monitoring.

Management Response

The extent to which salinity differences are found to affect shorebird species composition and density, foraging behavior of these birds, or the density and availability of important prey species will inform the future management of ponds within the SBSP Project area. If salinity differences significantly influence the use of managed ponds by waterbirds, future pond management in other areas may include salinity management to optimize densities of foraging birds. The results of this experiment, with respect to certain water salinities or depths corresponding to high densities of particular bird species, will also be used to optimize pond management for specific species or groups of species.

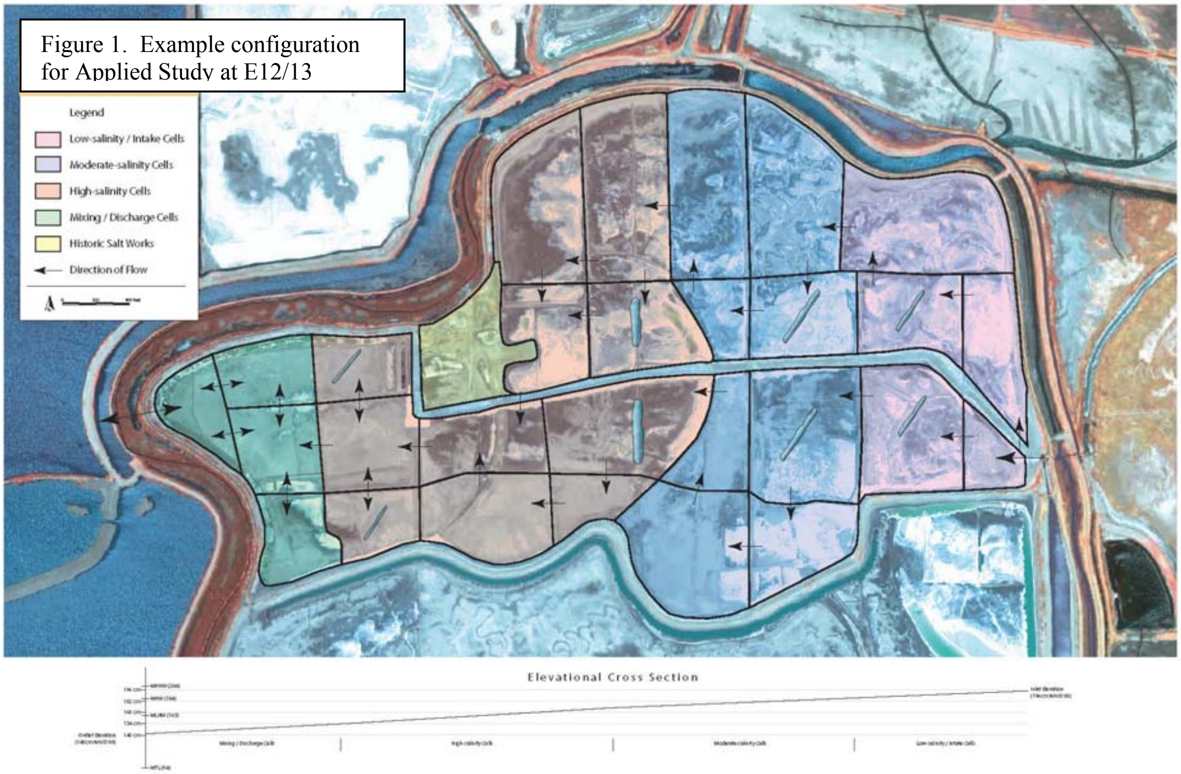


Figure 1. Example configuration for Applied Study at E12/13

Phase 1 Applied Studies at Ponds A16/SF2

Key uncertainty: Will ponds that are reconfigured to create large isolated islands for nesting and foraging significantly increase reproductive success for terns and other nesting birds and also increase the numbers and densities of foraging birds over the long term compared to existing ponds not managed in this manner? Constructing islands within managed ponds is expected to increase the densities of nesting birds in those ponds, and certain island shapes or densities may result in higher use by nesting birds than others. However, the extent to which nesting bird densities can be increased and sustained by island construction, and the shapes and densities of islands that will optimize bird use, is not known.

Background/Rationale
The A16 and SF2 managed ponds would be reconfigured to create islands for nesting birds and would be managed to provide shallow-water habitat for foraging waterbirds, particularly shorebirds (Figure 1). The Phase 1 actions at Ponds A16 and SF2 would help maintain populations of bird species breeding at the salt ponds (project objective 1B.1) through the creation of nesting islands and population levels of foraging shorebirds (projective objective 1B.3) by managing water levels to maximize foraging potential. These reconfigured ponds would test bird use of different island configurations as an applied study, and would also test management techniques for vegetation management, predator management, and water quality management. The specific studies described below will address the following hypotheses:

- Will pond reconfiguration to include numerous islands, and water-level management, increase the density of nesting and foraging shorebirds within Pond A16?
- Does island shape and density affect nesting success?
- Does vegetation type and density affect nesting success on the islands?
- Does passive human activity on trails affect nesting success on nearby islands?

Applied Study Design Concepts
Various nesting bird species may respond differently to different island shapes. For example, highly colonial species such as terns may make more use of circular islands while shorebirds such as Black-necked Stilts, American Avocets, and Snowy Plovers may benefit from long, linear islands. In addition to contrasting shapes, it is important to understand the effect of island density on habitat value. For example, high-density islands may reduce foraging area between islands and increase aggressive interactions among family groups of American Avocets and Black-necked Stilts. Vegetation also plays an important role in nesting success, as different birds species have varying vegetation tolerances or requirements. Snowy Plovers typically avoid vegetated areas for nesting, and avocets usually nest in bare or sparsely vegetated areas. While some South Bay tern colonies are located in areas with little or no vegetation, other tern colonies, as well as many Black-necked Stilt nests, are located in areas having some vegetation, which may also provide shade and cover from predators for chicks. Nesting waterfowl are likely to nest almost exclusively in vegetated areas. Although human activity in the vicinity of Ponds A16 and SF2 is expected to be limited to non-motorized recreation (*i.e.*, walking or biking around the outer levee of the pond) and pond/island maintenance, it is unknown whether this level of activity will affect island use or nesting success by birds.

The experimental studies designed for Ponds A16 and SF2 will provide an important model for island design, provide an understanding of the vegetation requirements of various pond-breeding bird species, and determine an acceptable level of human activity for reproductive success of bird species using managed ponds. This understanding will help inform and guide the design of optimal pond configurations that would be used at other locations in the South Bay.

Study Methodology

Island spacing, shape and distance to adjacent islands. Varying densities of islands will be created within Ponds A16 and SF2 to study the effects of island density on nesting bird use. There will be two island shapes: circular and linear (much longer than wide) to determine whether various nesting bird species respond differently to contrasting island shapes.

Vegetation type, density, and distribution. Vegetation is expected to establish on some of the islands after one or more years. At that point, the vegetation can either be controlled or vegetation can be manipulated by planting or selective removal, to determine the effects of vegetation type, density, and spatial distribution on nesting use and reproductive success of bird populations. The species composition, type of vegetation, and vegetation distribution will be manipulated by planting or selective control/removal to conduct studies to determine the effects and distribution of vegetation on nesting success. The decision regarding which plant species will be used in actual experiments will be determined by monitoring which vegetation types invade (and thus can be expected to survive on the islands) during the first few years following island construction.

Human activity. To determine whether human activities affect nesting birds at Ponds A16 and SF2, a portion of the trail around each pond (*e.g.*, along the entire northeastern side of Pond A16) could be closed during the breeding season every other year. The number of nests, and nest success and fledging success, would be estimated for a sample of islands to determine whether the location, number, and breeding success of birds varies depending on whether or not portions of the levee trails are open to human activity.

Timeframe. The study would commence prior to project implementation so that pre-construction conditions are documented. It is anticipated that a numerical response to island construction will be discernible in the first season after construction is complete and water level management is underway. However, it may be a few decades before ultimate densities are achieved as future phases of tidal restoration for the SBSP Project continue to reduce the amount of existing salt pond and levees available as potential nesting habitat.

Management Response

The extent to which the construction of nesting islands results in increased densities of nesting birds will inform the degree to which nesting islands are constructed in other managed ponds in the SBSP Project area. Species' responses to the shape and density of nesting islands will also help determine the types of islands that are constructed for nesting birds, and whether islands of various shapes or densities must be provided to optimize use by various species. The responses of nesting birds to vegetation type, density, and distribution will inform how the substrate on nesting islands should be managed for different species. If nesting birds respond negatively to increased human activity around the ponds, public access to trails will be modified (either spatially or temporally) to minimize disturbance. If no negative effects of human activity are noted, public access to trails will be incrementally increased and monitoring continued.

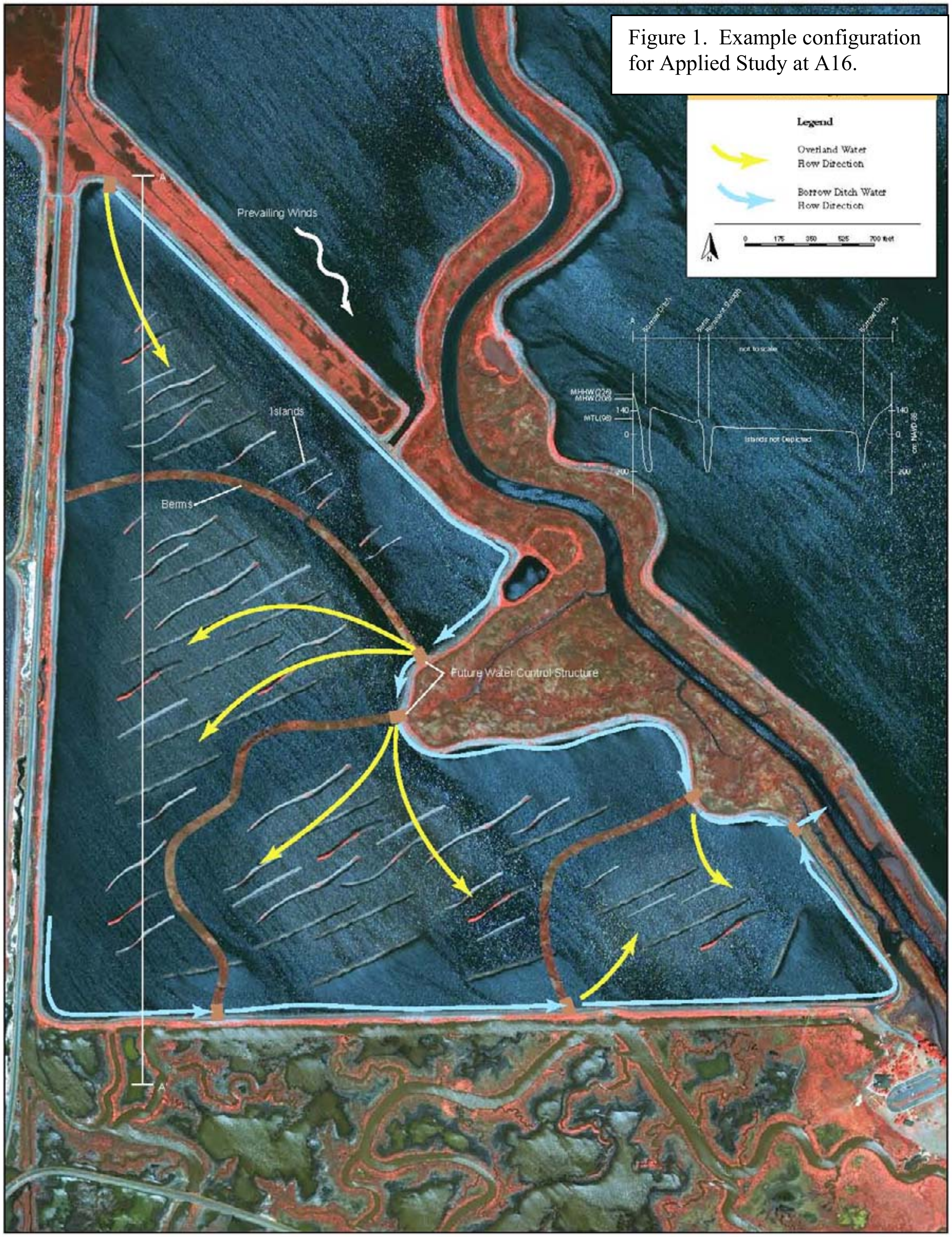


Figure 1. Example configuration for Applied Study at A16.

Appendix C.
Underwater Noise Analysis for Phase 2 Construction

M E M O R A N D U M

TO:	Members of the South Bay Salt Pond Restoration Project Management Team
FROM:	AECOM
DATE:	08/1/2016
RE:	**Underwater Noise Analysis for Phase 2 Construction**

1 Purpose

This memorandum provides an analysis of the potential for underwater noise resulting from the South Bay Salt Pond (SBSP) Restoration Project's Phase 2 actions to affect biological resources. This memorandum described potential underwater noise effects that will be needed for development of Endangered Species Act (ESA) consultation, and other regulatory agency permitting processes such as California Endangered Species Act (CESA), and a makes a recommendation on whether or not an Incidental Harassment Authorization (IHA) pursuant to the requirements of the Marine Mammal Protection Act (MMPA) should be requested for those actions.

2 Project Description

The SBSP Restoration Project is a multi-agency effort to restore tidal marsh habitat, reconfigure managed pond habitat, maintain or improve flood protection, and provide recreation opportunities and public access in 15,100 acres of former salt-evaporation ponds purchased from and donated by Cargill Incorporated (Cargill) in 2003. These former salt ponds are part of the U.S. Fish and Wildlife Service (USFWS) owned and managed Don Edwards San Francisco Bay National Wildlife Refuge (Refuge), and cover approximately 9,600 acres in the South San Francisco Bay (South Bay).

The selection of and planning for the Phase 2 projects started in 2010 and completed its Final EIS/R in April 2016. The project is currently developing more detailed designs sufficient to inform applications for permits and other regulatory agreements for work at four groups of ponds ("pond clusters") in the Ravenswood and Alviso pond complexes. The four Refuge ponds clusters in Phase 2 are collectively nearly 2,400 acres in size. One regulatory agreement that may be needed is an IHA under the MMPA.

The SBSP Restoration Project's proposed actions for Phase 2 provide a variety of habitat enhancements at all four Phase 2 pond clusters. It also includes maintained or increased flood protection and additional public access and recreation features at two of the pond clusters. Figure 1 and Figure 2 show the regional location and the vicinity of the Phase 2 pond clusters. Figures 3 through 7 illustrate the proposed construction as it would be implemented at each of the Phase 2 pond clusters. Generally speaking, Phase 2 activities include:

- Breaching, lowering, and removal of levees to provide tidal flows to pond interiors and to improve habitat connectivity
- Raising and improving certain levees for flood control
- Excavation of pilot channels to improve drainage and connect ponds to external waterways
- Construction of viewing areas and trails
- Installation of water control structures to enhance managed pond habitats
- Construction of habitat transition zones and habitat islands
- Building bridges over two new levee breaches, which would be armored to prevent scour
- Improvements to Pacific Gas and Electric (PG&E) transmission tower footings and associated access boardwalks

Of the above activities, only the construction of bridges and the installation of one particularly long water control structure are expected to require pile driving or other activities that would generate substantial under water noise. Only hand tools would be used for the improvements to PG&E transmission towers and the associated boardwalks. Hand tools would not generate substantial noise and thus are not considered in this analysis.

Pile driving would occur at three locations. Two of these locations (rail car bridges) are located along Whisman Slough/Stevens Creek, approximately 2,300 and 4,000 feet from its mouth with the bay, respectively. The third pile driving location (water control structure) is at the terminus of Flood Slough near the southeast corner of Bedwell Bayfront Park. This point is located approximately 3,500 feet from where Flood Slough meets others and flows around Greco Island before meeting the open Bay. Piles may be driven here to support a 100 foot-long (or longer) water control structure under the entrance road to Bedwell Bayfront Park.

Two rail car bridges would be installed to extend over the armored breaches on the eastern levee of Pond A2 and would provide access to existing PG&E utilities. These bridges would be approximately 60 feet long and 10 feet wide. The bridges would span the two proposed breaches along the Pond A2W east levee to provide all-weather PG&E access route to the utility’s facilities near the northwest corner of Pond A2W. A public access trail for bicycle and foot traffic would also be built on this levee and would use these bridges.

The railcar bridge superstructure would rest on top of cast-in-place concrete abutments. The integrated concrete wing walls would be built with stem to contain the embankment. Because the bridge is not subject to busy traffic, a concrete approach slab is not required. The abutments would be supported with multiple 14-inch x14-inch precast pre-stressed concrete piles with an estimated total of eight piles at each abutment. The pile length is assumed to be 45 feet long. Armoring and bridging of breaches would be done in dry conditions. Therefore, installation of temporary cofferdams would be required at the breach and bridge locations to facilitate the construction of concrete abutments and wingwalls. This analysis assumes the abutment piles would be driven with an impact pile driver, which is the installation method typically used for concrete piles. It is also assumed that creation of these cofferdams would use vibratory driving of 24-inch steel sheet piles. Pumped water would be discharged downstream of the construction area and possibly directed to Pond A2W or the lower end of Stevens Creek, shown on some maps as Whisman Slough.

The water control structure at Flood Slough would likely be supported by several 14-inch concrete piles. It is assumed that a temporary cofferdam, constructed of 24-inch steel sheet piles, would also be constructed at this location to temporarily dewater the site.

3 Site Conditions and Sensitive Resources Considered

Factors such as topography, bathymetry, and sediment type are important factors in considering how underwater noise propagates through the environment. This section also briefly describes the sensitive resources that are considered in this memorandum.

3.1 Site Topography, Bathymetry, and Sediment Profile

The portions of the project area that are above Mean Higher High Water (MHHW) are limited to levees and other areas of fill that parallel the sloughs and border the ponds of the project area. The levees and other areas of fill would greatly limit the movement of pile driving noise during construction, as the compacted fill of the levees is expected to reflect and absorb sound energy with very little transmission into the surrounding waters.

The project area is located in very shallow waters, ranging from approximately 0 feet Mean Lower Low Water (MLLW) in Flood Slough, -2 feet MLLW in Whisman Slough/Stevens Creek, and 4-5 feet MLLW within large areas of the ponds. The Ravenswood Ponds currently have no tidal connection to the Bay, and are dry unless rainwater collects in the ponds. The maximum tidal range there is approximately 9 feet, meaning that water depths would be, at most, 11 feet in the deepest parts of the project area.

Though the Phase 2 ponds vary in their own depth and hydrology, they all have bay mud as the dominant substrate type below their pond bottoms and in the areas surrounding them. The thickness of the bay mud depends on the location, with bay muds generally 10 to 20 feet thick in the Alviso complex and 20 to 60 feet deep in the Ravenswood complex (AECOM 2016). Underneath the bay mud are clays and alluvial deposits that may vary from sand to cobble. Due to the geology of the area, piles driven for the project are not expected to encounter bedrock.

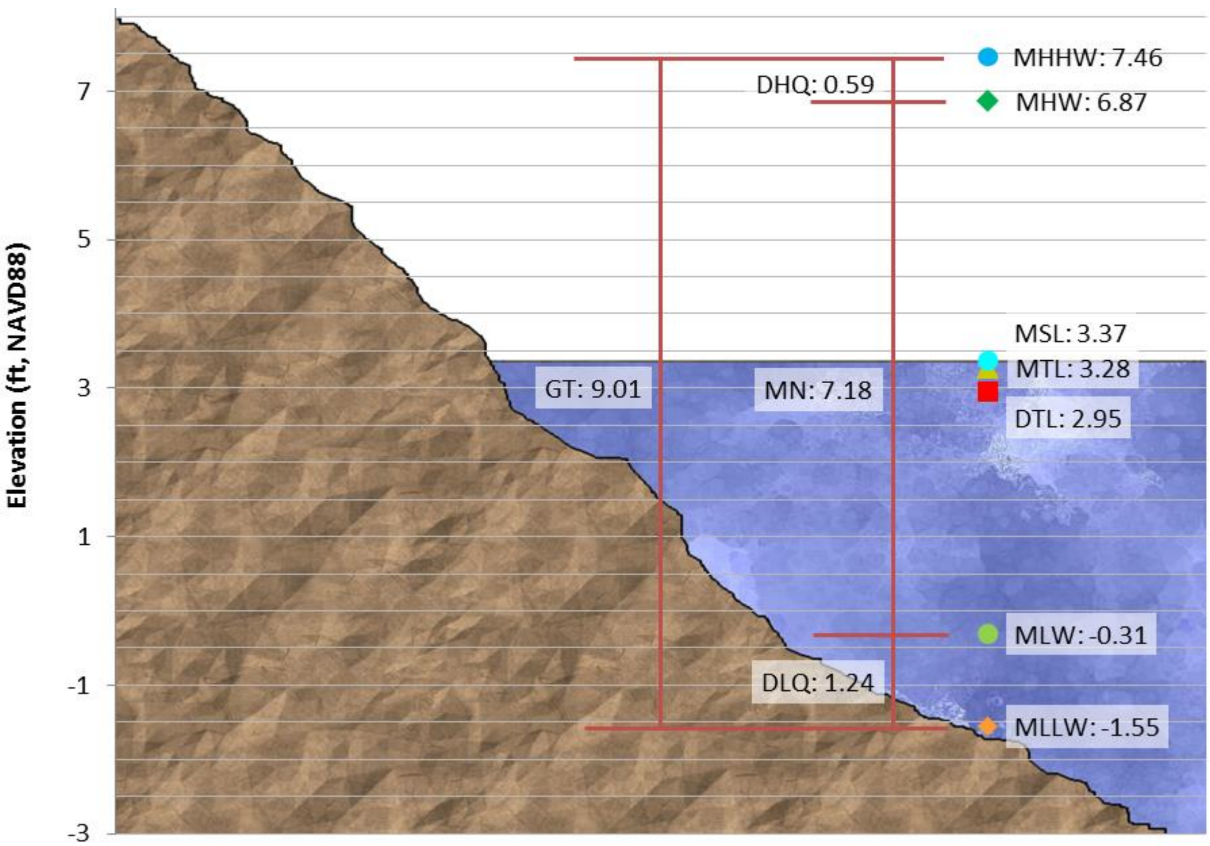
3.2 Hydrologic Data

Water surface elevations representative of the project area were obtained from the Coyote Creek tide gauge near the mouth of Coyote Creek (NOAA gauge 9414575). Tide elevation at this gauge generally varies between -1.64 feet (-0.5 meters) and 7.9 feet (2.4 meters). **Figure 8** shows the average tide elevations for the Coyote Creek station.

3.3 Sensitive Receptors of Underwater Noise in the Action Area

Underwater noise generated by pile driving can have adverse effects on both fish and marine mammals. Many species of marine mammals can be found in San Francisco Bay (Bay), but only one species, Pacific harbor seal, is typically present in the southern portion of the Bay. The largest harbor seal haul-out site in the South Bay occurs along lower Mowry Slough, which located approximately 3.5 miles northeast of the pile driving locations. Other areas frequently used as haul-out sites in the South Bay are near Calaveras Point along Coyote Slough, at Dumbarton Point, on Greco and Bair Islands, and along Corkscrew Slough (AECOM 2016). These lesser used sites are two miles or more from the proposed Phase 2 pile driving locations.

Two distinct population segments (DPS) of ESA listed fish may be present in the project area – Steelhead (Central California Coast DPS, or CCC) and Green Sturgeon (Southern DPS). Additionally, one CESA listed fish species may be present, the longfin smelt. These fish species may utilize tidal waters of the Bay (including the lower portions of Flood Slough, Stevens Creek and other waterways) for foraging areas. Stevens Creek supports an anadromous population of CCC steelhead and thus is a migratory pathway for that species. Stevens Creek, the Guadalupe River, and Coyote Creek are designated as critical habitat for the Central California Coast Distinct Population Segment for this species, and all portions of San Francisco Bay below MHHW are designated as critical habitat for Southern DPS green sturgeon.



Note: All elevations in feet, NAVD88 Source: NOAA 2013; SBSP 2013

Key: MHHW (mean higher high water), MHW (mean high water), MSL (mean sea level), MTL (mean tide level), DTL (mean diurnal tide level), MLW (mean low water), MLLW (mean lower low water), GT (great diurnal range), DHQ (mean diurnal high water inequality), MN (mean range of tide), DLQ (mean diurnal low water inequality)

Figure 8. Coyote Creek gauge tide elevations

4 Underwater Noise Analysis

The methods, results, and effects of the underwater noise analysis are discussed in the sections below.

4.1 Fundamentals of Underwater Noise

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. Sound is generally characterized by several variables, including frequency and intensity. Frequency describes the pitch of a sound, and is measured in the number of cycles per second, or hertz (Hz). Intensity describes the pressure per unit of area (i.e., loudness) of a sound, and is measured in decibels (dB). A dB is a unit of measurement describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. For underwater sounds, a reference pressure of 1 microPascal (µPa) is commonly used to describe sounds in terms of decibels, and is expressed as “dB re 1 µPa.” Therefore, 0 dB on the decibel scale would be a measure of sound pressure of 1 µPa. As sound levels in dB are calculated on a logarithmic basis, an increase of 10 dB represents a tenfold increase in acoustic energy, while 20 dB is 100 times more intense, 30 dB is 1,000 times more intense, etc. For airborne sound pressure, the reference amplitude is usually 20 µPa, and is expressed as “dB re 20 µPa.”

The method commonly used to quantify airborne sounds consists of evaluating all frequencies of a sound according to a weighting system that reflects the frequency range of human hearing. This method is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. The method is called A-weighting, and the dB level that is measured using this method is called the A-weighted sound level (dBA). Sounds levels measured underwater are not weighted, and include the entire frequency range of interest.

When a pile-driving hammer strikes a pile, a pulse is created that propagates through the pile and radiates sound into the water, substrate, and air. The sound pressure pulse is a function of time and is referred to as the waveform. The instantaneous peak sound pressure level (SPL_{peak}) is the highest absolute value of pressure over the measured waveform, and it can be a negative or positive pressure peak. Sound is frequently described as a root mean square (RMS) level, which is a statistical average of the sound wave amplitude. The RMS level is determined by analyzing the waveform and computing the average of the squared pressures over the time that constitutes the portion of the waveform containing 90 percent of the sound energy (Richardson et al., 1995).

Table 1 contains definitions of these terms. In this document, dB for underwater sound is referenced to 1 µPa, and dB for airborne noise is references to 20 µPa. The practical spreading model has been used to estimate underwater noise in this analysis.

In common use, noise refers to any unwanted sound. This meaning of noise will be used in the following discussion in reference to marine mammals and fish; that is—pile driving noise may harass marine mammals or affect fish.

Table 1. Definitions of Underwater Acoustical Terms

Term	Definition
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference

	pressure for air is 20 µPa, and 1 µPa for underwater.
SPL_{peak} Sound Pressure Level (dB)	Peak sound-pressure level, based on the largest absolute value of the instantaneous sound pressure. This pressure is expressed in this report as a decibel (referenced to a pressure of 1 µPa), but can also be expressed in units of pressure, such as µPa or pounds per square inch (psi).
SEL, sound exposure level	SEL is the total noise energy produced from a single noise event and is the integration of all the acoustic energy contained within the event. SEL takes into account both the intensity and the duration of a noise event. SEL is stated in dB re 1 µPa2 · s for underwater sound.
RMS Level, (NMFS Criterion)	The average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy for one pile-driving impulse.

Notes:
dB = decibel
µPa = microPascal
NMFS = National Marine Fisheries Service
psi = pounds per square inch
SPL_{peak} = sound pressure level
SEL = sound exposure level
RMS = root mean square

4.2 Applicable Criteria for Noise Effects

The National Marine Fisheries Service (NMFS), through coordination with other agencies, has established guidelines for the thresholds of underwater noise that may affect fish and underwater or airborne noise that may affect marine mammals. These criteria are summarized below.

4.2.1 Fish

On June 12, 2008, NMFS; USFWS; California, Oregon, and Washington Departments of Transportation; California Department of Fish and Wildlife; and the U.S. Federal Highway Administration agreed in principal to interim criteria to protect fish from pile driving activities. These criteria were established after extensive review of available analysis of the effect of underwater noise on fish. The agreed-upon threshold criteria for impulse-type noise to harm fish has been set at 206 dB SPL_{peak}, as well as 187 dB accumulated sound exposure level (SEL) for fish over 2 grams (0.07 ounces), and 183 dB accumulated SEL for fish less than 2 grams (FHWG, 2008). Any listed fish species that are present in the project area would be bigger than 2 grams, thus the 187 dB accumulated SEL threshold is used in this analysis.

The primary difference between the adopted criteria and previous recommendations is that the single strike SEL was replaced with a cumulative SEL over a day of pile driving. NMFS does not consider sound that produces an SEL per strike of less than 150 dB to accumulate and cause injury. The adopted criteria in the above paragraph are for pulse-type sounds (e.g., pile driving with an impact hammer) and do not address sound from vibratory driving of piles. As other guidance is lacking, the 206 dB SPL_{peak} and 187 dB accumulated SEL threshold has conservatively been applied to vibratory pile driving as well. NMFS also generally uses a 150 dB RMS threshold for potential behavioral effects to listed fish species, so this metric will also be utilized in this analysis.

4.2.2 Marine Mammals

Under the MMPA, NMFS has defined two levels of harassment for marine mammals (Cetaceans, Pinnipeds, Mustileds (sea otters), and Sirenians). Level A harassment is defined as “Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering."

Current NMFS recommendations regarding exposure of marine mammals to underwater noise are as follows: Cetaceans and Pinnipeds exposed to impulse sounds of 180 and 190 dB RMS or greater, respectively, are considered to have been taken by Level A harassment (potential injury). Level B (behavioral harassment) is considered to have occurred when marine mammals are exposed to sounds 160dB RMS or greater for impulse sounds (e.g., impact pile driving) and 120 dB RMS for continuous noise (e.g., vibratory pile extraction and driving). The application of the 120 dB RMS threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations.

The NMFS has also adopted thresholds for airborne noise that may cause harassment and injury to marine mammals. The appropriate airborne noise thresholds for behavioral disturbance for all Pinnipeds, except harbor seals, is 100 dB re 20 μPa RMS and for harbor seals is 90 dB re 20 μPa RMS. The underwater and airborne noise criteria for marine mammals are shown in Table 2. In-air noise generated during pile driving would likely exceed the 90 dB noise threshold (AECOM 2016). However, harbor seal haul-outs are two or more miles from the pile driving locations, and at that distance airborne noise would have attenuated to 50 dB or less, which is similar to typical ambient sound in a quiet natural environment (Dooling and Popper 2007). As a result, airborne noise will not be considered further.

