Appendix B

Supporting Planning and Environmental Documentation and Information

Appendix B: Supporting Planning and Environmental Documentation and Information

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Appendix B1

Shoreline Study Preliminary Alternatives and Landscape Evolution Memo

ESA PWA

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memorandum

date February 10, 2012

to Brenda Buxton

from Jeremy Lowe, Mark Lindley, Lindsey Sheehan, Matt Brennan and Michelle Orr

subject **Shoreline Study Preliminary Alternatives and Landscape Evolution**

Introduction

ESA PWA is developing ecosystem restoration options for Ponds A9 to A15 and Pond A18 as part of the habitat evolution assessment for the U.S. Army Corps of Engineers (USACE) Shoreline Study. Six preliminary alternatives are being developed for habitat evolution assessment based on three Ecosystem Restoration options (No, Medium and Large Fill) combined with two Flood Risk Management alignments provided by the Shoreline Study. Professional judgment has been used to develop the candidate alternatives; no modeling has occurred at this stage.

To provide a means of comparison between the six preliminary alternatives, their habitats are being evaluated for two points in time, Time 0 (2017) and Time 50 (2067). Each alternative will be evaluated for one sea level rise curve (NRC-III curve) and three suspended sediment concentrations (including one calibrated to the Island Pond sedimentation data and two lower values). Projected pond topography in 2067 is shown in a GIS map based on existing topography and calculated accretion rates using modified Krone sedimentation equations (Krone 1985).

The first version of this memorandum, dated November 14, 2011, presented scenarios where all ponds would be restored to tidal action together beginning in 2017, 2027, and 2037. We also presented a phased scenario (West Area First) where the western most ponds (A9-11) were restored to tidal action in 2017, the east area pond (A18) was restored in 2027, and the central area ponds (A12-15) were restored in 2037. This revised memorandum presents an alternate phasing scheme (Pond A12 First) that would restore tidal action to Pond A12 in 2017, followed by the western most ponds (A9-11) in 2022, the eastern pond (A18) in 2027, and the remaining central ponds (A13-15) in 2030. The intent of this alternate Pond A12 First phasing scheme is to restore tidal action to Pond A12 as soon as possible to maximize accretion in the lowest pond in the study area.

Ecosystem Restoration Goals

The intent of the ecosystem restoration is to create 'complete' marshes – from subtidal through mudflats, low, mid and high marsh to transitional and upland – a true cross-section of the Bay shore. However simply providing a mix of habitats is insufficient – the marshes need to be physically and biologically 'healthy'. To create healthy marshes requires the restoration of physical complexity - developing the natural drainage networks, natural levees, marsh pannes, and other features that are seen in ancient marshes such as those at China Camp and on the Petaluma River. These habitats also need to be connected both across shore and along shore between each other and with adjacent marshes. To create these complex and connected marshes requires larger parcels than has been the norm for restoration in the Bay, parcels which are carefully located in the landscape – 'a few very large parcels close together are better for Bay wildlife than many small parcels farther apart' (*The State of San Francisco Bay 2011*, p28).

Challenges

There have been paradigm shifts in the scientific recognition of the risk of abrupt climate change and accelerating sea level rise (OPC 2011) and of the risk of fine sediment availability as the erodible sediment pool is depleted (Schoellhamer 2011). After 3,000 years of relatively stable sea level and 150 years of a turbid estuary, San Francisco Bay is returning to a norm of rapid sea level rise and clear water where the landscape will be more dynamic and the bayshore will be less marsh plain and more fringing marsh. This is a dynamic landscape in which there may be downshifting of high marsh to low marsh and to mudflat over the next century; there may be landward movement of the marshes and mudflats; there may be the need to actively manage marshes more than in the past to maintain their ecosystem services.

However, the dynamic landscape reflected by these paradigm shifts is, in many ways, complementary to the ecosystem restoration goals. Wide transitional and upland areas adjacent to high marsh will allow the transgression of wetlands with rising sea level, as opposed to being squeezed against steep-sided levees. Healthy transitional and upland areas transport surface and subsurface flows of water and other materials, maintain water quality, provide macrodetritus, stabilize shorelines, store flood waters, all of which are affected by their width. Lowering outboard levees to marsh elevation, in addition to breaching, will reconnect marsh to mudflat for water, sediment, and organisms while also allowing future transgression of the outboard marshes and mudflats. The mid elevation marsh plain will play a more prominent role in attenuating waves and reducing storm surges. But a dynamic landscape implies movement and the need for space – something that is lacking on the urbanized shore of the South Bay. However the very fact that there is a juxtaposition of natural wetlands and urbanized shore creates opportunities for multi-objective restoration projects which have value for flood risk management, levee stability and stormwater channel maintenance.

Alternatives

Three Ecosystem Restoration (ER) options for Ponds A9 to A15 and Pond A18 have been developed. It is assumed that once tidal flows have been restored by breaching the outboard levees, natural sedimentation will allow the evolution of a marsh plain in the ponds. The ER options have some common features, such as number and location of levee breaches. Measures in the marshplain such as pilot channels, starter channels, side cast

natural levees and ditch blocks will be used to accelerate the evolution of the ponds and to enhance the habitat. The ER options differ mainly in the amount of fill which is used to create upland and transitional habitat adjacent to the inboard levees along Pond A12 and A13 and along Pond A18: the ER options are named No, Medium and Large Fill. Using fill to create long transitional slopes provides large areas of upland habitat that has been missing from the Bay, attenuates waves and reduces run-up, and increases resiliency to sea level rise. Increasing amounts of fill also increase the cost of the project and increase the demand for dredged (or other fill) material. The ER options therefore bookend the project in terms of cost, volume of fill, habitat quality, flood risk management benefits, and resiliency to sea level rise.

The Flood Risk Management options for Ponds A9 to A15 and Pond A18 are described in the Draft FRM Option Development Memorandum (HDR 2011). For Ponds A9 to A15 the FRM options follow two alignments: either along existing levees bordering Pond A12 and A13 (FRM options 1A, 1B, 1C, 1D and 2) or along existing levee bordering pond A12, and then west along the existing railroad line to Grand Boulevard (FRM options 3 and 4). For Pond A18 the FRM options also follow two alignments: either along existing levees bordering Pond A18 (FRM options 2 and 4) or along a new alignment cutting across Pond A18 (FRM options 1A, 1B, 1C, 1D, and 3). FRM options along Pond A16 and in New Chicago Marsh will not impact the ER options for Ponds A9 to A15 and Pond A18 and so are not considered further in this memo.

The six preliminary alternatives are a combination of the FRM and ER options as shown in table 1 below. Pond A9-A15 and Pond A18 are physically separated and considered to be independent of each other; any of the alternatives chosen for Pond A9-A15 could be matched with any of the alternatives for Pond A18. The benefits of applying the other ER measures, such as starter channels and ditch blocks, are being studied as part of the Island Ponds and Pond A6 monitoring which are Phase 1 actions of the SBSP Project. The inclusion of such measures in the preliminary alternatives should be based upon information from this monitoring.

Figures 1 to 3 show the fill footprint for Preliminary Alternatives 1 to 3, where the FRM alignment follows the existing levee, together with the existing topography. Topographic shading reflects the initial habitat types that would be expected based on tidal inundation regimes if the Ponds were all breached in 2017. The levees, fill footprint and other measures are described in the next section.

Table 1: Preliminary alternatives for Ponds A9-A15 and Pond A18

Preliminary Alternative	ER option	Other ER measures	FRM alignment Pond A12 and A13	FRM alignment Pond A18
1	No Fill	Outboard levee breaches, pilot channels, and internal berm breaches	Existing levee	Existing levee
2	Medium Fill	Outboard levee breaches, pilot channels, outboard levee lowering, ditch blocks, internal berm breaches, internal berm lowering, and starter channels with side cast natural berms	Existing levee	Existing levee
3	Large Fill	Outboard levee breaches, pilot channels, outboard levee lowering, ditch blocks, internal berm breaches, internal berm lowering, and starter channels with side cast natural berms	Existing levee	Existing levee
4	No Fill	Outboard levee breaches, pilot channels, and internal berm breaches	Existing levee along Pond A12, and then along the existing railroad line	New alignment cutting across Pond A18
5	Medium Fill	Outboard levee breaches, pilot channels, outboard levee lowering, ditch blocks, internal berm breaches, internal berm lowering, and starter channels with side cast natural berms	Existing levee along Pond A12, and along the existing railroad line	New alignment cutting across Pond A18
6	Large Fill	Outboard levee breaches, pilot channels, outboard levee lowering, ditch blocks, internal berm breaches, internal berm lowering, and starter channels with side cast natural berms	Existing levee along Pond A12, and then along the existing railroad line	New alignment cutting across Pond A18

Measures

Flood Risk Management Levees

To estimate the fill footprint an approximation of levee crest heights is required. PWA (2006) documents concept level designs for levees in the Alviso pond complex classified into a number of categories the following of which are relevant to the present study:

- New levee constructed on existing pond-bottom elevations
- Upgraded levee constructed on existing perimeter levees (typically the "inboard" levee located on the landward side of the ponds)

In addition, each typical flood control levee category was separated into three different exposure levels:

- Exposed levee landward of tidal marsh
- Exposed levee landward of an upland-transition area
- Reduced exposure levee landward of a managed-pond area

Table 2 shows conceptual design levee crest elevations from the SBSP Flood Analysis Report (PWA 2006). The conceptual design elevations are based on 100-year "total water levels" with an additional 1 ft allowance for freeboard. The total water level is defined as the combination of a high bay-water level and wind-wave runup. For this preliminary analysis, the joint occurrence of a 100-year bay-water level and a 10-year wind wave event was used to estimate the total water levels and required levee crest elevations for each exposure level. Levees landward of tidal marsh and upland-transition areas are assumed to be more exposed than levees landward of managed ponds. Long and short wave modeling by the USACE and Delta Modeling Associates will provide better estimates of total water levels at the levees following breaching and in 2067 and levee design crest elevations should be updated.

Table 2 Alviso Levee Design Crest Elevation from PWA Flood Analysis Report (2006)

Levee Exposure Category	Levee Design Crest Elevation (ft, NAVD88)
With Outboard Marsh / Upland Transition	16.5
With Outboard Managed Ponds	15.5

New and upgraded levee cross-sections are assumed to have inboard and outboard slope of 3:1 (H:V) and a crest width of 20 ft. To prevent levee erosion, new and upgraded levees that are fronted with either tidal marsh or managed ponds are assumed to be armored with rock. The armoring design used in the cost estimate is a rock revetment to be placed between the top elevation of the stability berm or upland transition area and the crest of the levee.

Elevations for existing perimeter levees for Alviso and Ravenswood are from Moffatt & Nichol (2005). Table 3 summarizes the elevation data used in estimating fill volumes for design levee cross-sections.

Table 3 Typical Existing Elevations in Alviso; crest elevations from Moffatt & Nichol (2005)

Levee Exposure Category	Elevation (ft, NAVD88)
Average Pond A12 Elevation	-0.5
Average Pond A18 Elevation	0.5
Internal Managed-Pond Berm Crests	6
Existing Perimeter Levee Crests	9

Stability berms may be required to prevent subgrade failure potentially resulting from the rapid placement of between 10 and 20 feet of soil. If required, these berms would be needed on both sides of a flood control levee that is exposed to either a tidal-marsh area or a managed pond. For a flood control levee that is exposed to an upland-transition area, only the landward side of the levee will need a stability berm. Stability berms are assumed to have crest elevations approximately 2 feet above mean higher high water (MHHW). The widths of the stability berms would vary depending on the type of levee and will have assumed side slopes of 3:1 (H:V). Due to differences in fill thickness and subgrade strength, the width of the stability berms for a new levee, an upgraded internal managed-pond berm and an upgraded existing perimeter levee would be 50 ft, 40 ft and 30 ft, respectively. The locations of drainage and borrow ditches will need to be considered and may alter the alignment. Alternative methods may be available which could be less expensive. These include soil reinforcement with geotextile fabric, stone column or foundation over-excavation, or replacement with stronger soil.

Initial fill volumes will likely include an “over-build” to compensate for the initial subsidence and an allowance should be made for placing additional earth (or other action such as a flood wall) as the levees subside. Initial subsidence is anticipated to be greatest for new levees constructed on existing pond bottoms.

Transitional-Upland Slopes

Three different cross-sectional designs for the transitional-upland areas adjacent to the levees are used, which correspond to the three ER options of No, Medium and Large Fill, and described in Table 4. For each design, the top of the transitional-upland area was assumed to be the same as the proposed levee crest elevations from Table 2 and the bottom of the transitional-upland area was assumed to be about 2 feet below MHHW within the lower range of cordgrass grass dominated marsh. Below the flat transition slope, the berm would slope down to the respective average pond-bottom elevations as shown in Table 3 at a steeper 3:1 to 5:1 (H:V) slope.

Table 4 Transitional-Upland Slope Design

ER Option	Design
No Fill	3:1 (H:V) front slope of the levee and stability berms (if required) form the transitional zone.
Medium Fill	30:1 (H:V) slope for the transitional zone. The zone begins at the approximate upgraded flood-control levee crest and maintains a 30:1 slope to the pond-bed elevation. It is assumed that the upper slope of the transitional zone will need planting or hydro-seeding.
Large Fill	100:1 (H:V) slope for the transitional zone. The zone begins at the approximate upgraded flood-control levee crest and maintains a 100:1 slope to the pond-bed elevation. It is assumed that the upper slope of the transitional zone will need planting or hydro-seeding.

The 30:1 and 100:1 (H:V) slopes in the Medium and Large Fill options represent idealized slopes. During final design and construction, the slopes would include some variation both in planform to create a more natural shoreline and along the slope to create benches and shallow depressions to form pannes at a variety of elevations. The intent is to work within the overall idealized slope to create an upland transitional zone with some complexity.

To reduce the initial fill requirements it may be possible to construct the transitional-upland slopes of the Medium Fill and Large Fill options in stages. An initial, smaller, berm would be built at the outboard edge of the transitional-upland zone, followed by breaching the ponds to tidal action, then filling behind it over time as material becomes available to bring the transition areas to final grade. An alternative may be to maintain a 3:1 slope to a horizontal bench located one-foot above MHHW. The levee bench could receive fine grading to create backshore pans and a 30:1 (or 100:1) slope will continue downward from the bench to about 2 feet below MHHW within the lower range of cordgrass colonization elevations. Additional fill would be placed on the bench as required to maintain its position in the tidal frame with sea level rise.

Outboard Levee Breaches

Outboard levee breaches are excavations through the perimeter levees that open the site to tidal inundation from the adjacent tidal sloughs. Breaches through the outboard levee and pilot channels through the outboard marsh will be excavated at the locations of the major remnant historic tidal channels (Figure 4). These locations would be the same for all the Preliminary Alternatives.

The levee breaches are sized using empirical relationships between tidal channel dimensions and marsh drainage area (hydraulic geometry relationships). Hydraulic geometry relationships from Williams et al (2002) are based on data from tidal channels in mature natural marshes located throughout the San Francisco Bay. A subset of the Williams et al (2002) data from South Bay marshes, including Laumeister, Newark Slough, and Ravenswood Slough, was used to develop hydraulic geometry relationships for the South Bay.

The hydraulic geometry relationships provide expected channel dimensions once a pond has developed into a mature marsh. The breaches were sized to long-term equilibrium dimensions to balance excavation costs, scour potential, and tidal drainage (see section below). This approach is consistent with the Design Guidelines for Tidal Wetland Restoration in San Francisco Bay (PWA 2004). These dimensions are adjusted to give a trapezoidal

breach cross section with side slopes (H:V) of approximately 4:1 to 5:1 and a minimum bottom width of approximately 10 ft. On the inboard side of the levee, the breach excavation will extend to the levee toe

The breaches are expected to be undersized compared to restored tidal flows due to the larger tidal prism of the subsided ponds. The large tidal flows are expected to scour and enlarge the breaches until equilibrium between the tidal prism and channel dimensions is reached. The tidal prism will decrease as the pond fills in due to sedimentation and vegetation establishment.

Undersized breaches may initially constrict tidal flows to the restoration site and cause water to "back-up" in the site on the ebb tide, delaying drainage and increasing the low water level in the site. The pilot channel connecting the levee breach and the adjacent slough through the outboard marsh (pilot channel) may limit tidal drainage in a similar manner. Over time, tidal flows are expected to scour undersized levee breaches and pilot channels, thus improving tidal drainage.

Outboard Levee Breach Sizing

The historic channels layer from SFEI was examined in GIS to analyze historic watersheds on the site (Figure 4). The area of each restored tidal watershed was calculated in GIS and used to find long-term channel equilibrium dimensions for that watershed using Williams *et al*, 2002 (). The order of each channel was determined from Williams *et al*, 1995 (). These dimensions can be applied to the historic channel network shown in Figure 4.

Table 5. Long-Term Equilibrium Channel Dimensions

Watersheds	Area [ac]	Breach Depth [ft]	Breach Top Width [ft]	Breach Cross-Sectional Area [ft^2]	Channel Order
Pond A9	454	16.1	188	1303	6
Pond A10	228	13.5	138	820	5
Pond A11	246	13.8	143	864	5
Pond A12	265	14.0	147	907	5
Ponds A13-15	914	19.1	257	2081	6
North A18	116	11.4	101	521	5
Central A18	221	13.4	136	805	5
Southwest A18	258	13.9	146	892	5
East A18	255	13.9	145	886	5

Pilot Channels

Wide mudflats outboard of breaches may limit tidal drainage; however, the pond breaches drain to deep tidal sloughs across relatively narrow mudflat channel banks. Pilot channels will be excavated through the outboard marsh to connect each outboard levee breach to the adjacent tidal slough. The ponds will be breached at the location of historic marsh channels and so the pilot channels would also follow the historic channels (Figure 4). These locations would be the same for all the Preliminary Alternatives.

The Design Guidelines (PWA 2004) recommend excavating breaches and pilot channels to long-term equilibrium dimensions to allow for adequate tidal exchange to quickly erode breaches and improve tidal drainage. Pilot channels will be excavated to the long-term equilibrium channel depth and 60 to 80% of the long-term channel width (i.e., narrower than the breach width at MHHW) (see above). The pilot channel side slopes will be approximately 3:1. The pilot channels are somewhat undersized to reduce the amount of excavation and are expected to scour and enlarge. Marsh vegetation will be excavated down to the root zone over the long-term equilibrium width to reduce the resistance to pilot channel bank erosion.

Tidal drainage for the pond restoration is likely to be adequate in the long-term, but may be restricted within the first few years after restoration. An assessment of Island Ponds monitoring data (PWA 2007) indicates that after the under-sized Island Pond breaches scoured to long-term equilibrium widths, the breaches provided adequate tidal drainage. These monitoring data suggest that breaches sized to long-term equilibrium dimensions for ponds with marshplain elevations similar to the Island Ponds can be expected to provide adequate tidal drainage. The elevation of the ponds is on average 3 feet lower than the Island Ponds and will initially have a larger restored tidal prism, which will tend to slow drainage at low tides. However, the number of breaches per acre of restored marsh will be greater than the Island Ponds, which will tend to improve drainage. If the pilot channels do not scour and enlarge as expected, excavation could be pursued as part of adaptive management.

Outboard Levee Lowering

Levee lowering would occur in the Medium and Large Fill Preliminary Alternatives. The majority of the outboard levee will be lowered by excavation to MHHW to create pickleweed marsh habitat, restore hydraulic and habitat connectivity between the sloughs and the marshplain, and provide material for ditch block construction. Portions of the outboard levees will not be lowered to limit wave action and to provide initial high tide refugia. The bayfront levee between Pond A9, and Coyote Creek is expected to limit wave action in Pond A9 until the bayfront levee completely erodes.

Borrow Ditch Blocks

Ditch blocks inhibit flow though the existing borrow ditches to promote scour and flow through the remnant historic channels. The desired elevation of the top of the ditch blocks is MHHW; at this elevation the ditch blocks are expected to provide pickleweed habitat. The initial fill elevation needed to achieve this elevation and account for settlement will be determined during final design. Material excavated from the levee breaches and levee lowering will be used to construct ditch blocks. To reduce the potential for fish stranding, the ditch blocks will be located such that the borrow ditch on both sides of the block connects directly to a breach.

Internal Berm Breaches

The internal berms within the ponds will be breached in several locations to reconnect remnant historic channels and restore the hydraulic connection across the site (figure 4). Breaches will be sized in a similar manner to the breaches in the outboard levee. The breach excavations will extend beyond the levee toe into either the internal borrow ditch or the remnant historic channel. The existing internal berm between Ponds A9 and A14 does cut across the historical watershed (Figure 4). It is suggested that this berm is realigned further into Pond A14 so that

the tidal prism will be sufficient to maintain the channels in Pond A9. The benefits and costs of adjusting the internal berm alignment need to be addressed at a later stage in the design.

Internal Berm Lowering

Internal berms within the ponds would serve as wave-break berms to limit wave action, enhance sedimentation, and create vegetated marsh habitat (on the berm crests) in the short term while the ponds develop from mudflat to vegetated marsh. The existing low internal berms separating the ponds would be lowered by excavation to MHHW to create pickleweed marsh habitat and act as a wave-break berms. This is the concept used in the adjacent Pond A6 and monitoring of sedimentation rates following restoration will test its effectiveness. Construction of additional wave-break berms is not included at this point because the benefits to the pond restoration may be small relative to the cost of construction. Short wave modeling by USACE may indicate the need for wave-break berms.

The extent and location of internal berm lowering would be determined during project design to match project construction to funding availability.

Starter Channels with Side Cast Berms

Natural levees adjacent to tidal channels in historic marshes support pickleweed and marsh gumplant which serve as critical high tide refugia for Salt Marsh Harvest Mouse and California Clapper Rail. Excavation of the shallow remnant historic tidal channels within the ponds would provide material to create side cast berms adjacent to the channels to emulate natural levee features seen adjacent to channels in historic marshes. These low berms would create topographic complexity within the otherwise plainer intertidal mudflat.

In addition, excavating the shallow remnant historic tidal channels within the pond would re-create tidal channel habitat and improve tidal drainage more rapidly following restoration. Tidal drainage is affected by the density, complexity, and form of the channel network. As water drains off the marshplain, flows are conveyed through tidal channels within the site. Silted-in portions of the remnant historic tidal channels (Figure 4) may be too shallow to efficiently convey tidal flows, causing more flow over the marshplain. Shallow flow and friction over the marshplain may delay low tide drainage. Tidal drainage is expected to improve as remnant channels scour in response to tidal flows. Ponds with a gypsum layer on the pond bed may also require excavation of channels to convey tidal exchange – the only ponds in the Alviso complex known to have gypsum layers are the Island Ponds.

Using a similar hydraulic geometry analysis as for pilot channels, starter channels could be excavated that are sized to the long-term equilibrium channel depth and 60 to 80% of the long-term channel width. The ultimate location and extent of starter channel excavation to create side cast berms would be determined during final design to balance the habitat benefits with project funding. For instance, in Ponds A15 and A13, existing internal berms are located adjacent to the large tidal channel through those ponds, so the need for excavation to create side cast berms would be a lower priority within those ponds. By comparison, within Pond A18 there are no internal berms within a large 850 acre pond, and starter channel excavation to create side cast berms would be a much higher priority in Pond A18 because these berms would serve a number of critical functions – as wave-break

berms to enhance sedimentation, to provide topographic complexity to support vegetation colonization, and to provide high tide refugia for critical special status species.

Experience in the Island Ponds indicated that material sidecast too close to the excavated channels was liable to be eroded as the channels scoured and enlarged. In Pond A6 starter channels were not included in the design due to the cost of construction and the expected low benefits. A comparison of natural levee evolution from the Island Ponds and Pond A6 monitoring would be a useful guide for evaluating the desirability of side-casting.

Landscape Evolution

Marsh accretion was predicted using the Marsh98 analysis, a procedure that has been used widely to examine marsh sustainability to sea level rise across San Francisco Bay (e.g. Orr et al., 2003). The Marsh98 analysis is based on the mass balance calculations described by Krone (1987). This procedure assumes that the elevation of a marsh plain rises to colonization elevations at rates that depend on the (1) availability of suspended sediment and (2) depth and periods of inundation by high tides. When the level of an evolving marsh surface is low with respect to the tidal range, sedimentation rates may be high if the suspended sediment supply is sufficient. However, as the marsh surface rises through the tidal range, the frequency and duration of flooding by high tides is diminished so that the rate of sediment accumulation declines. Marsh98 implements these physical processes by calculating the amount of suspended sediment that deposits during each period of tidal inundation and sums that amount of deposition over the period of record.

Two revisions have been made to Marsh98 to more accurately represent physical conditions. These revisions include:

- Accelerating, nonlinear sea level rise is included. The sea level rise curves that were implemented were originally proposed by the National Research Council and modified by the USACE (2009), specifically NRC-I, -II and –III curves.
- Organic material is now added directly to the bed elevation at each tidal cycle. This method more accurately reflects the physical process with nonlinear sea level rise. Accretion due to organic material occurs when the marsh plain reaches a specified vegetation colonization elevation.

Model Input Parameters

Tidal Boundary Condition

The modeling was conducted relative to the tidal datum of NAVD88. The tidal boundary condition used for all model runs was a tidal month which has statistical characteristics identical to the observed tides at the Golden Gate. This boundary condition was then amplified using the Coyote Creek tidal datums to create a time series that could be applied to the Coyote Creek area. The title datums are shown in Table 6.

Table 6. Coyote Creek Tidal Datums

Datums	ft MLLW	ft NAVD	m NAVD
MHHW	9.01	7.49	2.27
MHW	8.42	6.90	2.10
MSL	4.92	3.40	1.04
MTL	4.83	3.31	1.01
NAVD88	1.52	0.00	0.00
MLW	1.24	-0.28	-0.09
MLLW	0.00	-1.52	-0.46

*NOAA Tides & Currents. Station ID: 9414575. MLLW to NAVD conversions are from NOAA unpublished (2005).

Habitat Zones

Seven habitat zones were chosen to represent different elevation within each breached pond. Table 7 presents these zones and elevations.

Table 7. Habitat Zones and Elevations

Habitat Zone	Elevation (relative to datums)	2017 Elevation (ft NAVD)	2017 Elevation (m NAVD)
Deep Subtidal	6 m below MLLW and deeper	< -21.16	< -6.45
Shallow Subtidal A	2 to 6 m below MLLW	-21.16 to -8.04	-6.45 to -2.45
Shallow Subtidal B	2 m below MLLW to MLLW	-8.04 to -1.48	-2.45 to -0.45
Intertidal Mudflat	MLLW to MTL + 0.3 m	-1.48 to 4.33	-0.45 to 1.32
Cordgrass Dominated	MTL + 0.3 m to MHW	4.33 to 6.96	1.32 to 2.12
Pickleweed Dominated	MHW to MHHW	6.96 to 7.51	2.12 to 2.29
Upland*	MHHW and above	> 7.51	> 2.29

*HTH provided the elevations for the all of the subtidal and tidal habitat zones. NAVD elevations refer to 2017.

Suspended Sediment Concentration

Suspended sediment concentration (SSC) varies throughout San Francisco Bay because of variations in wave conditions, proximity to mudflats, and river inputs. Monitoring data from Pond A21, just north of the site, were used to calibrate the SSC to be used in the model. The data was divided by starting elevations into three categories and then elevations over time were averaged for each group. Marsh98 was run with the three averaged starting elevations from the data and with three potential SSC (100, 200, and 300 mg/L).

For the first 6 to 12 months after breaching, the Island Ponds data tracks with the 300 mg/L suspended sediment concentration curve. However, the later elevation measurements show little increase in between time steps and track better with the 100 mg/L and 200 mg/L SSC curves. It is possible that the Pond A21 mudflats accreted rapidly in the first year as easily eroded material was remobilized, perhaps from the breach and outboard marsh, which increased the local SSC. Over time this supply of easily eroded material was exhausted and the subsequent accretion rate reflects more the ambient suspended sediment concentration in Coyote Creek. We are investigating the calibration data more closely and looking for evidence to test the variable SSC hypothesis. To represent the range of SSC, all three concentrations were modeled to bracket the possibilities. Subsequent runs will focus on the

100, 200 mg/L range and will also include a better description of the initial high rates following breaching. Long term decline in SSC should also be incorporated (Schoellhamer 2011).

Organic Matter

Marshes with high rates of organic matter production have been observed to accrete at faster rates than marshes composed primary of inorganic sediments (Orr et al., 2003). Marshes associated with the highest organic matter accretion rates are typically found in brackish or freshwater environments. Based on guidance from HTH, an organic matter accretion rate of 1 mm/yr was modeled for all scenarios when the marsh plain elevation reached MTL + 1ft (MTL + 0.3 m).

Rate of Sea Level Rise

A nonlinear sea level rise scenario based on the guidance provided by the USACE (2009) was used. This document recommends scenarios modifying curves proposed by the National Research Council to extrapolate intermediate and high sea level rise projections ("NRC-I" and "NRC-III", respectively). These scenarios project 0.5 m and 1.5 m of sea level rise over the next century depending on emissions. The high rate is similar to the draft State of California planning guidelines, which recommends planning for 16" of rise in the next 50 years and 55" in the next 100 years. For the Preliminary Alternatives reported here the NRC-III curve was used.

Phasing

Two phasing schemes were examined. The West Area First phasing scheme examined phased restoration beginning in the western most ponds. The Pond A12 First phasing scheme illustrates a phased restoration beginning with Pond A12 which is the lowest pond in the study area.

West Area First phasing scheme: the site evolution projections were phased by pond area with the west region (Ponds A9-A11) beginning in 2017, the east region (Pond A18) beginning in 2027, and the central region (Pond A12-A15) beginning in 2037. The division between the west and central region includes the realignment of the internal berm between Pond A9 and A11 which more accurately reflects the historic watershed.

Pond A12 First phasing scheme: site evolution projections were phased with restoration of Pond A12 beginning in 2017, followed by the westernmost ponds (A9-11) beginning in 2022, the eastern pond (Pond A18) beginning in 2027, and the remaining central ponds (Ponds A13-15) beginning in 2030. The intent of this alternate Pond A12 First phasing scheme is to restore tidal action to the Pond A12 as soon as possible to maximize accretion in the lowest pond in the study area. This phasing also accelerates restoration of the central area ponds (Pond A13-A15) by seven years as compared to the West Area First phasing scheme.

All runs ended in 2067. The different starting times place each region on a different part of the sea level rise curve. This means that without substantial suspended sediment, the central region will end up at lower elevations than the west (or east region) because it has fewer years to accrete and it begins on a steeper part of the sea level rise curve so sea level is increasing more rapidly.

Landscape Evolution Results

In general we have found with previous Marsh98 analysis in the South Bay (Orr, et.al., 2003) that:

- SSC of 25 mg/L are unlikely to sustain marshes for all scenarios, regardless of the input parameters. These concentrations are unlikely based on the Island Ponds monitoring data.
- SSC of 50 mg/L are unlikely to sustain marshes for all scenarios except for most favorable conditions (high initial bed elevation and organic accretion rate; intermediate rate of sea level rise). These concentrations are unlikely based on the Island Ponds monitoring data.
- SSC of 100 or 150 mg/L can sustain marshes only for particular combinations of initial bed elevation, organic accretion rate and rate of sea level rise. Varying any one of these four parameters can alter whether the model predicts vegetated or unvegetated Year 100 conditions. These are the likely range of concentrations based on the Island Ponds monitoring data.
- SSC of 300 mg/L are likely to sustain marshes for all scenarios but are unlikely to occur after the initial period of tidal restoration, as shown by the Island Pond monitoring data.

The model input parameters and predicted 2067 bed elevations for the 54 combinations of initial bed elevation, SSC, and phasing are summarized in Appendix A. The colors in the last column represent the habitat zone of that elevation where blue is subtidal, brown is mudflat, light green is cordgrass, and dark green is pickleweed.

The results presented here provide a first order estimate of marsh accretion rates for San Francisco Bay under a range of input conditions. However, it should be recognized that significant uncertainties remain with respect to future changes in sea level rise as well as the physical and biological processes which affect marsh accretion. In particular, the analysis does not include the influence of waves, which become more important as site size increases and availability of sediment diminishes. Sites that are more vulnerable to waves include those with bed elevations between vegetation colonization elevation and MHHW, e.g. those elevations close to cordgrass dominated elevations.

Spatial Evolution

The results summarized in Appendix A were used to create digital elevation models (DEMs) of the site in 2067 years for different SSC and different start years (Figures 5 to 10). Phasing was not used in these figures to provide understanding of the evolution of the individual ponds. The ability to reach colonization elevation is controlled by both SSC and the start year. The start year has two influences, firstly there is less time to accrete sediment before the end of the project in 2067, and secondly the tidal inundation starts at a higher sea level and at a time when the sea level is rising faster.

Start Year 2017: Figure 5 and 6 show the likely evolution of the ponds by 2067 for a SSC of 100 and 200mg/L and a start date of 2017. It clearly shows for 100 mg/L none of the ponds attain elevations that allow for colonization and remain mudflats – all the sedimentation that is shown is due to inorganic sediment deposition at lower elevations, which is well-produced in Marsh98. The spatial pattern within the ponds reflects the initial start elevation and reflects how deeply subsided Pond A12 is, particularly adjacent to Alviso Slough and the Pond A12 inboard levee. For SSC of 200 mg/L nearly all the ponds reach colonization elevation, either cordgrass or pickleweed elevations.

Start Year 2027: Figure 7 and 8 show the likely evolution of the ponds by 2067 with a start date of 2027. For SSC of 100mg/L the mudflats within the ponds are lower than with a start date of 2017, as there has been less time to accrete. For SSC of 200 mg/L nearly all the ponds reach colonization elevation, but only attain cordgrass elevations.

Start Year 2037: Figure 9 and 10 show the likely evolution of the ponds by 2067 with a start date of 2037, a period of only 30 years. The pattern for both SSCs are the same as before but shifted lower in elevation. With the 200mg/L plot (Figure 10) there are areas in Pond A12 which do not achieve vegetation colonization elevation and remain mudflat.

Phased Evolution

Figures 11 and 12 show projections of the evolution of the site for the West Area First phasing scheme with varying start dates for the different Ponds with the west region (Ponds A9-A11) beginning in 2017, the east region (Pond A18) beginning in 2027, and the central region (Pond A12-A15) beginning in 2037. Figure 11 (SSC=100 mg/L) shows the impact of restoring tidal influence to the most deeply subsided ponds last; the elevation in Pond A12 remains low mudflat and shallow subtidal. Figure 12 (SSC=200 mg/L) shows the same basic pattern but all the elevations are higher, mostly achieving colonization elevations, except for Pond A12. This clearly shows the influence of phasing on the success in restoring a complete marsh in Ponds A9 to A15. Changing the order of restoration will have a significant impact on the outcome of the project in 2067.

Figures 13 and 14 illustrate the evolutionary projections for the Pond A12 First phasing scheme with the start dates for Pond A12 beginning in 2017, followed by west region (Pond A9-A11) in 2022, eastern region (Pond A18) in 2027, and the remaining central region ponds (Ponds A13-15) in 2030. Figure 13 (SSC=100 mg/L) shows the results of restoring the deeply subsided Pond A12 first and moving the restoration of Ponds A13-A15 up to 2030. Areas in Pond A12 that remained as shallow subtidal in the West Area First phasing scheme become low mudflat. Figure 14 (SSC=200 mg/L) illustrates that with higher sediment concentrations, restoration of Pond A12 beginning in 2017 allows this pond to reach cordgrass and pickleweed colonization elevations by 2067. Moving restoration of the remaining central area ponds (Ponds A13-15) up to 2030 allows areas of these ponds that remained as intertidal mudflat when restored in 2037, to reach low cordgrass colonization elevations by 2067.

Figures 15 and 16 present medium and large fill transitional alternatives with the projected evolution under Pond A12 First phasing scheme with the higher (200 mg/L) suspended sediment concentration.

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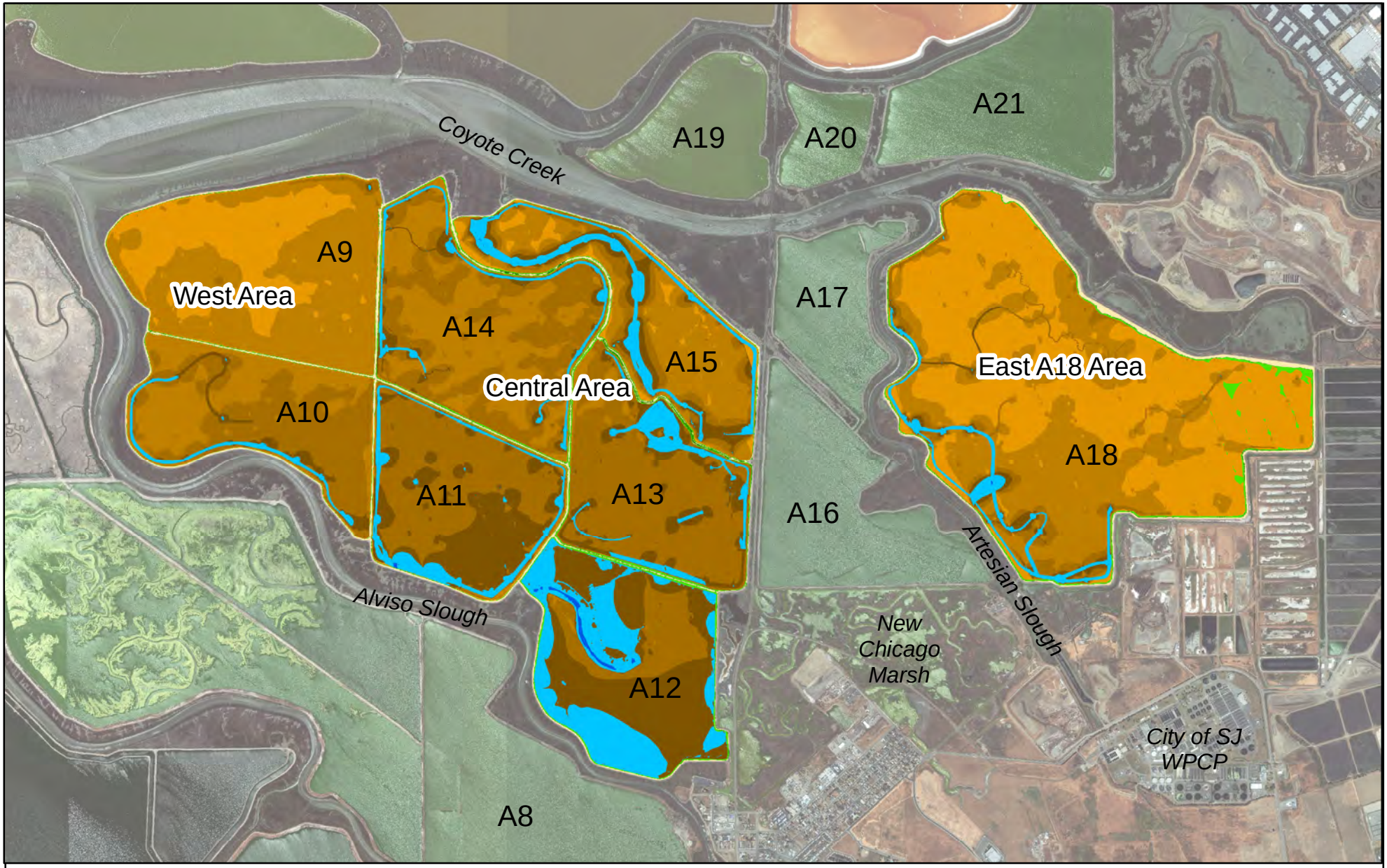
Appendix A

Summary of Landscape Evolution Projections

Habitat Zone	Elevation (relative to datums)
Deep Subtidal	6 m below MLLW and deeper
Shallow Subtidal A	2 to 6 m below MLLW
Shallow Subtidal B	2 m below MLLW to MLLW
Intertidal Mudflat	MLLW to MTL + 0.3 m
Cordgrass Dominated	MTL + 0.3 m to MHW
Pickleweed Dominated	MHW to MHHW