Table 2. Regulatory Noise Criteria for Marine Mammals

Marine Mammal Type	Airborne Marine Construction Criteria (re 20 μPa)	Underwater Continuous Noise Criteria (e.g., vibratory pile extraction and driving) (re 1μPa)		Underwater Pulsed Noise Criteria (e.g., impact pile driving) (re 1 μPa)	
	Level B Threshold	Level A Threshold	Level B Threshold	Level A Threshold	Level B Threshold
Cetaceans (whales, porpoises)	N/A	180 dB RMS	120 dB RMS	180 dB RMS	160 dB RMS
Pinnipeds (sea lions)	100 dB RMS (unweighted)	190 dB RMS	120 dB RMS	190 dB RMS	160 dB RMS
Pinnipeds (harbor seals)	90 dB RMS (unweighted)	190 dB RMS	120 dB RMS	190 dB RMS	160 dB RMS

Notes:
dB = decibel
μPa = microPascal
RMS = root-mean-square pressure

4.3 Approximation of Project-related Noise

A review of underwater sound measurements for similar projects was undertaken to estimate the near-source sound levels for vibratory pile extraction and driving and impact pile driving. Pile driving sound levels from similar types and sizes of piles have been measured from other projects and can be used to estimate the noise levels that the proposed action would generate. This analysis utilizes the practical spreading loss model (Transmission loss = 15*log(R1/R0), the use of which NMFS and the USFWS have accepted to estimate the propagation of noise through water. The default transmission loss utilized by NMFS of 15log R represents a loss of 4.5 dB per doubling of distance unless data are available to support a different model. Transmission losses within the project area are expected to be greater due to the extremely shallow waters (average depths of a few feet during high tide and many areas would be dry during low tide) and extensive unconsolidated sediments that are a poor conductor of sound energy.

The primary sources of underwater noise produced during construction would be pile driving. This includes the installation of 14-inch square concrete piles and the installation and removal of temporary steel sheet piles for cofferdams at the bridge construction locations as described in **Section 2**.

4.3.1 14-Inch Square Concrete Piles

The 14-inch square concrete piles, which current project designs assume would measure approximately 45 feet long, would be installed using an impact hammer. It is estimated that each pile would require approximately 300 blows of a Delmag D46 or similar sized hammer for full installation and that up to four piles may be installed per day. The best fit acoustic data of pile driving comes from installation of 14-inch square concrete piles at the Noyo Harbor in Fort Bragg, CA (Caltrans 2015). The pile lengths, substrate type, and maximum water depths were all similar to the pile driving scenario for the proposed project. During installation of those piles, the maximum sound levels measured for unattenuated pile strikes were 183 dB peak, 166 dB RMS, and 154 dB for the single strike SEL. Using the practical spreading loss model described above, these values were used for approximating the distance over which underwater noise thresholds may be exceeded during installation of the 14-inch square concrete piles. These distances are provided in **Table 3** and **Table 4**.

4.3.2 Steel Sheet Piles

Temporary steel sheet piles would be installed with a vibratory driver in the event that dewatering is needed for construction of the railcar bridge footings. It is estimated that each pile would require, at most, 5 minutes of vibratory driving for installation and for removal and that up to 6 of these piles may be installed per day. The best fit acoustic data of pile driving comes from installation of a sheet pile cofferdam at Ten Mile River Bridge, Fort Bragg, CA (Caltrans 2015). The pile size, substrate type, and maximum water depths were all similar to the pile driving scenario for the proposed project. During installation of those piles, the maximum sound levels measured for vibratory pile driving were 174 dB peak, 142 dB RMS, and 142 dB for the one-second SEL. Using the practical spreading loss model described above, these values were used for approximating the distance over which underwater noise thresholds may be exceeded during installation of the 14-inch square concrete piles. These distances are provided in **Table 3** and **Table 4**.

Table 3. Distances of Exceeded Regulatory Thresholds for Pile Driving Noise – Fish

Pile Type	Source Levels at 10 meters (dB)				Distance of Threshold* (feet)		
	Peak Noise Level	SEL, Single Strike**	SEL, Accumulated	RMS	206 dB Peak	187 dB accumulated SEL	150 dB RMS
Impact Driving							
14-inch square concrete (4 per day)	183	154	185	166	NE	24 (assumed)	385
Vibratory Driving/Extraction							
24-inch sheet pile (6 per day)	174	142	175	142	NE	5	10

Notes:

dB decibels
NE threshold not exceeded
SEL sound exposure level

* The distance from the pile over which the effects threshold of 206 dB peak sound level and 187 dB accumulated SEL would be exceeded. These threshold values apply to fish over 2 grams in weight.

** For vibratory driving, the Single Strike SEL represents the SEL of one second of pile driving.

Table 4. Distances of Exceeded Regulatory Thresholds for Pile Driving Noise – Marine Mammals

Pile Type	Source Levels at 10 meters (dB)		Distance to Threshold (meters)		
	Peak Noise Level	RMS	190 dB RMS (Level A)**	180 dB RMS (Level A)**	160/142 dB RMS (Level B)*
Impact Driving					
14-inch square concrete (4 per day)	183	166	NE	NE	83
Vibratory Driving/Extraction					
24-inch sheet pile (6 per day)	174	142	NE	NE	966

Notes:

dB decibels
NE threshold not exceeded within 10m of the pile
RMS root mean square
* For underwater noise, the Level B harassment threshold is 160 dB for impulsive noise and 120 dB for continuous noise.
** For underwater noise, the Level A harassment threshold for cetaceans is 180 dB and 190 dB for pinnipeds.

4.4 Effects of Approximated Noise to Fish

The above modeling indicates that underwater noise produced during pile driving for the proposed project would not exceed the 206 dB peak or 187 dB accumulated SEL thresholds that NMFS has established for injury or temporary hearing threshold shifts. However, the underwater noise would exceed the 150 dB RMS threshold used by NMFS for behavioral effects on fish. Potential behavioral effects of underwater noise include the temporary cessation of feeding, startle responses, or movements to other areas. Depending on the timing of work, these behavioral effects could disrupt migratory movements of steelhead. Following the cessation of pile driving, fish are expected to resume the use of the affected area. The estimated distance over which 150 dB RMS may be exceeded is 385 feet for impact driving of the concrete piles and 10 feet for vibratory driving of the sheet piles (**Table 3**). During low tide, the pile driving areas would be separated from the wetted channel by a distance of at least 30 feet. At these times, very little of the sound energy is expected to enter waters where fish may be present. During high tide, however, the pile driving noise could more readily radiate out into the channel and affect fish, such as green sturgeon or steelhead that may be present within the distances provided in **Table 3**.

In order to avoid impacts on nesting birds, pile driving activities may need to occur during the migration period. Steelhead and green sturgeon may be present in the project area year-round. As a result, complete seasonal avoidance of these special-status fish species is not possible, though there are months when these species are less abundant in the Bay. Pile driving could be scheduled to occur during low tide, during which there would minimize direct transmittal of noise into water in the work area and the presence of special-status fish would be unlikely in the nearby shallow waters that remain.

4.5 Effects of Approximated Noise to Marine Mammals

Pile driving noise could exceed the 160 dB RMS and 120 dB RMS thresholds established by NMFs for harassment of marine mammals over the distances specified in **Table 4**. The distance over which these thresholds may be exceeded (966 feet or less) does not extend into the open waters of the bay. Additionally, levees and other similar landforms present barriers to any sound emanating towards the open waters of the Bay. While harbor seals occasionally enter Stevens Creek slough, the likelihood that they may be present in the small area where underwater noise exceeds the aforementioned Level B harassment thresholds is very small. If pile driving is conducted during low tide periods, this likelihood shrinks to virtually non-existent as the water likely becomes too shallow to permit movement of harbor seal.

5 Recommendations

With regards to the potential effects of pile driving noise on fish, it is recommended that the results of the analysis be integrated into the biological assessment that is being prepared for NMFS. This will allow for proper consideration of the potential effects of pile driving noise on listed fish species.

With regards to marine mammals, the results of this analysis indicate that an IHA would not be needed for potential effects to marine mammals due to the remote chance of exposure. This chance becomes even more remote if pile driving is scheduled to occur only during periods of low tide.

Finally, it is recommended that restricting driving to low tide periods be considered to further reduce the potential for listed fish or harbor seal to be exposed to underwater noise in excess of the regulatory thresholds described above.

6 References

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Appendix D.
U.S. Fish and Wildlife Species List

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL, SUITE 8-300
SACRAMENTO, CA 95814
PHONE: (916)930-5603 FAX: (916)930-5654
URL: kim_squires@fws.gov

Consultation Code: 08FBDT00-2017-SLI-0086 January 26, 2017
Event Code: 08FBDT00-2017-E-00152
Project Name: Phase 2 - South Bay Salt Ponds Restoration Project - Mountain View and Alviso

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at:
http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm;
http://www.towerkill.com; and
http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment

Official Species List

Provided by:

San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL
SUITE 8-300
SACRAMENTO, CA 95814
(916) 930-5603
http://kim_squires@fws.gov

Expect additional Species list documents from the following office(s):

Sacramento Fish and Wildlife Office
FEDERAL BUILDING
2800 COTTAGE WAY, ROOM W-2605
SACRAMENTO, CA 95825
(916) 414-6600

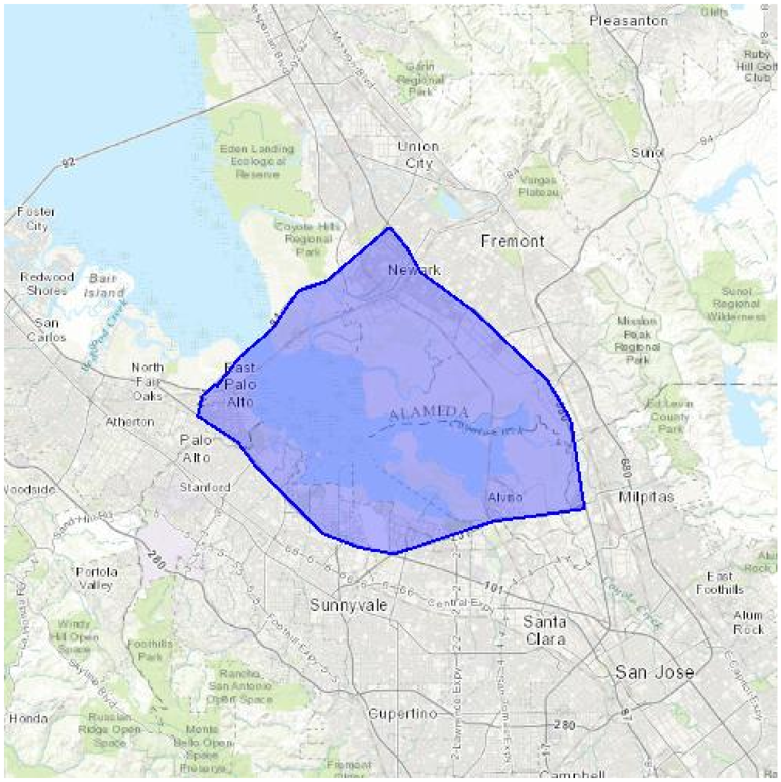
Consultation Code: 08FBDT00-2017-SLI-0086
Event Code: 08FBDT00-2017-E-00152

Project Type: LAND - RESTORATION / ENHANCEMENT

Project Name: Phase 2 - South Bay Salt Ponds Restoration Project - Mountain View and Alviso
Project Description: The SBSP Restoration Project is a multi-agency effort to restore tidal marsh habitat, reconfigure managed pond habitat, maintain or improve flood protection, and provide recreation opportunities and public access in 15,100 acres of former salt-evaporation ponds purchased from and donated by Cargill, Inc. in 2003. Project Website is here: http://www.southbayrestoration.org/. Location of the project is South San Francisco Bay. Draft EIR/S can be found here http://www.southbayrestoration.org/planning/phase2/.

Please Note: The FWS office may have modified the Project Name and/or Project Description, so it may be different from what was submitted in your previous request. If the Consultation Code matches, the FWS considers this to be the same project. Contact the office in the 'Provided by' section of your previous Official Species list if you have any questions or concerns.

Project Location Map:



Project Coordinates: The coordinates are too numerous to display here.

Project Counties: Alameda, CA | San Mateo, CA | Santa Clara, CA

Endangered Species Act Species List

There are a total of 21 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Amphibians	**Status**	**Has Critical Habitat**	**Condition(s)**
California red-legged frog *(Rana draytonii)* Population: Wherever found	Threatened	Final designated	
California tiger Salamander *(Ambystoma californiense)* Population: U.S.A. (Central CA DPS)	Threatened	Final designated	
Birds			
California Clapper rail *(Rallus longirostris obsoletus)* Population: Wherever found	Endangered		
California Least tern *(Sterna antillarum browni)* Population: Wherever found	Endangered		
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific Coast population DPS-U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast)	Threatened	Final designated	
Yellow-Billed Cuckoo *(Coccyzus*	Threatened	Proposed	

americanus) Population: Western U.S. DPS			
Crustaceans			
Conservancy fairy shrimp *(Branchinecta conservatio)* Population: Wherever found	Endangered	Final designated	
Vernal Pool fairy shrimp *(Branchinecta lynchi)* Population: Wherever found	Threatened	Final designated	
Vernal Pool tadpole shrimp *(Lepidurus packardi)* Population: Wherever found	Endangered	Final designated	
Fishes			
Delta smelt *(Hypomesus transpacificus)* Population: Wherever found	Threatened	Final designated	
steelhead *(Oncorhynchus (=salmo) mykiss)* Population: Northern California DPS	Threatened	Final designated	
Flowering Plants			
California seablite *(Suaeda californica)* Population: Wherever found	Endangered		
Contra Costa goldfields *(Lasthenia conjugens)* Population: Wherever found	Endangered	Final designated	
Fountain thistle *(Cirsium fontinale var. fontinale)*	Endangered		

Population: Wherever found			
Robust spineflower *(Chorizanthe robusta var. robusta)* Population: Wherever found	Endangered	Final designated	
Insects			
Bay Checkerspot butterfly *(Euphydryas editha bayensis)* Population: Wherever found	Threatened	Final designated	
San Bruno Elfin butterfly *(Callophrys mossii bayensis)* Population: Wherever found	Endangered		
Mammals			
Salt Marsh Harvest mouse *(Reithrodontomys raviventris)* Population: wherever found	Endangered		
San Joaquin Kit fox *(Vulpes macrotis mutica)* Population: wherever found	Endangered		
Reptiles			
Alameda whipsnake *(Masticophis lateralis euryxanthus)* Population: Wherever found	Threatened	Final designated	
San Francisco Garter snake *(Thamnophis sirtalis tetrataenia)* Population: Wherever found	Endangered		

Critical habitats that lie within your project area

The following critical habitats lie fully or partially within your project area.

Birds	**Critical Habitat Type**
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific Coast population DPS-U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast)	Final designated
Crustaceans	
Vernal Pool tadpole shrimp *(Lepidurus packardi)* Population: Wherever found	Final designated
Fishes	
steelhead *(Oncorhynchus (=salmo) mykiss)* Population: Northern California DPS	Final designated
Flowering Plants	
Contra Costa goldfields *(Lasthenia conjugens)* Population: Wherever found	Final designated

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
FEDERAL BUILDING, 2800 COTTAGE WAY, ROOM W-2605
SACRAMENTO, CA 95825
PHONE: (916)414-6600 FAX: (916)414-6713

Consultation Code: 08ESMF00-2017-SLI-0921 January 26, 2017
Event Code: 08ESMF00-2017-E-02065
Project Name: Phase 2 - South Bay Salt Ponds Restoration Project - Mountain View and Alviso

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, under the jurisdiction of the U.S. Fish and Wildlife Service (Service) that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Please follow the link below to see if your proposed project has the potential to affect other species or their habitats under the jurisdiction of the National Marine Fisheries Service:

http://www.nwr.noaa.gov/protected_species/species_list/species_lists.html

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

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If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

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http://kim_squires@fws.gov

Consultation Code: 08ESMF00-2017-SLI-0921
Event Code: 08ESMF00-2017-E-02065

Project Type: LAND - RESTORATION / ENHANCEMENT

Project Name: Phase 2 - South Bay Salt Ponds Restoration Project - Mountain View and Alviso
Project Description: The SBSP Restoration Project is a multi-agency effort to restore tidal marsh habitat, reconfigure managed pond habitat, maintain or improve flood protection, and provide recreation opportunities and public access in 15,100 acres of former salt-evaporation ponds purchased from and donated by Cargill, Inc. in 2003. Project Website is here: http://www.southbayrestoration.org/. Location of the project is South San Francisco Bay. Draft EIR/S can be found here http://www.southbayrestoration.org/planning/phase2/.

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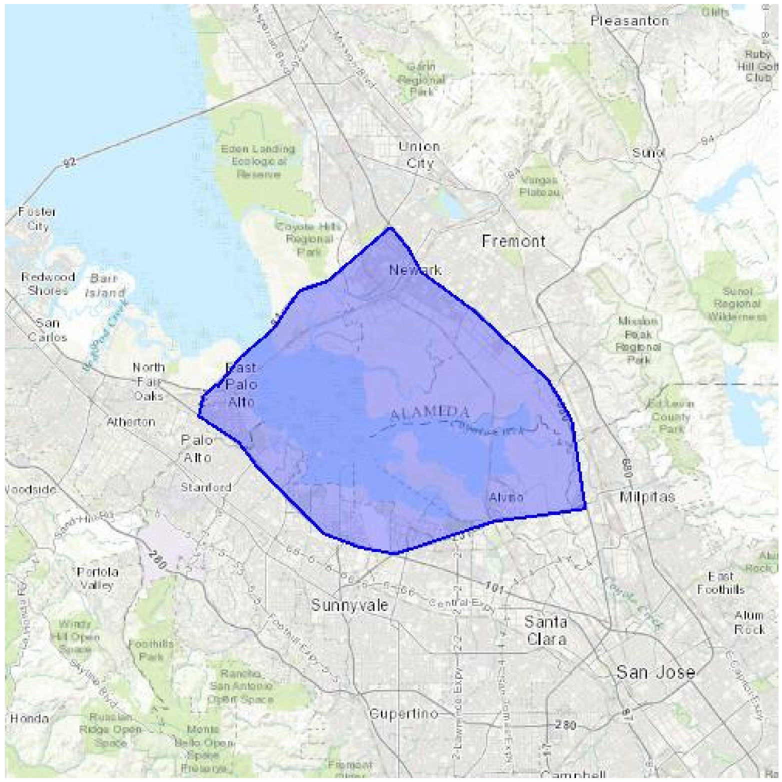
Project Location Map:



Project Coordinates: The coordinates are too numerous to display here.

Project Counties: Alameda, CA | San Mateo, CA | Santa Clara, CA

Endangered Species Act Species List

There are a total of 25 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Amphibians	Status	Has Critical Habitat	Condition(s)
California red-legged frog *(Rana draytonii)* Population: Wherever found	Threatened	Final designated	
California tiger Salamander *(Ambystoma californiense)* Population: U.S.A. (Central CA DPS)	Threatened	Final designated	
Birds			
California Clapper rail *(Rallus longirostris obsoletus)* Population: Wherever found	Endangered		
California Least tern *(Sterna antillarum browni)* Population: Wherever found	Endangered		
Marbled murrelet *(Brachyramphus marmoratus)* Population: U.S.A. (CA, OR, WA)	Threatened	Final designated	
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific Coast population DPS-	Threatened	Final designated	

U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast)			
Yellow-Billed Cuckoo *(Coccyzus americanus)* Population: Western U.S. DPS	Threatened	Proposed	
Crustaceans			
Conservancy fairy shrimp *(Branchinecta conservatio)* Population: Wherever found	Endangered	Final designated	
Vernal Pool fairy shrimp *(Branchinecta lynchi)* Population: Wherever found	Threatened	Final designated	
Vernal Pool tadpole shrimp *(Lepidurus packardi)* Population: Wherever found	Endangered	Final designated	
Fishes			
Delta smelt *(Hypomesus transpacificus)* Population: Wherever found	Threatened	Final designated	
steelhead *(Oncorhynchus (=salmo) mykiss)* Population: Northern California DPS	Threatened	Final designated	
Flowering Plants			
California seablite *(Suaeda californica)* Population: Wherever found	Endangered		
Contra Costa goldfields *(Lasthenia conjugens)*	Endangered	Final designated	

Population: Wherever found			
Fountain thistle *(Cirsium fontinale var. fontinale)* Population: Wherever found	Endangered		
Marin dwarf-flax *(Hesperolinon congestum)* Population: Wherever found	Threatened		
Robust spineflower *(Chorizanthe robusta var. robusta)* Population: Wherever found	Endangered	Final designated	
San Mateo thornmint *(Acanthomintha obovata ssp. duttonii)* Population: Wherever found	Endangered		
Showy Indian clover *(Trifolium amoenum)* Population: Wherever found	Endangered		
Insects			
Bay Checkerspot butterfly *(Euphydryas editha bayensis)* Population: Wherever found	Threatened	Final designated	
San Bruno Elfin butterfly *(Callophrys mossii bayensis)* Population: Wherever found	Endangered		
Mammals			
Salt Marsh Harvest mouse *(Reithrodontomys raviventris)* Population: wherever found	Endangered		
San Joaquin Kit fox *(Vulpes macrotis*	Endangered		

mutica) Population: wherever found			
Reptiles			
Alameda whipsnake *(Masticophis lateralis euryxanthus)* Population: Wherever found	Threatened	Final designated	
San Francisco Garter snake *(Thamnophis sirtalis tetrataenia)* Population: Wherever found	Endangered		

Critical habitats that lie within your project area

The following critical habitats lie fully or partially within your project area.

Birds	Critical Habitat Type
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific Coast population DPS-U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast)	Final designated
Crustaceans	
Vernal Pool tadpole shrimp *(Lepidurus packardi)* Population: Wherever found	Final designated
Fishes	
steelhead *(Oncorhynchus (=salmo) mykiss)* Population: Northern California DPS	Final designated
Flowering Plants	
Contra Costa goldfields *(Lasthenia conjugens)* Population: Wherever found	Final designated

Appendix E. California Natural Diversity Database – RareFind 3 Occurrence Record

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad IS (Milpitas (3712148) OR Mountain View (3712241) OR Newark (3712251) OR Niles (3712158) OR Palo Alto (3712242) OR Redwood Point (3712252))

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Acanthomintha duttonii San Mateo thorn-mint	G1 S1	Endangered Endangered	Rare Plant Rank - 1B.1 SB_UCBBG-UC Berkeley Botanical Garden	170 170	5 S:1	0	0	0	0	1	0	1	0	0	0	1
Accipiter cooperii Cooper's hawk	G5 S4	None None	CDFW_WL-Watch List IUCN_LC-Least Concern	505 950	107 S:3	0	1	0	0	0	2	0	3	3	0	0
Agelaius tricolor tricolored blackbird	G2G3 S1S2	None Candidate Endangered	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_EN-Endangered NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	5 254	906 S:9	0	0	0	0	3	6	8	1	6	3	0
Allium peninsulare var. franciscanum Franciscan onion	G5T1 S1	None None	Rare Plant Rank - 1B.2	170 415	21 S:4	0	0	1	0	0	3	2	2	4	0	0
Ambystoma californiense California tiger salamander	G2G3 S2S3	Threatened Threatened	CDFW_WL-Watch List IUCN_VU-Vulnerable	10 1,280	1148 S:24	1	11	2	2	4	4	7	17	20	1	3
Aneides niger Santa Cruz black salamander	G3 S3	None None	CDFW_SSC-Species of Special Concern	340 340	77 S:1	0	0	0	0	0	1	1	0	1	0	0
Antrozous pallidus pallid bat	G5 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFS_S-Sensitive WBWG_H-High Priority	30 420	406 S:4	0	0	0	0	0	4	4	0	4	0	0
Aquila chrysaetos golden eagle	G5 S3	None None	BLM_S-Sensitive CDF_S-Sensitive CDFW_FP-Fully Protected CDFW_WL-Watch List IUCN_LC-Least Concern USFWS_BCC-Birds of Conservation Concern	2,200 2,200	312 S:1	0	1	0	0	0	0	1	0	1	0	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Ardea herodias great blue heron	G5 S4	None None	CDF_S-Sensitive IUCN_LC-Least Concern	1 215	138 S:4	2	1	1	0	0	0	1	3	4	0	0
Asio flammeus short-eared owl	G5 S3	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern		10 S:1	0	0	0	0	0	1	1	0	1	0	0
Astragalus tener var. tener alkali milk-vetch	G2T2 S2	None None	Rare Plant Rank - 1B.2	5 20	65 S:5	0	1	0	0	4	0	4	1	1	3	1
Athene cunicularia burrowing owl	G4 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFWS_BCC-Birds of Conservation Concern	0 132	1923 S:55	3	13	8	15	10	6	11	44	45	8	2
Atriplex depressa brittlescale	G2 S2	None None	Rare Plant Rank - 1B.2	20 20	61 S:1	0	1	0	0	0	0	0	1	1	0	0
Atriplex minuscula lesser saltscale	G2 S2	None None	Rare Plant Rank - 1B.1	2 2	37 S:1	0	0	0	0	0	1	0	1	1	0	0
Bombus caliginosus obscure bumble bee	G4? S1S2	None None	IUCN_VU-Vulnerable	75 400	181 S:3	0	0	0	0	0	3	3	0	3	0	0
Bombus crotchii Crotch bumble bee	G3G4 S1S2	None None		100 100	233 S:2	0	0	0	0	0	2	2	0	2	0	0
Bombus occidentalis western bumble bee	G2G3 S1	None None	USFS_S-Sensitive XERCES_IM-Imperiled	10 400	282 S:8	0	0	0	0	0	8	8	0	8	0	0
Campanula exigua chaparral harebell	G2 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive SB_RSABG-Rancho Santa Ana Botanic Garden	300 300	32 S:1	0	0	0	0	0	1	1	0	1	0	0
Centromadia parryi ssp. congdonii Congdon's tarplant	G3T2 S2	None None	Rare Plant Rank - 1B.1 BLM_S-Sensitive SB_RSABG-Rancho Santa Ana Botanic Garden	2 290	93 S:15	0	4	6	2	2	1	2	13	13	1	1

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Charadrius alexandrinus nivosus western snowy plover	G3T3 S2S3	Threatened None	CDFW_SSC-Species of Special Concern NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	0 15	124 S:10	0	2	0	0	1	7	5	5	9	1	0
Chloropyron maritimum ssp. palustre Point Reyes salty bird's-beak	G4?T2 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive	1 5	68 S:5	0	0	0	0	5	0	5	0	0	4	1
Chorizanthe robusta var. robusta robust spineflower	G2T1 S1	Endangered None	Rare Plant Rank - 1B.1 BLM_S-Sensitive		20 S:1	0	0	0	0	1	0	1	0	0	1	0
Circus cyaneus northern harrier	G5 S3	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern	5 10	48 S:6	0	1	0	0	0	5	5	1	6	0	0
Cirsium fontinale var. fontinale Crystal Springs fountain thistle	G2T1 S1	Endangered Endangered	Rare Plant Rank - 1B.1 SB_RSABG-Rancho Santa Ana Botanic Garden	150 440	5 S:2	0	0	2	0	0	0	0	2	2	0	0
Cirsium praeteriens lost thistle	GX SX	None None	Rare Plant Rank - 1A	50 50	1 S:1	0	0	0	0	1	0	1	0	0	1	0
Clarkia concinna ssp. automixa Santa Clara red ribbons	G5?T3 S3	None None	Rare Plant Rank - 4.3	300 300	20 S:1	0	0	0	0	0	1	1	0	1	0	0
Coccyzus americanus occidentalis western yellow-billed cuckoo	G5T2T3 S1	Threatened Endangered	BLM_S-Sensitive NABCI_RWL-Red Watch List USFS_S-Sensitive USFWS_BCC-Birds of Conservation Concern	20 20	155 S:1	0	0	0	0	1	0	1	0	0	0	1
Collinsia corymbosa round-headed Chinese-houses	G1 S1	None None	Rare Plant Rank - 1B.2		13 S:1	0	0	0	0	1	0	1	0	0	0	1
Collinsia multicolor San Francisco collinsia	G2 S2	None None	Rare Plant Rank - 1B.2 SB_RSABG-Rancho Santa Ana Botanic Garden	100 100	25 S:1	0	0	0	0	0	1	1	0	1	0	0

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Corynorhinus townsendii Townsend's big-eared bat	G3G4 S2	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFS_S-Sensitive WBWG_H-High Priority	160 2,240	625 S:4	0	0	0	0	1	3	4	0	3	1	0
Danaus plexippus pop. 1 monarch - California overwintering population	G4T2T3 S2S3	None None	USFS_S-Sensitive	10 150	378 S:3	0	1	1	0	0	1	0	3	3	0	0
Dicamptodon ensatus California giant salamander	G3 S2S3	None None	CDFW_SSC-Species of Special Concern IUCN_NT-Near Threatened	380 380	228 S:1	0	0	0	0	0	1	1	0	1	0	0
Dipodomys venustus venustus Santa Cruz kangaroo rat	G4T1 S1	None None		5 600	14 S:3	0	0	0	0	0	3	3	0	3	0	0
Dirca occidentalis western leatherwood	G2 S2	None None	Rare Plant Rank - 1B.2 SB_RSABG-Rancho Santa Ana Botanic Garden	150 150	65 S:2	0	0	0	0	0	2	1	1	2	0	0
Egretta thula snowy egret	G5 S4	None None	IUCN_LC-Least Concern	10 10	17 S:1	0	0	0	0	0	1	0	1	1	0	0
Elanus leucurus white-tailed kite	G5 S3S4	None None	BLM_S-Sensitive CDFW_FP-Fully Protected IUCN_LC-Least Concern	5 10	162 S:8	0	1	0	0	0	7	7	1	8	0	0
Emys marmorata western pond turtle	G3G4 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_VU-Vulnerable USFS_S-Sensitive	0 370	1209 S:8	0	4	0	1	0	3	2	6	8	0	0
Eryngium aristulatum var. hooveri Hoover's button-celery	G5T1 S1	None None	Rare Plant Rank - 1B.1 SB_RSABG-Rancho Santa Ana Botanic Garden	5 80	16 S:7	0	0	2	0	4	1	5	2	3	4	0
Eryngium jepsonii Jepson's coyote-thistle	G2 S2	None None	Rare Plant Rank - 1B.2	525 625	19 S:2	0	0	0	0	0	2	1	1	2	0	0
Euphydryas editha bayensis Bay checkerspot butterfly	G5T1 S1	Threatened None	XERCES_CI-Critically Imperiled	600 600	24 S:1	0	0	0	0	1	0	1	0	0	0	1