Run ID	Start Year	Co (mg/L)	2017 Elevations (ft NAVD)	2067 Elevation (ft NAVD)	Change in Elevation (ft)	MHHW 2067 (ft NAVD)	2067 Elevations - MHHW (ft)
1	2017	100	-12.30	-8.48	3.82	9.62	-18.10
2	2017	100	-3.28	0.54	3.82	9.62	-9.07
3	2017	100	0.00	3.53	3.53	9.62	-6.08
4	2017	100	5.74	7.55	1.81	9.62	-2.06
5	2017	100	7.38	8.58	1.20	9.62	-1.04
6	2017	100	9.84	9.62	-0.22	9.62	0.00
7	2017	200	-12.30	2.99	15.29	9.62	-6.62
8	2017	200	-3.28	8.31	11.59	9.62	-1.30
9	2017	200	0.00	9.03	9.03	9.62	-0.58
10	2017	200	5.74	9.62	3.88	9.62	0.00
11	2017	200	7.38	9.62	2.24	9.62	0.00
12	2017	200	9.84	9.62	-0.22	9.62	0.00
13	2017	300	-12.30	9.62	21.92	9.62	0.00
14	2017	300	-3.28	9.62	12.90	9.62	0.00
15	2017	300	0.00	9.62	9.62	9.62	0.00
16	2017	300	5.74	9.62	3.88	9.62	0.00
17	2017	300	7.38	9.62	2.24	9.62	0.00
18	2017	300	9.84	9.62	-0.22	9.62	0.00
19	2027	100	-12.30	-9.25	3.05	9.61	-18.86
20	2027	100	-3.28	-0.22	3.06	9.61	-9.83
21	2027	100	0.00	2.87	2.87	9.61	-6.74
22	2027	100	5.74	7.22	1.48	9.61	-2.39
23	2027	100	7.38	8.34	0.96	9.61	-1.27
24	2027	100	9.84	9.61	-0.23	9.61	0.00

Run ID	Start Year	Co (mg/L)	2017 Elevations (ft NAVD)	2067 Elevation (ft NAVD)	Change in Elevation (ft)	MHHW 2067 (ft NAVD)	2067 Elevations - MHHW (ft)
25	2027	200	-12.30	-0.05	12.25	9.61	-9.66
26	2027	200	-3.28	7.04	10.32	9.61	-2.57
27	2027	200	0.00	8.15	8.15	9.61	-1.46
28	2027	200	5.74	9.39	3.65	9.61	-0.22
29	2027	200	7.38	9.61	2.23	9.61	0.00
30	2027	200	9.84	9.61	-0.23	9.61	0.00
31	2027	300	-12.30	8.81	21.11	9.61	-0.80
32	2027	300	-3.28	9.61	12.89	9.61	0.00
33	2027	300	0.00	9.61	9.61	9.61	0.00
34	2027	300	5.74	9.61	3.87	9.61	0.00
35	2027	300	7.38	9.61	2.23	9.61	0.00
36	2027	300	9.84	9.61	-0.23	9.61	0.00
37	2037	100	-12.30	-10.01	2.29	9.61	-19.63
38	2037	100	-3.28	-0.99	2.29	9.61	-10.60
39	2037	100	0.00	2.17	2.17	9.61	-7.44
40	2037	100	5.74	6.86	1.12	9.61	-2.75
41	2037	100	7.38	8.10	0.72	9.61	-1.52
42	2037	100	9.84	9.61	-0.23	9.61	0.00
43	2037	200	-12.30	-3.13	9.17	9.61	-12.74
44	2037	200	-3.28	5.24	8.52	9.61	-4.38
45	2037	200	0.00	6.91	6.91	9.61	-2.70
46	2037	200	5.74	8.77	3.03	9.61	-0.84
47	2037	200	7.38	9.26	1.88	9.61	-0.35
48	2037	200	9.84	9.61	-0.23	9.61	0.00
49	2037	300	-12.30	6.15	18.45	9.61	-3.47
50	2037	300	-3.28	9.01	12.29	9.61	-0.61
51	2037	300	0.00	9.40	9.40	9.61	-0.21
52	2037	300	5.74	9.61	3.87	9.61	0.00
53	2037	300	7.38	9.61	2.23	9.61	0.00
54	2037	300	9.84	9.61	-0.23	9.61	0.00



Initial conditions. No Marsh98 run. No fill.

N

0 550 1,100 2,200 3,300 4,400 5,500 Feet

Habitat Zones (ft NAVD)

- Deep Subtidal (< -21.2)
- Shallow Subtidal A (-21.2 to -8.0)
- Shallow Subtidal B (-8.0 to -1.5)
- Intertidal Mudflat low (-1.5 to 0)
- Intertidal Mudflat mid low (0 to 1.3)
- Intertidal Mudflat mid high (1.3 to 3.0)
- Intertidal Mudflat high (3.0 to 4.3)
- Cordgrass Dominated low (4.3 to 5.6)
- Cordgrass Dominated high (5.6 to 7.0)
- Pickleweed Dominated (7.0 to 7.5)
- Upland (> 7.5)

figure 1

Shoreline Study Alternatives

Preliminary Alternative 1 Transitional - Upland Fill Footprint

Proj. # 211259

ESA PWA

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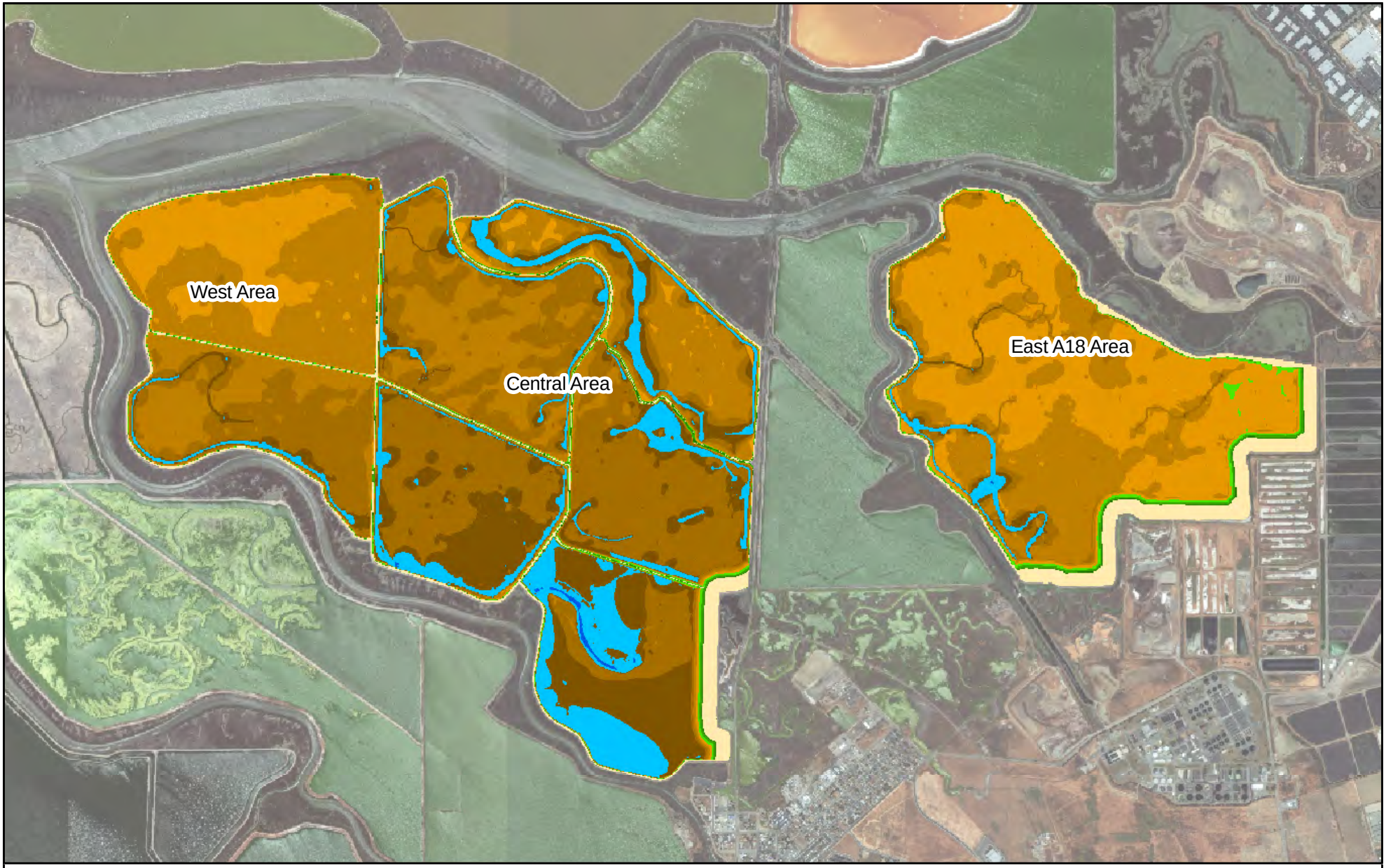
USACE - San Francisco District
South San Francisco Bay Shoreline Phase I Study
September 2015



Initial conditions. No Marsh98 run. Fill 1:30.

N

0 550 1,100 2,200 3,300 4,400 5,500 Feet

Habitat Zones (ft NAVD)

- Deep Subtidal (< -21.2)
- Shallow Subtidal A (-21.2 to -8.0)
- Shallow Subtidal B (-8.0 to -1.5)
- Intertidal Mudflat low (-1.5 to 0)
- Intertidal Mudflat mid low (0 to 1.3)
- Intertidal Mudflat mid high (1.3 to 3.0)
- Intertidal Mudflat high (3.0 to 4.3)
- Cordgrass Dominated low (4.3 to 5.6)
- Cordgrass Dominated high (5.6 to 7.0)
- Pickleweed Dominated (7.0 to 7.5)
- Upland (> 7.5)

figure 2

Shoreline Study Alternatives

Preliminary Alternative 2 Transitional - Upland Fill Footprint

Proj. # 211259

ESA PWA

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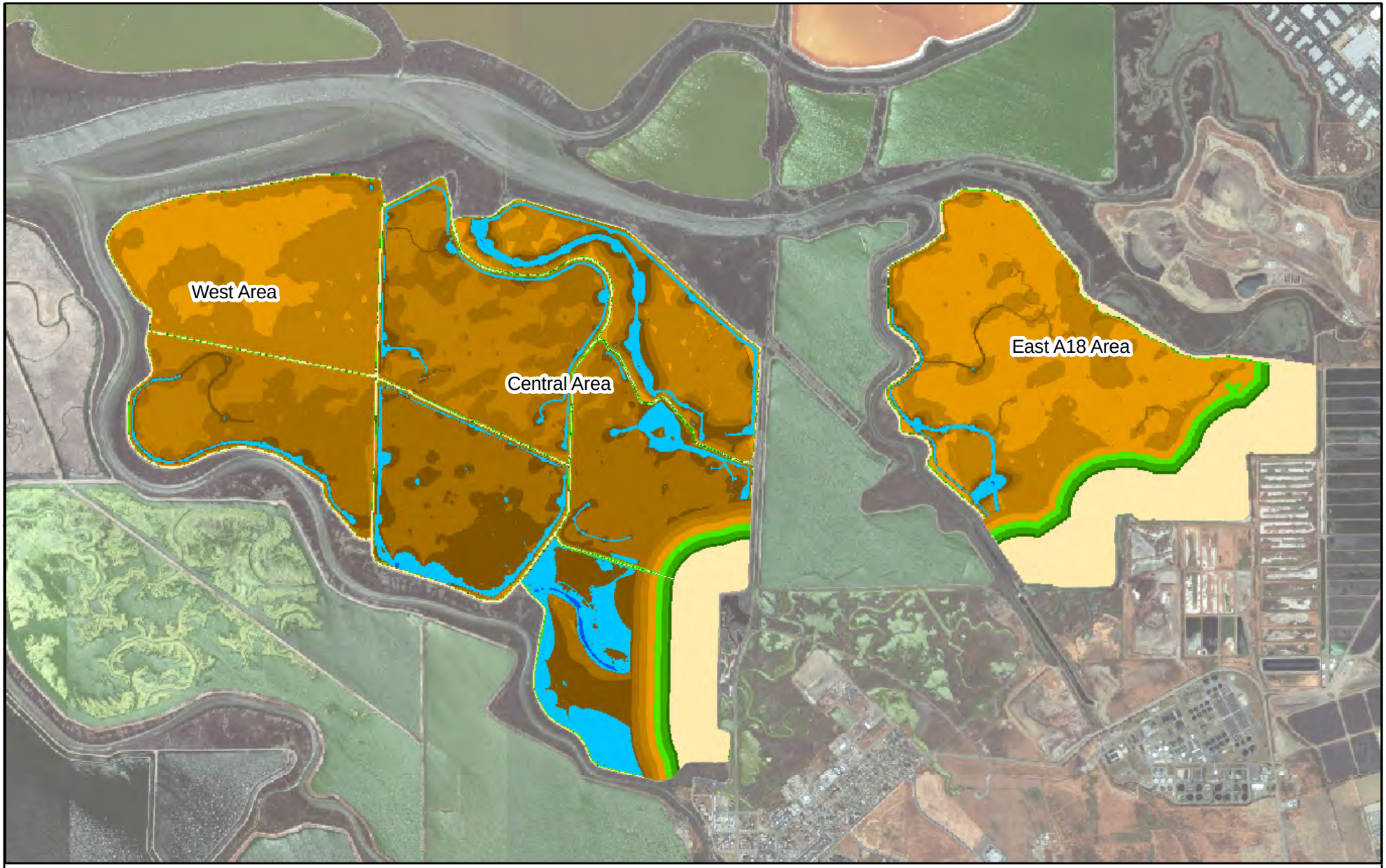

Initial conditions. No Marsh98 run. Fill 1:100.

N

0 550 1,100 2,200 3,300 4,400 5,500 Feet

Habitat Zones (ft NAVD)

- Deep Subtidal (< -21.2)
- Shallow Subtidal A (-21.2 to -8.0)
- Shallow Subtidal B (-8.0 to -1.5)
- Intertidal Mudflat low (-1.5 to 0)
- Intertidal Mudflat mid low (0 to 1.3)
- Intertidal Mudflat mid high (1.3 to 3.0)
- Intertidal Mudflat high (3.0 to 4.3)
- Cordgrass Dominated low (4.3 to 5.6)
- Cordgrass Dominated high (5.6 to 7.0)
- Pickleweed Dominated (7.0 to 7.5)
- Upland (> 7.5)

figure 3

Shoreline Study Alternatives

Preliminary Alternative 3 Transitional - Upland Fill Footprint

Proj. # 211259

ESA PWA

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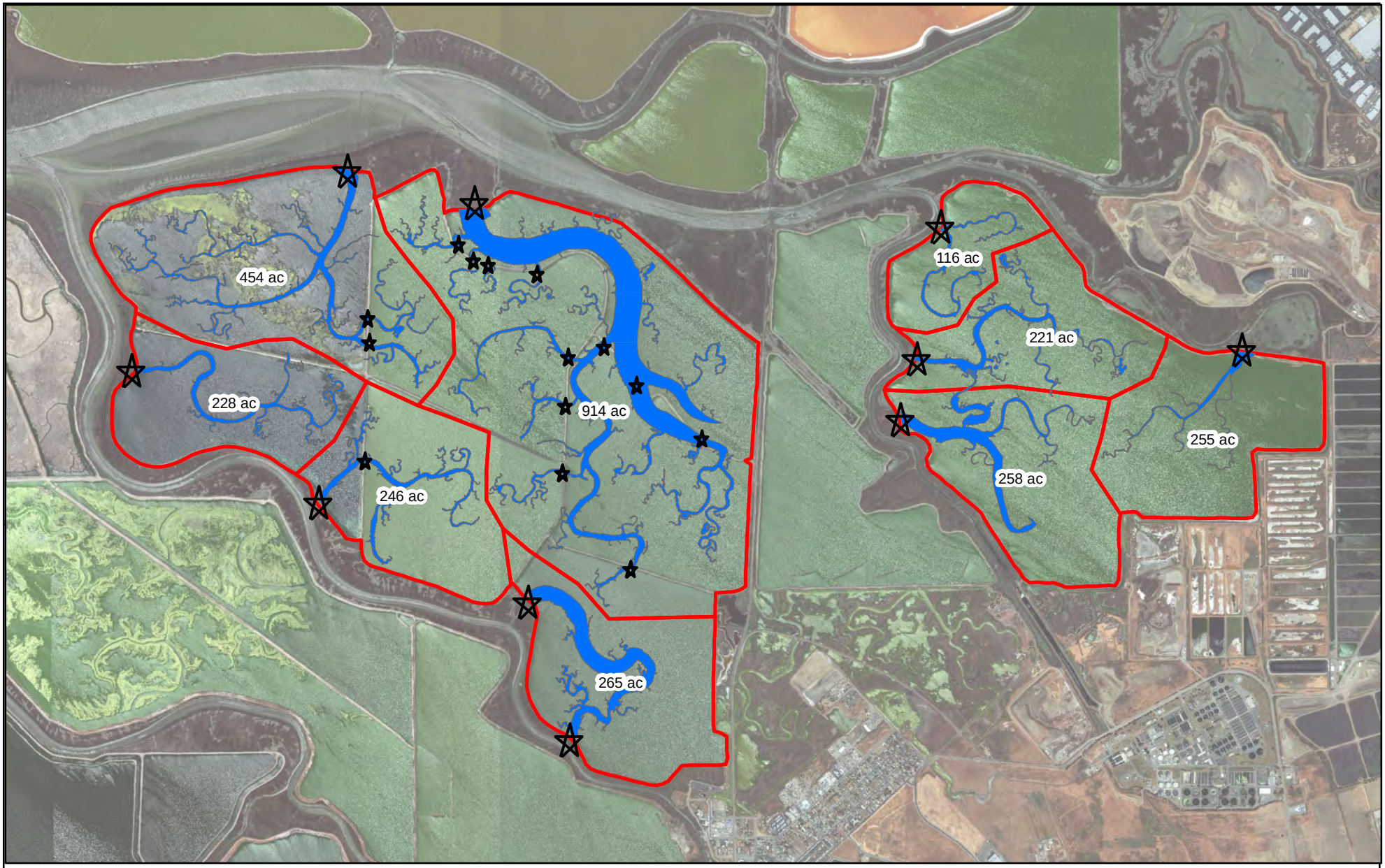

figure 4

Shoreline Study Alternatives

Historic Tidal Watersheds and Channels

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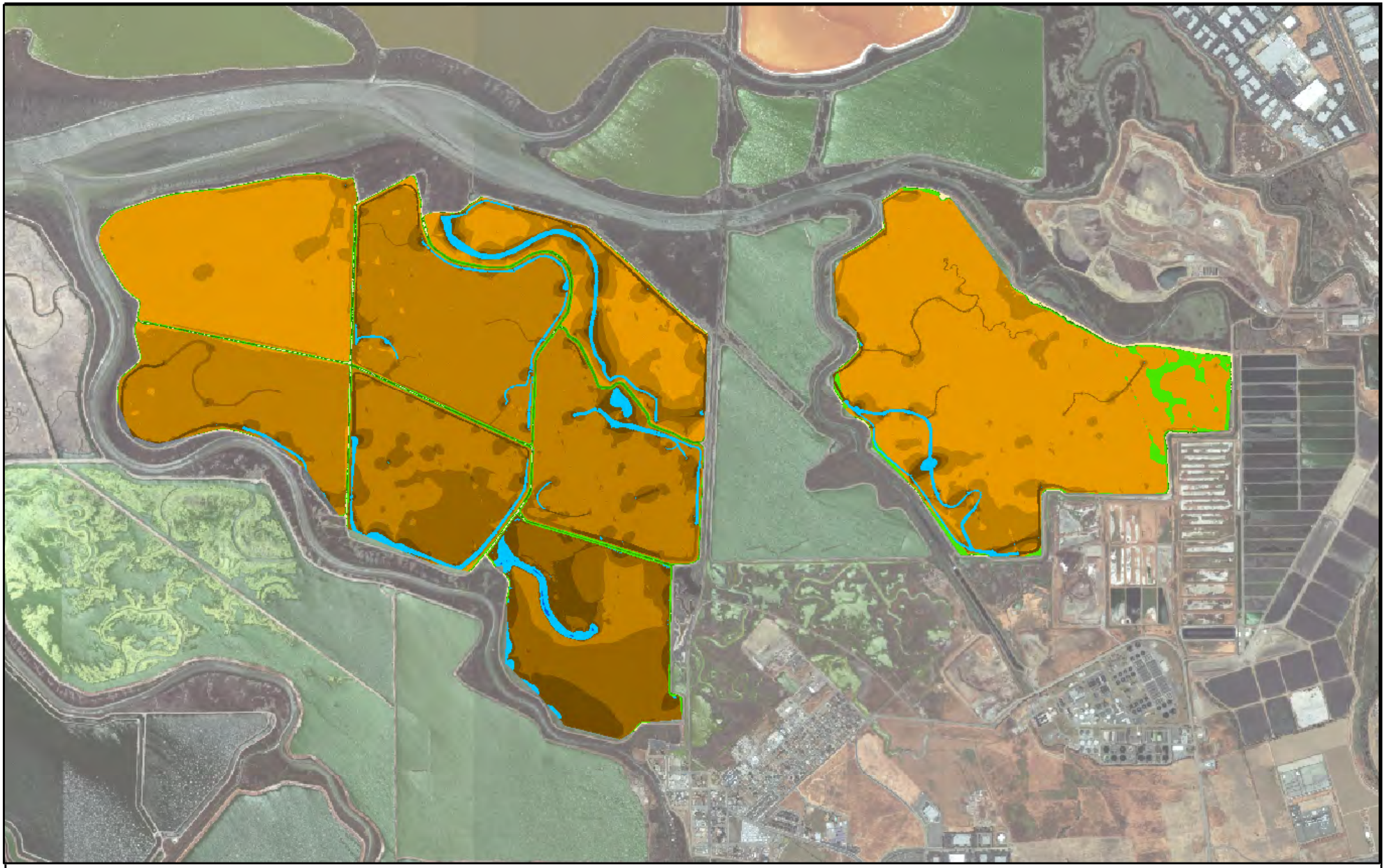

figure 5

Shoreline Study Alternatives

2067 Marsh Elevations with C0 = 100 mg/L and 2017 Start

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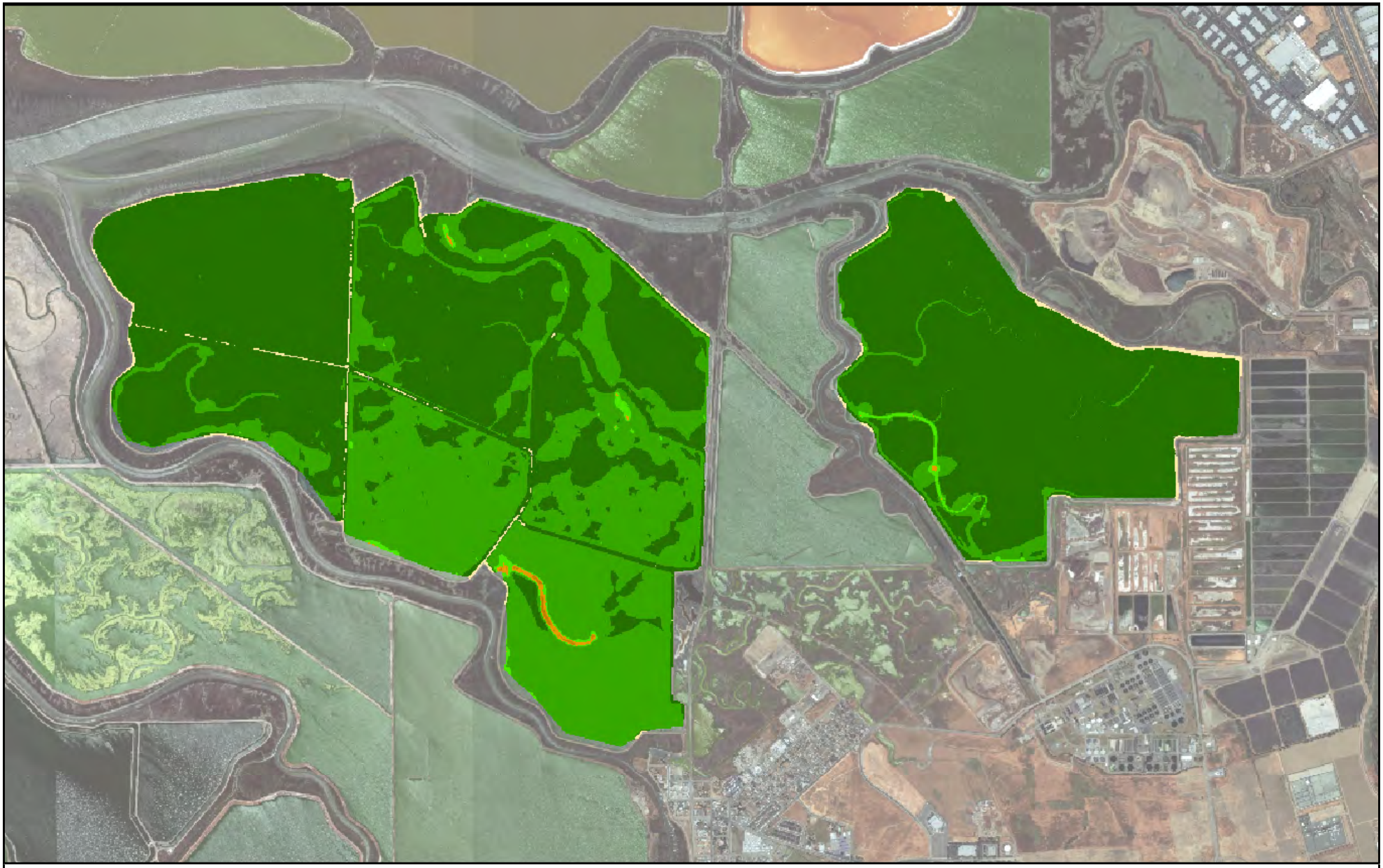
ESA PWA



C0 = 200 mg/L, NRC-III, organics = 1 mm/yr
Start all areas in 2017

N

0 1,000 2,000 4,000 6,000 Feet

Habitat Zones

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

figure 6

Shoreline Study Alternatives

2067 Marsh Elevations with C0 = 200 mg/L and 2017 Start

Proj. # 211259

ESA PWA

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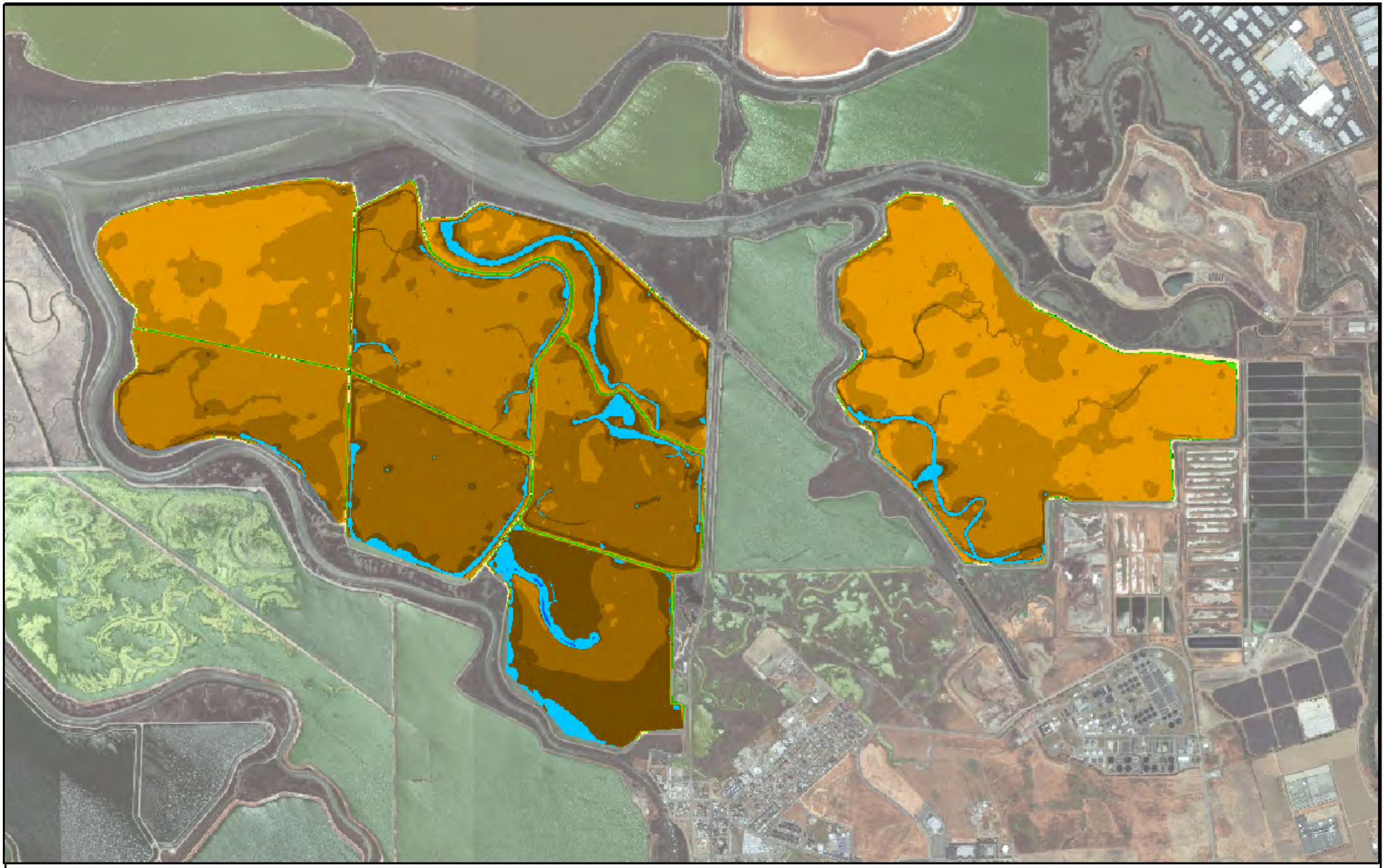