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Extriplex joaquinana San Joaquin spearscale	G2 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive SB_RSABG-Rancho Santa Ana Botanic Garden	6 10	109 S:3	0	1	0	0	0	2	2	1	3	0	0
Fritillaria liliacea fragrant fritillary	G2 S2	None None	Rare Plant Rank - 1B.2 USFS_S-Sensitive		81 S:1	0	0	0	0	0	1	1	0	1	0	0
Geothlypis trichas sinuosa saltmarsh common yellowthroat	G5T3 S3	None None	CDFW_SSC-Species of Special Concern USFWS_BCC-Birds of Conservation Concern	0 360	111 S:17	0	5	0	0	0	12	11	6	17	0	0
Hesperolinon congestum Marin western flax	G1 S1	Threatened Threatened	Rare Plant Rank - 1B.1 SB_RSABG-Rancho Santa Ana Botanic Garden	200 200	26 S:1	0	0	1	0	0	0	0	1	1	0	0
Lasiurus cinereus hoary bat	G5 S4	None None	IUCN_LC-Least Concern WBWG_M-Medium Priority		235 S:6	0	0	0	0	0	6	6	0	6	0	0
Lasthenia conjugens Contra Costa goldfields	G1 S1	Endangered None	Rare Plant Rank - 1B.1 SB_UCBBG-UC Berkeley Botanical Garden	10 10	33 S:3	0	2	0	0	1	0	1	2	2	0	1
Laterallus jamaicensis coturniculus California black rail	G3G4T1 S1	None Threatened	BLM_S-Sensitive CDFW_FP-Fully Protected IUCN_NT-Near Threatened NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	4 40	244 S:7	0	3	0	0	0	4	3	4	7	0	0
Lepidurus packardi vernal pool tadpole shrimp	G4 S3S4	Endangered None	IUCN_EN-Endangered	7 10	320 S:2	0	1	0	0	0	1	0	2	2	0	0
Malacothamnus arcuatus arcuate bush-mallow	G2Q S2	None None	Rare Plant Rank - 1B.2	5 360	30 S:4	0	0	0	1	0	3	2	2	4	0	0
Masticophis lateralis euryxanthus Alameda whipsnake	G4T2 S2	Threatened Threatened		1,160 1,745	158 S:2	1	1	0	0	0	0	0	2	2	0	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Melospiza melodia pusillula Alameda song sparrow	G5T2? S2S3	None None	CDFW_SSC-Species of Special Concern USFWS_BCC-Birds of Conservation Concern	1 70	38 S:21	0	13	0	0	0	8	9	12	21	0	0
Monolopia gracilens woodland woollythreads	G3 S3	None None	Rare Plant Rank - 1B.2	400 600	57 S:2	0	0	0	0	0	2	2	0	2	0	0
Myotis yumanensis Yuma myotis	G5 S4	None None	BLM_S-Sensitive IUCN_LC-Least Concern WBWG_LM-Low-Medium Priority	870 870	262 S:1	0	1	0	0	0	0	0	1	1	0	0
Navarretia prostrata prostrate vernal pool navarretia	G2 S2	None None	Rare Plant Rank - 1B.1	10 10	60 S:2	0	2	0	0	0	0	0	2	2	0	0
Neotoma fuscipes annectens San Francisco dusky-footed woodrat	G5T2T3 S2S3	None None	CDFW_SSC-Species of Special Concern	215 262	16 S:3	0	1	2	0	0	0	0	3	3	0	0
Northern Coastal Salt Marsh Northern Coastal Salt Marsh	G3 S3.2	None None		10 15	53 S:7	0	1	0	0	0	6	7	0	7	0	0
Nycticorax nycticorax black-crowned night heron	G5 S4	None None	IUCN_LC-Least Concern	10 10	26 S:1	0	0	1	0	0	0	1	0	1	0	0
Oncorhynchus mykiss irideus steelhead - central California coast DPS	G5T2T3Q S2S3	Threatened None	AFS_TH-Threatened	200 200	39 S:1	0	0	0	0	0	1	0	1	1	0	0
Phalacrocorax auritus double-crested cormorant	G5 S4	None None	CDFW_WL-Watch List IUCN_LC-Least Concern	1 30	38 S:2	1	0	0	0	0	1	1	1	2	0	0
Plagiobothrys chorisianus var. chorisianus Choris' popcornflower	G3T2Q S2	None None	Rare Plant Rank - 1B.2		40 S:1	0	0	0	0	0	1	1	0	1	0	0
Plagiobothrys glaber hairless popcornflower	GH SH	None None	Rare Plant Rank - 1A	15 15	9 S:1	0	0	0	0	0	1	1	0	0	1	0
Puccinellia simplex California alkali grass	G3 S2	None None	Rare Plant Rank - 1B.2	5 5	71 S:1	0	0	0	0	0	1	0	1	1	0	0
Rallus longirostris obsoletus California clapper rail	G5T1 S1	Endangered Endangered	CDFW_FP-Fully Protected NABCI_RWL-Red Watch List	0 15	98 S:17	4	4	0	0	0	9	10	7	17	0	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Rana draytonii California red-legged frog	G2G3 S2S3	Threatened None	CDFW_SSC-Species of Special Concern IUCN_VU-Vulnerable	45 1,190	1407 S:12	0	8	2	1	0	1	1	11	12	0	0
Reithrodontomys raviventris salt-marsh harvest mouse	G1G2 S1S2	Endangered Endangered	CDFW_FP-Fully Protected IUCN_EN-Endangered	0 5	144 S:44	3	9	3	1	1	27	40	4	43	0	1
Riparia riparia bank swallow	G5 S2	None Threatened	BLM_S-Sensitive IUCN_LC-Least Concern	10 10	297 S:1	0	0	0	0	0	1	1	0	1	0	0
Rynchops niger black skimmer	G5 S2	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern NABCI_YWL-Yellow Watch List USFWS_BCC-Birds of Conservation Concern	11 11	7 S:1	0	0	0	0	0	1	0	1	1	0	0
Senecio aphanactis chaparral ragwort	G3 S2	None None	Rare Plant Rank - 2B.2		47 S:1	0	0	0	0	0	1	1	0	1	0	0
Serpentine Bunchgrass Serpentine Bunchgrass	G2 S2.2	None None		5,800 5,800	22 S:1	0	0	0	0	0	1	1	0	1	0	0
Sorex vagrans halicoetes salt-marsh wandering shrew	G5T1 S1	None None	CDFW_SSC-Species of Special Concern	0 5	12 S:8	0	0	0	0	1	7	8	0	7	0	1
Spirinchus thaleichthys longfin smelt	G5 S1	Candidate Threatened	CDFW_SSC-Species of Special Concern	0 0	45 S:1	0	0	0	0	0	1	1	0	1	0	0
Sternula antillarum browni California least tern	G4T2T3Q S2	Endangered Endangered	CDFW_FP-Fully Protected NABCI_RWL-Red Watch List	1 3	68 S:7	0	0	0	0	1	6	7	0	6	0	1
Streptanthus albidus ssp. peramoenus most beautiful jewelflower	G2T2 S2	None None	Rare Plant Rank - 1B.2 SB_RSABG-Rancho Santa Ana Botanic Garden USFS_S-Sensitive	400 2,400	96 S:2	0	0	0	0	0	2	2	0	2	0	0
Stuckenia filiformis ssp. alpina slender-leaved pondweed	G5T5 S3	None None	Rare Plant Rank - 2B.2	40 50	21 S:2	0	0	0	0	0	2	2	0	2	0	0
Suaeda californica California seablite	G1 S1	Endangered None	Rare Plant Rank - 1B.1	5 10	18 S:2	0	0	0	0	2	0	2	0	0	2	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Taxidea taxus American badger	G5 S3	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern	70 200	523 S:2	0	0	0	0	0	2	2	0	2	0	0
Thamnophis sirtalis tetrataenia San Francisco gartersnake	G5T2Q S2	Endangered Endangered	CDFW_FP-Fully Protected	350 350	67 S:1	0	0	0	0	0	1	1	0	1	0	0
Trifolium amoenum two-fork clover	G1 S1	Endangered None	Rare Plant Rank - 1B.1 SB_RSABG-Rancho Santa Ana Botanic Garden SB_USDA-US Dept of Agriculture		26 S:1	0	0	0	0	0	1	1	0	1	0	0
Trifolium hydrophilum saline clover	G2 S2	None None	Rare Plant Rank - 1B.2	5 10	49 S:4	0	0	0	0	0	4	2	2	4	0	0
Tryonia imitator mimic tryonia (=California brackishwater snail)	G2 S2	None None	IUCN_DD-Data Deficient	0 5	39 S:2	0	0	0	0	0	2	2	0	2	0	0
Valley Oak Woodland Valley Oak Woodland	G3 S2.1	None None		40 40	91 S:1	0	0	0	0	0	1	1	0	1	0	0

Appendix F.
Evaluation of Occurrence Potential

Federally and State-Listed Plant Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS *	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
Federal or State Threatened or Endangered Species			
San Mateo thorn-mint (*Acanthomintha duttonii*)	FE, SE, CRPR 1B	Chaparral, valley and foothill grassland, coastal scrub in relatively open areas. Only known to occur on very uncommon serpentinite vertisol clays. Elev. 50–200 meters(m).	**No potential to occur.** Only CNDDB occurrence within 5 miles is presumed extirpated. No appropriate habitat or suitable serpentinite substrate is present in the Phase 2 project area.
Robust spineflower (*Chorizanthe robusta* var. *robusta*)	FE, CRPR 1B	Cismontane woodland, coastal dunes, coastal scrub, growing on sandy terraces and bluffs or in loose sand. Elev. 3–120 m.	**No potential to occur.** Only CNDDB occurrence within 5 miles is a historical record from 1882. The Phase 2 project area does not include appropriate coastal habitat with sandy substrate.
Fountain thistle (*Cirsium fontinale* var. *fontinale*)	FE, SE, CRPR 1B	Valley and foothill grassland, chaparral, growing in serpentine seeps and grassland. Elev. 90–180 m.	**No potential to occur.** No serpentine seeps are present in the Phase 2 project area.
Marin dwarf-flax (*Hesperolinon congestum*)	FT, ST, CRPR 1B	Chaparral, valley and foothill grassland, growing in serpentine barrens and in serpentine grassland and chaparral. Elev. 30–365 m.	**No potential to occur.** No serpentine habitats are present in the Phase 2 project area.
Contra Costa goldfields (*Lasthenia conjugens)*	FE, CRPR 1B	Saline/alkaline vernal pools, mesic areas within grassland. Known from Alameda, Solano, Monterey, Contra Costa, and Napa Counties. Annual; blooms March through June. Elev. 4 – 180 m,	**No potential to occur.** Historically known from edges of salt ponds at the Bay shore near Mt. Eden and Newark. Occurs on the Warm Springs vernal pool unit of the Refuge (Fremont). No suitable habitat is present in the Phase 2 project area. Otherwise occurs in disjunct populations in Monterey and North Bay areas.

Federally and State-Listed Plant Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS *	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
California seablite (*Suaeda californica*)	FE, CRPR 1B	Sandy, high-energy shorelines within salt marsh. Relictual populations in South Bay considered extirpated; known from the San Francisco Bay and Morro Bay, San Luis Obispo county. Elev. 0 – 160 m.	**No potential to occur.** Suitable habitat occurs within Ravenswood pond complexes. However the species was last documented in the South Bay Salt Ponds Region in 1971 (Calflora 2016).
* Definitions: FE – Federally Endangered FT – Federally Threatened SE – State Endangered (California) ST – State Threatened (California) Sources: CNDDB 2013. Nomenclature from Baldwin et al. 2012.		CRPR – California Rare Plant Rank CRPR 1A – Plants considered extinct. CRPR 1B – Plants rare, threatened, or endangered in California and elsewhere.	

Federally and State-Listed Wildlife Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
Threatened or Endangered Species			
Green sturgeon, Southern	FT, CSSC	Spends majority of life in near-shore oceanic	**Known to occur.** Spawns in Sacramento River, but

Federally and State-Listed Wildlife Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
Distinct Population Segment (DPS) (*Acipenser medirostris*)		waters, bays, and estuaries; spawns in freshwater rivers.	not known to spawn in South Bay. Present in the South Bay; unlikely to be inside ponds.
Steelhead – California Central Coast DPS (*Oncorhynchus mykiss irideus*)	FT, CSSC	Cool streams with suitable spawning habitat and conditions allowing migration and marine habitats.	**Known to occur.** Known to be present in several South Bay creeks (including Coyote, Stevens, San Francisquito, and Alameda Creeks and the Guadalupe River) and associated slough channels within the project area. Suitable spawning habitat is not present in the project area, but this species moves through the area to spawn upstream.
Delta Smelt (*Hypomesus transpacificus*)	FT, SE	Occurs in the Sacramento-San Joaquin Delta. Seasonally in Suisun Bay, Carquinez Strait & San Pablo Bay. Seldom found at salinities > 10 ppt. Most often at salinities < 2ppt.	**No potential to occur.** The location of the Phase 2 project does not fall within the habitat for this species. Programmatic BA notes that this species exists in the region, but not in the project area.
Longfin smelt (*Spirinchus thaleichthys)*	FC, ST, CSSC	Spends the majority of life in San Francisco Bay, moving upstream to spawn in low-salinity waters in winter/spring.	**Known to occur**. Occurs year-round in San Francisco Bay and known to occur in the South Bay. Longfin smelt have been caught in Coyote Creek and Alviso Slough and could possibly be present in Pond A8 but have not yet been detected there. They are present throughout the Bay and presumed to spawn and rear in freshwater habitats.
California red-legged frog *(Rana draytonii*)	FT,CSSC	Lowlands & foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation.	**No potential to occur.** The location of the Phase 2 project does not fall within the habitat for this species. Programmatic BA notes that this species exists in the region, but not in the project area.
California tiger salamander (Central California population) (*Ambystoma*	FT, ST, WL	Vernal or temporary pools in annual grasslands, or open stages of woodlands.	**No potential to occur.** A population is present on Don Edwards Refuge lands in the Fremont/Warm Springs area, though not in the immediate SBSP pond complexes. The population is closest to the Island Ponds action area. However, a road as well as ponds A23 and A22, are movement barriers preventing any

Federally and State-Listed Wildlife Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
californiense)			CTS individuals from entering the action area of the Islands Ponds.
Salt marsh harvest mouse (*Reithrodontomys r. raviventris*)	FE,SE, SFP	Salt marsh habitat dominated by pickleweed.	**Known to occur.** Resident in pickleweed marshes within the project area.
San Joaquin Kit fox *(Vulpes macrotis mutica)*	FE, ST	Annual grasslands or grassy open stages with scattered shrubby vegetation.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA.
Bald eagle (*Haliaeetus leucocephalus*)	Delisted, SE, SFP, BCC	Occurs mainly along seacoasts, rivers, and lakes; nests in tall trees or in cliffs. Feeds mostly on fish.	**Potential to occur.** Occasional visitor, primarily during winter, to the project area. May occasionally forage, but does not nest, in the project area.
California Ridgway's rail (*Rallus obsoletus obsoletus*)	FE, SE, SFP	Salt and brackish marsh habitat usually dominated by pickleweed and cordgrass.	**Known to occur.** Resident in many tidal marshes and sloughs in the project area. Large numbers are known to occur in tidal marsh habitats adjacent to Phase 2.
California least tern (*Sterna antillarum browni*)	FE, SE, SFP	Nests along the coast on bare or sparsely vegetated flat substrates.	**Known to occur.** The South Bay is an important post-breeding staging area for California least terns. Current Bay Area nesting sites include Alameda Point and Hayward Regional Shoreline. Has attempted to nest in small numbers at Eden Landing Pond E8A, but not in recent years. Forages and roosts in a number of South Bay ponds, especially Ponds A1 and A2W.
California brown pelican (*Pelecanus occidentalis californicus*)	SFP	Occurs in near-shore marine habitats and coastal bays. Nests on islands in Mexico and Southern California.	**Known to occur.** Regular in project area during nonbreeding season (summer and fall). Roosts on levees in the interiors of pond complexes; forages in ponds and Bay.
California black rail (*Laterallus jamaicensis coturniculus*)	ST, SFP	Breeds in fresh, brackish, and tidal salt marsh.	**Known to occur.** Non-breeding individuals winter in small numbers in tidal marsh within the project area. Have been observed in small numbers during breeding

Federally and State-Listed Wildlife Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
			seasons around the Island Ponds and potentially breeding in small numbers.
Western snowy plover (*Charadrius alexandrinus nivosus*)	FT, CSSC, BCC	Nests on sandy beaches and salt panne habitats, including dry ponds.	**Known to occur.** Resident in the project area. Greatest numbers at Eden Landing and Ravenswood pond complexes. Additional birds occur in the project area during winter.
Critical Habitat for Western Snowy Plover	Final Designated		**No potential to occur.** There is no Designated Critical Habitat within the Phase 2 Action Area.
Bank swallow (*Riparia riparia*)	ST	Colonial nester on vertical banks or cliffs with fine-textured soils near water.	**Potential to occur.** Observed in the project area as rare transient. No suitable breeding habitat in the project area.
Conservancy fairy shrimp *(Branchinecta conservatio)*	FE	Endemic to the grasslands of the northern two-thirds of the Central Valley; found in large, turbid pools.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA.
Vernal Pool tadpole shrimp *(Lepidurus packardi)*	FE	Inhabits vernal pools and swales in the Sacramento Valley containing clear to highly turbid water.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA. Suitable habitat for species is absent from the Action Area.
Bay Checkerspot butterfly *(Euphydryas editha bayensis)*	FT	Restricted to native grasslands on outcrops of serpentine soil in the vicinity of San Francisco Bay.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA.
San Bruno Elfin butterfly *(Callophrys mossii bayensis)*	FE	Coastal, mountainous areas with grassy ground cover, mainly in the vicinity of San Bruno Mountain, San Mateo County.	**No potential to occur.** The CNDDB shows no records of this species in Alameda and Santa Clara Counties. There is no habitat for this species within the Phase 2 project area.
Alameda whipsnake *(Masticophis lateralis euryxanthus)*	FT, ST	Typically found in chaparral and scrub habitats but will also use adjacent grassland, oak savanna and woodland habitats.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA.

Federally and State-Listed Wildlife Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
San Francisco garter snake *(Thamnophis sirtalis tetrataenia)*	FE, SE, SFP	Vicinity of freshwater marshes, ponds and slow-moving streams in San Mateo County & extreme northern Santa Cruz County.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA.
State Fully Protected Species			
Golden eagle (*Aquila chrysaetos*)	SFP, WL, BCC	Breeds on cliffs or in large trees or electrical towers; forages in open areas.	**Potential to occur.** Occasional forager, primarily during the nonbreeding season. No nesting records within the project area.
Tricolored blackbird (*Agelaius tricolor*)	Provisional Listing, CDFW (nesting), CSSC, BCC	Breeds near freshwater in dense emergent vegetation.	**Potential to occur.** May breed in extensive freshwater marshes around the periphery of the project area, such as at Coyote Hills. Occurs elsewhere in the project area as a nonbreeding forager.
American peregrine falcon (*Falco peregrinus anatum*)	SFP, BCC	Forages in many habitats; nests on cliffs and similar human-made structures.	**Known to occur.** Regular forager (on other birds) in the project area, primarily during migration and winter. In the Alviso pond complex, individuals have nested on electrical towers regularly since at least 2006, and two pairs nested on towers in 2007.
White-tailed kite (*Elanus caeruleus*)	SFP (nesting)	Nests in tall shrubs and trees; forages in grasslands, marshes, and ruderal habitats.	**Known to occur.** Common resident; breeds at inland margins of the study site, where suitable nesting habitat occurs.
Definitions: FE – Federally Endangered FT – Federally Threatened FC – Candidate for Federal Listing BCC – USFWS Bird of Conservation Concern SE – State Endangered		ST – State Threatened SFP – Fully Protected (California) CSSC – California Species of Special Concern WL – CDFW Watch List Source: CNDDB 2014.	

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, California 94555

26 April 2017

Gary Stern, San Francisco Bay Region Supervisor
North-Central Coast Office
NOAA Fisheries West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, CA 95404

RE: South Bay Salt Pond Restoration Project, Phase 2, Biological Assessment

Dear Mr. Stern:

On March 24, 2017, a letter signed and dated on March 23, 2017, was transmitted to your office requesting formal consultation for Phase 2 of the South Bay Salt Pond Restoration Project (SBSP) Restoration Project pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) and for Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (16 U.S.C. §§ 1801 et seq.). That letter was signed by SBSP Executive Manager John Bourgeois on California State Coastal Conservancy (SCC) letterhead. The U.S. Fish and Wildlife Service (USFWS) understands that under section 7(a)(2) of the ESA that this formal request needs to be initiated by the USFWS as the Federal Action Agency to initiate section 7 consultations. With this letter, the USFWS is requesting formal consultation pursuant to the section 7 of the ESA. Please update your records accordingly.

On behalf of the USFWS Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) and the SCC, I am submitting this letter to request formal consultation for Phase 2 of the SBSP Restoration Project under section 7 of the ESA and for EFH under the MSA. Enclosed with this letter, please find the SBSP Restoration Project's Phase 2 Biological Assessment (BA). This is the same BA that was transmitted to your office on March 24, 2017.

Background

The SBSP Project is the largest wetland restoration project on the West Coast, encompassing 15,100 acres of the former Cargill Inc. (Cargill) salt ponds in the South San Francisco Bay (South Bay) that were acquired by a public-private partnership for restoration and management by the USFWS and the California Department of Fish and Wildlife (CDFW) in 2003. The USFWS and SCC propose to continue implementing the SBSP Restoration Project through the construction, operation, and maintenance of selected ponds as part of Phase 2 project activities that cover approximately 2,200 acres on the Refuge. Phase 2 of the SBSP Restoration Project continues the collaborative efforts among federal, state, and local agencies working with scientists and the public to develop and implement project-level plans and designs for habitat restoration, flood management, and wildlife-oriented public access. These activities will result in the restoration, enhancement or conservation of thousands of acres of tidal marsh, managed pond, subtidal, or open water habitats as well as contribute to the recovery of endangered, threatened, and other special-status terrestrial and aquatic species.

Restoration of habitat for listed species was successfully achieved during Phase 1 which converted former commercial salt ponds to 1,600 acres of tidal habitats and 1,440 acres of muted tidal habitats. These tidal habitats will contribute to the recovery of endangered, threatened, and other special-status species; tidal marsh-dependent species; and the recovery of South Bay fisheries and water quality. In fitting with the SBSP Restoration Project goals, Phase 2 work was designed to increase the net conservation benefits to federally listed species in the Action Area and the estuarine habitats that they rely on. Based on these goals, the results of the project's Initial Stewardship Plan, and Phase 1 action results, we are confident that the SBSP Restoration Project has demonstrated a proven track record of successful implementation of producing a beneficial effect to listed species. In addition, the Project is directly implementing the goals set forth in regional planning documents such as the Baylands Ecosystem Habitat Goals Science Update, the San Francisco Bay Conservation and Development Commission's San Francisco Bay Plan, and many others.

Scope of Consultation Request and Relationship to Previous and Anticipated Future Consultations

After completing the Programmatic and Phase 1 consultations for the SBSP Restoration Project, the initial authorizations included actions on both the State and Federally-owned pond complexes. These consultations also were submitted in conjunction with the Operations and Maintenance (O&M) actions within all SBSP Restoration Project ponds, including those that were not the subject of actual Phase 1 restoration actions. At this time, the Phase 1 actions are complete, and the project ponds included in the programmatic authorizations are still operating under the current O&M approvals, which expire in 2019.

For Phase 2 actions, the USFWS was determined to be the lead federal agency, as it is the federal agency with the best expertise and relationship to the proposed action. For Phase 1 and Programmatic SBSP Restoration Project actions, the Refuge worked in collaboration with the USACE's Shoreline Study. Since that time, Phase 1 operations have been completed and Phase 2 actions are distinctly separate from the Shoreline Study. Therefore, for Phase 2 actions, the USFWS was determined to be the appropriate federal lead as it owns and manages the land as part of the Refuge.

This request for consultation is limited to Phase 2 restoration actions on property owned by the USFWS, and includes additional subsequent O&M actions within those ponds. A separate BA will be submitted for Phase 2 actions on CDFW owned ponds (Eden Landing) subsequent to the CEQA/NEPA approvals which are anticipated later in 2017. Renewal of the broader authorizations for O&M activities on ponds that are not subject to specific restoration actions for both agencies is anticipated to occur prior to the existing permit's expiration in 2019.

Summary of the Enclosed Biological Assessment

The enclosed BA describes the Phase 2 design elements, conservation measures, environmental setting, Action Area, consultation history with multiple agencies, and presents the determination of effects to federally listed species. A separate consultation with the USFWS for potential effects to federally listed birds, terrestrial mammals, and resident fishes regulated under their jurisdiction is occurring simultaneously.

As described in the attached BA, there is potential for Southern Distinct Population Segment (DPS) green sturgeon (*Acipenser medirostris*) and Central California Coast (CCC) DPS steelhead (*Oncorhynchus mykiss*) to occur in the action area, and designated critical habitat (DCH) for these species is present in the action area. The Action Area also contains Essential Fish Habitat (EFH) pursuant to MSA as designated under the Coastal Pelagic (PFMC 2016), Pacific Coast Groundfish (PFMC 2005), and Pacific Coast Salmon (PFMC 2014) Fishery Management Plans (FMP).

Adverse effects to listed species from construction are anticipated to be minor and temporary in nature; potential effects may include increases in turbidity, changes in water quality, and increases in underwater noise. Small numbers of ESA-listed fish species may be injured or killed as a result of in-water construction or entrainment into managed ponds during operations. Conservation measures are provided to avoid or minimize effects related to construction and operation. Additionally, the area of disturbance would be relatively small and temporary in nature compared with the extent of similar habitats in the San Francisco Bay estuary.

The proposed action is expected to result in considerable increases in the quantity, quality, and connectivity of estuarine habitat in the South Bay, far outweighing the small areas of fill in habitats to create habitat transition zones and habitat islands and the minor, localized impacts to habitat that would occur during construction, operation, and maintenance activities.

The USFWS and the SCC have determined in the attached BA that due to the potential for listed fish to interact with construction activities, the proposed action *may affect, and is likely to adversely affect* Southern DPS green sturgeon and CCC DPS steelhead. Additionally, it has been determined that the proposed action is *not likely to adversely affect* critical habitat for those two fish species.

With regards to EFH, the project may result in short-term changes that may *adversely affect* EFH, but such effects would be minimal, and the long-term effects to EFH would be greatly beneficial.

Thank you for your consideration of this request and for the important work you do in our shared goal of recovery for endangered species and their habitats in the San Francisco Bay estuary. Please feel free to contact me at (510) 792-0222 extension 123 or SBSP Executive Project Manager John Bourgeois at John.Bourgeois@scc.ca.gov or 408.314.8859 if you have further questions.

Sincerely,

Anne E. Morkill

Anne Morkill
Refuge Complex Manager

cc: Chris Barr/Jared Underwood, USFWS
John Krause, CDFW
John Bourgeois/Brenda Buxton, SCC
Seth Gentzler/Dillon Lennebacker, AECOM

the delay was that the cover letter signed by SBSP Executive Manager John Bourgeois requesting formal consultation had come from the California State Coastal Conservancy, the Refuge's partner and the state lead agency for the project, and not from the USFWS as the Federal Action Agency. Consequently, I re-submitted the cover letter on April 26, 2017 under my signature on behalf of the USFWS as the Federal Action Agency, along with the original BA attached. Please confirm that the revised cover letter is sufficient and that NMFS has initiated formal Section 7 consultation for the SBSP Restoration Project Phase 2 actions accordingly. Thank you for your consideration.

Sincerely,

Anne Morkill
Refuge Complex Manager

cc: Autumn Cleave, National Marine Fisheries Service
Brian Meux, National Marine Fisheries Service
Jared Underwood, Refuge Manager, Don Edwards SF Bay National Wildlife Refuge
Brenda Buxton, State Coastal Conservancy
John Bourgeois, SBSP Restoration Project
John Krause, California Department of Fish and Wildlife
Katherine Sun, USFWS Bay-Delta Fish & Wildlife Office

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, California 94555

May 26, 2017

Mr. Gary Stern
San Francisco Bay Branch Supervisor
NOAA Fisheries - West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, CA 95404

Dear Mr. Stern Gary

Thank you for your email dated May 5, 2017 and the attached document that outlined a revised scope for the submitted Biological Assessment of the South Bay Salt Pond (SBSP) Restoration Project's proposed Phase 2 actions at the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge). The revised scope you shared included the addition of operations and maintenance (O&M) activities on all ponds, levees, and other related facilities within the Refuge's Alviso and Ravenswood complexes. As per a number of other email and telephone discussions with you, we are considering NMFS' requested approach for combining Refuge O&M activities with Phase 2 actions into a single consultation process, and we intend to prepare a package of the supplemental information you requested in response to our initial submission to the National Marine Fisheries Service (NMFS) of a Biological Assessment for the Phase 2 actions at the Refuge.

However, the Refuge and the rest of the SBSP Restoration Project team are concerned about consistency between the Section 7 consultations conducted respectively by the NMFS and the U.S. Fish and Wildlife Service (USFWS) Bay-Delta Fish and Wildlife Office (FWO). To that end, we plan to share NMFS' suggested approach with the USFWS Bay-Delta FWO and request their input and guidance on whether to use the same approach for that consultation. Alternatively, if the Bay-Delta FWO does not require, or accept, a consistent approach across the two processes, the Refuge may be comfortable proceeding on different paths with each agency, as long as both agencies (and other regulators) understand and agree with that approach. The SBSP Restoration Project team will be meeting with Bay-Delta FWO staff on May 31, and we expect to have more information to share with you soon afterwards.