C0 = 100 mg/L, NRC-III, organics = 1 mm/yr
Start all areas in 2027

N

0 1,000 2,000 4,000 6,000 Feet

Habitat Zones

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

figure 7

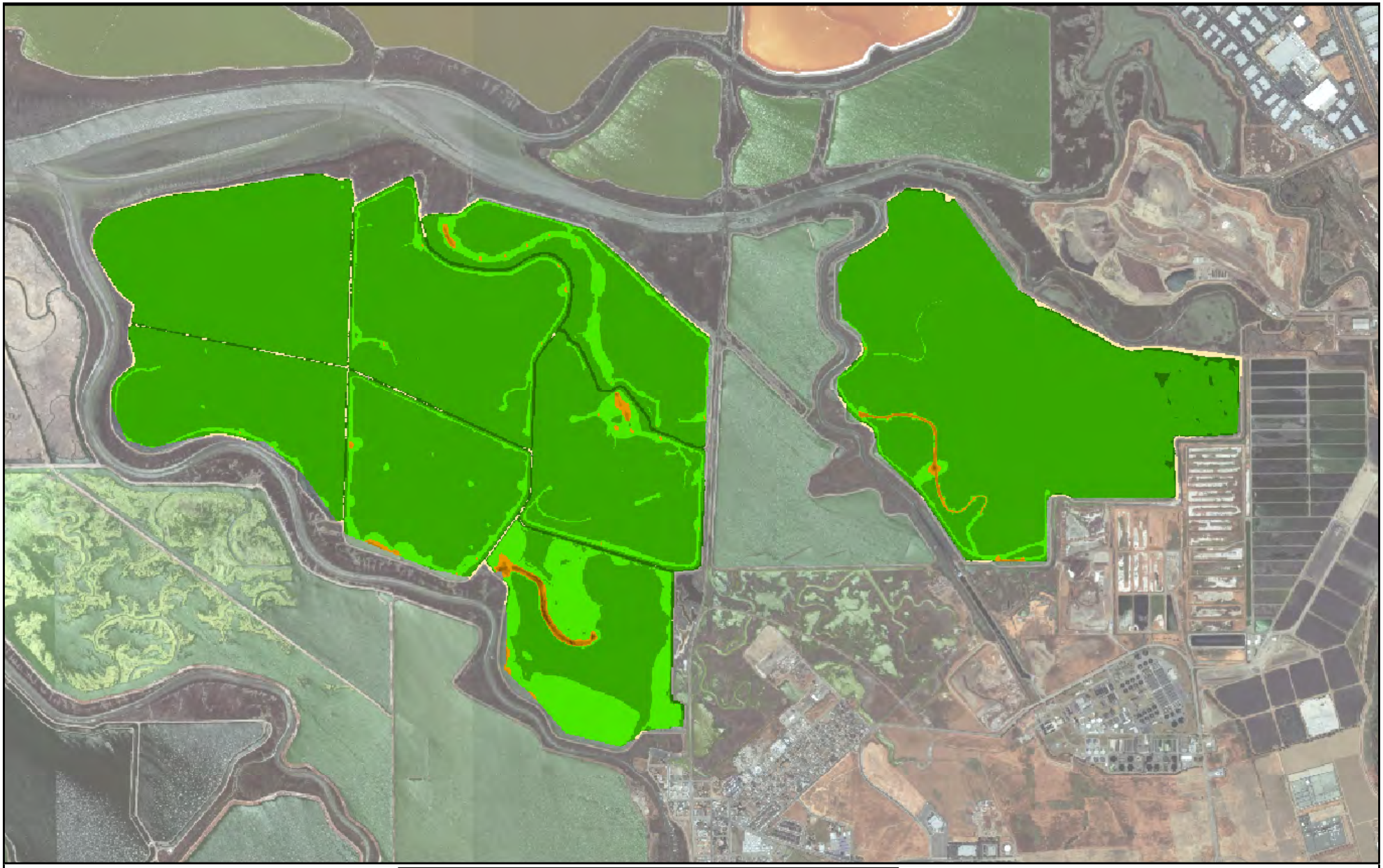
Shoreline Study Alternatives

2067 Marsh Elevations with C0 = 100 mg/L and 2027 Start

Proj. # 211259

ESA PWA

J:\211259 Shoreline\Mxds\50yrall2027_C0=100.mxd



C0 = 200 mg/L, NRC-III, organics = 1 mm/yr
Start all areas in 2027

N

0 1,000 2,000 4,000 6,000 Feet

Habitat Zones

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

figure 8

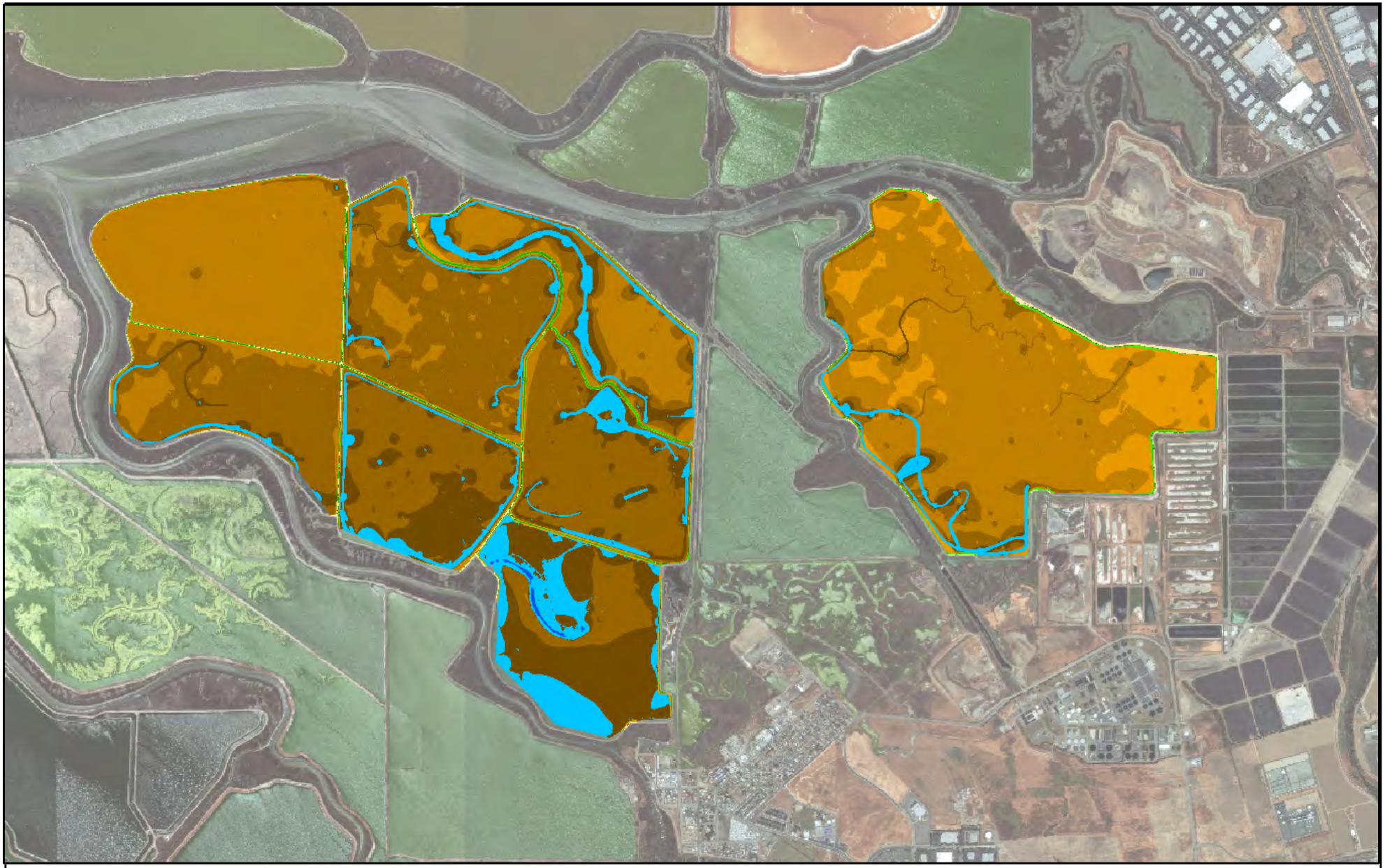
Shoreline Study Alternatives

2067 Marsh Elevations with C0 = 200 mg/L and 2027 Start

Proj. # 211259

ESA PWA

J:\211259 Shoreline\Mxds\50yrall\2027_C0=200.mxd



C0 = 100 mg/L, NRC-III, organics = 1 mm/yr
Start all areas in 2037

N

0 1,000 2,000 4,000 6,000 Feet

Habitat Zones

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

figure 9

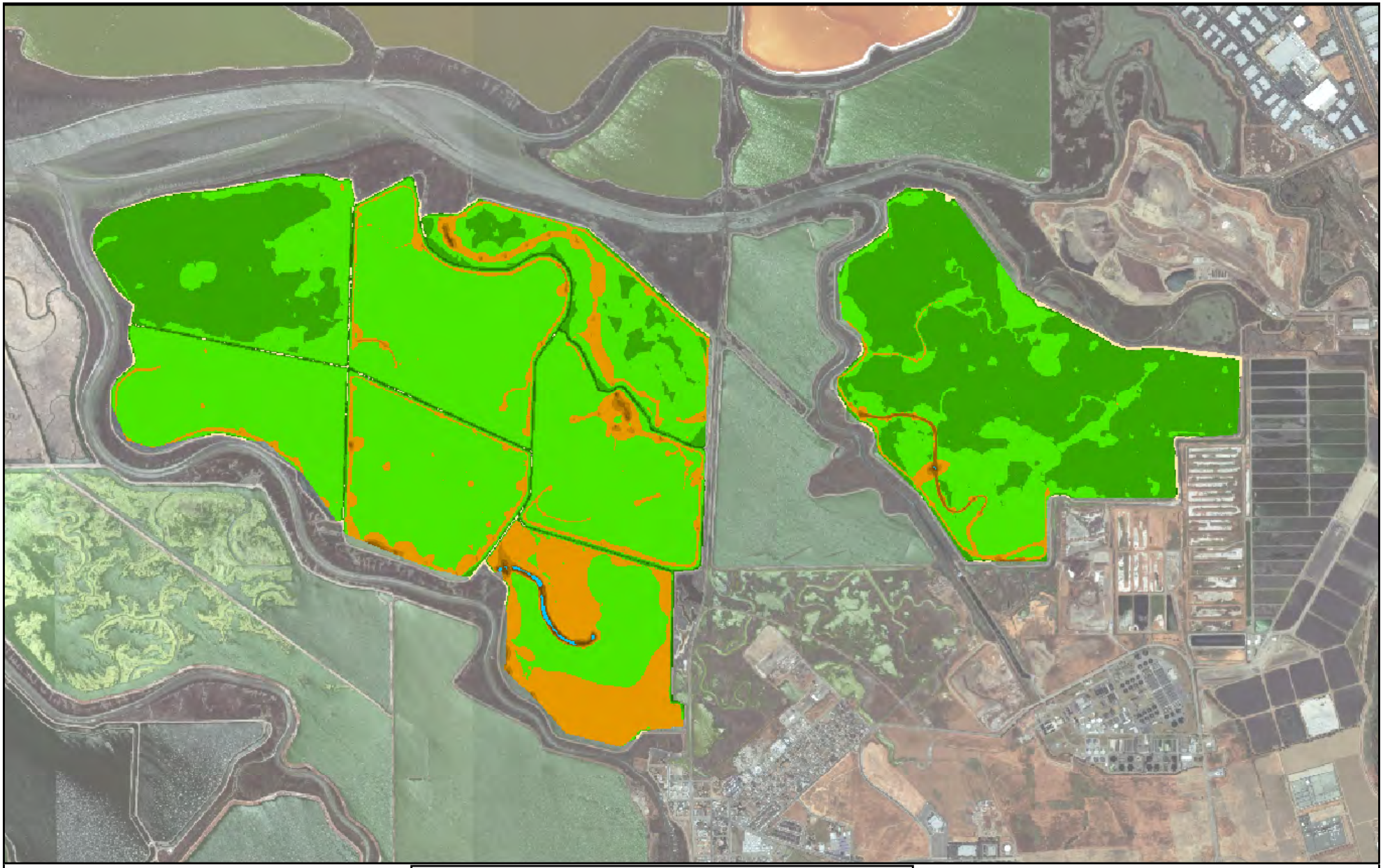
Shoreline Study Alternatives

2067 Marsh Elevations with C0 = 100 mg/L and 2037 Start

Proj. # 211259

ESA PWA

J:\211259-Shoreline\mxds\50yall\2037_C0=100.mxd



C0 = 200 mg/L, NRC-III, organics = 1 mm/yr
Start all areas in 2037

N

0 1,000 2,000 4,000 6,000 Feet

Habitat Zones

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

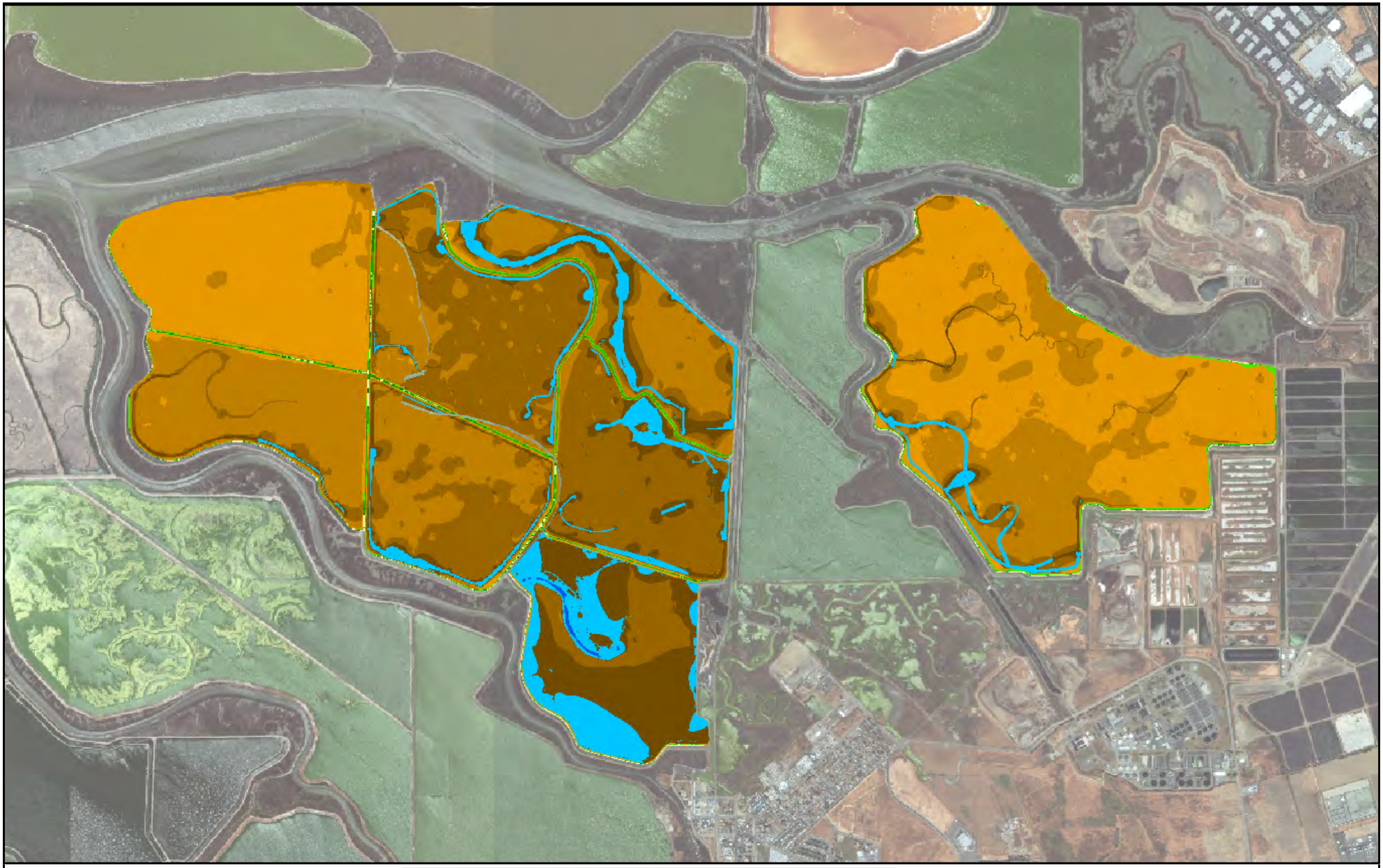
figure 10

Shoreline Study Alternatives

2067 Marsh Elevations with C0 = 200 mg/L and 2037 Start

Proj. # 211259

ESA PWA



C0 = 100 mg/L, NRC-III, organics = 1 mm/yr
Start West Area in 2017, East Area (A18) in 2027, and Central Area in 2037

N

0 1,000 2,000 4,000 6,000 Feet

Habitat Zones

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

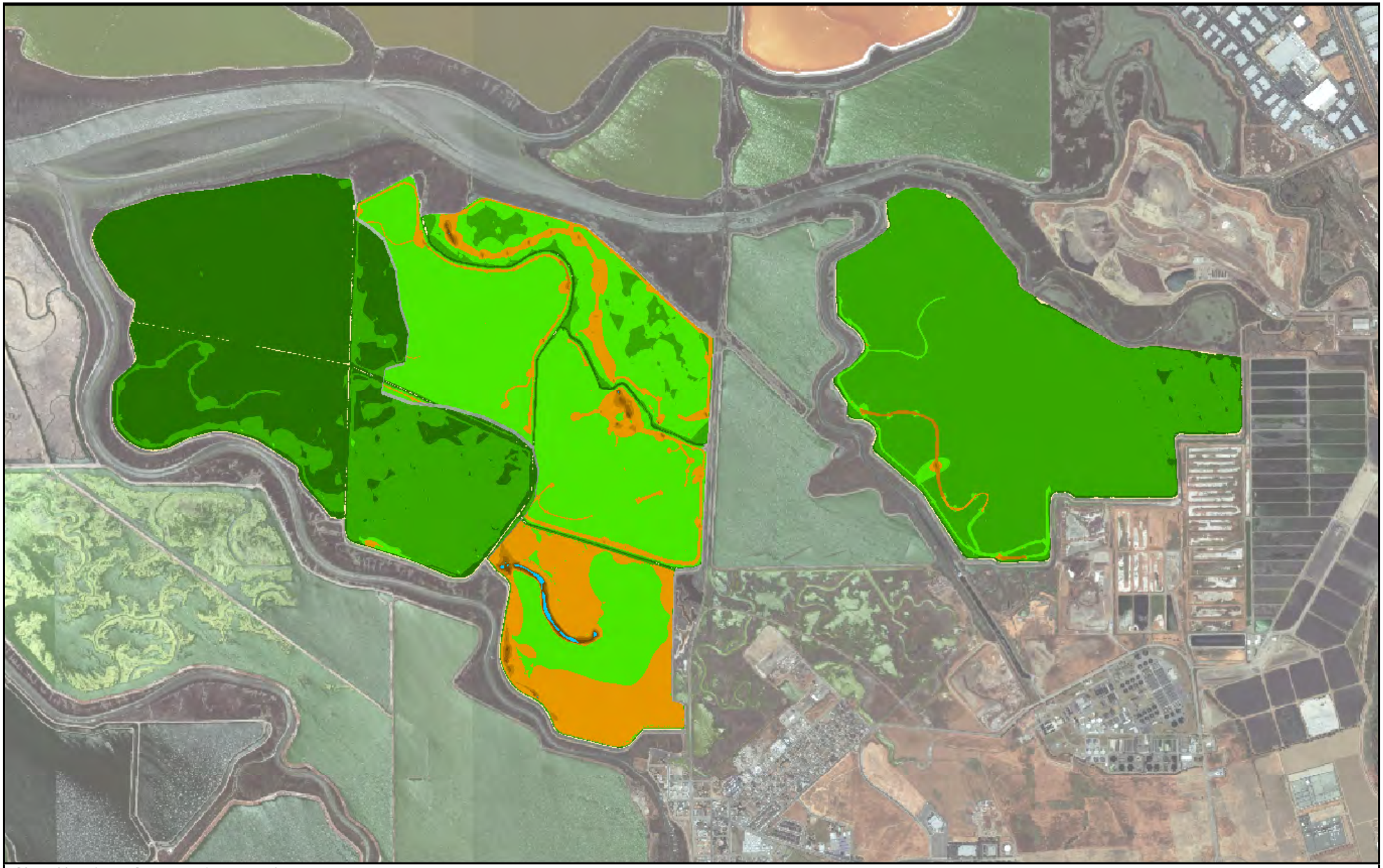
figure 11

Shoreline Study Alternatives

2067 Marsh Elevations with C0 = 100 mg/L

Proj. # 211259

ESA PWA



C0 = 200 mg/L, NRC-III, organics = 1 mm/yr
Start West Area in 2017, East Area (A18) in 2027, and Central Area in 2037

N

0 1,000 2,000 4,000 6,000 Feet

Habitat Zones

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

figure 12

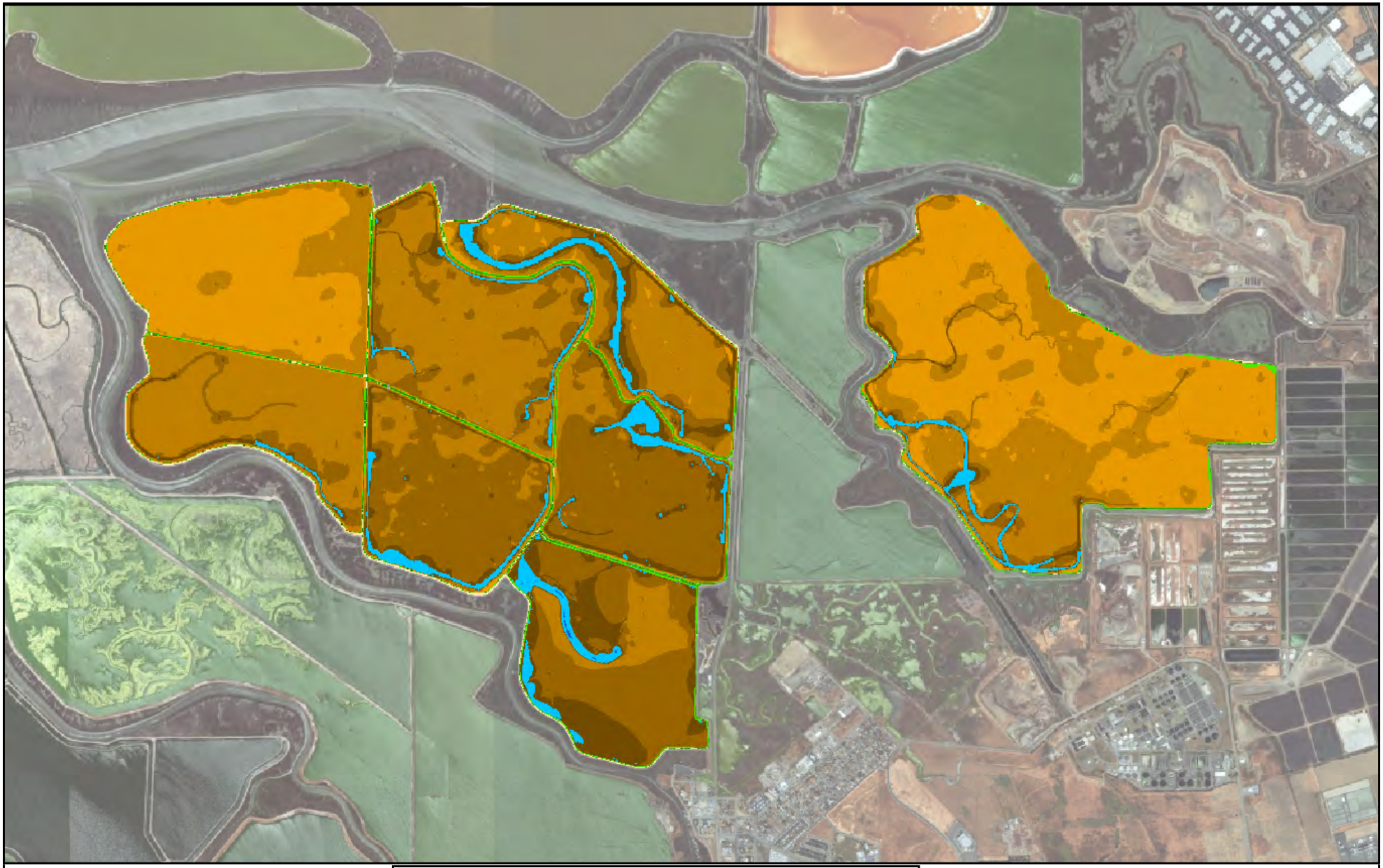
Shoreline Study Alternatives

2067 Marsh Elevations with C0 = 200 mg/L

Proj. # 211259

ESA PWA

J:\211259 Shoreline\Mxds\60yrWestEastCentralV2\C0=200.mxd



C0 = 100 mg/L, NRC-III, organics = 1 mm/yr
Start A12 in 2017, A9-11 in 2022, A18 in 2027, and A13-15 in 2030

N

0 1,000 2,000 4,000 6,000 Feet

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

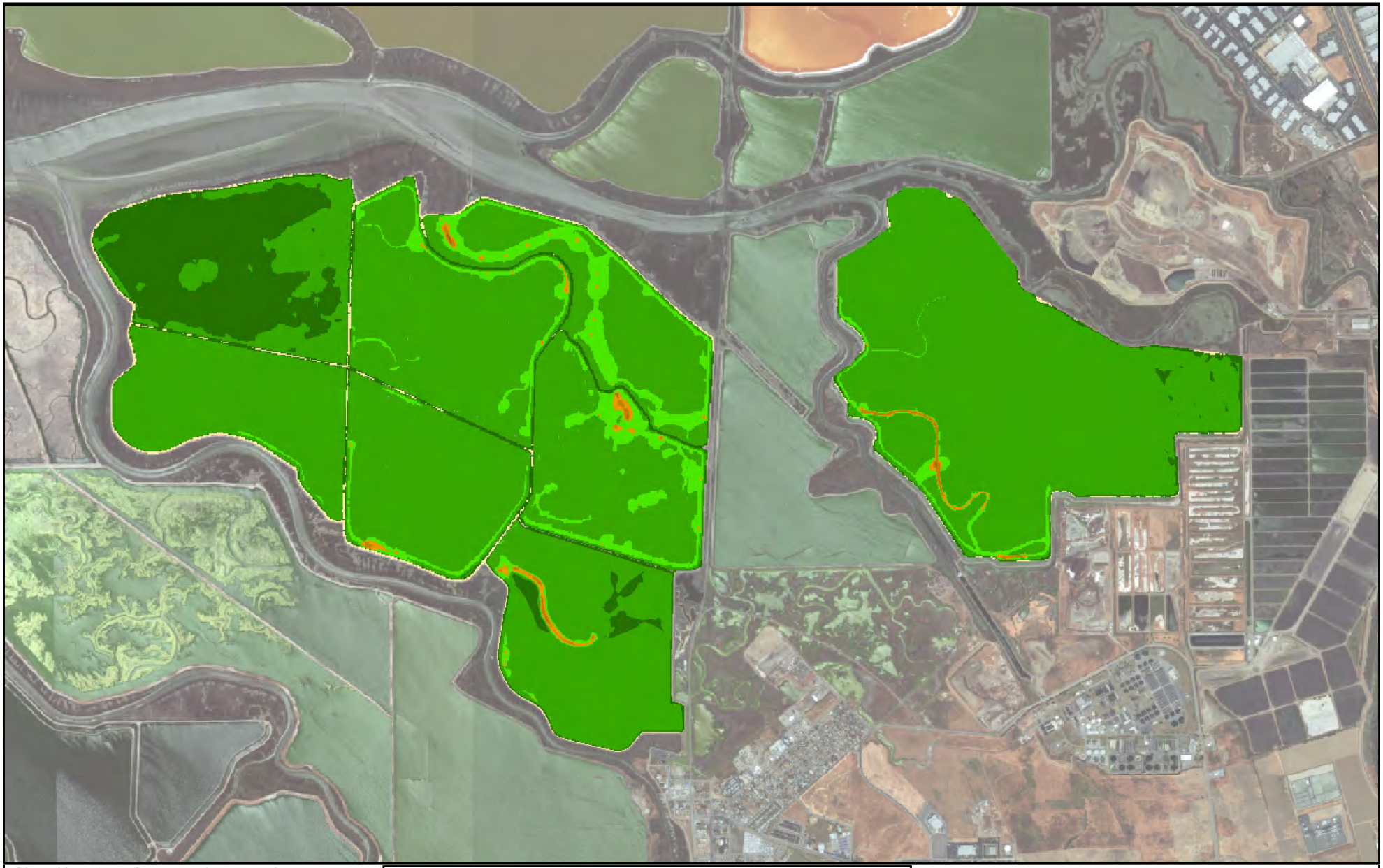
figure 13

Shoreline Study Alternatives

2067 Marsh Elevations with C0 = 100 mg/L

Proj. # 211259

ESA PWA



C0 = 200 mg/L, NRC-III, organics = 1 mm/yr
Start A12 in 2017, A9-11 in 2022, A18 in 2027,
and A13-15 in 2030