If pursued, we would also share this combined approach with the other regulatory agencies currently reviewing applications for Phase 2 authorization. Those include the San Francisco Bay Regional Water Quality Control Board, the San Francisco District of the U.S. Army Corps of Engineers, and the San Francisco Bay Conservation and Development Commission. These other agencies do not necessarily need to follow the same approach that is used for the ESA Section 7 consultation, but their review should consider the scope of work that will drive the Terms and Conditions in the respective NMFS and USFWS Biological Opinions. The Refuge has concerns that a variation in the scope provided to NMFS from what was provided to other agencies may cause confusion, conflict, or disconnect in their processes.

We would further like to request confirmation that formal consultation for the SBSP Restoration Project's Phase 2 actions has been initiated, and that NMFS is reviewing the Biological Assessment that was originally transmitted on March 24, 2017. During a conference call on April 20, 2017 to discuss the submitted Biological Assessment, NMFS indicated to Refuge and California State Coastal Conservancy staff that formal Section 7 consultation had not yet begun at that time. The reason provided by NMFS for

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404-4731

July 17, 2017 **In response refer to:** WCR-2017-6803

Anne Morkill
Refuge Manager
U.S. Fish and Wildlife Service
San Francisco Bay National Wildlife Complex
1 Marshlands Road
Fremont, California 94555

Re: Status of Endangered Species Act Section 7(a)(2) Consultation for the South Bay Salt Pond Restoration Project Phase 2

Dear Ms. Morkill:

Thank you for your letters of March 23, 2017, April 26, 2017, and May 26, 2017, regarding consultation pursuant to section 7 of the Endangered Species Act (ESA) for Phase 2 of the South Bay Salt Pond (SBSP) Restoration Project. The U.S. Fish and Wildlife Service (USFWS) Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) has requested initiation of formal consultation with NOAA's National Marine Fisheries Service (NMFS) to address construction, operation and maintenance of selected ponds that are part of SBSP Phase 2 restoration actions. As discussed in your May 26, 2017 letter, NMFS is concerned with the Refuge's proposed scope and approach for consultation on Phase 2 actions, and NMFS proposed a revised scope for this consultation via email to the Refuge on May 5, 2017. By telephone conference call on July 14, 2017, NMFS staff had an opportunity to further discuss this issue with you and develop a pathway to move this consultation forward.

As outlined in your letter of April 26, 2017, the Refuge proposed to conduct a consultation with NMFS that is limited to Phase 2 restoration actions on property owned by the USFWS and would include subsequent operations and maintenance (O&M) activities within only those ponds that included Phase 2 restoration actions. To address the remaining O&M activities at ponds owned by the USFWS within the boundaries of the SBSP Restoration Project, the Refuge proposed to rely on an existing ESA section consultation between NMFS and the Army Corps of Engineers (Corps) for a permit that expires in 2019. To comply with section 7 of the ESA and obtain an incidental take exemption post-2019 for these remaining ponds owned by the USFWS, the Refuge proposed to rely on a future consultation between NMFS and the Corps pertaining to the renewal of the Corps' permit. This approach concerns NMFS for several reasons including the likelihood that it is inconsistent with the NMFS/USFWS implementing regulations for section 7 consultations and creates a cumbersome procedural process. To avoid fragmenting the project into two consultations (*i.e.*, one with the Refuge and one with the Corps), NMFS recommends a single consultation with

USFWS that addresses proposed Phase 2 actions and future O&M associated with the SBSP Restoration Project on lands owned by USFWS.

As discussed by conference call on July 14, 2017, NMFS and the Refuge agree to conduct a single consultation which addresses implementation of Phase 2 actions and O&M activities throughout the SBSP Restoration Project on lands owned by USFWS for a period of 12 years (2018 through 2029). The February 2017 Biological Assessment for Phase 2 of the SBSP program provides a description of Phase 2 project activities and the O&M activities associated with Phase 2 actions. For a description of O&M activities at the remaining ponds, the Refuge is currently working with consultants to prepare a supplemental information package for NMFS. Upon transmittal of this supplemental information, NMFS expects to have sufficient information to initiate formal consultation.

Regarding the development of a fisheries monitoring program for Phase 2 of the SBSP Restoration Project, there is a need to continue and refine the Pond A8 steelhead studies. As discussed during the July 14, 2017 conference call, the Santa Clara Valley Water District (District) proposes to apply PIT tags to juvenile steelhead in the Guadalupe River watershed during the fall of 2017. With the District's tagging of juvenile steelhead in the watershed, installation of PIT tag receiving arrays at the Pond A8 notch could yield valuable information regarding the effects of Pond A8 operations on outmigrating steelhead smolts. Furthermore, receiving arrays at additional locations within the SBSP project area could provide information regarding steelhead presence at other sites. My staff is also working with the NMFS Southwest Fisheries Science Center – Fisheries Ecology Division in Santa Cruz to develop a tidal wetland monitoring framework for the San Francisco Estuary to guide monitoring of fish use and habitat conditions within restored tidal wetlands and interconnected subtidal habitats. Unfortunately, this framework will not be completed until 2018 but some preliminary work will be available to assist NMFS and the Refuge develop a fisheries monitoring program for Phase 2 of the SBSP.

We look forward to receiving the supplemental information package for the SBSP Phase 2 consultation and continuing our work with the Refuge on this vital restoration project. If you have any questions regarding these comments, please contact Autumn Cleave at 707-575-6056 or by email at autumn.cleave@noaa.gov.

Sincerely,

FOR

Alecia Van Atta
Assistant Regional Administrator
Coastal California Office

cc: Chris Barr, USFWS, Don Edwards National Wildlife Refuge, Fremont, California
John Bourgeois, State Coastal Conservancy, Oakland, California
Frances Malamud-Roam, USACE, San Francisco, California
Brian Wines, RWQCB, Oakland, California
Katherine Sun, USFWS Bay-Delta Office, Sacramento, California
Copy to ARN file #151422WCR2017SR00137
Copy to CHRON File

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, California 94555

8 September 2017

Gary Stern
San Francisco Bay Branch Supervisor
NOAA Fisheries - West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, CA 95404

Dear ~~Mr. Stern,~~ Gary:

Please find enclosed with this letter a package of supplemental information to the previously submitted Biological Assessment of the South Bay Salt Pond (SBSP) Restoration Project's proposed Phase 2 actions at the U.S. Fish and Wildlife Service (USFWS) Don Edwards San Francisco Bay National Wildlife Refuge (Refuge). The USFWS submitted its Phase 2 Biological Assessment to the National Marine Fisheries Service (NMFS) on March 24, 2017, and again on April 26, 2017, requesting formal consultation. As per NMFS request via previous letters, emails, and telephone discussions, we have prepared this supplemental information following our initial submission.

Specifically, this supplemental information includes the content requested so that NMFS could integrate the Refuge's planned operations and maintenance (O&M) activities at the federally-owned ponds into the same consultation pursuant to section 7 of the Endangered Species Act of 1973 (ESA) with the proposed Phase 2 restoration actions. We hope that these materials adequately address your request for additional information to include on-going O&M activities on the Refuge.

We have shared NMFS' suggested consultation approach with the USFWS Bay Delta Fish and Wildlife Office (FWO) and requested their input and guidance on whether to use the same approach for that consultation. The Bay Delta FWO does not require a consistent approach across the two processes, and therefore the Refuge is proceeding on different paths with each agency. Similar discussions are underway with the project's other regulatory agencies currently reviewing applications for Phase 2 authorization. Those include the San Francisco Bay Regional Water Quality Control Board, the San Francisco District of the U.S. Army Corps of Engineers, and the San Francisco Bay Conservation and Development Commission. These agencies did not indicate there would be any disconnect or conflict created by including O&M activities in the NMFS consultation.

With this letter and enclosed supplemental information, the USFWS, as the federal action agency, believes it has provided all requested and necessary information to NMFS for the SBSP Restoration Project's Phase 2 actions. Please provide confirmation that NMFS has initiated its formal consultation and the date that this consultation was initiated pursuant to section 7(b)(1)(A) of the ESA at your earliest convenience. Should you have any questions feel free to contact me at (510) 792-0222 extension 123, or SBSP Restoration Project's Executive Project Manager, John Bourgeois, at (408)-314-8859. Thank you for your continued cooperation on this matter.

Sincerely,

Anne Morkill
Refuge Complex Manager

cc:

Kaylee Allen, USFWS Bay Delta Fish and Wildlife Office
John Bourgeois, SBSP Restoration Project
Brenda Buxton, State Coastal Conservancy
John Krause, California Department of Fish and Wildlife

South Bay Salt Pond Restoration Project, Phase 2
Biological Assessment: Supplemental Information to the National Marine Fisheries Service
Operations and Maintenance at Refuge Ponds

United States Fish and Wildlife Service: Don Edwards San Francisco Bay National Wildlife Refuge

Prepared for:

United States Fish and Wildlife Service
Don Edwards San Francisco Bay National Wildlife Refuge
1 Marshlands Road, Fremont, CA 94555

Prepared by:

AECOM
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Prepared in association with:

California State Coastal Conservancy

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1. Introduction

This document provides supplemental information to the South Bay Salt Pond (SBSP) Restoration Project's Phase 2 Biological Assessment (BA) for operations and maintenance (O&M) of the United States Fish and Wildlife Service's (USFWS) and the California State Coastal Conservancy's (SCC) at the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge). The O&M actions would take place in the Alviso pond complex and the Ravenswood pond complex, both of which are part of the USFWS's properties in the larger Refuge.

The SBSP Restoration Project is a multi-agency effort to restore tidal marsh habitat, reconfigure managed pond habitat, maintain or improve flood protection, and provide recreation opportunities and public access in 15,100 acres of former salt-evaporation ponds purchased from and donated by Cargill Incorporated (Cargill) in 2003. The former salt-production areas are no longer used for that purpose, and, in many cases, they are no more saline than San Francisco Bay (Bay) itself. Immediately after the March 2003 acquisition and subsequent transfer of those ponds from Cargill, the landowners, the USWFS and California Department of Fish and Wildlife (CDFW), began implementation of the Initial Stewardship Plan (ISP) (USFWS and CDFG 2003), which was designed to maintain open water and unvegetated pond habitats with enough water circulation to preclude salt production and maintain habitat values and conditions until the long-term restoration actions of the SBSP Restoration Project could be implemented.

The longer-term planning effort involves a 50-year programmatic-level plan for restoration, flood risk management, and public access. This effort has already seen the implementation of Phase 1 projects, which are described in the SBSP Restoration Project's 2007 EIS/R. That longer-term planning was facilitated by the California State Coastal Conservancy (SCC) working with the two landowner agencies listed above and was completed in January 2009. The planning phase of the SBSP Restoration Project was completed in January 2009 with the publication of the Final 2007 Environmental Impact Statement/Report (EIS/R), which was both a programmatic document and a Phase 1 project-level document.

For the overall Program and for proposed Phase 1 actions, the SBSP Restoration Project completed consultation pursuant to section 7 of the Endangered Species Act of 1972 (ESA) and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for Essential Fish Habitat (EFH) with the National Marine Fisheries Service (NMFS) for the SBSP Restoration Project for actions associated with the Initial Stewardship Plan, Phase 1 restoration actions, and O&M at the Refuge-owned and CDFW-owned ponds. NMFS issued a Biological Opinion and EFH Consultation in 2009. Phase 1's restoration actions were successfully completed in December 2010; the last of the public access and recreation features (at Eden Landing) were completed in April 2016. At the end of Phase 1, 1,600 acres of tidal habitats and 1,440 acres of muted tidal habitats were opened to tidal inundation. The tidal areas already show signs of estuarine sedimentation and natural vegetative colonization. These tidal habitats will contribute to the recovery of endangered, threatened, and other special-status species; tidal-marsh-dependent species; and the recovery of South Bay fisheries and water quality. Also, 710 acres of reconfigured managed ponds were constructed for use by migratory birds at a range of water depths to create a variety of depth, hydrology, and salinity regimes through the use of flow control structures, grading, and other means. In addition, approximately 7 miles of new trail were built, providing new recreational opportunities. Small habitat transition zones were constructed in Eden Landing Pond E9 and vegetated with native upland species. Habitat islands were constructed in Ponds SF2, A16, E12, and E13.

Phase 2 of the SBSP Restoration Project is a collaborative effort among federal, state, and local agencies working with scientists and the public to develop and implement project-level plans and designs for habitat restoration, flood management, and wildlife-oriented public access. The former salt ponds are part of the USFWS-owned and managed Don Edwards San Francisco Bay National Wildlife Refuge (Refuge), and cover approximately 9,600 acres in the South Bay. The Refuge ponds in Phase 2 are collectively nearly 2,400 acres in size.

In 2010, the Phase 2 planning was initiated. The initial project elements included restoration, public access, and flood protection[1] actions in all three pond complexes: Alviso, Ravenswood, and Eden Landing. In April 2016 the FEIS/R for Phase 2 at the Refuge (i.e., Alviso and Ravenswood) was completed. Phase 2 at Eden Landing is proceeding separately.

For Section 7 consultation for Phase 2, the USFWS submitted a Biological Assessment (BA) to NMFS that covered actions at selected Refuge ponds within the Alviso pond complex and at the Ravenswood pond complex. This BA was submitted to NMFS on March 24, 2017. On May 5, 2017, NMFS provided a request for additional information and provided guidance on expanding the scope of their consultation to include O&M at all Refuge ponds for a twelve-year period starting when that Biological Opinion (BO) is issued late in 2017 or early in 2018. The NMFS guidance letter included the following requests.

1. Describe the full suite of O&M actions that the Refuge could implement at all of its ponds in the Ravenswood and Alviso complexes, including ponds that are part of Phase 2 and ponds that are not part of Phase 2. This would include the types of equipment to be used, time of year activities would be performed, habitats affected, and measures to avoid or minimize impacts.
2. Provide updated descriptions of ponds that were breached in Phase 1 and their O&M activities under the new operational mode. It noted that an updated map would also be helpful.
3. Describe the actions that could occur but that would be new O&M elements not previously included in existing O&M permits. These might include habitat transition zones, for example, or the beneficial reuse of upland fill or dredged material.
4. The description of these actions should also include new methods of doing maintenance on previously covered elements. This could include the "Living Shorelines" approaches to outboard levee maintenance, for example.
5. Provide a general description of the potential effects of the O&M actions, including new O&M elements, on fish habitat.
6. Expand the Action Area to include all Refuge ponds and not be limited to those included in the Phase 2 Biological Assessment.
7. Add detail on proposed reporting and monitoring. The letter suggested that the USFWS provide NMFS with annual Work Plans and annual implementation reports. The letter also noted that, regarding fish monitoring, there is a need for additional fish monitoring throughout the larger Action Area for O&M actions, as well as a need to assess the potential for steelhead entrainment at the A8 Ponds (these now-connected ponds include Ponds A8, A8S, A5, and A7). The letter noted that the NMFS staff would work with the Refuge staff to develop fish survey protocols and monitoring plans, which would then be submitted by FWS to NMFS as a proposed action for inclusion in the Biological Opinion. Presumably, the joint development of these monitoring and reporting plans and protocols would not delay the initiation of formal consultation with NMFS and could be developed concurrent with that consultation and the preparation of that Biological Opinion.

The following supplemental information is provided to fulfill these requests from NMFS. Throughout, the environmental setting and the environmental baseline for the species considered in this BA have been well established in the Programmatic EIS/R, the Phase 2 EIS/R, Phase 1 BO and the Phase 2 BA. This supplemental information package is intended to build on those documents and fill in gaps in the content they provided. Please refer to those documents for detailed information on the environmental baseline in the project area. For standard O&M practices, it also builds on the approved actions covered in the Programmatic/Phase 1 Biological Opinion, in the ISP itself, and in the SBSP Restoration Project's Adaptive Management Plan (AMP). The ponds that were neither part of Phase 1 nor part of Phase 2 will continue to be actively managed according to the goals and practices set forth in those documents until

[1] The typical terminology has since changed, and more recent documents are using "flood risk reduction" as the term of art. However, in 2010, "flood protection" was the preferred wording.

further implementation planning for future restoration or enhancement actions, and the appropriate adaptive management studies are completed.

2. Agency Coordination

As noted above, the Phase 2 BA was submitted on March 24, 2017. It contains a summary of communication, coordination, and other aspects of consultation between NMFS and the Refuge or the SBSP Restoration Project. Since then the following interactions have taken place.

- April 3, 2017: Dillon Lennebacker of AECOM contacted NMFS to request confirmation of receipt of the submitted BA.
- April 4-17, 2017: Several emails between Gary Stern and Anne Morkill, USFWS, Refuge Complex Manager to arrange and coordinate a telephone meeting to discuss the submitted BA.
- April 20, 2017: Telephone meeting between NMFS' Gary Stern and Brian Meux and several members of Refuge management, as well as other SBSP Restoration Project team members from the State Coastal Conservancy and consultants Dillon Lennebacker from AECOM and David Halsing from Environmental Science Associates.
- April 27, 2017: John Bourgeois sent an email note to Gary Stern summarizing the main points of the telephone meeting.
- May 5, 2017: Gary Stern responded to John bourgeois, Anne Morkill, and others via an email with an attachment. The attachment was the above-referenced NMFS guidance letter with the requested details.
- Late May, 2017: Anne Morkill sent a letter or response to Gary Stern that the USFWS is considering how best to respond to the requests from NMFS but also expressing concern that other regulatory agencies may not be comfortable with the different treatments of O&M and of the Action Area (or other agencies' equivalents of it) that NMFS was requesting. The USFWS and other SBSP Restoration Project proponents were going to discuss this proposed approach with the other agencies to elicit input or request agreement that it would be acceptable to them. If no objections were heard, the USFWS would then begin developing that. The USFWS also requested confirmation that the formal consultation period had begun.
- July 14, 2017: Telephone meeting between Gary Stern, Anne Morkill, John Bourgeois, and Dillon Lennebacker to report that USFWS Bay Delta Fish and Wildlife Office will only consult on Phase 2 project actions and not include O&M of all remaining ponds in their BO. General agreement to proceed as proposed for NMFS consultation to include Phase 2 projects and all O&M activities for all remaining ponds.

3. Action Area

The Action Area for Refuge O&M activities would be the entirety of two former salt-production pond complexes: Alviso (8,000 acres) and Ravenswood (1,600 acres). The Alviso pond complex consists of 25 ponds on the shores of the South Bay in Fremont, San Jose, Sunnyvale and Mountain View in Santa Clara and Alameda Counties. The Ravenswood pond complex consists of 7 ponds on the bayside of the Peninsula, along both sides of Highway 84 west of the Dumbarton Bridge, and on the bayside of the City of Menlo Park in San Mateo County, California.

The on-going operations and maintenance activities include a number of discrete actions that may occur throughout that Action Area, contingent upon available funding in any given year. Note that the SBSP Restoration Project's Phase 2 ponds at the Refuge are a subset of that larger O&M Action Area. The Action Area presented in the Biological Assessment that was specific to Phase 2 was smaller and discontinuous because of the geographic dispersal of the four Phase 2 pond groups (Alviso-Island Ponds, Alviso-A8 Ponds, Alviso-Mountain View Ponds, and Ravenswood Ponds). **Figure 1** depicts the Action Area for proposed O&M activities and the Phase 2 Action Areas within it.

4. Study Methods

The following steps were taken to assess the potential for Refuge O&M activities to adversely affect ESA-listed, NMFS-regulated species and their habitats and/or to EFH were are follows:

- The existing conditions within the Action Area – including all of the Refuge's Ravenswood and Alviso ponds and their immediate surroundings – were established as an environmental baseline against which the Refuge's O&M activities could be evaluated.

- The potential for ESA-listed, NMFS-regulated species to occur in the Action Area were assessed and updated relative to the Programmatic BO. Similar updates and reassessments were conducted for the critical habitats for these listed species and for EFH regulated under the MSA. The species and habitats are as follows:

  Endangered Species Act

  - Central California Coast (CCC) Steelhead (*Oncorhynchus mykiss*)
  - Designated critical habitat for CCC steelhead
  - Southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*)
  - Designated critical habitat for green sturgeon

  Magnuson-Stevens Fishery Conservation and Management Act

  - EFH for Pacific Groundfish Fisheries Management Plan (FMP)
  - EFH for Coastal Pelagic FMP
  - EFH for Pacific Salmon FMP

- All ponds in the Action Area were grouped into three categories, as shown in **Table 1** below. **Figure 2** illustrates the restoration status of these ponds, as they will be after Phase 2 implementation. These categories were as follows:

  - Ponds included in the Initial Stewardship Plan (ISP) or SBSP Restoration Project - Phase 1. There are no proposed changes to the Phase 1-specific O&M actions at these ponds. The O&M activities described in the Programmatic or Phase 1 BO and/or the ISP documents would remain in effect.

  - Ponds proposed as part of Phase 2 actions and that will have new O&M practices after Phase 2 implementation. New or different O&M actions proposed at Phase 2 ponds from existing Programmatic or Phase 1 O&M activities were described in the submitted Phase 2 BA. Note that many of the proposed Phase 2 actions would implement the same types of O&M activities that were considered and approved for Programmatic or Phase 1 actions in new places, as part of the Phase 2. For example, converting a seasonal pond like R4 to tidal marsh would change the suite of O&M actions that would be implemented there, but each of those actions was already approved as part of Programmatic O&M or as part of a Phase 1 restoration action.

  - Ponds that have not yet been included in an SBSP Restoration Project phase. The O&M practices at these ponds also remain as they were described in the Programmatic BO and other documents until such time as they are included in a future project phase or are changed as part of some other restoration project.

- Ideas or concepts for new O&M measures that were not covered in any previous BOs and that may be implemented during the time frame to be covered by the NMFS-issued BO for Refuge O&M were also developed. Those novel actions could be implemented at some or all of the three groups of ponds, as is discussed in more detail below.

- All of the previously approved O&M actions from the Programmatic / Phase 1 BO or proposed new O&M concepts evaluated as to the nature and amount of affect it would have on ESA-listed, NMFS-regulated species and their habitats as well as EFH in the Refuge O&M Action Area.

Table 1. Pond Groups and Restoration Status

Group	Pond	Current Status	Notes
ISP/Phase 1 Ponds	A5	Enhanced Managed Pond	Was included in Phase 1
	A6	Tidal Marsh	Was included in Phase 1
	A7	Enhanced Managed Pond	Was included in Phase 1
	A8	Enhanced Managed Pond	Was included in Phase 1
	A16	Enhanced Managed Pond	Was included in Phase 1
	A17	Tidal Marsh	Was included in Phase 1
	A19	Tidal Marsh	Was breached in Initial Stewardship Plan; structural changes only in Phase 2
	A20	Tidal Marsh	Was breached in Initial Stewardship Plan; structural changes only in Phase 2
	A21	Tidal Marsh	Was included in Phase 1
	SF2	Enhanced Managed Pond	Was included in Phase 1
Phase 2 Ponds	A1	Managed Pond	Part of Phase 2; will be restored to tidal marsh
	A2W	Managed Pond	Part of Phase 2; will be restored to tidal marsh
	A8S	Enhanced Managed Pond	Was included in Phase 1; will be further enhanced in Phase 2
	R3	Managed Pond	Part of Phase 2; will be restored to enhanced managed pond
	R4	Managed Pond	Part of Phase 2; will be restored to tidal marsh
	R5	Managed Pond	Part of Phase 2; will be restored to enhanced managed pond
	S5	Managed Pond	Part of Phase 2; will be restored to enhanced managed pond
Remaining Ponds	A2E	Managed Pond	Not yet included in a project phase
	AB1	Managed Pond	Not yet included in a project phase
	AB2	Managed Pond	Not yet included in a project phase
	A3W	Managed Pond	Not yet included in a project phase
	A3N	Managed Pond	Not yet included in a project phase
	A9*	Managed Pond	Not yet included in a project phase

	A10*	Managed Pond	Not yet included in a project phase
	A11*	Managed Pond	Not yet included in a project phase
	A12*	Managed Pond	Not yet included in a project phase
	A13*	Managed Pond	Not yet included in a project phase
	A14*	Managed Pond	Not yet included in a project phase
	A15*	Managed Pond	Not yet included in a project phase
	A22	Managed Pond	Not yet included in a project phase
	A23	Managed Pond	Not yet included in a project phase
	R1	Managed Pond	Not yet included in a project phase
	R2	Managed Pond	Not yet included in a project phase

* Pond is part of the USACE-Santa Clara Valley Water District-State Coastal Conservancy South San Francisco Bay Shoreline Study Project and was included in a separate Section 7 consultation for that project (NMFS No: WCR-2-14-1850). The Refuge still need Section 7 consultation for general O&M until the time when that project is implemented.

5. Description of Proposed Action

With this document, the Refuge is proposing two types of O&M activities:

1) **General O&M Activities**. Continuation of previously approved O&M operations at all the federally owned ponds within the Alviso pond complex and the Ravenswood pond complex, where such actions apply. These Phase 1 and general O&M operations were considered in the BO issued by NMFS on January 14, 2009 (Tracking Numbers 2007/08128 and 2008/02283 respectively). This category of general O&M actions also requests approval of the proposed O&M at ponds included in the Phase 2 work at the Refuge. Actions at Phase 2 ponds were included in the BA submitted to NMFS in March of 2017, and approval for their implementation at those locations was requested as part of that document, However, the Refuge is also requesting approval for similar O&M activities associated with future restoration actions at locations where those actions would be appropriate. For example, the maintenance of slope stability and removal of invasive plant species on habitat transition zones was requested at the Phase 2 ponds where those features would be constructed. Future SBSP Restoration Project phases may include those constructed features at other locations, and a general approval for their necessary maintenance (similar to that provided in the Programmatic/Phase 1 BO) is hereby requested. Potential impacts from placement or construction of those features (e.g., habitat conversion impacts, construction impacts, etc.) will be covered in the BAs prepared for those projects, but the O&M actions to maintain them is proposed for coverage here.

2) New O&M Actions. This category includes a request for approval of novel O&M activities that have not yet been included in any proposed Section 7 consultation document associated with the SBSP Restoration Project or Refuge itself. These include the "Living Shorelines" actions discussed in the sections that follow. Habitat transition zones and the beneficial reuse of upland fill material are also novel, but O&M actions for those were addressed in the Phase 2 BA, as discussed above. Therefore, the proposed consultation here is for the O&M actions associated

with the initial placement of Living Shorelines treatments and their subsequent maintenance and/or repair as needed.

5.1 General O&M Actions

This section addresses Refuge-wide O&M actions, as described in the Programmatic and Phase 1 O&M actions and in the Phase 2 BA. These actions could be implemented as needed at ponds that were modified in the ISP or in the Phase 1 project, proposed for modification n the Phase 2 project, and/or at ponds outside of these two phases of work and that may be considered for future restoration or enhancement actions at a future date. All three of those groups will continue to be managed by the Refuge as per the general O&M actions.

The areas within the SBSP Restoration Project area require periodic maintenance. Examples include.

- Some levees need to be maintained for flood protection and habitat protection purposes.
- Water control structures require maintenance for proper operation.
- Inlet and outlet channels through tidal marsh to these structures require periodic dredging, trash racks and fish screens to be cleared.
- Habitat islands need periodic vegetation management and may need added fill to address erosion.
- Additional actions may be required to manage emergency situations that put public safety or endanger habitat for protected and sensitive species.

Notably, ongoing tidal marsh restoration actions will continue to reduce the need to maintain many miles of levees and berms for ad-hoc flood risk reduction. Breached levees around marsh restoration areas will generally be allowed to erode and become part of a reduced O&M requirement. Exceptions would be those levees which need to be retained for PG&E access or for trails or other public safety measures, including flood risk reduction. Conversely, some ponds will be retained as enhanced managed ponds to benefit wintering waterfowl and shorebirds. Levees or berms and associated water control structures necessary for the continued operation of managed ponds will be maintained for this purpose;

In both of these cases, certain levees or berms and associated water control structures would require continued operation and maintenance of the existing levees and pond system. The Refuge is thus committed to routine maintenance and periodic repairs of these features to ensure pond habitat availability for fish and wildlife in a manner that does not increase the risk of off-site flooding of subsided areas adjacent to the Refuge.

<u>Common O&M Actions</u>

As noted in the issued BO Number 2008-00103S, maintenance activities will be conducted periodically (as needed) at all Refuge ponds and would include: dredge lock access; placement of material to repair and protect levees; maintenance and installation of existing docks, marine crossings, intake channels, tide gates, brine ditches, pumps and water control structures and access facilities. Maintenance may also require the installation of new pipes, culverts, siphons, intake structures, electrical distribution lines and pumping facilities. Maintenance also requires the temporary storage of dredged material stockpiled after dredge lock and salt pond access. Each of the above activities would require access by land or sea and may also require staging areas and storage/stockpile areas.

A Refuge Maintenance Worker performs weekly monitoring and subsequent tasks as needed, such as filling in degraded low spots, minor rip-rapping of certain problem areas if needed, maintenance of water control structures, and grading of berm crowns for safe vehicle access. The weekly monitoring program includes visual inspections of water control structures, siphons and berms, as well as visual pond observations and water level measurements to detect potential water quality issues, such as low dissolved oxygen.

Normal summer pond operations focus on maintaining full tidal circulation while maintaining discharge salinities by preventing local stagnant areas which may create areas of higher salinity or algal blooms. Water levels in some ponds are lowered during the summer to improve shorebird nesting and foraging habitat. Some ponds are maintained as a higher salinity pond during summer to favor brine shrimp development for foraging waterbirds. Some ponds are often mostly dry during the summer to provide nesting habitat for western snowy plover, with only high salinity water in the borrow ditches and some standing water to provide foraging habitat. Water levels are managed at specific levels in ponds depending on their elevation and tidal range to avoid wave erosion of the berms.

Normal winter pond operations focus on maintaining water surface levels lower in winter months to reduce potential overtopping in anticipation of heavy winter rains and high tides. Deeper water levels are managed in several ponds to support roosting and foraging for wintering waterfowl and to provide waterfowl hunting opportunities.

General Avoidance & Minimization Measures

As noted in the issued BO Number 2008-00103S, avoidance and minimization measures (AMMs) would continue to be implemented as they have been to reduce the potential for adverse effects on protected species and various types of protected habitats. Examples of these AMMs include seasonal avoidance, work at low tide, use of vibratory pile drivers rather than impact pile drivers, preconstruction surveys, biological monitoring during construction, silt fences and other applicable construction best management practices to reduce upland erosion into waterway or other aquatic habitats, all of which would be implemented to the maximum extent practicable. Also, the submitted Phase 2 BA elaborates on certain updates or modifications to these AMMs, as they would be implemented at Phase 2 ponds.

Habitat Transitions Zones

As part of Phase 2 operations, the SBSP Restoration Project has proposed use of restoration features not considered in the Phase 1 consultation by NMFS. These features are included to improve the habitats and to give the Refuge more flexibility to implement maintenance activities that support habitat goals. One of these feature types is habitat transition zones, which are proposed at selected Phase 2 ponds, as described in the previously submitted BA. That Phase 2 BA requested approval for the construction and the O&M of those features. The request here is that programmatic coverage be extended to those features throughout the Refuge.

As an adaptation to future sea level rise, the project is proposing the creation of habitat transition zones as part of Phase 2 actions. Habitat transition zones involve the beneficial reuse of placement of material to create transitional habitats from the pond or marsh bottom to the adjacent upland habitat along portions of the upland edge. These habitat transition zones, are sometimes referred to elsewhere as “upland transition zones,” “transition zone habitats,” “ecotones,” or “horizontal levees”; this document uses the term “habitat transition zones” for these constructed features. Habitat transition zones are specifically called out in documents such as the U.S. Fish and Wildlife Service’s Tidal Marsh Recovery Plan (USFWS 2013) and the recent Science Update to the Baylands Ecosystem Habitat Goals Project Report (Goals Project 2010). A gradual transition from submerged Baylands, ponds, or open waters to uplands is largely missing in the current landscape of the South Bay, where there is often an abrupt boundary between the bay or ponds and the built environment. The SBSP Restoration Project’s intention in including habitat transition zones in the Phase 2 alternatives is to restore this missing habitat feature. Doing so would:

- Establish areas in which terrestrial marsh species can take refuge during high tides and storm events, thereby reducing their vulnerability.
- Expand habitat for a variety of special status plant species that occupy this specific elevation zone.
- Provide space for marshes to migrate upslope over time as sea-level rise occurs.

Before proposing these features, the SBSP Restoration Project examined the landscape to see if there were any areas adjacent to the project site where this could occur naturally. In general, the best locations for building these features would be located adjacent to open space or park land where the project can provide an even greater extent of transition into upland habitats. However, at the edge of the Bay, these open space areas are largely former (now closed and capped) landfills which present a variety of challenges for creating the missing upland habitat. First, the existing elevation gradient between the restored marsh and the edge of the landfill is usually too steep to provide a gradual transition. Secondly, these landfills would otherwise pose a water quality risk from erosion if tidal action were introduced immediately adjacent to the protective clay liner or un-engineered rip rap slopes. In these instances, it is necessary that the project place material inside the former salt ponds to create the desired slope (generally 15:1 to 30:1 but potentially larger). At other locations, the actual elevations landward of the project sites are too low to create an uphill slope with the desired habitat functions. Therefore, once new levees are built to protect that area from tidal flooding, the only area remaining to build the transition zones is in the former salt ponds. Finally, most of the adjacent property is not within the SBSP Restoration Project's ability to acquire, whether or not it has the desired elevation profile, because it is currently developed. In addition to being very expensive to acquire these areas, it would be infeasible to relocate all of the residences and businesses that have been built adjacent to the ponds.

For these reasons, the project plans to construct the habitat transition zones inside the former salt ponds. The transition zones would improve the habitat quality of the restored marsh, particularly for endangered and threatened species, and improve resiliency of the shoreline over time as sea levels rise. The construction of those habitat transition zones – and the associated potential impacts from habitat conversion, construction disturbance, and other possible effects from placement of fill – would be only as authorized by future project permits. This document requests coverage for post-construction O&M of those habitat transition zone features.

The fill used for these features would be sourced from beneficial reuse of levee material on-site as feasible or sourced from upland excavation projects. As part of the Phase 2 operations, the Refuge has developed a Quality Assurance Program Plan (QAPP) (**Appendix 1**) for upland fill material will ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water. The Refuge would implement the same stringent standards if placement of fill is required during O&M activities for habitat transition zones. Fill material sourced on-site (i.e., from levee removals, breaches, pilot channels) is authorized by existing project permits for re-use in the ponds and are exempt from the QAPP review and approval process.

O&M activities specific to these habitat transition zones are described in detail in in the submitted Phase 2 BA. However, to support their future implementation and assist in obtaining more general coverage for their future operations and maintenance, a list of possible O&M actions includes the following: placement of material to repair areas of significant erosion and/or protect levees; vegetation (weed) removal; active revelation with native plant species; addition of soil amendments; light grading; addition of coarse woody debris; removal of trash or significant wrack areas that create a hazard to slope stability or trail user safety. The goal of all of these O&M activities would be to ensure slope stability and/or improve the habitat quality.

The Phase 2 BA also includes descriptions of AMMs for the construction, operation, and maintenance of these habitat transition zones at the places where they would be built in Phase 2. Those AMMs would be applied more generally at other habitat transition zones that could be constructed in the Refuge.

5.2 O&M Actions for Living Shorelines

Novel types of O&M actions are those proposed to support habitat goals like those outlined in the various "Living Shorelines" projects around the United States, including the San Francisco Bay Living Shorelines Project. Living Shorelines projects use a suite of bank stabilization and habitat restoration techniques to reinforce the shoreline, minimize coastal erosion, and maintain coastal processes while protecting, restoring, enhancing, and creating natural habitat for fish and aquatic plants and wildlife. The term

"Living Shorelines" was coined because these techniques provide living space for estuarine and coastal organisms by the strategic placement of native vegetation, natural materials, and reinforcing rock or shell for native shellfish settlement. The approach has been implemented primarily on the East and Gulf Coasts, where it enhances habitat values and increases connectivity of wetlands and deeper intertidal and subtidal lands, while providing a measure of shoreline protection.

Living Shorelines projects are relatively new to San Francisco Bay, where pilot restoration work on eelgrass and oyster reefs has recently led to recommendations for additional experimental testing of techniques and gradual scaling up to larger projects. The 2010 San Francisco Bay Subtidal Habitat Goals Report recommended that the next generation of projects considers the possibility of integrating multiple habitat types to improve linkages among habitats and promote potential synergistic effects of habitat features on each other as well as on associated fauna. Such habitat features, if scaled up slightly beyond previous efforts, could positively influence physical processes (such as sediment erosion and accretion) that affect shoreline configuration.

The SBSP Restoration Project requests permission to consider elements of Living Shoreline projects at the Refuge Ponds as a way to potentially offset the need for more traditional maintenance activities such as the placement of rip-rap to reduce erosion on salt pond levees. General O&M activities specific to these elements include: placement of natural material to repair areas of significant erosion and/or protect levees; addition of coarse woody debris or root wads; use of small areas of artificial oyster reefs and/or installation eel grass beds; active revegetation of native plant species. The goal of these O&M activities would generally be to use more natural or more ecologically oriented means of reducing erosion on levee features.

6. Equipment

The existing programmatic/Phase 1 BO and the Phase 2 BA list the equipment expected to be used for O&M work. A general list of this equipment would include excavators (amphibious and/or terrestrial, fitted with long-reach attachments), haul trucks, bulldozers, water trucks, compaction rollers, low-bed truck, conventional hand-tools and other common construction equipment, skiffs, boats, floating dredges, and amphibious equipment (i.e., amphibious dredge or vegetation removal equipment) and pickup vehicles for transportation in and out of the project site.

7. Reporting and Monitoring

This section includes three types of reporting and monitoring, as follows:

- Annual Work Plans and reporting
- Steelhead entrainment studies
- Implementation of an updated version of the SBSP Restoration Project's AMP

7.1 Annual Work Plans and Reporting

The SBSP Restoration Project proposes to develop, implement, and report on the outcomes of annual Work Plans for submission to NMFS. These Work Plans will convey each year's expected O&M activities, the locations and timing of their implementation, note the possible effects on species and habitats, and list any changes to the general programmatic conservation measures/AMMs and any proposed adjustments to the typical monitoring and reporting efforts which the Refuge has made in previous years.

In developing the annual work plan priorities for operations and maintenance activities, we consider several factors: a) the condition of the berms and water control structures; b) the restoration plans and timeline for each pond; c) the relative flooding risk to neighboring properties; and d) the opportunity to leverage costs by either doing the work in-house with Refuge maintenance staff and equipment (or Maintenance Action Teams), utilizing partner resources, or contracting out the work.

Each year's Work Plan will continue to be provided to the regulatory agencies as per previous years. This includes joint submission to the RWQCB, BCDC, and the U.S Army Corps of Engineers, with copies also going to the two Section 7 consulting agencies (USFWS and NMFS). This will include a report on the O&M actions that were actually implemented in the prior year and on the outcomes observed and reported during monitoring. The Refuge proposes this combination of the prior year's reporting with the next year's planned activities to make the connection between observations and plans more clear and tangible. This is an important component of adaptive management, a concept under which the SBSP Restoration Project has operated since its inception.

7.2 Steelhead Entrainment Studies

A study plan is being considered by the SBSP Restoration Project, in joint development and consultation with NMFS staff, for tracking the entry and exit of juvenile CCC steelhead into the A8 Ponds through the armored notch at Guadalupe River/Alviso Slough. This study would be intended to assess the risks of entrainment in that set of ponds that were part of a Phase 1 action to connect them to the slough. The general design would be to electrofish steelhead in the upper watershed, insert RFID or other trackers into the fish, and then deploy sensors through the watershed and at the entry/exit points of the managed ponds to track fish movement through the system. The Project looks forward to working with NMFS to determine the appropriate timing of this potential study, and to adapt the proposed study plan as necessary. If determined to be necessary, and once finalized and approved by NMFS, the study plan would be implemented by project partners including NMFS, contingent on available funding. In the meantime, the SBSP Restoration Project and the Refuge request that this steelhead study be included as a "Conservation Recommendation" when NMFS issues its BO. That would allow NMFS to authorize and promote the study in writing without committing the project to it or any specific parameters. All study details must then be approved by NMFS before project implementation.

7.3 Adaptive Management Plan Updates

As noted above, habitat transition zones are a new type of habitat feature that were proposed in the Phase 2 BA. They are also likely to be considered for implementation elsewhere in future project phases. Unlike most habitat enhancement actions proposed by the SBSP Restoration Project, however, these are elements that were not previously included in the Project's AMP, and so the planned monitoring and adaptive management actions (including general O&M) for them need to be developed and presented here. To address that request, the SBSP Restoration Project has prepared an addendum to the Project's AMP that is specific to habitat transition zones. That draft addendum to the AMP is presented here as **Appendix 2**, and it is submitted here for NMFS' review and consideration.

8. Listed Species, Critical Habitat and EFH in the Proposed Action Area

With regard to NMFS jurisdiction, the same listed species, habitats, designated critical habitats, and EFH that were presented in the Programmatic/Phase 1 BO and updated in the Phase 2 BA are present in the Action Area for the more general Refuge O&M actions discussed here. The life histories are included in the Programmatic/Phase 1 BO as well.

Figure 1 shows the Action Area for the proposed O&M activities at the Refuge. **Figure 3** illustrates the habitat areas and the designated critical habitat areas for these species Note that both species discussed herein are potentially present in the Action Area; green sturgeon are potentially present throughout the entire year, and CCC steelhead are potentially present during their seasonal migrations into (adults) or out of (juvenile) streams with spawning habitat in them. Designated critical habitat for both species is also present throughout the Action Area, up to the mean higher high water elevation, except in those Refuge ponds that do not currently have hydraulic connectivity with the Bay or adjacent sloughs or creeks. However, following Phase 2 implementation, several ponds that are presently lacking in such connectivity will have it added. Therefore, **Figure 3** also illustrates the ponds that would be added to the designated critical habitat following those actions.

There are three types of EFH in the O&M Action Area. They are the EFH for the species covered in the Pacific Groundfish Fisheries Management Plan FMP, Coastal Pelagic FMP, and Pacific Salmon FMP. All three are present in every tidally influenced portion of the Action Area below mean higher high water. As in the ESA-listed species and habitats, the EFH for these three FMPs are illustrated in **Figure 3** as it would be following Phase 2 implementation.

9. Section 7 Determinations for Listed Species, Critical Habitats, and EFH

The environmental baseline, species status and effects to species, critical habitat and EFH, and effects of the actions for O&M at Phase 1 ponds were covered in the existing NMFS BO. Environmental baseline, species status and effects to species, critical habitat and EFH from Phase 2 actions and additional O&M are described in the Phase 2 BA which this document is supplementing. Additionally, the programmatic BA was reviewed by NMFS for the project's phase 1 consultation includes general O&M at the Alviso, Ravenswood and Eden Landing complex ponds.

9.1 ESA-Listed Species and Critical Habitats

Both of the species discussed in this supplemental information document were also considered in the Phase 2 BA, programmatic portion of the 2007 EIS/R and the SBSP Phase 1 BO Consultation (NMFS 2009).[2] These species are

- Central California Coast (CCC) Steelhead
- Southern Distinct Population Segment (DPS) of North American green sturgeon

For the two ESA-listed species in the O&M Action Area, the USFWS has determined that the proposed O&M activities described here and incorporated by reference from the aforementioned Section 7 consultation documents **may affect, and are likely to adversely affect**, but would not jeopardize those species.

Regarding critical habitats for the two ESA-listed in the O&M Action Area, the USFWS has determined that the proposed O&M activities described here and incorporated by reference from the aforementioned Section 7 consultation documents **may affect but are not likely to adversely modify** the designated critical habitats.

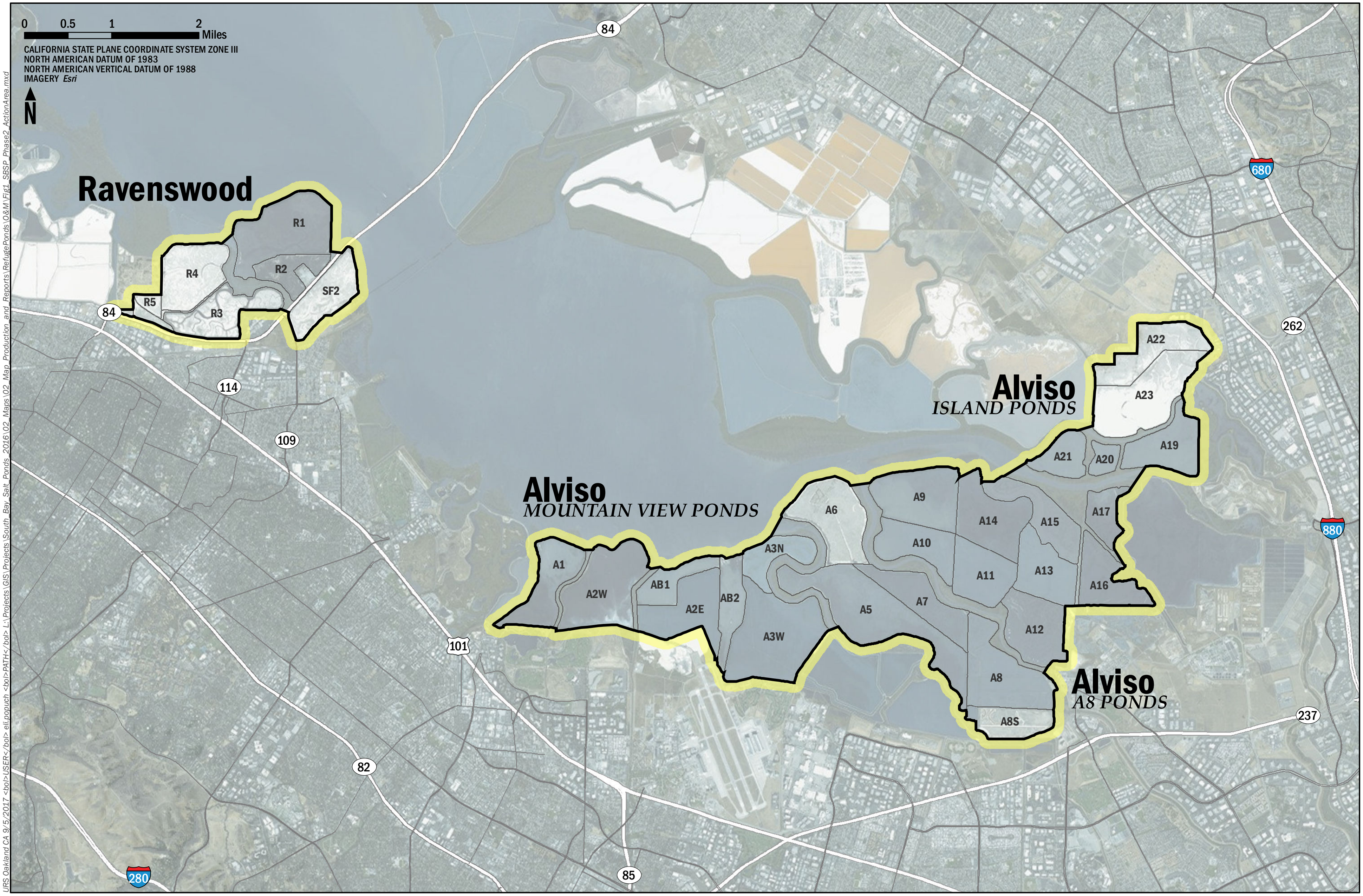
9.2 Essential Fish Habitat

For all three FMPs, the potential impacts are the same as those considered in the Phase 1 BO and Phase 2 BA. Operations and maintenance effects may be somewhat detrimental to EFH in the short term, but would greatly benefit the availability of aquatic habitats, the habitat complexity, and the overall ecological habitat functions and value in the long term. The temporary negative effects of the proposed action are minimal and would be outweighed by maintaining tidal flows to the ponds and restored tidal marshes, which are the key part of SBSP Restoration Project. That general answer applies to all three categories of O&M (Programmatic and Phase 1 Action, Phase 2 Actions, Novel Actions).

The programmatic/Phase 1 BO and the submitted Phase 2 BA provide assessment of the various O&M activities on the EFH in the proposed O&M Action Area. The USFWS has determined that the proposed O&M actions **would adversely affect** EFH for the three FMPs in the Action Area. The SBSP Restoration

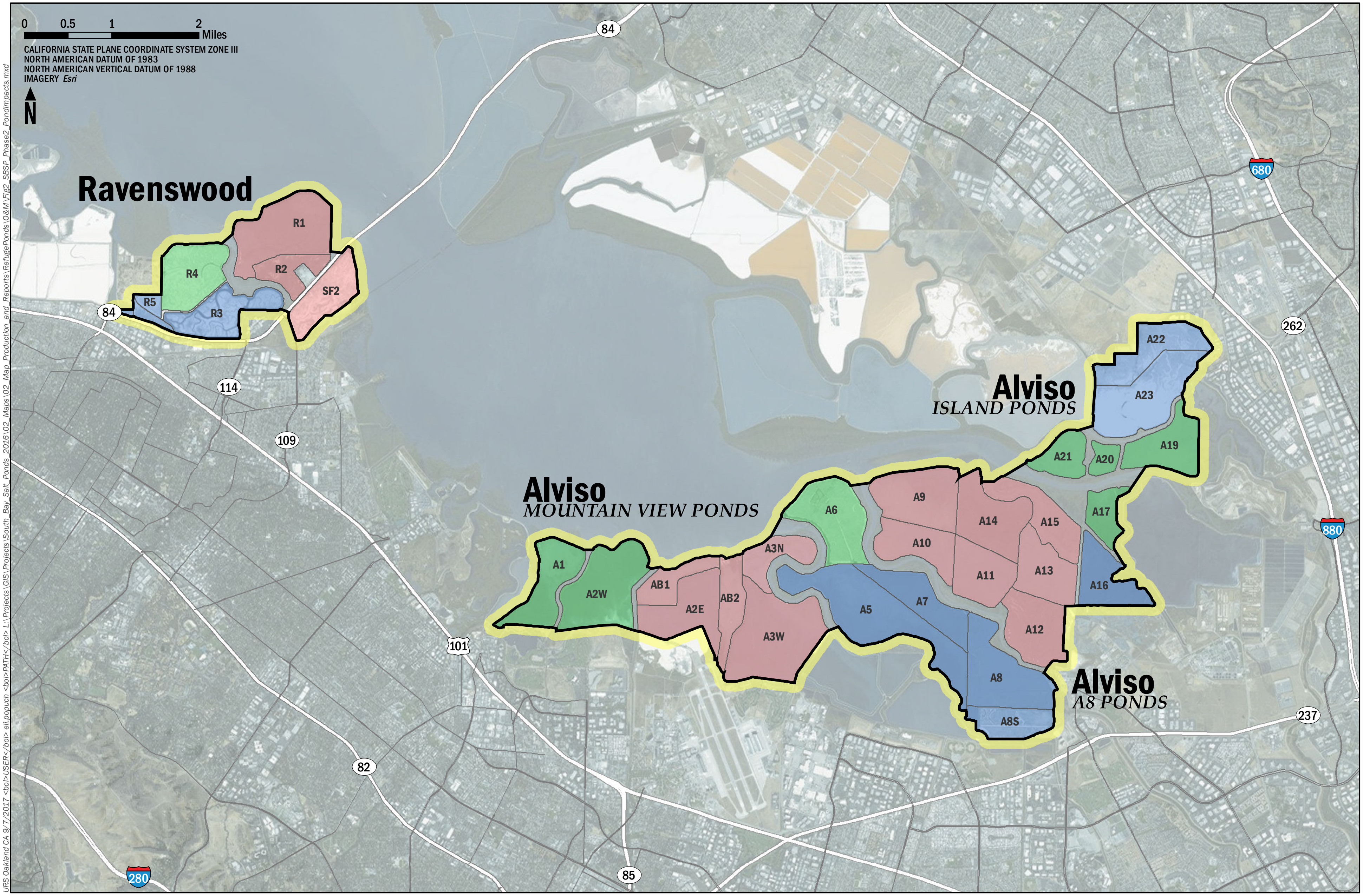
[2] Species under the jurisdiction of the USFWS will be addressed in a separate consultation for O&M with the Endangered Species section of the USFWS' Bay-Delta Office at a later date.

Project requests EFH Conservation Recommendations for the SBSP Restoration Project's O&M activities at the Don Edwards San Francisco Bay National Wildlife Refuge.



AECOM
South Bay Salt Pond Restoration Project

Figure 1
Action Area for SBSP Operations and Maintenance



Pond Status

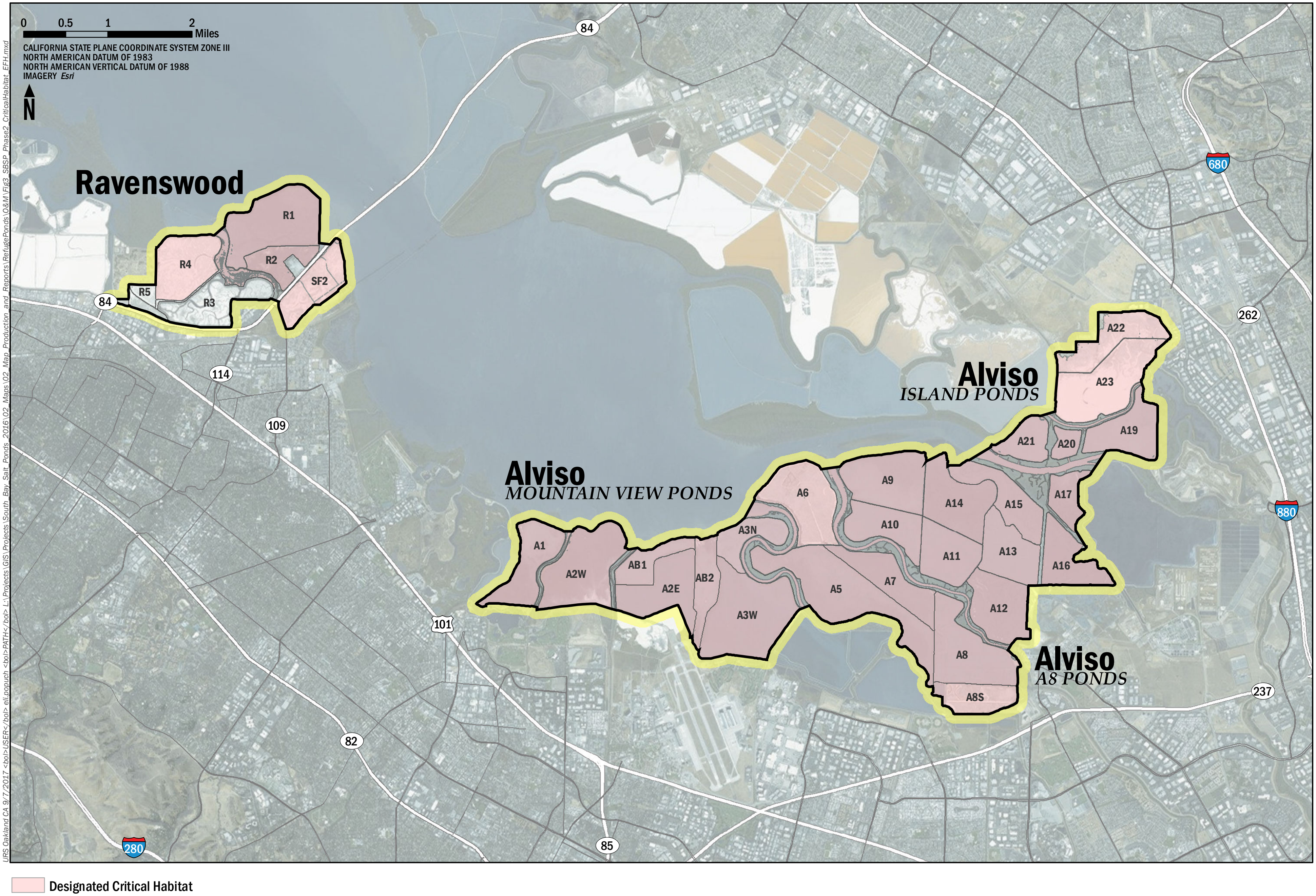
- Managed Pond
- Pond
- Tidal Marsh

AECOM

South Bay Salt Pond Restoration Project

Figure 2

Restoration Status Following Phase 2

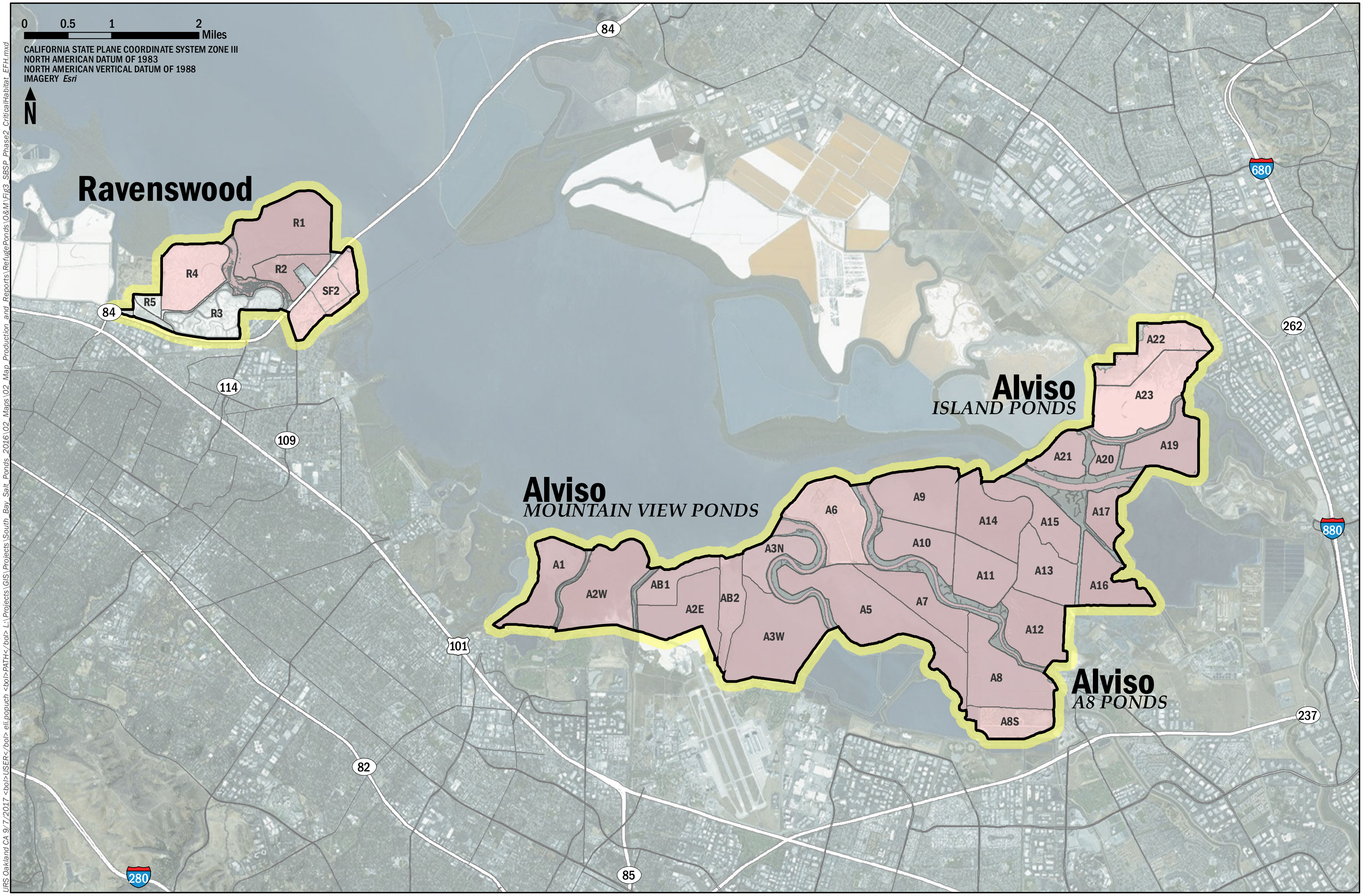


AECOM

South Bay Salt Pond Restoration Project

Figure 3a

Designated Critical Habitat within the Action Area



Essential Fish Habitat

AECOM
South Bay Salt Pond Restoration Project

Figure 3b
NOAA Essential Fish Habitat within the Action Area

Appendix 1. Quality Assurance Program Plan for Use of Upland Fill Material

SOUTH BAY SALT POND RESTORATION PROJECT
QUALITY ASSURANCE PROJECT PLAN
FOR FILL IMPORT TO OPERATE AND MAINTAIN LEVEES AT RAVENSWOOD AND ALVISO SALT POND COMPLEXES

Prepared for:

California Wildlife Foundation

Prepared by:

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April 26, 2016 Project # 3685-01

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List of Preparers

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Section 1.0 Introduction

1.1 Problem Definition

The Don Edwards National Wildlife Refuge (Refuge) Alviso and Ravenswood pond complexes are located in South San Francisco Bay, California, in an area formerly owned by Cargill (Figure 1). The complexes contain more than 70 miles of levees that require ongoing operations and maintenance (O&M) to maintain the level of flood protection formerly provided under Cargill's management. The South Bay Salt Pond Restoration Project (SBSPRP), the largest tidal wetland restoration project on the West Coast, is being implemented over several phases (e.g., Phase 1, Phase 2) in the complexes. O&M of levees in the complexes was permitted in conjunction with Phase 1 of the SBSPRP (BCDC 2008, NMFS 2009, RWQCB 2008, USFWS 2008a, USACE 2009).