N

0 1,000 2,000 4,000 6,000 Feet

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

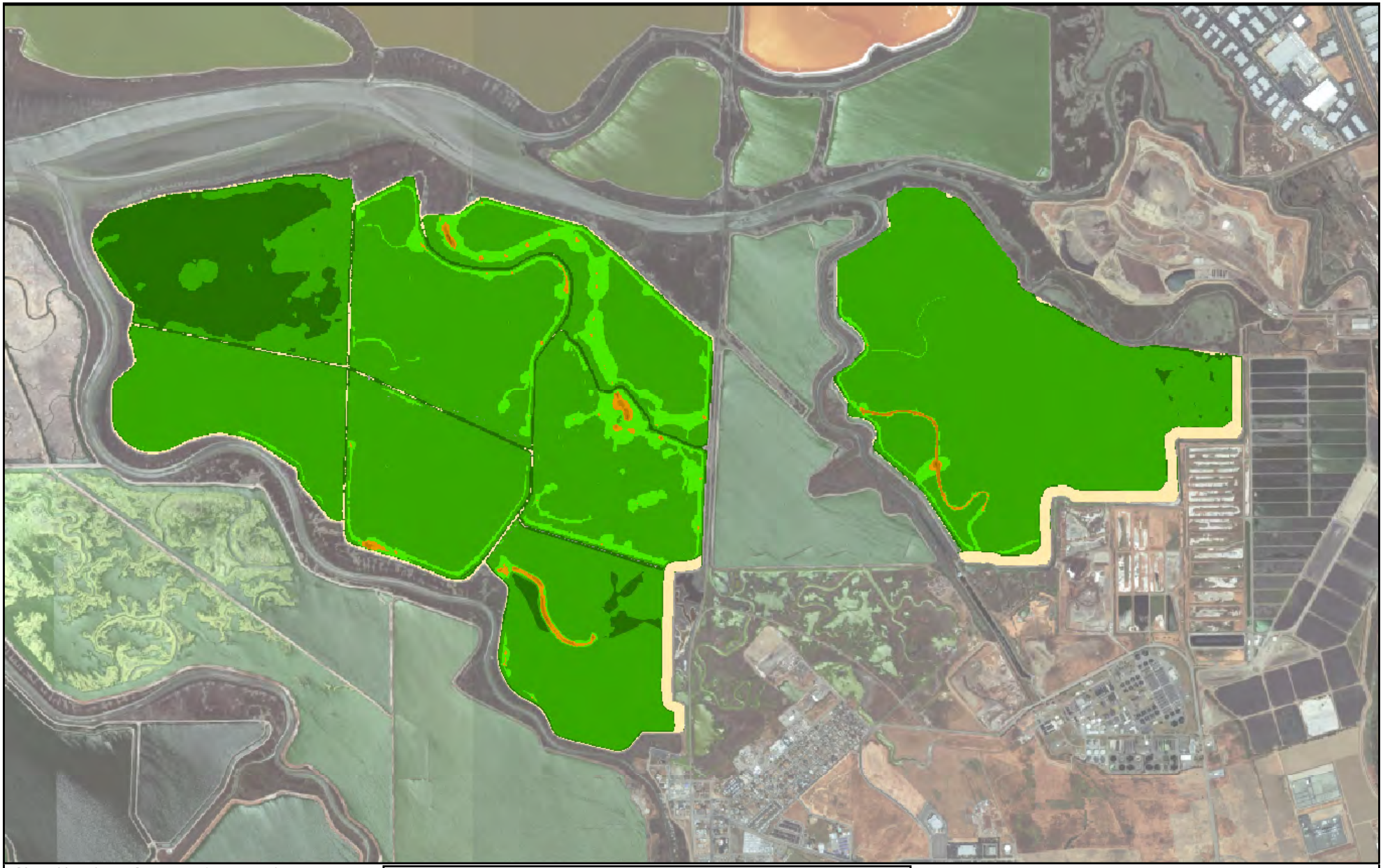
figure 14

Shoreline Study Alternatives

2067 Marsh Elevations with C0 = 200 mg/L

Proj. # 211259

ESA PWA



C0 = 200 mg/L, NRC-III, organics = 1 mm/yr
Start A12 in 2017, A9-11 in 2022, A18 in 2027, and A13-15 in 2030. Fill 1:30

N

0 1,000 2,000 4,000 6,000 Feet

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

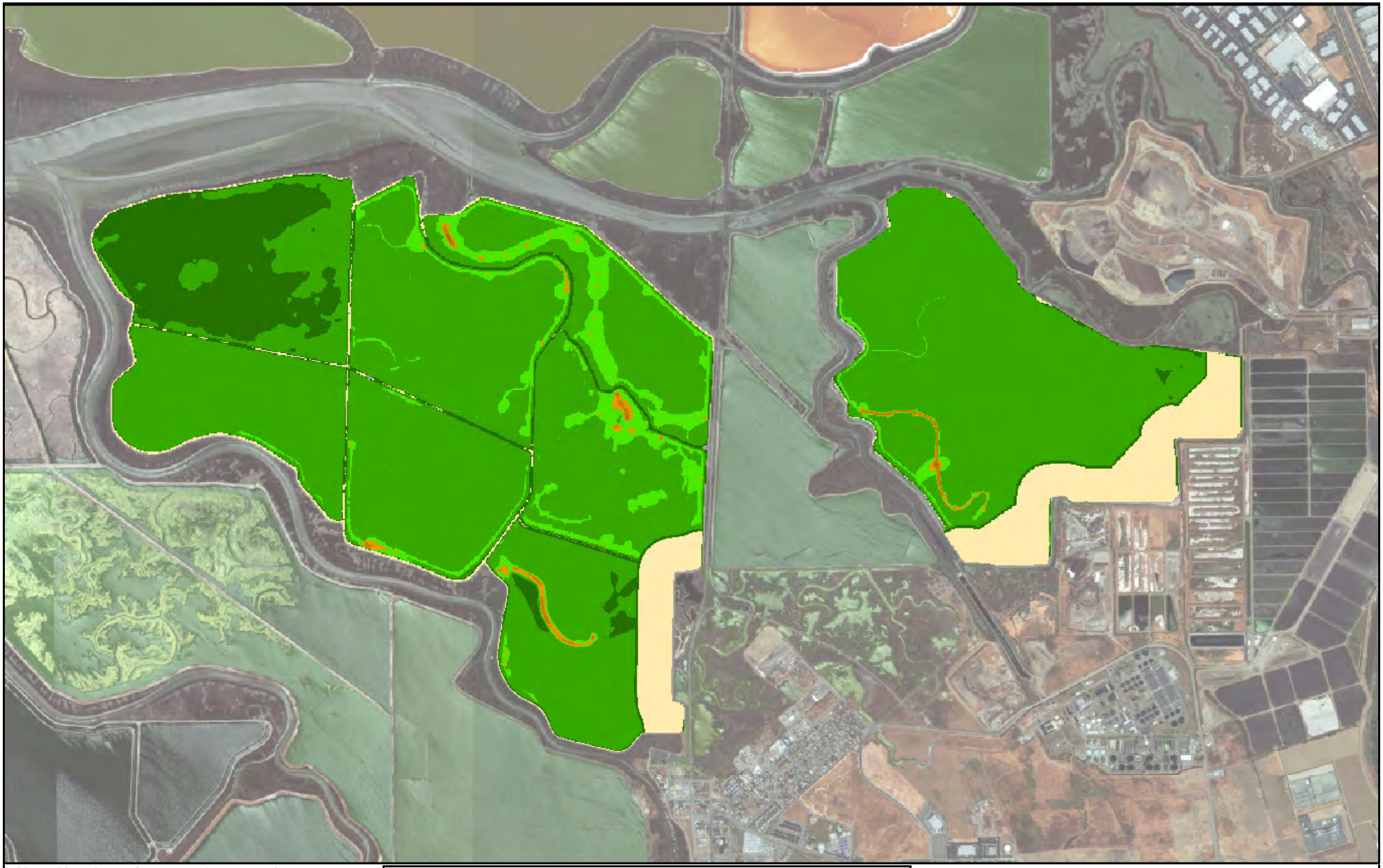
figure 15

Shoreline Study Alternatives

2067 Marsh Elevations with Prelim
Alt 2 Transitional - Upland Fill Footprint

Proj. # 211259

ESA PWA



C0 = 200 mg/L, NRC-III, organics = 1 mm/yr
Start A12 in 2017, A9-11 in 2022, A18 in 2027,
and A13-15 in 2030. Fill 1:100

N

0 1,000 2,000 4,000 6,000 Feet

- Deep Subtidal
- Shallow Subtidal A
- Shallow Subtidal B
- Intertidal Mudflat low
- Intertidal Mudflat mid low
- Intertidal Mudflat mid high
- Intertidal Mudflat high
- Cordgrass Dominated low
- Cordgrass Dominated high
- Pickleweed Dominated
- Upland

figure 16

Shoreline Study Alternatives

2067 Marsh Elevations with Prelim
Alt 3 Transitional - Upland Fill Footprint

Proj. # 211259

ESA PWA

Appendix B2

Environmental Benefits Analysis (CHAP) Summary and Model Outputs

South San Francisco Bay Shoreline Study

COMBINED HABITAT ASSESSMENT PROTOCOLS (CHAP) RESULTS FOR THE WITH-PROJECT AND WITHOUT-PROJECT CONDITIONS

San Francisco District, U.S. Army Corps of Engineers

July 22, 2015

1.0 Introduction

1.1 Study and Study Area

The San Francisco Estuary, including San Francisco Bay and adjoining bays, has lost approximately 90 percent of its tidal marshes over the last 165 years due to diking, filling, and other human activities. This has resulted in substantial loss of tidal marsh functions and wildlife habitat, and has led to listing of several species under the Endangered Species Act. In the south portion of San Francisco Bay (the South Bay), a large portion of these tidal marsh losses were due to conversion of tidal marsh to commercial salt ponds decades ago. Many of these ponds were acquired for conservation purposes by Federal and State agencies in 2003.

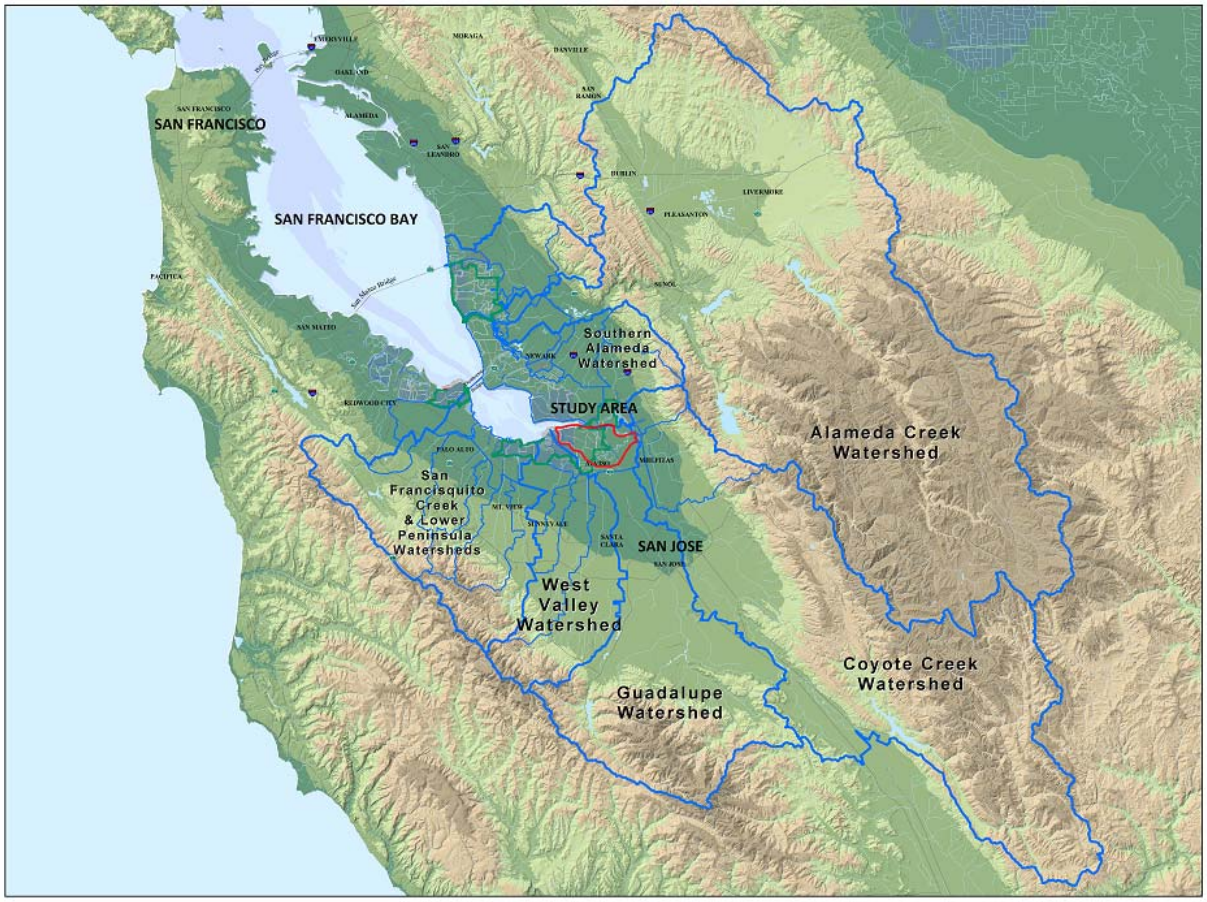
The South San Francisco Bay Shoreline Study is considering flood risk management (FRM) and ecosystem restoration (ER) actions in the Alviso area in the South Bay. FRM actions under consideration would cause loss of a small portion of existing habitats, and conversion of managed ponds into tidal and transitional habitats for ER purposes would affect existing habitat values by replacing one kind of habitat with several other types. Figure 1 shows the general location of the study area in the context of San Francisco Bay and local watersheds.

U.S. Army Corps of Engineers (USACE) planning policy requires a cost-effectiveness analysis of potential ER measures to determine the optimal components to be included in the final array of alternatives and to assist in the selection of the preferred alternative. In addition, various environmental laws and regulations require analysis of environmental impacts from a project including effects on fish and wildlife habitat. Thus, quantifying effects on fish and wildlife habitat is an important task for this study. Additional habitat and species analyses, such as acres of habitat types and effect on endangered species, were handled separately using other methods and are reported in other documents such as the Final Integrated Report for this study.

1.2 Selection of Habitat Goals

The key issue in considering the future of existing managed ponds along the shoreline of San Francisco Bay is the habitat and wildlife tradeoff between retaining or improving these ponds as habitat for water birds (waterfowl and shorebirds) versus restoring these sites to tidal action with their associated habitats, fish, and wildlife. A planning effort by federal and state agencies, the South Bay Salt Pond Restoration Study, has determined that some of the managed ponds in the South Bay should be converted to tidal habitats, primarily tidal marsh, to restore marsh functions and to further the recovery of endangered species that use these habitats (South Bay Salt Pond Project, 2007). This decision has been made with the full understanding that considerable existing habitat value for water birds will be lost in order to obtain the needed tidal habitat benefits. The South Bay Salt Pond Project has subsequently breached some ponds while enhancing other ponds for bird use to offset losses of habitat value for birds.

Figure 1: Study Area



2.0 Methods

2.1 Value and Limitations of Habitat Evaluation Methods

Habitat evaluation methods are intended to quantify the relative values of different areas whose ecological value may be lost, degraded, or improved by project activities. Determining the ecological value of an area is a complex matter, in part because any area that serves as fish or wildlife habitat will have a number of ecological functions and values in the context of a larger landscape. In a very limited context it may be relatively easy to determine what would improve habitat values in a small area, but local optimization of habitat value may not always be optimal in a landscape context. This issue will be discussed further later on in this report.

2.2 Tidal vs. Non-Tidal Habitats

Given the findings of the South Bay Salt Pond Restoration Study, the Shoreline Study has examined the feasibility of converting existing managed pond habitat to tidal habitats, with the understanding that such restoration efforts would convert one valuable habitat into another. In such cases, comparing the habitat outputs of study alternatives to the without-project condition may not show any net gain, and is not useful in comparing the cost-effectiveness of these alternatives.

Thus, *only for purposes of evaluating the cost-effectiveness of ER measures and alternatives*, this study set the habitat units for non-tidal habitats to zero. The gross tidal habitat outputs under CHAP from within the restoration area are counted as ecosystem restoration benefits for USACE planning purposes. This issue is addressed again in Section 4.

2.3 Overview of Habitat Evaluation Methods Selected for this Study

The Combined Habitat Assessment Protocols (CHAP) was selected, in consultation with the South Pacific Division of USACE, for quantifying ecosystem restoration benefits for the South San Francisco Bay Shoreline Study. CHAP is a method for quantifying the value of habitat for wildlife developed by the Northwest Habitat Institute (NHI). It builds upon older methods such as the FWS' Habitat Evaluation Procedures (HEP) and the Habitat Accounting and Appraisal (HAB) method. Unlike HEP it evaluates all the vertebrate species found in a given habitat area, and can be expanded to cover selected invertebrate species. CHAP habitat units are not comparable to HEP habitat units and should not be directly compared due to their different scaling.

CHAP looks at both the requirements of individual species (key ecological correlates or KECs) as well as the functions these species provide for their ecosystem (key ecological functions or KEFs). Given these areas of emphasis, CHAP generally gives higher scores for locations with higher biodiversity and more complex habitat structure within a given habitat type. CHAP operates within a geographic information system (GIS) environment.

A habitat study using the California Rapid Assessment Method (CRAM) was also performed. While this study provided very useful projections of future habitat conditions, it was not able to produce annualized benefits for assessing the cost-effectiveness of ecosystem restoration efforts and was not used to evaluate alternatives.

2.4 Method for Determining Baseline Conditions

The CHAP approach involves four steps: 1) preliminary mapping, 2) field inventory, 3) data compilation and analysis, and 4) production of GIS maps, spreadsheets, and report. Detailed information on methods used and the baseline findings are available in Northwest Habitat Institute (2015a). Results are provided here in summary form for reference. Habitat types are listed in Table 1 and mapped in Figure 2. The species numbers selected are listed by class in Table 2. Key ecological correlates (KECs) and key ecological functions (KEFs) were identified for each species and are presented in Northwest Habitat Institute (2015a).

To complete the determination of baseline CHAP information, GIS maps were generated that depict the habitat values (HUs) of each polygon. Supporting maps illustrated: a) study area boundaries; b) polygon numbering; c) corrected habitat value per acre; d) habitat units; e) amounts of non-native plant species by polygon; f) wildlife habitat types by polygon; and g) structural conditions by polygon. Spreadsheets were developed that contain the polygon calculations of the species-functions and habitat-functions matrices, along with an overall site or area habitat value.

2.5 Forecast of Future Without-Project Habitat Conditions

Existing wetland habitats in the south portion of San Francisco Bay are artificially fragmented and degraded, which raises the question of whether all existing wildlife species and populations in the area

are sustainable in the long term. The habitat evaluation team reviewed the species included in the CHAP analysis and projected loss of four species over the course of the habitat evaluation period, in the absence of an ecosystem restoration project.

Several external factors could affect future habitat values in the absence of a project. These include sea level rise, climate change, invasive species, or other unforeseen environmental changes. However, other than land use changes guided by existing land use plans, such changes are highly uncertain as described below. Future habitat conditions were therefore assumed to be the same as current conditions in the absence of a project, except as noted below.

Table 1: Habitat Types		
Tidal Habitats	*Non-Tidal Habitats*	
Saline Marsh	Batch Pond	Parks / Upland Grassland
Brackish Marsh	Managed Pond	Levee
Freshwater Marsh	Muted Tidal / Diked Marsh	Water / Sewage Treatment
Tidal Flats/Mudflats	Seasonal Wetland	Landfill
Open Water/Slough Channel	Upland Vegetation	Developed
	Riparian/Creek Corridor	

Table 2: Number of Vertebrate Species Included in the CHAP Analysis						
Class	Fish	Amphibians	Reptiles	Birds	Mammals	Total
Number of Species	51	0	6	177	17	251

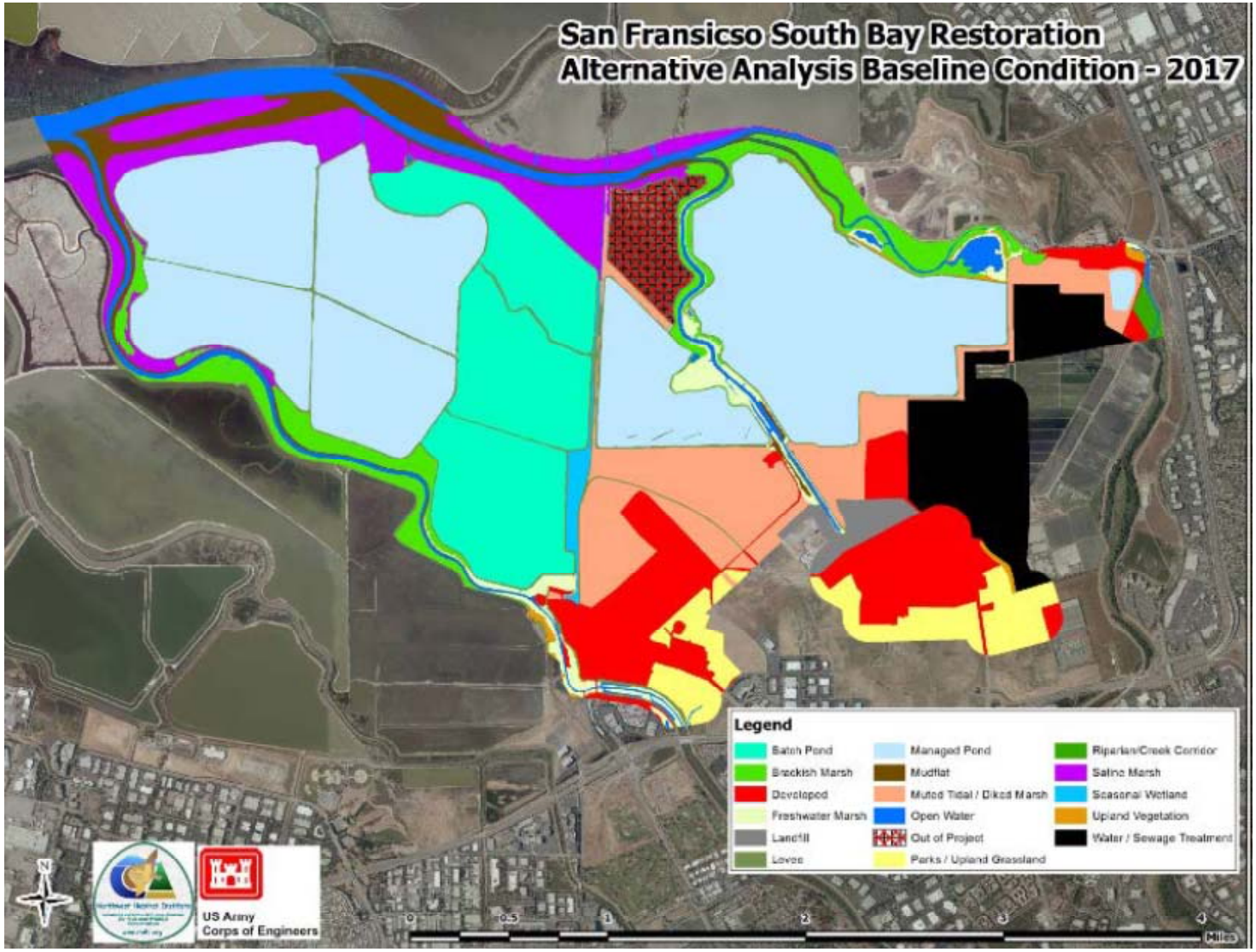
Note: Classes shown are the traditional taxonomic groupings for vertebrates that are most commonly used in planning and management of ecosystems. Evolutionarily unified (monophyletic) groups may differ from these categories.

2.5.1 Sediment Availability and Sea Level Rise

Areas already subject to tidal action would be affected by sea level rise (SLR). To evaluate this issue, consideration of the past behavior of the area as well as forecasts of future sediment dynamics should be taken into account. Due to the past construction of steep-sided levees and dikes along the shores of essentially all land areas in the study area, the transition from tidal to non-tidal areas within the study area is very abrupt. Therefore, significant encroachment of tidal waters and marshes onto currently non-tidal lands is not expected during the evaluation period.

During portions of the 20th Century, the study area experienced large amounts (2 to 6 feet in 33 years) of relative SLR due to land subsidence caused by overdraft of deep aquifers underlying the Santa Clara Valley and neighboring portions of San Francisco Bay. Due to relatively high suspended sediment concentrations in tidal waters within the study area, local tidal marshes were able to trap sufficient sediment to keep up with this relative SLR and even expand into mudflat areas (H.T. Harvey and Associates, 2012).

Figure 2: Habitat Types



Map credit: H.T. Harvey and Associates; Northwest Habitat Institute

Tidal wetlands in the San Francisco Estuary are generally accreting sediment fast enough to keep up with SLR (Callaway et al.,2012). In the immediate vicinity of the study area, Coyote Creek and Alviso Slough show much higher rates of accretion (Watson 2004, and Patrick and DeLaune 1990), which may be a response to past local subsidence coupled with the abundant fine sediment supply in the area (Patrick and DeLaune 1990). This past subsidence can be viewed as an analog for current eustatic SLR.

Projected net local SLR between the present time and the end of the evaluation period (56 years from the present) is at the low end of past relative SLR in the study area and would occur over a much longer period. Modeling of tidal marsh adaptation to SLR in San Francisco Bay suggests that the study area is expected to retain a relatively high ability to adapt to SLR over the next 60 years (Stralberg et al., 2011).

Therefore, it is reasonable to project that tidal marshes in the study area will be able to keep up with SLR through sediment capture for the duration of the evaluation period. Mudflats and subtidal habitats can be expected to evolve some during this period but no large net changes in their extent is expected. However, it should be noted that this situation may change in decades following the evaluation period, as the rate of SLR is expected to accelerate greatly later in the century.

2.5.2 Climate Change

Another factor that could affect habitat values is climate change. While most attention on this issue has focused on global forecasts, regional climate change is what would affect local conditions. However, regional forecasts contain considerable uncertainty, including that due to uncertainty over future emissions of greenhouse gases. These forecasts do agree that increasing average temperatures can be expected in California over the course of this period. However, it can reasonably be expected that sites within a short distance of tidal waters and downwind from those waters, such as those in the study area, can be expected to have relatively modest changes in average air temperatures due to the moderating effect of these waters.

The most likely means for future regional climate change to affect local habitat conditions would be through changes in moisture balance. Increased temperatures increase evapotranspiration even if precipitation stays the same. However, the Third National Climate Assessment (Melillo, et al., 2014) shows only modest (under five percent) projected reductions in soil moisture in the San Francisco Bay Area for the 2040-2071 period. This would primarily affect non-tidal habitat areas, though decreased moisture could have a modest effect on upper tidal marsh vegetation which receives relatively infrequent tidal water input.

With the exception of New Chicago Marsh which has some access to Bay water, non-tidal vegetated areas in the study area consist nearly entirely of degraded and invasive non-native vegetation types. Based on the ecological tolerances of these habitat types, they are not expected to experience substantial changes in habitat attributes and structure under the modest temperature increases and soil moisture deficits projected for the study period, and in any case it is not possible to quantify such changes with any degree of reliability at this time.

2.5.3 Invasive Species

Invasive species have continued to arrive in the study area and cause new ecological disruptions from time to time. The CHAP evaluation assumes this will continue to occur and adjusts future habitat values accordingly.

2.5.4 Site-Specific Factors

Site-specific factors that could affect habitat values in the study area consist of potential changes in land use and management. Relevant study assumptions for the without-project condition include:

•The managed ponds under study (A12-A15 and A18) would continue under similar management as present. Levee reinforcement efforts under current management would continue in the future. While pond breaches might occur sporadically, they would be repaired reasonably promptly and would not result in significant changes in habitat value in the long term. Pond A16 and A17 were not evaluated under this study as they have recently been restored or modified as part of a separate project.
•New Chicago Marsh would not change significantly. This assumes that the USFWS raises levees adequately over time to keep out regular tidal action. This would be needed for the USFWS to minimize liability for flooding of Alviso. This does not imply an adequate level of flood protection for developed areas, but rather the exclusion of tidal action under normal circumstances.
•The City of San José implements its master plan for the San José-Santa Clara Water Pollution Control Plant and surrounding lands it owns. This would include new development in some currently undeveloped areas.
•The City of San José would allow development to continue in the Alviso area as provided by existing plans. Over several decades all remaining developable private lands would become urbanized in this planning area. It is assumed that any subsequent abandonment of developed properties in the Alviso area due to increased flooding risk late in the evaluation period would not result in restoration of natural habitat values on these properties, due to the dominance of pavement and buildings on these sites which would largely prevent natural revegetation.
•Other non-tidal habitats would not be expected to change significantly.

2.6 Forecast of Future With-Project Habitat Conditions

All study alternatives include a phased approach to implementation of ecosystem restoration. Modeling of landscape evolution assumed that construction of the flood risk management levee would start in 2017 along with the restoration features within Pond A12. The pond would be breached in 2020, which would represent the start of the first phase of habitat development. Additional construction of restoration features, culminating in breaching of additional sets of ponds, would be accomplished in two successive phases to be completed in 2025 and 2030. See Section 2.7 for updates to this schedule. Following completion of each phase, the breached pond(s) would evolve naturally into mudflats and tidal marsh over time, potentially with assistance from the proposed adaptive management program.

Forecast of future habitat conditions started with the landscape evolution modeling performed by Environmental Sciences Associates/Philip Williams Associates. This modeling provided forecasts of substrate elevation in the breached ponds at discrete intervals for a period extending 50 years into the future from the expected start of construction. These forecasts provided a basis for projecting basic habitat types and acreages in the restored ponds at specific times in the future.

The next phase of forecasting was conducted by H.T. Harvey and Associates, and provided more detailed projections of habitat conditions in breached ponds to assist in the CRAM modeling. Projected habitat information available in GIS format was used by NHI to provide additional habitat details in restored ponds at specific points in the future. The result was a comprehensive set of maps of future habitat polygons. NHI then applied appropriate species, KECs, and KEFs to these polygons, based on their baseline work, to provide the basis for calculating CHAP outputs at specific points in the future under

with-project conditions. Finally, with habitat units projected for specific times in the future, these units were averaged to produce average annual habitat units (AAHUs) which were the basis for comparing alternatives.

Forecast of future conditions was also needed for two sets of habitats not directly affected by the alternatives. First, marshes already subject to tidal action could be affected by SLR; this is addressed under the discussion of without-project conditions. Second, areas not subject to tidal action and not directly affected by an alternative might change in the future for other reasons. For these areas, future habitat conditions were generally determined to be the same as under the without-project condition except as otherwise noted.

2.7 Modeling and Evaluation Periods

Analyses performed for the South San Francisco Bay Shoreline Study used a 50-year economic evaluation period running from 2017 to 2067. After the modeling efforts were completed and the draft Integrated Report was circulated, the timing and phasing of construction including pond restoration was modified to address passage of time as well as public and agency concerns:

- Construction is now projected to start in 2018, which would move all following dates one year back.
- The first phase of construction would be complete in 2021, including breaching the first ponds.
- For USACE planning purposes, the evaluation period was changed to run from 2021 to 2071 to ensure consistency with USACE planning requirements.
- Ponds A12 and A18 are now proposed to be breached in the same year, after which further phases of breaching would be sequenced as originally planned, albeit delayed by one year. This would move up the breaching of Pond A18 by five years relative to other ponds, and would likely have a similar effect on subsequent habitat evolution in this pond.

Incorporating these changes into the CHAP study would have required redoing the landscape evolution and habitat evolution modeling before redoing the CHAP modeling itself, thereby causing substantial delays in the study. However, effects of these changes should be essentially identical across all four restoration alternatives due to their similarity. Since the NHI CHAP reports (Northwest Habitat Institute, 2015a; Northwest Habitat Institute, 2015b) use the earlier dates these will be retained for this report as well. Habitat changes beyond the end of this period are considered in evaluating the long-term sustainability and adaptability of study alternatives, but are not used for calculating ecosystem restoration or flood risk management benefits for these alternatives.

3.0 Alternatives and CHAP Results

3.1 Overview

FRM and ER measures (individual actions) were considered and combined into FRM and ER options (related actions that constitute building blocks for formulating complete alternatives). The bases for formulating these measures, for initial screening of them, and for the overall restoration design are described in the Integrated Report.

The options were assembled into combined FRM/ER alternatives for evaluation. ER options could not be evaluated on their own, as their success requires additional options to be implemented. For instance, the ecotone requires both an FRM levee option and a pond restoration option to be workable.

3.2 Ecosystem Restoration Options

A variety of ER and FRM measures were assessed for possible combination into ER options. ER options carried forward for detailed evaluation are listed below. The basic pond restoration, levee, and bench options were base action conditions (the minimum restoration actions required for a functioning alternative), and the other options represent additional expense and complexity incurred in pursuit of improved ER outputs.

- Basic pond restoration
- Accelerated pond restoration (additional ER measures in ponds)
- FRM levee with bench along the pond side
- 30:1 ecotone
- 100:1 ecotone

The minimal ER action would be basic pond restoration. The bench is an integral component of the several FRM levee alternatives considered and has incidental ER value. The 30:1 ecotone and 100:1 ecotone options represent increased investment in ecosystem restoration. An additional option for increased investment, accelerated pond restoration, could not be evaluated by CHAP due to data issues.

Various combinations of these options were considered in the plan formulation process. At the time of the initial CHAP alternatives modeling, two levee alignments with the three levels of ecotone (bench, 30:1, and 100:1 were included to obtain information on the cost-effectiveness of these options. Ponds were broken into four increments of restoration, based primarily on historic drainage patterns which are important to effective tidal marsh restoration.

3.3 Initial Round of CHAP Analysis, 2012

The initial CHAP analysis showed very similar outputs for the two alternatives evaluated. This is not surprising given that the pond habitat scored about as high as the tidal marsh habitat, and under both alternatives about the same acreage was allocated to the combined total of these two habitat categories. (The north alignment in Pond A18 under the early Alternative 2 resulted in portions of the pond being retained as pond rather than being restored to tidal action.)

This analysis showed fairly similar habitat benefits for restoration of each of the several pond groupings as shown in Table 3. Note that, as discussed in Section 2.2, these numbers are only tidal habitat outputs for areas undergoing restoration. Non-tidal habitat outputs are set to zero for purposes of evaluating tidal habitat outputs.

The highest output was from Pond A12 at 19.3 annualized habitat units per acre and the lowest (Ponds A13-A15) was 14.0 habitat units per acre. The differences are probably due primarily to the phasing of restoration, with ponds breached earlier having more time to develop complex tidal marsh features which provide better habitat value.

The transitional period between the breaching of ponds and the development of tidal marshes, during which the former ponds consisted of mudflats and subtidal aquatic habitat, showed slightly lower total habitat values than either the preceding ponds or the tidal marshes which followed. Breaching initially causes a reduction in habitat units per pond grouping of eleven to fifteen percent, followed by a slow climb up to very close to the pre-breaching number of habitat units with a net difference of one to three

percent from the starting values. Both these habitat outputs and the habitat outputs for the managed ponds are similar under CHAP, so there is little net change in total CHAP outputs at the end of the evaluation period from implementing any of the final alternatives from this tradeoff.

The initial CHAP analysis showed no significant differences in outputs under the three ecotone fill options. This is because gains in marsh wildlife habitat value from additional fill were offset by losses in fish habitat from this fill. While the lower portion of the ecotone would be underwater much of the time, benefitting in turn both fish and marsh wildlife, the upper portion would nearly always or always be above water, benefitting only marsh and upland wildlife (some marsh species require adjacent upland with adequate vegetation so they can avoid predation during very high tides). This quantitative analysis does not take into account concerns over restoration of listed or otherwise rare species, as all species are weighted equally in CHAP.

Table 3: Comparison of Pond Groupings, Initial CHAP Analysis

Alternative 1 with bench	Breakpoints in Habitat Development							Annualized Outputs	Annualized Outputs per Acre
	2017	2020	2025	2030	2037	2047	2067		
Pond A9-A11	0	0	16,340	16,241	17,797	19,156	19,090	15,356	17.1
Pond A12	0	6,145	5,929	6,662	6,674	6,677	6,670	6,171	19.3
Ponds A13-A15	0	0	0	16,261	16,178	16,151	18,347	12,403	14.0
Pond A18	0	0	15,347	15,485	16,202	18,309	18,525	14,577	17.0
Total	0	6,145	37,617	54,649	58,851	60,293	62,631	48,508	

Alternative 2 (different levee alignment) had very similar outputs, as did either alternative with the 30:1 or 100:1 ecotone added. Impacts to habitats in areas which remain non-tidal, such as New Chicago Marsh, would be very small (about two percent for non-tidal habitats) compared to impacts in the pond areas to be opened to tidal action under the alternatives. The non-tidal impacts would not significantly affect the calculation of restoration benefits.

3.4 Evaluation of the Final Array of Alternatives, 2014-2015

Based in part on the results of the initial CHAP analysis, alternatives were reformulated and the final array of alternatives selected. These alternatives included four different levee alignments and two levels of ecotone: none (bench only) and 30:1. Details of the revised CHAP analysis are found in Northwest Habitat Institute (2015b).

Table 4 shows CHAP restoration outputs for the four final alternatives, within the areas where restoration measures would be implemented. Note that, as discussed in Section 2.2, these numbers are only tidal habitat outputs for areas undergoing restoration. Non-tidal habitat outputs are set to zero for purposes of evaluating tidal habitat outputs.

Differences between the alternatives were minimal because under all four alternatives, habitat conditions on the vast majority of the site would be the same at any one time during the period of habitat evaluation. As previously discussed, there would be modest differences between the output per acre of the several pond groupings.

Outputs shown are based on the original phasing of pond restoration where Pond A18 is not breached until the second phase of breaching. As discussed in Section 2.7, this phasing was later accelerated to address public and agency concerns but it was not practical to revise the results to reflect this. The effects of this acceleration should be nearly identical across the alternatives due to their great similarity in restoration actions.

Table 4: Comparison of CHAP Outputs, Final Array of Alternatives [1]

	Breakpoints in Habitat Development [2]							Annualized Outputs
	2017	2020	2025	2030	2037	2047	2067	
Alternative 2 (NED/NER)								
Pond A9-A11	0	0	16,510	16,416	17,936	19,261	19,094	15,442
Pond A12	0	6,039	5,894	6,591	6,603	6,606	6,592	6,105
Ponds A13-A15	0	0	0	15,557	16,273	16,230	18,312	12,434
Pond A18 [3]	0	0	15,439	15,557	16,273	18,384	18,520	14,624
Total	0	6,039	37,843	54,878	57,054	60,481	62,518	48,606
Alternative 3								
Pond A9-A11	0	0	16,510	16,416	17,936	19,261	19,094	15,442
Pond A12	0	6,056	5,911	6,607	6,619	6,622	6,609	6,120
Ponds A13-A15	0	0	0	16,316	16,244	16,230	18,313	12,435
Pond A18 [3]	0	0	15,439	15,557	16,273	18,384	18,520	14,624
Total	0	6,056	37,859	54,895	57,072	60,498	62,535	48,622
Alternative 4 (LPP)								
Pond A9-A11	0	0	16,510	16,416	17,936	19,261	19,094	15,442
Pond A12	0	5,915	5,786	6,418	6,430	6,433	6,423	5,952
Ponds A13-A15	0	0	0	16,282	16,211	16,198	18,278	12,411
Pond A18 [3]	0	0	15,098	15,188	15,834	17,844	17,958	14,214
Total	0	5,915	37,393	54,304	56,412	59,737	61,753	48,019
Alternative 5								
Pond A9-A11	0	0	16,510	16,416	17,936	19,261	19,094	15,442
Pond A12	0	6,039	5,894	6,591	6,603	6,606	6,592	6,105
Ponds A13-A15	0	0	0	16,315	16,243	16,230	18,312	12,434
Pond A18 [3]	0	0	15,439	15,557	16,273	18,384	18,520	14,624
Total	0	6,039	37,843	54,878	57,054	60,481	62,518	48,606

1 Outputs are for tidal habitats in breached ponds only
2 Breakpoint dates are from the CHAP study and are expected to slip one year
3 Pond A18 is now planned to be breached in the same year as Pond A12

The ecotone was originally expected to show habitat benefits under CHAP. However, as in the first round of modeling, addition of the ecotone to the restoration plans very slightly reduced total tidal habitat benefits, with the reduction being about one percent. This difference is visible in Table 4 in comparing the NED/NER plan and the LPP. The specific reasons for this difference are discussed under subsection 3.3.

Models that tabulate site-specific habitat values (to arrive at an overall sum of habitat value for a defined area) typically are unable to assign a higher value to habitat tradeoffs which might very locally decrease total vertebrate diversity while increasing total landscape diversity, ecological function, and sustainability over a larger area. This is a common difficulty in ecosystem modeling when formulating and evaluating ecosystem restoration projects, and came into play with the evaluation of the ecotone.

Looking at all habitat units (tidal and non-tidal) combined, the 2012 and 2014-2015 analyses showed habitat units initially declining by up to eight percent after breaching of ponds as they became mudflats. Habitat units then increased over time as marshes developed in the former ponds. The final habitat values after fifty years were very close to the initial pond habitat values prior to breaching.

As a result, the restoration alternatives showed slightly lower AAHUs than the without-project condition (Northwest Habitat Institute, 2015b). This may seem to be counterintuitive, but it is not surprising considering the large bird populations which can exist in the ponds. As discussed earlier, the Shoreline Study considered conversion of one valuable habitat type to another to reverse historic losses of tidal marsh habitat value. Modeling alone cannot determine which habitat type should take precedence in a given situation, but can help inform such decisions.

The CHAP baseline and alternative reports from NHI were revised in July 2015 to provide additional information and to ensure all CHAP assumptions are consistent with study assumptions. This revision did not change the with-project habitat outputs or the zeroing out of non-tidal habitat outputs for purposes of ER formulation and evaluation.

4.0 Conclusions

The CHAP analysis provides a way of quantifying habitat values with and without a given project or alternative, by compiling animal species presence, species function, and habitat function data. In practice, it will tend to show a higher habitat value for areas with more vertebrate species and more diverse habitat features.