The Refuge and SBSPRP Project Management Team seek fill from upland projects to use for O&M of levees in the complexes. The San Francisco Bay Regional Water Quality Control Board (RWQCB) requires an RWQCB-approved quality assurance project plan (QAPP) before terrestrial fill can be imported and used for O&M or restoration actions in the complexes (RWQCB 2008).

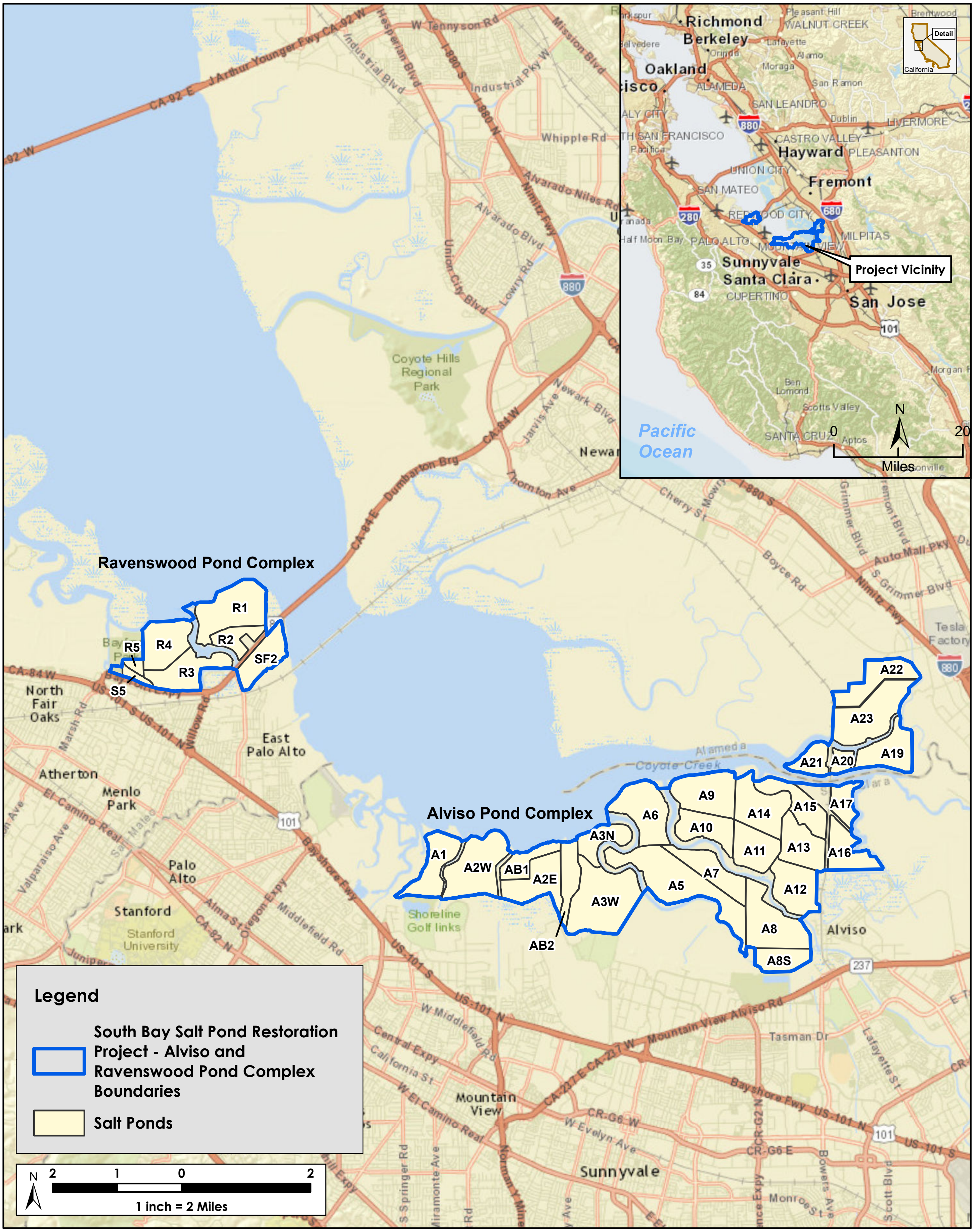
1.2 Purpose of QAPP

The purpose of this QAPP is to set forth the process for evaluating the sources of fill to be used for O&M so that the fill imported to the complexes meets RWQCB contaminant screening guidelines for the protection of aquatic life (RWQCB 2000). This QAPP establishes the team responsible for QAPP implementation, describes fill material screening procedures, identifies limits on contaminants, and specifies the laboratory testing methods that, when properly implemented, provide a high level of confidence that material placed in the complexes will meet RWQCB contaminant screening guidelines. It also describes the quality assurance measures that will be implemented during the transport and placement of fill.

Import of terrestrial fill for restoration actions may be required during Phase 1, Phase 2, or future phases of the SBSPRP. For example, fill will be required for the restoration of transition zones proposed in Phase 2. This QAPP does not cover import of terrestrial fill for actions other than O&M in the complexes. Therefore, a revised QAPP will be developed to cover future SBSPRP restoration actions.

1.3 Basis for QAPP Criteria and Procedures

For terrestrial fill to be approved, the borrow site proponent must demonstrate that the fill has contaminant levels below screening limits established in this QAPP. The contaminant screening limits in this QAPP are based on those in the San Francisco Bay RWQCB's *Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines* (RWQCB 2000) for use of fill in wetland environments, the RWQCB-approved QAPP for



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Ecological Consultants

Figure 1. Vicinity Map

Quality Assurance Project Plan for Fill Import and Placement at Ravenswood and Alviso Salt Pond Complexes (3685-01)

April 2016

Inner Bair Island Fill Import and Placement (USFWS 2008b), and the RWQCB's *Environmental Screening Levels* (RWQCB 2013). The requirement that fill intended for use in wetland environments meet contaminant screening limits is appropriate because levee material may become part of the wetland environment in the future (e.g., through reworking of levees during future restoration actions).

Screening procedures in this QAPP were developed using the QAPP for Inner Bair Island Fill Import and Placement (USFWS 2008b), the California Department of Toxic Substance Control's (DTSC's) Information Advisory: Clean Imported Fill Material (DTSC 2001), and the U.S. Environmental Protection Agency's (EPA's) *Guidance for Quality Assurance Project Plans* (EPA 2002).

1.4 Permits Guiding Use of Terrestrial Fill in the SBSPRP

The following permits guide the use and placement of imported terrestrial fill for O&M of levees in the complexes:

- U.S. Army Corps of Engineers O&M permit for the SBSPRP (No. 2008-00103S) (USACE 2009)
- San Francisco Bay RWQCB Water Discharge Requirements and Water Quality Certification for the SBSPRP, Phase 1 (Order No. R2-2008-0078) (RWQCB 2008)
- San Francisco Bay Conservation and Development Commission Permit No. 7-03 for SBSPRP Phase 1 and O&M Activities (BCDC 2008)
- U.S. Fish and Wildlife Service (USFWS) Formal Endangered Species Consultation on the Proposed South Bay Salt Pond Restoration Project Long-Term Plan and the Project-Level Phase 1 Actions (No. 81420-08-F-0621) (USFWS 2008a)
- Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for SBSPRP Phase 1 and O&M Activities (Tracking No. 2007/08128 and 2008/02283) (NMFS 2009)

Section 2.0 Project Team Organization and Responsibilities

This section identifies the parties involved with implementing this QAPP and their respective roles. Sites that will serve as potential sources for fill for levee O&M are referred to as borrow sites.

- **Quality Assurance Officer**. Max Busnardo (Principal, H. T. Harvey & Associates) will serve as the quality assurance officer. Mr. Busnardo' s resume is provided in Appendix A. The quality assurance officer is responsible for leading his staff in verifying that all QAPP procedures and contaminant screening criteria are met and has the following key responsibilities:

  - The quality assurance officer will verify that the borrow site sampling procedures identified in this QAPP are followed. The quality assurance officer will review the Phase 1 Borrow Site Analysis (Phase 1 Analysis), the Borrow Site Sampling Plan (Site Sampling Plan), and the Phase 2 Borrow Site Analysis (Phase 2 Analysis); make a minimum of one visit to each borrow site; and review borrow site sampling results.
  - After the quality assurance officer is satisfied that the proposed borrow site meets the contaminant screening criteria outlined in this QAPP, the quality assurance officer will prepare a borrow site characterization memorandum for submission to the Project Management Team. The borrow site characterization memorandum will document that the fill meets the contaminant screening levels.
  - The quality assurance officer will maintain a spreadsheet cataloging the names, addresses, and fill volumes of acceptable borrow sites.
  - The quality assurance officer will monitor construction to verify that QAPP procedures are followed during borrow site excavation and fill placement. Monitoring includes making random, unannounced visits to the borrow sites during excavation and random, unannounced visits during fill placement to monitor compliance with this QAPP. The quality assurance officer also will verify that the gate keeper is accepting and tracking trucks in accordance with this QAPP.
  - The quality assurance officer will prepare and submit quarterly reports described in Section 3.7.

- **Project Management Team**—The Project Management Team, composed of representatives from the California Wildlife Foundation, the California Coastal Conservancy, and USFWS, will manage the roles and responsibilities of all parties involved throughout the life of this QAPP. The Project Management Team also will review quarterly reports provided by the quality assurance officer.

- **Borrow Site Proponent**—The borrow site proponent will carry out the Phase 1 Analysis to screen potential fill sources, develop the Site Sampling Plan, sample the borrow site in accordance with the Site Sampling Plan, and send fill sample data to a laboratory approved by the quality assurance officer for contaminant screening.

- **Contractor**—California Wildlife Foundation's contractor for fill import is Pacific States Environmental Contractors, Inc. The contractor will identify and review potential borrow sites, orient and guide the borrow site proponent through QAPP procedures, and submit the Phase 1 and Phase 2 Analyses to the quality assurance officer. If fill is approved by the quality assurance officer, the contractor will transport and place the fill on site. The contractor will issue a daily dispatch log, documenting the approved number of trucks and the trucking company transporting fill from each borrow site.

- **Peer Reviewer**—Justin Hanzel-Durbin (Senior Engineer, TRC Solutions Inc.) will serve as the data peer reviewer for the project. Mr. Hanzel-Durbin's resume is provided in Appendix B. If deemed necessary by the quality assurance officer, the peer reviewer and his staff will review laboratory analysis methods for suitability based on the QAPP goals and will provide a second level of review of the Site Sampling Plan and borrow site sampling results. The peer reviewer will be contracted to the quality assurance officer and will therefore be contractually independent of the borrow site proponent.

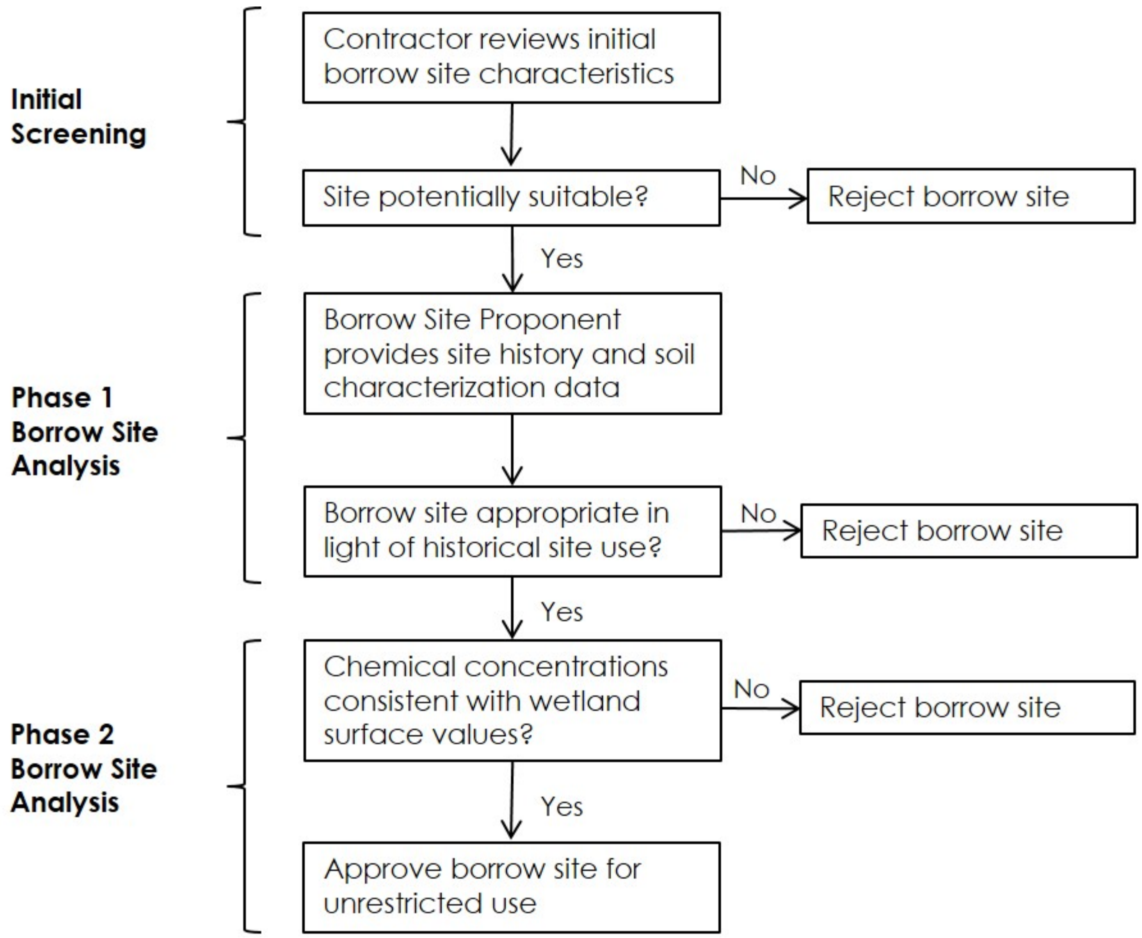
- **Gate Keeper**—The gate keeper is an employee of the contractor. The gate keeper will ensure that only trucks carrying fill from approved borrow sites are allowed onto the project site. The gate keeper will monitor the entrance to the project site full time during fill transport. The gate keeper will keep a log to document the number of trucks entering the project site, the borrow source location of each truck, the trucking company, and the volume of fill delivered for comparison with the dispatch log issued by the contractor. Upon approval by the peer reviewer, a soil acceptance form will be generated listing the name and location of the project, approved volume, and the date of approval. Copies of these forms will be delivered to the borrow site to be handed to each truck. These forms will be collected upon entry and logged by the gate keeper. Trucks without a soil acceptance form from an approved source will be rejected from entry to the fill site.

- **Persons Responsible for QAPP Update and Maintenance**—Changes and updates to this QAPP will be made after a review of the rationale for change by the quality assurance officer and with the concurrence of RWQCB and the Project Management Team. The Project Management Team will identify an agent (e.g., the quality assurance officer) to make changes to this QAPP, submit drafts for review, prepare a final copy, and submit the final version for review and approval by RWQCB.

Section 3.0 Fill Analysis Procedures and Contaminant Screening Criteria

This QAPP will be implemented in accordance with the procedures and fill screening criteria described below. Figure 2 summarizes the screening decision tree process for approving borrow sites.

Figure 2. Screening Guideline Decision Tree for Approving Borrow Sites



3.1 Initial Screening

- The contractor will work with the borrow site proponent to determine whether a borrow site is potentially suitable for use as a source for fill based on the borrow site location, land use history, economics, timing, and the quantity of material available. Sites that have any history of industrial or commercial activities likely to lead to contamination (e.g., gas stations and dry cleaners) will not be considered as a source. If a borrow site is potentially suitable, then the contractor will request a Phase

1 Analysis from the borrow site proponent. The borrow site proponent will make appropriate due diligence inquiries into the previous ownership and uses of the site including, but not limited to, review of previous environmental site assessments (if available), review of city and historical records, interviews with the current property owner and other persons associated with the subject and adjoining properties, and searches of environmental databases such as the California State Water Resources Control Board's GeoTracker. Borrow sites are likely to be located in the San Francisco Bay Area. The contractor will review the initial borrow site characteristics, including review of Geotracker, Envirostar, prior Phase 1 or Phase 2 environmental site assessments, and any other available site history documents including available environmental and geotechnical reports.

3.2 Phase 1 Borrow Site Analysis

Phase 1 Analysis is a qualitative analysis carried out by the borrow site proponent to help the contractor and quality assurance officer identify potential environmental hazards present in the borrow site fill. Either party may reject part or all of a borrow site that has a high likelihood of contamination based on the results of the Phase 1 Analysis (Figure 2). The borrow site proponent is responsible for carrying out the Phase 1 Analysis and providing a Phase 1 Analysis report to the contractor and quality assurance officer for review.

A complete Phase 1 Analysis report will include the following information:

- Name of borrow site proponent
- A map showing the location and extent of the potential borrow site
- Current and previous landowners' names and dates of ownership
- A description of current and past site use(s) and any possible environmental conditions that could lead to fill contamination, including the likelihood that volatile organic compounds (VOCs) may be present in fill material
- Photos of the borrow site with descriptions that can inform the type of analysis to perform
- Any previously collected contaminant data for the site
- The approximate volume of anticipated clean fill

The following steps are involved with carrying out Phase 1 Analysis:

- The borrow site proponent writes the Phase 1 Analysis report and provides it to the contractor.
- The contractor prescreens the Phase 1 Analysis report for accuracy and completeness and then provides the Phase 1 Analysis report to the quality assurance officer for review.
- If requested by the quality assurance officer, the contractor and quality assurance officer will perform a site visit to confirm site conditions and identify potential sources of contamination.

3.3 Phase 2 Borrow Site Analysis

Phase 2 Analysis consists of conducting the quantitative assessment of contaminant concentrations in the potential borrow material. Following completion of the Phase 2 Analysis, the contractor will review the sampling plan to confirm alignment with QAPP procedures and screen laboratory data results against the contaminant screening criteria. If contamination levels in the potential fill are below the threshold levels identified in this QAPP (Section 3.4), the contractor will prepare a Phase 2 Analysis report for review by the quality assurance officer.

A complete Phase 2 Analysis report will include the following information:

- A borrow site sampling plan (described below)
- A description of the sampling methods used and summary of whether the methods deviated from those described in the borrow site sampling plan (and if so, why)
- A description of laboratory contaminant analysis methods
- Laboratory contaminant results and identification of any contaminants exceeding the screening criteria presented in Section 3.4
- Conclusions with an accurate map of the areas that the contractor recommends be accepted or rejected for use

The following steps are involved with carrying out the Phase 2 Analysis:

- The borrow site proponent develops a Site Sampling Plan (Section 3.3.1).
- The contractor provides the Site Sampling Plan to the quality assurance officer.
- The Site Sampling Plan is reviewed by the quality assurance officer and peer reviewer (if deemed necessary by the quality assurance officer). If needed, the borrow site proponent will revise the Site Sampling Plan to address concerns.
- The Site Sampling Plan is approved by the quality assurance officer.
- The borrow site proponent carries out the Site Sampling Plan.
- The quality assurance officer may make site visits during fill sampling to verify that methods are being followed.
- The borrow site proponent sends samples for analysis to an approved laboratory.
- Laboratory results are sent to the borrow site proponent, contractor, and quality assurance officer.
- If some or all portions of the borrow site meet the contaminant criteria, the contractor will prepare a Phase 2 Analysis report and provide it to the quality assurance officer.
- The quality assurance officer and peer reviewer (if deemed necessary by the quality assurance officer) will review the Phase 2 Analysis report and then determine whether the fill meets the screening requirements in this QAPP. The quality assurance officer may approve the borrow site, reject the borrow site, or request that the contractor and borrow site proponent conduct further sampling and testing and resubmit the results for review.

3.3.1 Site Sampling Plan

The Site Sampling Plan will be developed by the borrow site proponent before samples are collected. The Site Sampling Plan will be submitted to the quality assurance officer by the contractor and will:

- Include accurate maps showing the proposed borrow site, any areas of environmental concern identified in the Phase 1 Analysis report, and sample locations;
- Identify the expected volume and acreage of the borrow site;
- Describe the rationale for the sampling design (the number of samples should, at a minimum, meet DTSC recommendations (Table 1) (DTSC 2001);
- Describe the methods for sample collection, including:
  - Global Positioning System or other navigation method to proposed sample locations;
  - sampling equipment (e.g., coring device; type of buckets, glass jars, coolers);
  - depth of samples;
  - sample compositing plan, if any; and
  - sample handling (i.e., identification, labeling, transport, storage, holding time, and disposal);
- Provide contact information for the selected laboratory where samples will be analyzed;
- Specify the chain-of-custody form and procedure that will be followed from sample collection through laboratory analysis so that the physical possession of samples is known at all points in the project;
- Identify the analytical parameters to be tested (Section 3.5); and
- Identify the laboratory's reporting limit for each constituent being sampled compared to the contaminant screening criteria below. If the reporting limit is greater than the contaminant screening criteria for a constituent(s), the method detection limit (MDL) for the constituent(s) also will be provided (see section 3.5.2).

Table 1. Minimum Sampling Requirements

Area or Volume	Minimum Number of Samples Required
Area of individual borrow area	
2 acres or less	Four samples
2–4 acres	One sample every 0.5 acre
4–10 acres	Eight samples
Volume of borrow area stockpile	
Up to 1,000 cubic yards	One sample per 250 cubic yards
1,000–5,000 cubic yards	Four samples for first 1,000 cubic yards and one sample for each additional 500 cubic yards
Greater than 5,000 cubic yards	12 samples for first 5,000 cubic yards and one sample for each additional 1,000 cubic yards

Source: DTSC 2001

3.3.2 Acceptance or Rejection of Fill

All fill samples must meet the contamination criteria for wetland surface material (Section 3.4.1) for an entire borrow site to be approved for unrestricted use as fill (Figure 2). If only a portion of the samples collected at a potential borrow site meet the specified contaminant criteria for wetland surface material, the quality assurance officer will specify on a map the volume and extent of the portion of the site that is approved for use based on sample locations and associated results. At the discretion of the quality assurance officer, additional sampling may be required to delineate the extent of the suitable fill material. If a high potential for pesticide residue exists at a site, such as from previous agricultural use, the upper 3 feet of material may be rejected. This will be specifically evaluated and considered for approval of material.

If the results of the Phase 2 Analysis indicate that the borrow site contains fill that is suitable as wetland surface material, the quality assurance officer will summarize the conclusions in a borrow site characterization memorandum submitted to the contractor and the SBSPRP Project Management Team. The memorandum will serve as the soil acceptance form and will document the name and address of the acceptable borrow site, the volume of material at the site, the volume of fill approved, and its location in the borrow area. The Phase 1 and 2 Analysis reports will be included as attachments.

3.4 Contaminant Screening Criteria

Fill used for the SBSPRP must meet the contaminant screening criteria identified in Table 2. If the reporting limit is greater than the contaminant screening criteria for a constituent, the MDL and the associated test result will be used for comparison to the contaminant screening criteria (see section 3.5.2).

The contaminant limits identified in this QAPP are identical to those in the San Francisco Bay RWQCB's *Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines* (RWQCB 2000). RWQCB 2000 provides contaminant screening levels based on the RWQCB's current understanding of the appropriate physical, chemical and biological quality requirements of re-use of dredge materials for various beneficial reuse placement options (RWQCB 2000). The RWQCB 2000 screening levels were used as the basis to accept or reject terrestrial soil for use in tidal wetland and upland habitats in the *Quality Assurance Project Plan for Inner Bair Island Fill Import and Placement* (USFWS 2008b). The RWQCB 2000 contaminant screening criteria were adopted in this QAPP with the following two exceptions:

- Limits to total hydrocarbon components were not covered in RWQCB 2000.Therefore, limits to total hydrocarbon components are based on the limits approved by the RWQCB in the QAPP for Inner Bair Island Fill Import and Placement (USFWS 2008b).
- Limits to VOCs are not covered in RWQCB 2000 or the QAPP for Inner Bair Island Fill Import and Placement (USFWS 2008b). Therefore, limits to VOC's are based on RWQCB 2013 Environmental Screening Levels (RWQCB 2013). These screening levels were developed by the RWQCB to help expedite the identification and evaluation of potential environmental concerns in soils (and other media).

3.4.1 Wetland Surface Material

Wetland surface material is fill material chemically suitable to come in contact with wetland flora and fauna. RWQCB has set limits to identify what level of contamination is permissible for wetland surface material (RWQCB 2000) (Table 2). Because levee material may be reworked during future levee maintenance or wetland restoration as part of the SBSPRP, new imported fill placed on levees must be suitable for placement in wetlands. Therefore, material used for levee repair in the salt pond complexes, which may be reworked in the future, must meet the criteria for wetland surface material (Figure 3). Wetland surface material will be placed on levees according to the conditions of the O&M permits. Table 2 identifies the maximum contaminant levels considered suitable for wetland surface material.

Table 2. Contaminant Screening Criteria for Wetland Surface Material

Constituent	Screening Criterion
Metals (mg/kg, dry weight)	
Arsenic	15.3[a]
Cadmium	0.33[a]
Chromium	112[a]
Copper	68.1[a]
Lead	43.2[a]
Mercury	0.43[a]
Nickel	112[a]
Selenium	0.64[a]
Silver	0.58[a]
Zinc	158[a]
Organochlorine pesticides/polychlorinated biphenyls (µg/kg, dry weight)	
DDTs, sum	7.0[a]
Chlordanes, sum	2.3[a]
Dieldrin	0.72[a]
Hexachlorocyclohexane, sum	0.78[a]
Hexachlorobenzene	0.485[a]
Polyclorinated biphenyls, sum	22.7[a]
Polycyclic Aromatic Hydrocarbons (µg/kg, dry weight)	
Polycyclic Aromatic Hydrocarbons, total	3,390[a]
Total Hydrocarbon Components (mg/kg, dry weight)	
Total Petroleum Hydrocarbons from Gasoline	100[b]
Total Petroleum Hydrocarbons from Jet Fuel, Kerosene, Diesel Fuel, or Motor Oil	200[b]
Volatile organic compounds (µg/kg, dry weight)	

Constituent	Screening Criterion
Acetone	8.6[c]
Benzene	27[c]
Bromodichloromethane	605[c]
Bromoform (Tribromomethane)	1,210[c]
Bromomethane	14[c]
Carbon tetrachloride	17[c]
Chlorobenzene	55[c]
Chloroethane	2.4[c]
Chloroform	247[c]
Chloromethane	385[c]
Dibromochloromethane	5,148[c]
1,2-dibromo-3-chloropropane	0.26[c]
1,2-Dibromoethane	393[c]
1,2-Dichlorobenzene	86[c]
1,3-Dichlorobenzene	398[c]
1,4-Dichlorobenzene	93[c]
1,1-Dichloroethane	15[c]
1,2-Dichloroethane	348[c]
1,1-Dichloroethene	15[c]
cis-1,2-Dichloroethene	209[c]
trans-1,2-Dichloroethene	310[c]
1,2-Dichloropropane	664[c]
1,3-Dichloropropene	11[c]
1,4-Dioxane	11,725[c]
Ethylbenzene	156[c]
Hexachlorobutadiene	270[c]
Hexachloroethane	2,400[c]
Methylene chloride	244[c]
Methyl ethyl ketone	630[c]
Methyl isobutyl ketone	228[c]
tert-Butyl methyl ether	480[c]
Naphthalene	286[c]
tert-Butyl alcohol	6,660[c]
1,1,1,2-Tetrachloroethane	873[c]
1,1,2,2-Tetrachloroethane	225[c]
Tetrachloroethene	186[c]
Toluene	237[c]

Constituent	Screening Criterion
1,2,4-Trichlorobenzene	445[c]
1,1,1-Trichloroethane	68[c]
1,1,2-Trichloroethane	471[c]
Trichloroethene	598[c]
Vinyl chloride	145[c]
Xylenes	407[c]

Notes: mg/kg = milligrams per kilogram; RWQCB = Regional Water Quality Control Board; THC = Total Hydrocarbon Components; µg/kg = micrograms per kilogram.

[a] Source for contaminant screening criteria is RWQCB's *Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines* (RWQCB 2000) unless otherwise noted.

[b] THC levels in accordance with the *Quality Assurance Project Plan for Inner Bair Island Fill Import and Placement* (USFWS 2008b).

[c] Values from RWQCB December 2013 Estuary Aquatic Habitat Environmental Screening Levels (RWQCB 2013). The values were converted using the following equation:

Soil value = Surface water value x organic carbon coefficient x fraction of organic carbon (assumed 1%).

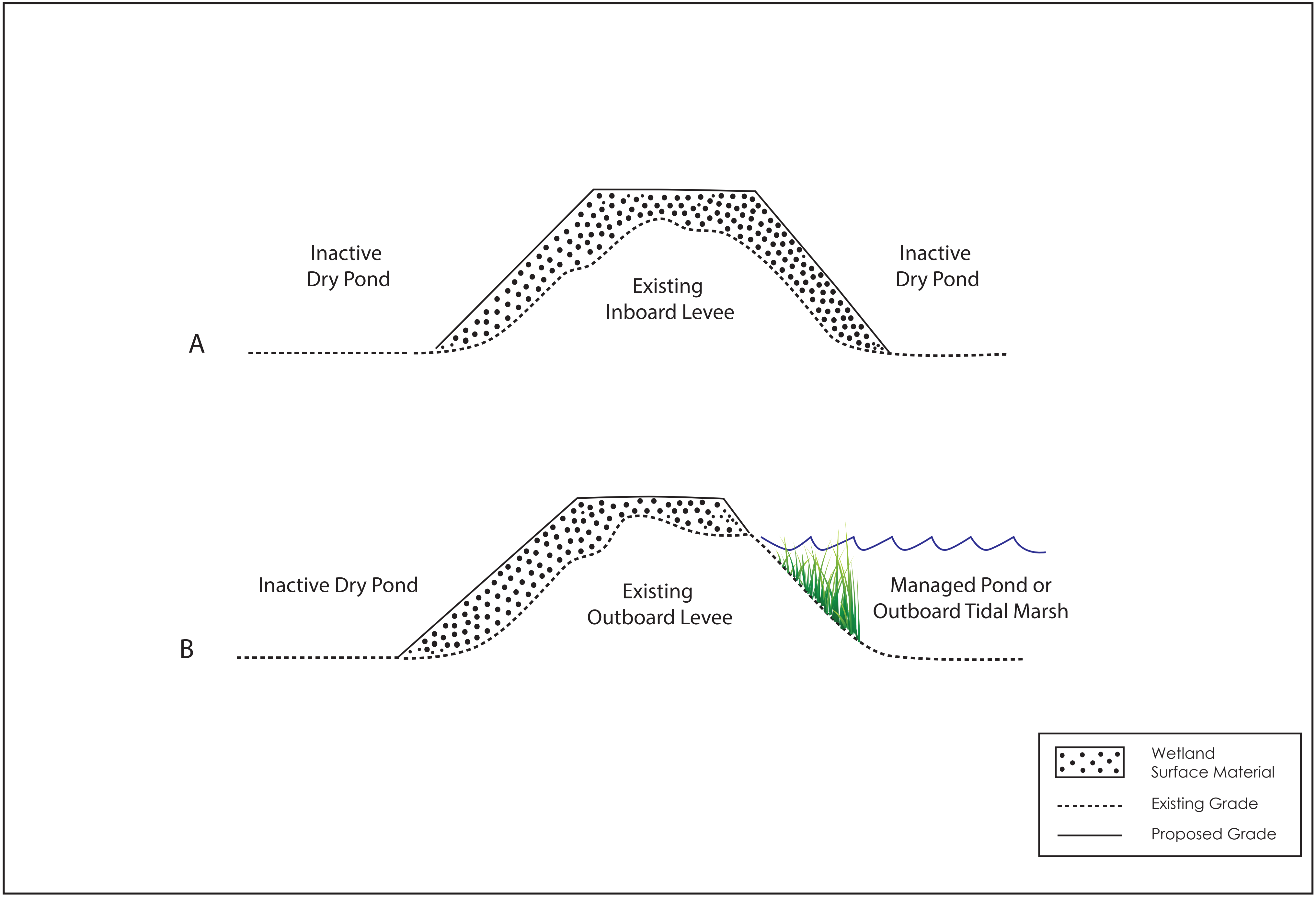


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Figure 3. Wetland Surface Material Placement for Levee Operations and Maintenance

South Bay Salt Pond Restoration Project Quality Assurance Project Plan for Fill Import to Operate and Maintain Levees at Ravenswood and Alviso Salt Pond Complex (3685-01)
April 2016

3.5 Laboratory Analysis Methods

The following laboratory methods will be used during the Phase 2 Analysis. With approval from the quality assurance officer, laboratories may use professional judgment to modify the protocols described below.

3.5.1 Chemical Constituents

Fill samples will be collected and analyzed for specific chemical compounds using the methodologies set forth in EPA's *Test Methods for Evaluating Solid Waste, Physical and Chemical Methods* (EPA 1986). Specifically, analyses for metals will follow the EPA Methods 6000/7000 series, analyses for organochlorine pesticides will follow EPA Method 8081B, analyses for polychlorinated biphenyls will follow EPA Method 8082A, and analyses for polycyclic aromatic hydrocarbons will follow EPA Method 8270. If the Phase 1 Analysis determines there is potential VOC contamination in the proposed import soils, laboratory analysis for VOCs will follow EPA Method 8260B. If the Phase 1 Analysis indicates there is no potential for VOC contamination, there will be no test for VOCs. Analytical results for compounds will be reported in dry weight.

3.5.2 Method Detection Limits and Reporting Limits

MDL is the lowest concentration at which a particular compound can be measured and reported with a 99% confidence that the concentration is greater than zero. MDLs for each analyte will be determined by the analytical laboratory using the applicable Solid Waste (SW)-846 protocol (EPA 1986) or the method specified in Title 40 Code of Federal Regulations Part 136, Appendix B (GPO 2015). The laboratory will then develop reporting limits that represent concentration levels that can be consistently obtained by the specified method and that generally are two to five times the applicable MDL. The reporting limits for data submitted by analytical laboratories will be below the contaminant screening criteria identified in Table 2. In cases when the reporting limit for a constituent is greater than the screening criterion, the MDL will be below the screening criterion.

For example, chlordane (technical) contaminant screening criterion at a potential wetland site located in the San Francisco Bay Area is 0.009 mg/kg. The laboratory reporting limit for chlordane (technical) was 0.042 mg/kg. Since the reporting limit was greater than the screening criterion, the laboratory was requested to provide the MDL, which was 0.0031 mg/kg. The MDL met the contaminant screening criterion for chlordane (technical) at the site. Finding laboratories with the required MDLs are not anticipated to be an issue. However, if meeting the MDL is an issue, the laboratory would be contacted to determine if another analyte may be interfering with the specific MDL, an alternative analytical method is recommended to achieve the screening levels, and/or additional soil volume may need to be collected and re-analyzed.

3.5.3 Accuracy

Accuracy is the degree of closeness between laboratory contaminant concentration results and the actual contaminant concentrations in the samples. Accuracy will be assessed through the evaluation of the percent recoveries associated with laboratory control samples and matrix spikes and matrix spike duplicates (MS/MSDs). Accuracy is generally expressed as percent recovery (%R), which is defined as:

$$\%R = 100\% \times \frac{s - C}{T}$$

where:

s = measured spike sample concentration,

C = sample concentration, and

T = true or actual concentration of the spike.

Accuracy will be controlled by comparing percent recoveries to the acceptable control limits in the SW-846 tables (EPA 1986).

3.5.4 Precision

Precision is a measurement of the reproducibility of data under a specific set of conditions (e.g., variation in contaminant concentrations among laboratory replicates of a given sample). It is a quantitative measure used to assess the variability of a data set in reference to the calculated average value. Precision will be assessed by the evaluation of the day-to-day variances in the laboratory control samples. Precision will be evaluated for matrix effects using the MS/MSDs. Results of the duplicate analysis are used to calculate the relative percent difference (RPD) or relative standard deviation (RSD).

The RPD is defined as:

$$RPD = 100\% \times \frac{(x_1 - x_2)}{(x_1 + x_2)/2}$$

where:

x_1 = first duplicate concentration and

x_2 = second duplicate concentration.

The RSD is defined as:

$$RSD = 100\% \times \frac{S}{x_m}$$

where:

S = standard deviation; and

x_m = arithmetic mean of replicate analysis.

The laboratory analyses will meet the acceptable levels of precision identified by method in SW-846 (EPA 1986).

3.6 Quality Assurance during Fill Transport and Placement

The following measures will be implemented to ensure that only fill from approved borrow sites is used for O&M levee repair and permitted restoration actions and to ensure that the fill is placed in the complexes according to permit requirements.

3.6.1 Agency Approval of Proposed Work

O&M project permits require that USFWS and the SBSPRP Project Management Team provide advanced notification (BCDC 2008**,** RWQCB 2008, USFWS 2008b, USACE 2009) before levee repair work is conducted. The advanced notification will identify the purpose of the fill, the fill volumes, and placement locations.

3.6.2 From Borrow Site to Truck

The quality assurance officer will make unannounced visits to borrow sites to verify that approved material is being loaded. The quality assurance officer will visually spot-check the suitability of material loaded in trucks for the project using such indicators as color, texture, and odor. If questionable or anomalous material is encountered, the quality assurance officer may halt transport of fill until suitability is confirmed. If a borrow site has segregated fill into material acceptable and unacceptable for project use, the quality assurance officer will conduct periodic site visits to the borrow site to confirm that acceptable material is loaded for transport to the project site. The quality assurance officer also will confirm that proper best management practices are being implemented at the site. For example, incoming trucks must be clean of soils and debris from other sites, and loading equipment must be clean and in good working order.

Prior to leaving the borrow site, a soil acceptance form will provided to each truck.

3.6.3 From Truck to Project Site

The contractor will dispatch trucks carrying approved borrow fill to a designated site. A truck dispatch log will be maintained by the contractor to keep track of which trucks left which approved borrow sites and their ultimate, correct destination. The truck dispatch log will be communicated in a timely way to the gate keeper daily so that only approved trucks are allowed into the site. The truck dispatch log will include the following information:

- Name and contact information of trucking company and truck boss
- Number of trucks and volume of fill approved for transport
- Borrow site origination name and address
- Location in the complexes where the imported fill will be used

The entrance to the fill site will be monitored by the gate keeper on a full-time basis. When trucks arrive, the gate keeper will fill out a truck log with the identification tag number (or license plate number) and trucking company. It is the gate keeper's responsibility to confirm that the truck and dispatch log data match before the truck is admitted. If any data from the dispatch log and the truck log do not match, then the truck will not be allowed to enter the site.

Soil acceptance forms will be collected upon entry and logged by the gate keeper. Trucks without a soil acceptance form from an approved source will be rejected from entry to the fill site.

The gate keeper will keep a running total of the volume of fill brought on site by borrow site. The gate keeper will ensure that the volume of fill allowed on site will not exceed the estimated quantity approved in the borrow site characterization memorandum. For the duration of fill import, the quality assurance officer will make random, unannounced visits to review the gate keeper's work.

3.6.4 Fill Placement at Project Site

The quality assurance officer will monitor placement of fill material at the start of new work and then make random, unannounced visits throughout the duration of fill placement to determine whether the intent of this QAPP is being met. If questionable or anomalous material is encountered, the quality assurance officer may halt placement of fill until suitability in accordance with this QAPP is confirmed.

3.7 Reporting Requirements

The quality assurance officer will provide quarterly progress reports during fill placement. Reports will identify the location of the borrow site(s), the quantity of fill material moved and placed during the last quarter by borrow site, the balance of approved fill volume remaining by borrow site, and the approximate location of fill placed by borrow site. Borrow site characterization memoranda (including sample plans, sample maps, Phase 1 reports, test data, and other associated reports related to fill acceptance) approving sources during the preceding quarter will be attached as appendices to quarterly reports. Field notes and dispatch/truck logs will also be included as appendices.

Section 4.0 Project Schedule

Imported terrestrial fill approved for use through QAPP procedures will be imported for O&M levee maintenance in accordance with the schedule(s) included in the advanced notification of proposed work required by Phase 1 permits (BCDC 2008, RWQCB 2008, USFWS 2008b, USACE 2009).

Section 5.0 References

[BCDC] San Francisco Bay Conservation and Development Commission. 2008. Permit No. 7-03 for SBSPRP Phase 1 and O&M Activities. October. San Francisco, California.

[DTSC] California Department of Toxic Substance Control. 2001. Information Advisory: Clean Imported Fill Material. October. Sacramento, California.

[EPA] U.S. Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste, Physical and Chemical Methods (SW-846). Third edition of SW-846 with Update I (pages dated September 1992), Update II (pages dated August 1993), Update IIA (pages dated September 1994), Update IIB (pages dated January 1995), Update III (pages dated December 1996), Update IIIa (pages dated April 1998), and Update IIIb (pages dated November 2004)

[EPA] U.S. Environmental Protection Agency. 2002. Guidance for Quality Assurance Project Plans. ESP QA/G-5. Office of Environmental Information, Washington, D.C.

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Appendix A. Quality Assurance Officer Resume

Max J. Busnardo, M.S.

Principal, Restoration Ecology

mbusnardo@harveyecology.com
408.458.3222

AREAS OF EXPERTISE

- Ecosystem Restoration and Revegetation
- Ecosystem Restoration at Contaminant Remediation Sites
- Wetland Biogeochemistry

EDUCATION

- M.S. Ecology, San Diego State University, 1992
- M.S. Biochemistry, University of California, San Diego, 1988
- B.S. Environmental Studies & Chemistry, Stockton State College, 1986

PRIOR PROFESSIONAL EXPERIENCE

- Contaminants Assessment Scientist, Marine Ecological Consultants 1994-1995
- Chemistry Instructor, U.S. Peace Corps, Benin West Africa, 1992-1993
- Wetlands Scientist, Pacific Estuarine Research Lab, 1988-1992

KEY PRESENTATIONS/ PUBLICATIONS

Busnardo, M. 2014. Habitat Restoration Challenges and Solutions on Remediated Army Landfills in the Presidio of San Francisco. Presentation at SERCAL Annual Conference.

Busnardo, M. 2012. Penn Mine Heavy Metal Remediation and Restoration Project-Presentation at Reclaiming the Sierras Conference

Zedler, J., M. Busnardo, T. Sinicrope, R. Langis, R. Gersberg, S. Baczkowski. 1994. Pulsed-discharge wastewater wetlands: the potential for solving multiple problems by varying hydroperiod. in Global Wetlands: Old World and New. ed. William Mitsch. Elsevier Science Publishers. Amsterdam, The Netherlands.

Busnardo, M., R. Gersberg, R. Langis, T. Sinicrope, J. Zedler. 1992. Nitrogen and phosphorus removal by wetland mesocosms subjected to different hydroperiods. Ecological Engineering, 1:287-307.

Sinicrope, T., R. Langis, R. Gersberg, M. Busnardo, J. Zedler. 1992 Metal removal by wetland mesocosms subjected to different hydroperiods. Ecological Engineering, 1: 309-322.

PROFESSIONAL PROFILE

Mr. Busnardo is a principal restoration ecologist specializing in ecosystem restoration and habitat restoration at contaminant remediation sites. He brings 19 years of experience in H. T. Harvey & Associate's ecological restoration division, helping to mentor staff and build this division. Max is well versed in the environmental regulations protecting natural resources and routinely helps to guide client projects through the environmental review and permitting process.

Max's academic and project experience have focused on tidal wetland restoration and restoration of contaminated sites primarily in the San Francisco Estuary. He has applied his expertise in wetland science and chemistry to the restoration design of numerous sites where soils were contaminated with heavy metals, pesticides, and/or petroleum hydrocarbons. These projects involved assessment of the potential effects of contaminants on aquatic biota and design of restoration measures to minimize exposure of aquatic biota to contaminants of concern and maximize benefits to restored habitats.

The following is a selection of exemplary projects that demonstrate the depth and breadth of Max's expertise:

M.S. Thesis Project: Constructed Wetlands for Wastewater Treatment
Max designed and carried out research project funded through the National Oceanic and Atmospheric Administration on the use of constructed freshwater wetlands in wastewater treatment. This project included the design and construction of an outdoor manipulative experiment with 20 wetland mesocosms simulating constructed freshwater wetlands receiving secondary wastewater loaded with heavy metals (Cd, Cu, Hg, Pb, Zn) and nutrients (NH_4^+, NO_3^-, PO_4^{3-}). Performed sample collection, nutrient analyses, statistical analyses, and carried the work to publication in the journal Ecological Engineering.

Contaminant Screening of Dredged Material in San Francisco Bay
Max has reviewed laboratory contaminant concentration data in sediment samples from numerous proposed dredging projects in the San Francisco Bay. The purpose of Max's contaminants screening work was to determine appropriate disposal sites (e.g., Class I or Class II landfills, in-bay disposal and approved sites) for dredged material based upon comparison of lab data to landfill and aquatic screening criteria.

Marine Monitoring of Effects of Orange County Sewage Outfall
Max conducted a study to determine the effects of outfall contaminants on fish populations. He performed a statistical analysis of sediment and fish muscle/organ chemistry (metals, PAHS, PCBs, pesticides) and fish histopathology (prevalence of liver lesions) to determine if the concentrations of certain sediment contaminants were correlated with liver lesion prevalence in demersal fish species.

Foster City Tidal Wetland Mitigation Project
Max led the design, ecological construction monitoring, and long-term monitoring of this approximately 8 acre tidal marsh restoration project in Foster City. The design involved excavation of uplands to create new tidal

PROFESSIONAL AFFILIATIONS/CERTIFICATIONS

- SERCAL
- Certified in California Rapid Assessment Method (CRAM) for Riverine and Estuarine Habitats

wetlands. Max collaborated with the design engineers to conduct a contaminant soils investigation to determine if soils at the design grade met the SFBRWQCB's contaminant screening criteria for beneficial reuse of dredged materials. Soils that did not meet these criteria were removed and replaced with a cover of salvaged on-site sediments that met the SFBRWQCB's screening criteria.

Tasman Corridor Tidal Wetland Mitigation

Max assisted with the design, ecological construction monitoring, and long-term monitoring of a 3 acre muted-tidal wetland on the Lower Guadalupe River in San Jose. The installation work included assessment of heavy metal concentrations in soils at the wetland design grade. The concentrations of mercury, nickel, and organochlorine pesticides were elevated in design grade soils above SFBRWQCB screening criteria for beneficial reuse of dredged material. Max worked with the SFBRWQCB to develop an acceptable remediation solution that met the habitat goals for the restoration project.

Los Capitancillos Freshwater Wetland Mitigation Design.

Max collaborated with the project engineers to develop perennial freshwater wetland design alternatives for the 4-acre site. The site is located in the Guadalupe Creek watershed downstream of the Almaden Quicksilver Mine. As such, the soils were contaminated with mercury. The wetland design process included and analysis of soil mercury concentrations and development of design solutions to minimize mercury methylation and trophic transfer within the constructed wetland.

Ulistac Freshwater Wetland Mitigation

Max worked with a multi-disciplinary team to design the restoration of a 4.5-acre perennial freshwater wetland along the south side of the Lower Guadalupe River for the City of Santa Clara. The site soils contained hazardous levels of DDT and DDT derivatives. Max collaborated with the geotechnical engineer to incorporate design measures to protect aquatic biota. These measures included soil testing at the wetland design grade, over-excavation of contaminated sediments and import and placement of a soil cover of appropriate thickness to project aquatic biota.

Penn Mine Environmental Restoration Project

The goal of the Penn Mine Project was to establish wetland, riparian and herbaceous vegetation on a 30-acre abandoned copper and zinc mine. Mining activities removed most of the vegetation and produced acidic soils with elevated concentrations of copper, zinc and iron. Max worked on a multi-disciplinary team and developed final plans and specifications for suitable soil cover, hydroseeding, riparian and wetland restoration at the Penn Mine site. Max also led the assessment of the fate of copper, zinc, and aluminum is a downstream wetland on the restored site.

Wetland Treatment Options for the Lower Salinas River Watershed. Max managed HTH's work as prime consultant. He worked with an engineering subconsultant to assess the efficacy, size, and cost of in-stream versus off-channel wetland treatment options for agricultural drain water contaminated with nitrates.

Appendix B. Peer Reviewer Resume

JUSTIN HANZEL-DURBIN, EIT

EDUCATION
B.S., Environmental Engineering, California Polytechnic State University, 2004

PROFESSIONAL REGISTRATIONS
Engineer in Training, 2003

AREAS OF EXPERTISE

Environmental
- Regulations (Federal, State, and Local)
- RI/FS/RAP
- Site Investigations
- Site Remediation (in-situ and ex-situ)
- Air, groundwater, Water and Soil Monitoring
- Import/Export Soil Quality Evaluation
- Community Outreach

Civil
- Demolition Design, Planning, and Support
- CEQA Support
- Preliminary design
- Grading Design and Quantity Takeoffs (AutoCAD)
- Scheduling and Cost Estimating
- Roadway/Storm Drain Design

Construction Oversight
- Subcontractor Management
- Daily Construction Reporting
- Cut and Fill Operations
- Remediation Systems
- Environmental Monitoring
- Compaction Testing

Sustainability
- Remediation Sustainability Analysis

REPRESENTATIVE EXPERIENCE
Justin Hanzel-Durbin, a Senior Engineer and Project Manager, has been performing environmental, civil, and construction engineering services for both infrastructure and remediation projects since 2004. He has completed projects across California for a diverse set of clients including private companies, state and local governments, and the federal government. He has completed numerous environmental projects which required site assessments, investigations, remedial feasibility studies, remedial action plans, CEQA documents, design plans and specifications for abatement, demolition, and remediation, import/export soil quality evaluations, construction quality assurance, and completion reports. In addition, he has completed civil engineering projects including the development of construction documents, bid packages, estimates, and schedules necessary for the completion of the project. He also has extensive experience working with a variety of regulators in ad around the bay area including the DTSC, RWQCB, BAAQMD, SFDPH,

PROJECT EXPERIENCE
Lennar, Hunters Point Naval Shipyard/Candlestick Point Redevelopment (Project Manager/Project Engineer: 2008-current)
This project consists of a planned 700+acre redevelopment of the former Hunters Point Naval Shipyard (HPS) and Candlestick Point, a Navy BRAC site and adjacent land.
Environmental and Civil
As a project manager and project engineer provided both environmental and civil engineering services to support property transfer and redevelopment which included the following. Environmental review and assistance in the completion and approval of the EIR for the project specifically in areas of hazardous materials handling, air quality, traffic, historic preservation, phasing and mitigation measures. The review of Navy cleanup and transfer documents on behalf of Lennar and the City and provide comments. Development of project Risk Management Plans and Soil and Groundwater Management Plans. Daily Naturally Occurring Asbestos (NOA) and dust air monitoring services during construction; working closely with the City (San Francisco Department of Public Health) and Regulators (Bay Area Air Quality Management District). Engineering analyses (demolition, infrastructure, and environmental), costing, and scheduling services to support project entitlement, property transfer and redevelopment. Assist in the development of transportation improvement projects such as Yosemite Slough Bridge and offsite street reconstruction. Developed many project cost estimates and schedules. Drafted design drawings incorporated into the Infrastructure Plan.

Supported development of environmental import soil screening criteria and on site reuse criteria. Assisted in coordination between Lennar, San Francisco Redevelopment Agency, San Francisco Department of Public Works, and other sub consultants. Develop shoreline structural inspection and offshore drilling geotechnical investigation work plan including radiological monitoring for the Hunter Point Shipyard. In addition, managed the implementation of the work plan including coordination between Lennar, the City, the Navy, and the sub consultants (geotechnical, radiological, underwater, drilling, and shoreline engineering) performing the work.

Construction

As a project engineer provided preliminary project phasing and scheduling to assist in large scale project planning. Incorporating workforce hand heavy equipment demand into large scale 26 year schedule for employment estimates and emission calculations for air quality analysis. Development of project wide Construction Traffic Management Program.

The Presidio Trust, Site Closure Environmental Services, San Francisco California (Project Manager/Field/Project Engineer: 2005-current)

Redevelopment and restoration of the historic 1,416-acre former military base at the south end of the Golden Gate Bridge.

Environmental and Civil

As a project manager and field/project engineer provided consulting on 31 separate sites to the Presidio Trust related to soil and groundwater site investigation, feasibility studies, regulatory and public stakeholder coordination, sustainability analysis, engineering design, data management, ecological risk assessment, remedial action plans, budgeting, scheduling, work plans and specifications. Provided engineering analyses, building demolition design and specifications, developed import soils specifications for recreational use, residential use and ecological special status use sites, utility reroute design, utility bypass design, grading design, steep slope and cliffside excavation with specifications, earthwork and disposal of hazardous and non-hazardous materials totaling over 70,000 cubic yards, building demolition, cost estimating services, SWPPP preparation and compliance support, as well as, construction of a 160-foot long temporary access bridge, cost estimating, regulatory support, and schedule support for remediation projects at numerous sites throughout the Presidio.

Construction

While working on several projects in the Presidio as a field engineer and construction manager I have provided oversight and construction quality assurance of mass excavation and grading activities, utility removal and re-rerouting, vegetation clearance, investigative trenching and borings, archeological monitoring, compaction testing, and storm water management. I provided coordination between the Presidio, National Park Service, Regulators (Department of Toxic Substance Control and Water Quality Control Board) and the other community stakeholders. Reviewed submittals for construction at 5 remediation sites including backfill soil environmental data review for compliance with specifications.

Vista Montana Park Apartment Holdings, LLC (Equity Residential), Vista Montana Park Apartments (2013-current)

Environmental and Construction

The Vista Montana Project is comprised of four parcels totaling approximately 21 acres. Originally the Parcels contained office and high tech research buildings that were to be demolished to accommodate the redevelopment project. Three of the Parcels are being be developed will residential units including 4 levels of apartments and townhomes over a concrete podium structure, over a one-level at grade parking garage totaling approximately 400 to 500 units with a 1 acre park, the fourth parcel has been developed as a 5 acre park. As Project Manager and Senior Engineer on this project have provided management and support throughout this construction project. Environmental oversight, testing, and coordination services including:

- Perimeter and personnel air monitoring (Dust, Arsenic, and Asbestos)
- Testing of exiting soils and determination of suitability for reuse or disposal classification
- Monitoring of excavation and disposal of Class I and Class II impacted soil
- Oversight and quality control testing and approval of import soil and construction materials

- Recommendations, Testing, and oversight associated with the on-site crushing and recycling of concrete building foundations and asphalt and re-use of the material as backfill below parking lots, sidewalks, and basketball courts.
- Preparation of Completion Reports, Operation and Management Plans, Soil Management Plans, and DTSC closure coordination and legal agreements.

Centerville United Redevelopment Site, City of Fremont, California (Project Manager: 2014-current)
Project Manager/Engineer. The Redevelopment Project is comprised of a six acre property previously containing a dry cleaning operation within the shopping center footprint. The future plan for the site is commercial building development. This site has been found to contain PCE impacted groundwater and soil vapor. Currently, the site is being overseen by Alameda County Water District (ACWD). TRC has performed the Phase I, Phase II, additional investigations, risk assessments, and prepared the corrective action plan, soil management plan, and completion reports for contaminated soil, and UST removal projects at the site. In the role of project manager and engineer, Mr. Hanzel-Durbin has provided management and support throughout the removal of a historic hydraulic lift, storm drain utility corridors, screening of excavated soils for reuse and offsite disposal, and the preparation and approval of a soil vapor extraction system design containing over 70 extraction wells. He has actively coordinated with the City of Fremont, ACWD, and the City Fire Department to attain approval of completed removal actions and plan for future remediation activities and commercial development.

Santa Clara Gateway Parcel 3 and Parcel 3 Remainder Site, City of Santa Clara, California (Project Manager: 2014-2015)
Project Manager/Engineer. The Santa Clara Gateway Project is located in Santa Clara County between Great America Parkway and Lafayette Street in Santa Clara County (Gateway Site). The Gateway Site is divided into three parcels, Parcels 1, 2 and 3, which are all currently being redeveloped for commercial use. Portions of Parcel 3 of the Gateway Site were previously determined to contain polycyclic aromatic hydrocarbon (PAH) impacted soils at concentrations above established residential cleanup. The majority of impacted soils were excavated and transferred to a consolidation cell that was constructed on-Site in September 2001. The consolidation cell measuring 400-feet long and 60-feet wide and 18-feet deep was re-zoned as Parcel 3 Remainder. A portion of the cell was inadvertently constructed on Parcel 3. In order to clear Parcel 3 of the contaminated soil, approximately 1,560 tons of impacted soil was excavated and appropriately disposed of and the cap was reconstructed.

Mr. Hanzel-Durbin lead the TRC team that assisted the City and the developer The Irvine Company with coordination with the Department of Toxics Substances Control (DTSC) in accordance with the *Covenant to Restrict Use of Property: Environmental Restriction* requirements for excavation and disturbance of previously-identified impacted soil areas at Parcel 3 Remainder of the Gateway Site, procurement and management of the remedial contractor performing the work, construction quality assurance of the work, and development and approval of a summary report for the DTSC. Additionally, during construction TRC tested materials for disposal, reviewed proposed import soils for environmental and geotechnical suitability, and performed compaction testing.

High Tech Commercial Development Sites, Confidential Clients, Santa Clara/Palo Alto/San Jose, California (Project Manager: 2013-2015)
Project Manager/Engineer. For three confidential clients Mr. Hanzel-Durbin managed the TRC team responsible for working with the client's contractor to test soils to be excavated during upcoming development activities. Soils were tested for either reuse on site or offsite disposal, soils were screened using commercial screening levels and sampled in accordance with the DTSC 2001 Clean Import Fill Advisory. TRC made recommendations for soil reuse and if necessary appropriate landfill disposal.

Central Middle School, San Carlos School District, California (Project Manager: 2014)
Project Manager/Engineer. For the construction of several new buildings and playgrounds at Central Middle School Mr. Hanzel-Durbin managed the TRC team responsible for working with the school district to test soils to be excavated during upcoming development activities. Soils were tested for either reuse on site or offsite disposal, soils were screened using the most stringent of DTSC and RWQCB residential screening levels and sampled in accordance with the DTSC 2001 Clean Import Fill Advisory. TRC made recommendations for soil reuse and where necessary appropriate landfill disposal.

Cedar Grove and Dove Hill Elementary Schools, Evergreen School District, San Jose, California (Project Manager: 2014)
Project Manager/Engineer. For the construction of several new buildings and playgrounds at both cedar Grove and Dove Hill Elementary Schools Mr. Hanzel-Durbin managed the TRC team responsible for working with the school district to test soils to be excavated during upcoming development activities. Soils were tested for either reuse on site or offsite disposal, soils were screened using the most stringent of DTSC and RWQCB residential screening levels and sampled in accordance with the DTSC 2001 Clean Import Fill Advisory. Additionally, TRC tested all soils for naturally occurring asbestos (NOA). TRC made recommendations for soil reuse and where necessary appropriate landfill disposal.

At Dove Hill Elementary NOA was discovered in subsurface soils and additional guidance was provided to ensure compliance with DTSC and BAAQMD, work at this site was subsequently placed on hold.

Bishop and Lakewood Elementary Schools, Sunnyvale School District, Sunnyvale, California (Project Manager: 2014-2016)
Project Manager/Engineer. For the construction of several new buildings and playgrounds at both Bishop and Lakewood Elementary Schools Mr. Hanzel-Durbin managed the TRC team responsible for working with the school district to test soils to be excavated during upcoming development activities. Soils were tested for either reuse on site or offsite disposal, soils were screened using the most stringent of DTSC and RWQCB residential screening levels and sampled in accordance with the DTSC 2001 Clean Import Fill Advisory. Additionally, TRC tested all soils for naturally occurring asbestos (NOA). TRC made recommendations for soil reuse and where necessary appropriate landfill disposal.

At Bishop Elementary NOA was discovered in subsurface soils and additional sampling was performed to characterize impacts across the site. TRC developed a Soil Management Plan, Air and Dust Mitigation Plan and provided Health and Safety recommendations for workers. Additionally Mr. Hanzel-Durbin coordinated with BAAQMD and DTSC to get approval for continuing the work at the school site without daily monitoring due to the low levels of NOA detected given mitigations were in place to ensure no visible dust, this coordination potentially saved the school district $500,000 in monitoring costs over the 3 year construction period.

Palo Alto MSC Fuel Station Demolition, City of Palo Alto, California (Project Manager: 2014-Current)
Project Manager/Engineer. Mr. Hanzel-Durbin is the project manager and engineer supporting the City of Palo Alto in preparing their demolition plans and specifications at their Municipal Service Center (MSC) Fuel Station site located in Palo Alto, California. The approximately 6,500 square foot (sq. ft.) fuel station and tank containment area Site is located on the northwest side of 3201 East Bayshore Road in Palo Alto, adjacent to Highway 101 to the southwest and surrounded on all other sides by the Palo Alto Baylands Nature Preserve. The Site includes four tanks to be removed, including a 10,000-gallon-diesel aboveground storage tank (AST), a 10,000-gallon unleaded fuel AST, a 5,000-gallon ethyl-gas AST, a 200-gallon partially buried condensate AST, a containment vault, fueling station, and associated utilities (air, water, storm drain, natural gas, and electrical). TRC performed up front soil sampling and characterization to pre-determine the depths of excavation around the fuel lines and fueling stations and determined that some material could be reused in the backfill of the AST containment vault and classified the remainder of the soil for offsite disposal at a class II licensed facility. TRC then prepared demolition plans and specifications, a Soil Management and

Sampling Plan, an engineer's estimate, health and safety plan, and preliminary risk assessment. The City is currently procuring a contractor to perform the demolition and TRC is supporting the City with entering into a Voluntary Cleanup Agreement with the County to address historic groundwater contamination associated with this Site.

EMC and Motor Pool Projects, County of San Mateo, California (Project Manager: 2014-Current)
Project Manager/Engineer. The EMC site is located at 501 Winslow Street, Redwood City, California. The Site is bounded by Winslow Street to the west, existing County parking to the north, and existing County buildings to the south and east. The project consists of the removal and/or demolition of the existing above and below ground structures, re-grading, and the construction of an 8,800 square foot three-story building to be located on County of San Mateo Civic Center. The proposed building area is currently occupied by a parking lot, refueling and maintenance facility and existing building.

The Motor Pool Site is located at 752 Chestnut Street, Redwood City, California. This Site is located in the southeast corner of the Grant Yard San Mateo County Road Department lot and for purposes of this proposal includes three buildings and an adjacent fueling station (one identified for demolition, two identified for reuse). The Site is bounded by Chestnut Street to the west, Spring Street to the north, Woodside Road/State Route 84 to the east and existing residences to the south. The project consists of demolition of one existing building, reuse of two existing buildings, relocating and reuse of below ground structures to be removed from Site A, and the construction of 9,100 square foot two-story utility building including storage and work space.

Mr. Hanzel-Durbin managed the environmental consulting work at both sites to determine the existing conditions at each site and if those conditions would have an effect on the future re-development of the properties. The work TRC preformed included:

EMC Site

- Phase I ESA
- Phase II ESA (soil, soil vapor, and groundwater)
- On Site soil characterization for reuse and disposal
- Soil and Groundwater Management Plan
- UST Removal Plan
- Hazardous Materials Assessment and Abatement Specifications
- Regulatory coordination

Motor Pool Site

- Phase I ESA
- Phase II ESA
- Hazardous Materials Assessment and Abatement Specifications

North 6th Street Residential Redevelopment Project, 6th Street Flats, LLC., San Jose, California (Project Manager: 2014-Current)
Project Manager/Engineer. The project consists of the construction of residential buildings consisting of 6 wood-framed stories over a reinforced concrete podium. The approximately rectangular, 0.75-acre site is bounded by North 6th Street to the northeast, E. St. John St. to the west, existing commercial buildings to the northwest and southwest and an asphalt paved parking lot to the southeast. The site is currently occupied by several residences and parking areas.

Mr. Hanzel-Durbin managed the environmental consulting work to determine the existing conditions at the site and if those conditions would have an effect on the future re-development of the property. The work TRC preformed included:

- Phase I ESA
- Phase II ESA (soil, soil vapor, and groundwater)
- On Site soil characterization for reuse and disposal

Julian Street Residential Redevelopment Project, Valley Oak Partners and Speno Enterprises, San Jose, California (Project Manager: 2014-Current)
Project Manager/Engineer. The project consists of construction of a 4 to 7 story residential structure with ½ level below grade parking. The approximately 1¼-acre irregularly shaped site is bounded by West Julian Street to the south, Stockton Avenue to the northeast, and existing residential structures to the west and north. The site is currently occupied by commercial buildings and parking lots.

Mr. Hanzel-Durbin managed the environmental consulting work to determine the existing conditions at the site and if those conditions would have an effect on the future re-development of the property. The work TRC preformed included:

- Phase I ESA
- Phase II ESA (soil and groundwater)
- On Site soil characterization for reuse and disposal
- NOA sampling and associated recommendations due to detections above 2% weight by volume
- Engineering cost estimates for environmental related impacts to overall project budget.

Libbey-Owens-Ford Lathrop Glass Facility, Hull and Associates, Inc., Lathrop, California (Project Manager: 2014-2015)
Project Manager/Engineer. The project consists performing a Phase I Environmental Site Assessment (Phase I ESA) for the Former Libbey-Owens-Ford (LOF) Lathrop Glass Facility, in Lathrop, California (Site). The Phase I ESA is in support of the property sale and redevelopment. The Site is approximately 113-acre and located between Interstate 5, Louise Avenue, and Howland Road. The Site consists of the LOF Lathrop glass facility and adjacent undeveloped land within the property limits. This Phase I ESA followed ASTM Standard E-1527-13 and meet all the EPA's standards for Phase I ESA's. TRC identified several Recognized Environmental Conditions and proposed follow-up phase II investigations which were put on hold till after the sale of the property.

Former Schlage Lock and Southern Pacific Brisbane Rail Yard Brownfield Soil and Groundwater Remediation Services for Redevelopment (Project/Field Engineer: 2008-2011)
This Brownfield site is scheduled to be redeveloped into a $450 million mixed-use development, including residential homes and public open space.
Environmental and Civil
As the project engineer provided engineering grading design, cost, and schedule support for site redevelopment. Performed ongoing groundwater monitoring, two pilot studies of groundwater injection with Lactate and Hydrogen Peroxide followed by performance monitoring and site wide Lactate Injection.
Construction
As the field engineer assisted in the management and then demolition of SVE system, field support for oversight of building demolition, and maintenance of pump and treat system.

U.S. Army Corps of Engineers - Fort Hunter Liggett (Task Manager/Field Engineer: 2004-2010)
As task manager and field engineer assisted in developing sampling and analysis plans, groundwater monitoring plans/reports, and feasibility studies; performed planning and oversight of field work for groundwater investigations and monitoring programs as well as performing erosion and landfill gas monitoring and maintained groundwater remediation systems.

U.S. Army Corps of Engineers - Fort Ord (Task Manager/Field Engineer: 2004-2010)
As task manager and field engineer assisted in developing sampling and analysis plans and groundwater monitoring plans/reports; performed planning and oversight of field work for groundwater investigations and monitoring programs.

IBM Corporation Phase I Environmental Site Assessments, Groundwater Treatment System O&M and Monitoring (Field Engineer: 2004-2008)
As field engineer assisted in developing sampling and analysis plans and groundwater monitoring plans/reports; performed oversight and field work for groundwater investigation and monitoring programs. Oversight and QA/QC on pump and treat system. In addition, during decommissioning of the facility assisted in preparation of plans and oversight of the demolition of many groundwater monitoring wells at and in the vicinity of the facility.

General Electric Company Bolinas Transmitting Station Debris Area Management (Project Engineer: 2006-2009)
This project area is a large area of the Bolinas shoreline bluffs that contains 9 debris disposal areas containing electronic and residential waste dating back to the early 1900's when the transmitting station was first constructed. Land is currently owned by the NPS but General Electric retains responsibility for the waste.
As project engineer provided services including developing erosion control plans, debris removal plans, monitoring plans, and monitoring and removal reports; performed erosion monitoring, regulatory reporting, planning and supervising of debris removal activities.

SPECIALIZED TRAINING/CERTIFICATIONS

- HAZWOPER 40 Hour
- HAZWOPER 8 Hour Refresher, expires - 6/16
- HAZWOPER 8 Hour Supervisor
- Radiation Safety and Use of Nuclear Gauges, expires – 9/15
- CPR/First Aid/AED, expires- 5/16

Appendix 2. Addendum to the Adaptive Management Plan

Addendum to the Adaptive Management Plan

20 June 2017

This Addendum to the Adaptive Management Plan (AMP) for the South Bay Salt Pond (SBSP) Restoration Project is intended to incorporate a new type of habitat restoration and enhancement feature to the previously adopted AMP. It defines and explains those features and sets for a system for how the AMP's principles and feedback mechanisms would be applied to the new features and what sorts of monitoring and adaptive management actions may be applied to them.

The SBSP Restoration Project is proposing the creation of habitat transition zones as part of Phase 2 actions. Habitat transition zones involve the beneficial reuse of material to create transitional habitats from the pond or marsh bottom to the adjacent upland habitat or levees along portions of the upland edge. These "habitat transition zones", are sometimes referred to elsewhere as "upland transition zones," "transition zone habitats," "ecotones," or "horizontal levees". Transition zones are specifically called out in documents such as the U.S. Fish and Wildlife Service's Tidal Marsh Recovery Plan and the recent Science Update to the Baylands Ecosystem Habitat Goals Project Report. A gradual transition from submerged Baylands, ponds, or open waters to uplands is largely missing in the current landscape of the South Bay, where there is often an abrupt boundary between the bay or ponds and the built environment. The SBSP Restoration Project's intention in including habitat transition zones in the Phase 2 alternatives is to restore this missing habitat feature. Doing so would:

1. Establish areas in which terrestrial marsh species can take refuge during high tides and storm events, thereby reducing their vulnerability.
2. Expand habitat for a variety of special status plant species that occupy this specific elevation zone.
3. Provide space for marshes to migrate upslope over time as sea-level rise occurs.

Before proposing these features, the SBSP Restoration Project examined the landscape to see if there are any areas adjacent to the project site where this could occur naturally. In general, the best locations for building these features would be located adjacent to open space or park land where the project can provide an even greater extent of transition into upland habitats.

However, at the edge of the Bay, these open space areas are largely former (now closed and capped) landfills which present a variety of challenges for creating the missing upland habitat. First, the existing elevation gradient between the restored marsh and the edge of the landfill is usually too steep to provide a gradual transition. Secondly, these landfills would otherwise pose a water quality risk from erosion if tidal action were introduced immediately adjacent to the protective clay liner or un-engineered rip rap slopes. In these instances, it is necessary that the project place material inside the former salt ponds to create the desired slope (15:1 to 30:1). At other locations, the actual elevations landward of the project sites are too low to create an uphill slope with the desired habitat functions. Therefore, once levees are raised or improved, such as at the All-American Canal levees, the only area remaining to build the transition zones is into the salt ponds. Finally, most of the adjacent property is not within the SBSP Restoration Project's ability to acquire, whether or not it has the desired elevation profile, because it is currently developed. In addition to being very expensive to acquire these areas, it would be infeasible to relocate all of the residences and businesses that have been built adjacent to the salt ponds. For these reasons, the project plans to use fill from upland excavation projects to create habitat transition zones inside the former salt ponds. The transition zones would provide habitat complexity and connectivity as marsh is restored. This would help improve habitat quality, particularly for endangered and threatened species, and improve resiliency of the shoreline over time as sea levels rise.

The SBSP Restoration Project notes in this Addendum that there are other new actions associated with the ongoing and more basic actions of maintaining the habitat transition zones that are more like routine maintenance of any part of the National Wildlife Refuge than they are adaptive in nature. Those activities would include the same kinds of actions performed under various regulatory permits, guidance documents, and other agreed-upon protocols. For example, commonplace Refuge practices like trash removal, fencing repairs, biological monitoring of bird populations, trail upkeep, removing invasive plant species and controlling or removing nuisance wildlife species, and other actions would proceed as normal and would therefore be implemented as needed on the habitat transition zones.

More broadly, the SBSP Restoration Project would continue to cooperate with the Santa Clara County, Alameda County, and San Mateo County Mosquito Abatement Districts to provide access by these districts to control mosquito populations. The Project would also work with the Invasive Spartina Project to remove or control populations of the non-native forms of that plant species. Similar coordination efforts to coordinate with adjacent or nearby city or county parks to control and manage use of the public access trails near transition zones by humans (and their pets, if/where allowed) would proceed as normal. None of these actions is what is typically meant by “adaptive management”.

Therefore, the table below is limited to the two more adaptive aspects of habitat transition zones: (1) the successful establishment and spread of elevationally-varying vegetation communities and habitat types, and (2) the transition zones’ ability to help maintain or improve existing levels of flood protection in the areas landward of where they are constructed. This effect is largely indirect, as habitat transition zones do not directly provide flood protection but do help protect existing levees or uplands from scour or wave run-up.

Proposed New Rows for Adaptive Management Plan Summary Table

Category / Project Objective	Restoration Target	Monitoring Parameter (Method)	Spatial Scale for Monitoring Results	Expected Time Frame for Decision-Making	Management Trigger	Applied Studies	Potential Management Action
Habitat Transition Zones Project Objective 1A. Create, restore, or enhance habitats of sufficient size, function, and appropriate structure to promote restoration of native special-status plants and animals that depend on South San Francisco Bay habitat for all or part of their life cycles.	The range and mosaic/composition of various vegetation communities and associated wildlife species habitat on the transition zones is at or on a trajectory resembling that of a natural (i.e., predevelopment) gradient between intertidal mudflats, low tidal marsh, high tidal marsh, and upland vegetation. This includes characteristics such as vegetation acreage and density per unit of transitional habitat, species composition, and other observable aspects of existing natural or successful marsh restoration sites in South San Francisco Bay.	- Monitoring of planted vegetation to evaluate success of establishment and spread - Acreages of each type of sub-, inter-, and -supratidal habitat (collected via remote imagery with limited ground-truthing) as a percent of the total restoration area; plant species composition, including abundance of nonnatives such as those listed elsewhere in the AMP (qualitative assessments for invasive species will occur annually, quadrant or transect sampling once habitat transition zone has 20% vegetation cover); being on habitat trajectory toward a reference marsh and other restoration sites - Habitat qualities of those different elevationally varying habitat rated as high, medium, or low based on suitability or potential usefulness to Ridgway's rail and salt marsh harvest mouse, determined every 2-3 years using aerial photos, ground-truthing, and/or other methods to evaluate these characteristics - Habitat mapping will take place every 5-8 years, beginning 5 years after the different sections of the constructed transition zone have established vegetation communities. Once 40% vegetation cover has been achieved, species composition (including native vs non-native) will be collected in a variety of zones (low marsh, high marsh, upland) on each transition zone.	Each of the proposed Phase 2 transition zones would be monitored. There are six in total. Two in Pond R4, two in Pond A8S, and one each in Pond A1 and Pond A2W.	- Establishment of different vegetation communities on the lower slopes of habitat transition zones depends on tidal flux, the depth of each pond (i.e., pond bottom elevations relative to tidal elevations). Yet natural vegetation colonization is anticipated to be detectable within 5 years (or less) of reaching appropriate elevations, while habitat development trajectory anticipated to be detectable within 15 years (and possibly less) of the onset of vegetation colonization. - In the areas where planting would take place (the higher portions of the zones), the successful establishment and spread of the planted vegetation is expected to be detectable in 5 years. - Invasive species establishment is expected to be detectable within the first year of its occurrence.	- Failure of habitat transition zones to develop native vegetation communities in elevations where those are expected to develop. - Vegetation deviates significantly (30–50%) from projected trajectory after colonization elevations are achieved. - Failure of the zones to hold or retain actively seeded or planted vegetation communities in elevations where that takes place. - Non-native Spartina, Pepperweed or Phragmites present in large numbers on site. - A level of invasive plant establishment and resistance to active control and management efforts that undermines the ecological values of the native communities and habitats intended for the transition zones to provide. - Inability to control and prevent outbreaks of vector (mosquitoes) on the slopes of the habitat transition zones using the methods and techniques discussed in the Vector Control Project Objectives.	**Applied Study Question #2017-1. Will habitat transition zones become established with naturalistic, native vegetation communities across a range of elevations and thereby provide a gradient of habitats for marsh plants and special-status species, including the California Ridgway's rail and the salt marsh harvest mouse?** Project Objective 1A states that the South Bay Salt Pond Restoration Project will create, restore, or enhance habitats of sufficient size, function, and appropriate structure to promote restoration of native special-status plants and animals that depend on South San Francisco Bay habitat for all or part of their life cycles. Most ecotone and transitional habitat between the waters of San Francisco Bay and the adjacent uplands have been lost as a consequence of historical land use and development. The Phase 2 actions to construct habitat features to replace this lost natural gradient is an important part of meeting Project Objective 1A.	- Study causes of slow vegetation establishment - Active revegetation - Increased non-native invasive plant species control - If invasive species cannot be controlled, study biotic response to non-native vegetation - Continue to re-evaluate what is meant by "control" of invasive species and adjust monitoring and management triggers based on the latest scientific consensus

Category / Project Objective	Restoration Target	Monitoring Parameter (Method)	Spatial Scale for Monitoring Results	Expected Time Frame for Decision-Making	Management Trigger	Applied Studies	Potential Management Action
Habitat Transition Zones. Project Objective 2. Maintain or improve existing levels of flood protection in the South Bay area.	- No increase in tidal flood risk at any levee or adjacent uplands associated with a habitat transition zone.	- Collect high water mark elevations on the existing levees and adjacent uplands prior to construction and then periodically after construction, especially following large storm or flood events. - Inspect for levee erosion initially monthly, then annually, and after major rainfall and/or tidal events	Each of the proposed Phase 2 transition zones would be monitored. There are six in total. Two in Pond R4, two in Pond A8S, and one each in Pond A1 and Pond A2W.	- Slope failure or erosion/scour is expected to be detectable within 5 years of normal weather, but heavy storm years may cause it to occur earlier or sooner. -If after 10 years, no substantial failure or erosion beyond minor, localized failures, it would be unlikely to occur, as the vegetation communities and natural sediment dynamics should have become established.	- Significant erosion observed - Elevated (higher) water surface elevations projected by modeling effort and/or observed in the field - Field data collection and/or observation indicates that flood risk is greater than that predicted by models	**Are habitat transition zones effective in slowing the amount of erosion or scour due to tides, storm surges, wind waves, or other erosional forces and thereby reducing the risk of levee failure or other aspects of flood risk to surrounding communities and infrastructure?** Habitat transition zones also address Project Objective 2 (Maintain or improve existing levels of flood protection in the South Bay area) because they slow wave run up, buffer storm surges, and provide a broader range of roughly horizontal surfaces on which sediment can accrete and vegetation can form. They thereby provide a foundation for naturalistic future sea-level rise adaptation by providing substrate on which tidally varying habitats can migrate upslope.	- Reconstruct failing portions of the habitat transition zones with material of higher quality. - Construct transition zones with a higher level of soil compaction.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, California 94555

10 January 2018

Gary Stern, San Francisco Bay Region Supervisor
North Central Office
NOAA Fisheries West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, CA 95404

Attention: Mr. Brian Meux

RE: South Bay Salt Pond Restoration Project, Phase 2 Biological Assessment

Dear Gary:

On December 15, 2017, the and the U.S. Fish and Wildlife Service (USFWS) and South Bay Salt Pond (SBSP) Restoration staff held a discussion with National Marine Fisheries Service (NMFS) during a phone conference to clarify items in the Biological Assessment submitted March 23, 2017, and the supplemental information submitted on September 8, 2017, for SBSP Restoration Project Phase 2 actions. These documents were submitted pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.). Following that discussion, on December 21, 2017, an email from Brian Meux of NMFS provided a list of additional information requests. The following provides a complete response to this request. Each NMFS information item requested is numbered, a complete response from USFWS follows for each.

<u>**Applicable to All Ponds**</u>

1. **"On our 12/15/17 call there was a question if there were any concerns of driving piles (14-inch concrete and 24-inch steel sheet piles) during winter. There is little concern if using a vibratory hammer within the cofferdam in dry conditions."**

The project proposes pile driving during three types of construction operations; installation of temporary cofferdams, installation of four new water control structures at the Ravenswood Ponds, and installation of piles to support two bridges at the Mountain View Ponds.

<u>Temporary Pile Installation for Cofferdams</u>: For temporary installation of sheet piles and associated piles for cofferdam installation, vibratory driving methods would be used to install all piles.

Permanent Pile Installation for Water Control Structures: Approximately 32 16-inch concrete piles will be installed within de-watered cofferdams to construct new water control structures. Installation of piles for the water control structures is not expected to affect fish species as pile driving will occur within de-watered cofferdams, or within de-watered ponds, where fish will not be present. Piles will be installed with a vibratory hammer where possible, or an impact hammer if needed. Use of impact hammers will be minimized to the extent practicable. The project anticipates that there would be no seasonal restrictions on pile driving in areas where fish are not present.

Permanent Pile Installation for Bridges: Approximately 32 14-inch concrete piles would be installed to construct two bridges within the Mountain View Ponds. These piles would be installed within a de-watered cofferdam. The cofferdam would be installed using vibratory methods and include, on each side of the proposed structure, approximately 150 linear feet of sheet piles and supporting H-piles, for a total of 300 linear feet of cofferdam per structure.

As described in the BA submitted to NMFS, the underwater noise generated during concrete pile installation with an impact hammer would not exceed the 206 dB Peak or 187 dB accumulated SEL thresholds established by NMFS (for potential onset of injury or temporary threshold shift). Also discussed in the BA and in the appended hydroacoustic analysis (Appendix C to the BA), noise levels from impact hammering may reach above the 150 dB RMS level that NMFS considers relative quiet. At and above that noise level, there is potential for sub-injurious behavioral effects to fish.

Proposed Minimization measures: To reduce potential impacts to listed fish species during impact pile driving operations at locations where fish may be present, the project will implement the following measure:

- Conduct impact pile driving within a de-watered coffer dam or de-watered pond

NMFS does not currently provide criteria for impacts from vibratory installation. The continuous noise associated with vibratory pile driving has a slower rise time with energy spread out over time and is considered the least impactful method for pile installation. Based on the guidance developed by NMFS and the Fisheries Hydroacoustic Working Group, the project anticipates that vibratory installation or temporary or permanent piles would be unrestricted year round for the proposed project.

2. "Regarding de-watering in open area where fish may be present, what is the expected duration of the de-watering, and how much area will be de-watered?"

De-watering will occur within temporary cofferdams (to construct structures) and within ponds (to construct structures, habitat islands, pilot channels, etc.). Cofferdam de-watering would be done within a restricted area as described in the BA and is not included in this response. The below paragraphs therefore pertain only to project elements where the ponds would be de-watered.

Channel excavation within Ravenswood Pond R4 would be conducted prior to pond breaching. Fish would not be present during pilot channel excavation because these ponds do not currently support fish habitat. Pilot channel excavation is anticipated to occur over a few months during a single construction season, however the duration is dependent on when the work is conducted and weather conditions. The area that would be de-watered for pilot channel excavation would be within Pond R4, which is approximately 295 acres. The footprint area of the proposed channel is approximately 4.1 acres. Construction of the Pond R4 interior pilot channel would be done over several months within a single construction season.

For construction of the ten proposed habitat islands in the Mountain View Ponds, the project may draw water levels down during island construction. These ponds do have some hydraulic connection and may have fish present during the proposed actions. However, due to the subsided bottom elevations and the large area and volume of water at these ponds, the project would not be able to completely de-water these areas during construction. Construction of habitat islands would be done over several months within a single construction season.

3. "What are the depth and width of the excavated pilot channels? I have the lengths of each."

Proposed breach depths and widths are approximated in the design plan sheets included with the BA, and are summarized in the table below. The designed width of the channel bottoms are expected to erode after breaching and the final channel width for the breaches is anticipated to be from 100 to 200 feet at equilibrium.

Table 1 - South Bay Salt Pond Restoration Project Phase 2: Approximate Breach Dimensions

Pond Cluster	Pond	Breach Location	Breach Cut Length (feet)	Breach Bottom Width (feet)	Bottom Elevation (feet NAVD88)	Average Depth (feet)	Total Breach Area		Connecting Water Body
							(square feet)	(acres)	
Island	A19	NW	150	50	4	4	9,510	0.22	Mud Slough
	A19	NE	90	50	4	5	6,120	0.14	Mud Slough
Mountain View	A1	NW	110	60	0	6	8,010	0.18	Charleston Slough
	A1	SE	110	60	2	6	8,430	0.19	Permanente Creek/Mountain View Slough
	A2W	NW	200	60	2.5	5	14,440	0.33	Permanente Creek/Mountain View Slough
	A2W	SW	230	60	2	5	17,170	0.39	Permanente Creek/Mountain View Slough
	A2W	NE	90	40	3	6	5,380	0.12	Stevens Creek/Whisman Slough
	A2W	SE	210	40	3	6	11,820	0.27	Stevens Creek/Whisman Slough
Ravenswood	R4	NE	470	200	2	4	92,360	2.12	Ravenswood Slough
	R3	WCS-4 Channel	230	10	1	4	6,980	0.16	Ravenswood Slough
	R4	R4 Interior Pilot Channels (2 Channels)	2,890	50	2	3	176,470	4.05	NA

Applicable to Mountain View Ponds

4. "Pile driving with an impact hammer. Will a cofferdam be used? Or driven during low tide when there is no standing water at the base of the pile?"

Please see response to Question 1.

5. "PG&E boardwalk - the project description states that the replacement boardwalk would increase the width of the existing boardwalk by approximately two feet, resulting in a width of five feet and an increase of total overwater structure of 13,500 square feet (0.31 acre) in this area. On our call last Friday you mentioned that there would not be an overall increase in overwater structure area."

The proposed PG&E boardwalk will result in an increase of overwater fill area of 13,500 square feet, as provided in BA Section 2.6.8 and Appendix A of the BA. If there was any communication indicating that there would be no new increase in overwater structure area, that was incorrect information.

6. "Also, what is the current height of the boardwalk over the substrate surface?"

Current height of the existing PG&E boardwalk is approximately 6 feet over the substrate (pond bottom).

7. "Habitat islands - what are the approximate dimensions of the habitat islands? How much total area will be filled by habitat islands?"

In the BA, Section 2.6.9, Table 5 provides quantities for the ten proposed habitat islands. Total estimated area for a single island would be on an average of 22,180 square feet (0.51 acres). Total area for all ten islands would be approximately 222,180 square feet (5.1 acres).

Average dimensions for a single island would be approximately 84 feet wide and 280 feet long.

Applicable to Ravenswood Ponds

8. "How many piles are expected to be driven for the S5 cofferdam?"

The temporary cofferdam at the S5 water control structure would be installed using vibratory methods. Since this cofferdam would not use impact driving methods, the project is not requesting a specific pile count to be covered in its NMFS BO.

9. "Where are the six water control structures to be removed?

The six existing water control structures to be removed are detailed in the project plan sheets for Ravenswood. These include two between R3 and S5; one between R3 and R5; one between R4 and R5; one between R5 and S5; and one at the eastern terminal end of the All

American Canal. In the design plan sheets for the Ravenswood Ponds that were included with the BA, the locations for these structures are called out on sheets L-1; L-2; L-3; G-3; G-5; G-6; G-7; G-8; and G-11.

<u>Applicable to Alviso Ponds</u>

10. "What is the current status of the water control structures of Ponds A5, A7, A8? Are there any proposed changes to their current configuration in this consultation?"

As of June 2017 all 8 gates of the A8 notch were opened as planned creating a muted tidal system throughout the A5/A7/A8S/A8 pond system and there is no change with its current operation with this consultation. All gravity intake flow occurs at high tide, and all outflow occurs when the tide is below 8.12 ft. MLLW.

The WCS at the A5 and A7 are still in place but in poor condition as the expected lifespan for the structures has been exceeded.

- A5 WCS is comprised of 2x48" gate intake from Guadalupe Slough. The tide gate has been broken since October 2014 and intakes water at high tide (cannot be fully closed)

- A7 WCS is comprised of 2x48" gate in/outlet with two 24' weir boxes at A7 from Alviso Slough; this functions as the outlet for the system

Upon completion of the Phase 2 transition zone project for Pond A8, and based on results from the operation of the A8 notch with all bays open year round, it may be feasible in the near future for the Refuge to consider in a separate project of the removal of WCS at A5/A7 to allow for full tidal influence in these ponds.

It is also possible that intense winter storms could cause either the A5 or A7 WCS to fail given their current condition. We have been working through our Agency budget process to secure federal funding for our priority levee maintenance, including funding for replacement of priority WCS throughout the Don Edwards San Francisco Bay NWR. We are encouraged by recent monitoring results for the pond complex showing little to no negative impacts of the muted tidal system, and remain hopeful that we will soon be able to restore the pond system to full tidal influence by removing the failing WCS and in doing so alleviate the need to maintain/replace these assets.

11. "Fish screens - what is the current status of the A17 fish screen?"

<u>A16/A17 Fish Screen</u>:

The fish screen has been repaired and is operating consistently without issue since April 2017

- Beginning in August 2016, Intralox worked to identify the causes of our performance issues/failures with the fish-screen

- Nov. 2016 Intralox notified us that the materials used in the rods of our screens were incorrect material for water based application and company did not know how the material ended up in their manufacturing plant.

- April 2017 - Intralox replaced the existing screens with a new edge module and agreed to cover all repairs under warranty. We were pleased that the company took responsibility for the issue as the original warranty was expired and repair costs exceeded our funding.

- Ongoing regular maintenance is required to keep screens aligned and performing as designed. Response to this question was provided by Chris Barr in an email on December 12, 2017

Conclusion

With this letter I believe the USFWS has provided a complete response to NMFS request for additional information. Thank you for the important work that you do in our shared goal of recovery for endangered species in the San Francisco Bay Estuary. Please feel free to contact me at (510) 792-0222 or SBSP Executive Project Manager, John Bourgeois, at (408) 314-8859 if you have any additional questions.

Sincerely,

Chris Barr
Deputy Complex Manager
San Francisco Bay National Wildlife Refuge
U.S. Fish and Wildlife Service

cc: Anne Morkill/Jared Underwood, USFWS
John Krause, CDFW
John Bourgeois/Brenda Buxton, SCC
Seth Gentzler/Dillon Lennebacker, AECOM