The CHAP analysis for the Shoreline Study showed similar values for managed ponds and tidal habitats, with slightly lower values for the initial period after breaching of ponds when little or no marsh would be present. It showed large increases in *tidal* habitat value after breaching of ponds, with tidal values continuing to increase over time to the end of the evaluation period. The analysis showed fairly similar habitat benefits per acre for restoration of the several pond groupings in the final array of alternatives. CHAP also showed slightly lower values for alternatives with an ecotone, but this was due to the method's tendency to give higher scores for areas with higher species diversity within a given evaluation polygon.

In summary, CHAP:

- Confirms the high habitat values of both managed ponds and tidal habitats in the study area.
- Shows large gains in tidal habitat value from the restoration actions under consideration.
- Shows fairly similar gains in tidal habitat value from restoration of each the several different pond groupings.
- Does not show additional gains from adding an ecotone to the restoration plan due to the nature of the CHAP analysis.

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Combined Habitat Assessment Protocols (CHAP)
Fish & Wildlife Habitat Assessment
Final Report

South San Francisco Bay Shoreline



South San Francisco Bay Shoreline Project Area

Baseline Conditions
U.S. Army Corps of Engineers
San Francisco District

Report and Analysis by
Northwest Habitat Institute





July14, 2015

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CHAP
Wildlife Habitat Assessment of
South San Francisco Bay Shoreline

Executive Summary

The wildlife habitat assessment of the South San Francisco Bay Shoreline study evaluated 173 polygons. Baseline conditions that consisted of 16 different habitat types were determined to describe the 6,674 acres (2,700 ha) site. The number of fish and wildlife species associated with the project totaled 253, of which 51 were fish, 165 birds, 30 terrestrial mammals, 6 reptiles, and 1 marine mammal. The baseline condition evaluation for the project area showed a total of 119,652 habitat units. Of these, about 60,000 habitat units are associated with Ponds A9 – A18. Breaking out the different habitat types revealed that there are 2,298 acres (930 ha) managed ponds within the study site. Of these, there are 826 acres (334 ha) batch ponds, 413 acres (167 ha) saline marsh ponds, 545 acres (221 ha) muted tidal or diked marsh ponds, and 119 acres (48 ha) freshwater marsh ponds. The average per-acre value of managed ponds overall is 22.1. By type, the values are 22.0 for batch ponds, 19.9 for saline marsh, 14.4 for muted tidal and diked marsh ponds, and 21.3 for freshwater marsh ponds. All habitat types' per-acre values fell within the range of 0 and 29.8.

To examine the future conditions that might exist if the proposed project does not occur, we began to put the project site into perspective by conducting a coarse evaluation of the amount of change in land use that has occurred from historic (ca. 1800) to modern times (ca. 2001) for the shoreline around the entire San Francisco Bay. To do this, the San Francisco Estuary Institute's Historic and Modern Bayland maps were used. This assessment showed an apparent loss in value that ranges from about 1.7 to 2.3 million habitat units for the area. To develop the future perspective for the next 50 years, additional steps were taken to obtain information on fish and wildlife species populations, invasive plant species, planned development, climate change influences and earthquake frequencies. Evaluating this information suggests that there will be a low turnover in species composition, salinity levels will still be controlling the spread of some of the invasive plants, future planned development will occur in already developed areas, sea rise due to climate change may periodically expand the bay's aquatic footprint for short periods in the Alviso area, and the design and engineering of the current levees and dikes are expected to withstand predictive earthquakes for the area. However, if this infrastructure failed, some flooding may occur though the surface water is expected to flow back in the San Francisco South Bay.

Introduction

Throughout the United States, there is a move towards assessing restoration and other conservation activities at the ecosystem level. Under current U.S. Army Corps of Engineers (Corps or USACE) authority, the objective of Civil Works ecosystem restoration is to restore significant ecosystem structure, function, and dynamic processes that have been degraded to a

less degraded, more natural condition. Even partial restoration may provide significant and valuable improvements to degraded ecological resources.

Ecosystem restoration projects should examine the needs for improving or re-establishing both the structural components and the functions of the natural system. Restored ecosystems should mimic, as closely as possible, conditions that would occur in the area in the absence of human changes to the landscape and hydrology. Indicators of successful restoration would include the presence of a large variety of native plants and animals, the ability of the area to sustain larger numbers of certain indicator species or more biologically desirable species, and the ability of the restored area to continue to function and produce the desired outputs with a minimum of continuing human intervention. Those restoration opportunities that are associated with wetlands, riparian and other floodplain and aquatic systems are most appropriate for Corps involvement.

The information used in formulating, evaluating and selecting ecosystem restoration alternatives in Corps Civil Works projects includes both quantitative and qualitative information about outputs, costs, significance, acceptability, completeness, effectiveness, and reasonableness of costs. Within the USACE ecosystem restoration policy, *"An ecosystem restoration proposal must be justified on the basis of its contribution to restoring the structure or function, or both, of a degraded ecosystem, when considering the cost of the proposal. Ecosystem restoration projects are justified through a determination that the combined monetary and non-monetary benefits of the project are greater than its monetary and non-monetary costs. As such, plan selection is not based on economic justification in terms of a traditional monetary benefit to cost analysis, since the majority of benefits associated with the primary outputs of ecosystem restoration can rarely be quantified in dollars. Therefore, ecosystem restoration proposals need not have either a benefit-cost ratio greater than 1.0, or positive net economic benefits. However, any monetary incidental benefits which are anticipated from proposed ecosystem restoration projects, and relevant to the particular circumstances associated with the study, should be displayed to aide in decision making"* (USACE, EP 1165-2-502, 1999).

Instead of calculating economic benefits in monetary terms, Corps ecosystem restoration projects calculate the value and benefits of habitat using established habitat assessment methodologies. Evaluating habitat quality is the approach most often taken to compare ecosystem restoration alternatives because habitat is thought of as a surrogate for ecosystems; it is the setting where plants and animals live, interact, and reproduce. Habitat is frequently viewed in conjunction with species information to gain insight to various uses, structures, and functions existing within a landscape or site. Determining habitat structure and functional integrity of an area is supportive of an ecosystem management approach.

Habitat Units (HUs) are one of the currencies the Corps currently uses to rate and compare the value of one ecosystem restoration alternative to another. The concept of HUs is derived from the U.S. Fish and Wildlife Service's (USFWS) single-species habitat-assessment methodology known as Habitat Evaluation Procedures or HEP (1980), which the Corps has long used as a habitat evaluation tool.

The Combined Habitat Assessment Protocol (CHAP) is an accounting and appraisal methodology that utilizes an ecosystem-based habitat and biodiversity evaluation framework. CHAP generates an objective habitat-value score. This approach involves a triad assessment of habitat, species, and functions (O'Neil et al., 2005), and can provide assessments at multiple scales. The CHAP method integrates a habitat and biodiversity or HAB calculation that determines habitat units (HUs) based on an assessment of multiple species (all potential species at a site), habitat features, and functions by habitat type.

The overall goal of the South San Francisco Bay Shoreline Feasibility Study (Shoreline Study) ecosystem restoration project assessment was to evaluate baseline habitat conditions at a fine level of resolution within an ecosystem context. An ecosystem context is more holistic than assessing just a few individual species (Perkins, 2002), especially with federal or state-listed taxa. It calls for a multiple-species framework that includes an evaluation of ecological functions. Additionally, the Corps would like to assess alternative scenarios; hence a realistic depiction of actual habitat site conditions at a fine scale level was needed. The approach reported herein depicts the wildlife habitat baseline conditions at a fine resolution or site-level scale, uses multiple species and their habitat functions in its evaluation, and accounts for actual habitat types, structural conditions, and key environmental correlates within the Shoreline Study project assessment boundary based on input from knowledgeable field staff, inventories, and past studies of the area's habitat components.

Goal

The primary goal of this feasibility study is to determine the best solution under Corps criteria for provision of tidal flood risk management and/or ecosystem restoration in the study area, considering existing plans and projects such as the South Bay Salt Pond Restoration Project and the new recovery plans for listed species in the South Bay. Partners in this study include the U.S. Fish and Wildlife Service (USFWS), the State Coastal Conservancy (CSCC, a non-federal sponsor), and the Santa Clara Valley Water District (SCVWD, a non-federal sponsor).

Study Site

The Shoreline Study examines the feasibility of flood risk management and ecosystem restoration along a portion of the south shoreline of San Francisco Bay (http://www.southbayshoreline.org/. also see also Figure 1). In March 2011, the study was refocused on an area of about 6,800 acres (2,751 hectares) that cover the area between the Guadalupe River and Coyote Creek, also known as Economic Impact Area (EIA) 11. This area includes the community of Alviso, which is incorporated into San Jose, the San Jose-Santa Clara Water Pollution Control Plant (WPCP), and adjacent managed ponds formerly used as part of Cargill, Inc.'s salt production system.

The baseline condition assessment encompasses Ponds A9 through A16, Pond A18, and adjacent areas (see Figure 2). Pond A16 will be reconfigured by the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) but will still be a pond. Pond A17 will be breached for restoration of tidal habitats by the Refuge, but mapped habitat predictions are not available so this pond is excluded from the CHAP study. However, Pond A18 is being studied by the City of

San Jose as part of the reconfiguration of its wastewater treatment plant, and will also be considered by this study.

Background

The Alviso ponds were formerly part of the Cargill, Inc. solar salt production system, but were sold to the federal government in 2003. The Alviso ponds are now managed by the FWS as part of the Refuge. Current management of these ponds primarily favors various species of migratory shorebirds and waterfowl. The ponds are surrounded by sloughs and remnant tidal marshes which are habitat for listed species such as the Ridgeway's rail (formerly California Clapper rail) and the salt marsh harvest mouse. The ponds also provide other important ecological services, like retention and storage of water and filtering of water by wetland habitats.

The existing pond levees are not engineered structures. The lands behind them are low-lying and in some cases well below sea level. These lands include the community of Alviso, the New Chicago Marsh, and the San Jose/Santa Clara WPCP (Figure 2). These areas are vulnerable to tidal flooding if the perimeter pond levees fail.

The former salt ponds offer considerable potential for management of shorebirds and waterfowl populations, or for restoration to tidal habitats including marshes. Tidal marsh restoration is expected to be an important measure in assisting the recovery of several endangered species found in the study area such as the salt marsh harvest mouse and the California clapper rail. However, the ponds are currently valuable habitat for many species and hundreds of thousands of individual shorebirds, waterfowl, and other water birds.

Quantification of habitat restoration benefits will begin with the development of a baseline condition assessment and conclude with an assessment of the "no action" or without-project alternative with a 50- year projection horizon. These assessments will then be compared to various alternative scenarios to determine the overall cost-effectiveness of habitat restoration in a national context, and to determine optimum outcomes for restoration actions proposed for Ponds A9-A15 and Pond A18.

Evaluation of project benefits and impacts will be quantified for a period of 50 years from the start of construction, which is assumed to be 2017. Limited qualitative evaluation of projected effects after these 50 years will be conducted by others and is not part of this assessment.



Figure 1. Regional context for Shoreline study area location
(Source map: South Bay Salt Pond Restoration Project)



Figure 2. A local view of the Shoreline study area general project boundary delineation along with pond polygon identification numbers.

Methods for Determining Baseline Conditions

First, CHAP's habitat valuing system produces Habitat Units (HUs) for baseline and alternative future scenarios. When talking about HUs it is good to clarify (especially for non-ecologist) that CHAP's habitat values are not the same as those obtained using USFWS's Habitat Evaluation Procedures or HEP. CHAP assesses condition and function by incorporating multiple species, habitat components and functions into the analysis. When attempting to compare HUs between CHAP and HEP one would immediately see a magnitude of higher habitat values using CHAP because we do not normalize the values, evaluate only a few species, or use subjective values to determine habitat quality as HEP does.

So to begin the CHAP process, we start by developing a fish and wildlife species list for the project. The initial Habitat Evaluation Team meeting revealed that USFWS staff residing or working at the Refuge are a valuable source of wildlife information. The Habitat Evaluation Team suggested using the Refuge staff as the initial point of contact for pond and adjacent habitat information. Refuge staff in consultation with other knowledgeable people generated fish

and wildlife species lists for the baseline habitat classifications and the conditions resulting from restoration scenarios and the no-action alternative. Additionally, the Northwest Habitat Institute (NHI) also generated an initial species list for the project by accessing the California Wildlife Habitat Relationships (CWHR) geographic information system (GIS) as a cross-reference. A query of the site's potential species was done by accessing the peer-reviewed wildlife-species range maps that overlapped with the project boundary. Refuge staff was also able to review the NHI-generated potential species list, as well as develop specific bird lists for each pond along with determining their presence during the four seasons. The species listed then needed to be associated with habitat types, which required a several step process.

First, it was necessary to develop a list of wildlife habitat types located within the South Shoreline project boundary by polygon. A number of habitat classifications have been used in past and ongoing studies. Additionally, there is a strong desire by the Habitat Evaluation Team to use this existing information for this project. NHI was able to work with the Refuge staff to determine two habitat classifications that would allow fish and wildlife species habitat associations to be created and used in the baseline condition report. One habitat classification was used for assessing baseline conditions (Table 1) and the other was used to evaluate without-project future conditions for the next 50-year period (see Table 9 in 50 Year Future without-project section).

Baseline Conditions
Batch Pond
Brackish Marsh
Developed
Freshwater Marsh
Landfill
Levee
Managed Pond
Tidal Flats/Mudflats
Muted Tidal / Diked Marsh
Open Water/Slough Channel
Parks / Upland Grassland
Riparian/Creek Corridor
Saline Marsh
Seasonal Wetland
Upland Vegetation
Water / Sewage Treatment

Table 1. Habitat classification used to determine baseline conditions effects.

Because there were a number of past projects that used more specific habitat classes to breakout portions of the San Francisco Bay, the partners wanted to use them. The above habitat types show the classification that was incorporated into the baseline evaluation. Specific vegetation

types and associations were also noted when creating the crosswalk(s) [which is relating vegetation types and associations to habitat types] along with the number and extent of invasive species. Next, the Key Ecological Correlates (KECs) or fine-feature elements that may exist within each polygon were identified. Refuge staff developed a list of common KECs that would be found by habitat type that could be applied to the polygons within the project boundary.

Because CHAP is built around the triad concept of species-habitat-functions, the next step was to update the Northwest Habitat Institute's Integrated Biodiversity Information System (IBIS) data system[1] (Johnson and O'Neil, 2001) and establish the key ecological functions (KEFs) for each species. For 35 new species that were not already a part of IBIS, this required researching the species and identifying a list of KEFs for inclusion into IBIS.

To reiterate, KECs represent physical and biological habitat elements that are thought to most influence a species' distribution, abundance, fitness, and viability, while KEFs refer to the principal set of ecological roles performed by each species in its ecosystem. More specifically, KEFs refer to the main ways organisms use, influence, and alter their biotic and abiotic environments. The KECs and KEFs are crucial components in determining the wildlife habitat unit values.

An approach at the scale of the site is used to refine the habitat value calculations for the Shoreline project polygons. The CHAP approach involves four components: 1) preliminary mapping, 2) field inventory, 3) data compilation and analysis, and 4) GIS maps, spreadsheets and report.

1. Preliminary mapping: The Shoreline Study site is refined by identifying and delineating polygons with homogenous habitat types based on visual interpretation of photography or imagery. At the onset, the National Agriculture Imagery Program or NAIP imagery was used but this effort was later transferred to high-resolution imagery supplied by USACE.

2. Field inventory: This CHAP analysis used existing field inventory data generated by the project partners.

3. Data compilation and analysis: Data from the field inventory is used to generate a habitat value for each polygon within the study site. The species list developed for the project area was reviewed by the knowledgeable field staff. Additionally, the list of taxa is merged with the KEC and KEF fields within the IBIS data sets to allow the creation of two matrices for each polygon: species by functions and habitat by functions. These matrices are then summed and multiplied by the acreage of the polygon to calculate HUs for each polygon.

4. GIS maps, spreadsheets, and report: GIS maps are generated that depict the habitat values (HUs) of each polygon. Supporting maps illustrate: a) project or area boundaries; b) polygon numbering; c) corrected habitat value per acre; d) habitat

[1] The IBIS data system is based on expert knowledge and peer reviews and contains current ecological information on more than 1,000 fish and wildlife species.

units; e) amounts of non-native plant species by polygon; f) wildlife habitat types by polygon; and g) structural conditions by polygon. Spreadsheets are developed that contain the polygon calculations of the species-functions and habitat-functions matrices, along with an overall site or area habitat value.

Determining the Habitat Unit Value

To establish a habitat unit value, two matrices are developed. The first matrix determines the species' mean functional redundancies (MFRI) based on the species list (Appendix A-1). This was developed and reviewed for the baseline condition of Shoreline Study by habitat class (Appendix A-2). Determining the MFRI is the first step in the computation to determine the baseline habitat condition values [see Appendix B - Matrix Relationships, Matrix 1]. A MFRI is created for each habitat type present within the study area.

The second matrix is usually generated by conducting field inventories by polygon. However, because of the number of knowledgeable field staff located at the site and the number of past studies conducted, it was determined that enough data existed to generate this information without further fieldwork. Using these resources, a list of Key Environmental Correlates (KECs[2]) was generated for each polygon. Once this was completed, a KEC function matrix by habitat type was created [see Appendix B - Matrix Relationships, Matrix 2]. This matrix represents the habitat components which characterize potential functions within each polygon at the site. Per-acre baseline values were then computed for each polygon by adding Matrices 1 and 2 together [species-functional redundancy (MFRI) value and the KEC-functional redundancy value] for each habitat type.

The per-acre value is a strong indicator of wildlife habitat quality because it represents the animal taxa, habitat characteristics, and biodiversity as determined by accounting for species, habitats, and their functions. It is also a stronger indicator because the influence of polygon size (acres) is removed from consideration. Thus, small polygon areas can be shown to have a high per-acre value, whereas large areas may show a low per acre value. Nevertheless, to determine a site's overall baseline HU value, each polygon's per-acre value is multiplied by its acreage and then these values are summed across all polygons. This generates an uncorrected HU value because no adjustments have been considered.

Site Location Adjustment Value

Because the South Shoreline project area is located near an urban setting, there are several ecosystem drivers and stressors that can affect the baseline condition and how it is currently managed. We identified invasive plant species as one major influence that can affect the habitat value potential in each habitat type. The CHAP protocol allows us to adjust polygon values based on the presence and abundance of invasive plant species, as documented during the field inventory from past projects or based on local knowledge (see Table 2). Additionally, the percent abundance of invasive species by polygon can also be spatially displayed to show their influence on the habitat value.

[2] See Appendix B – Matrix 2.

Subsequently, each polygon is assigned an invasive-plant value based on the occurrence of invasive species identified within the polygon. If a vegetation layer is not present, it is left blank and that layer does not contribute to the invasive factor calculation. Because invasive species generally negatively influence ecosystem function, the per-acre values were then discounted for the presence of invasive plants, using the values in Table 2; this allows us to arrive at a corrected per-acre value for each polygon.

The only locally invasive species of concern with the project area is peppergrass, also known as perennial pepperweed (*Lepidium latifolium*). Areas containing pepperweed were identified and delineated into GIS polygons by H.T. Harvey & Associates resulting during their 2010 Marsh Study. There were 10 vegetation classes within the Marsh Study that contained pepperweed as shown in Table 2 below. Based on conversations with H.T. Harvey & Associates staff about how the Marsh Study data collection methodology was designed and information collected, we were able to assign invasive plant adjustment factors that corresponded with CHAP protocols to each class. For instance, the "pickleweed/pepperweed" designation indicates that pickleweed is dominant with a pepperweed component between 15 and 49% of the total areal surface of the polygon. Conversely a "pepperweed/pickleweed" designation indicates that pepperweed is dominant with a pickleweed component between 15 and 49%. A polygon with only one species name in such as "pepperweed" indicates a composition of that species over 85% of the polygon. So, given these constructs by the Marsh Study the following adjustment factors by vegetation class are:

Adjustment Factor	Invasive Vegetation Class
0.3	Pepperweed
0.5	Pepperweed/Pickleweed
0.5	Pepperweed/Peripheral Halophytes
0.5	Pepperweed/Alkali Bulrush
0.5	Pepperweed/Upland vegetation
0.7	Pickleweed/Pepperweed
0.7	Peripheral Halophytes/Pepperweed
0.7	Alkali Bulrush/Pepperweed
0.7	Spearscale/Pepperweed
0.7	Alkali Heath/Pepperweed

Table 2. Invasive adjustment factor as identified by the 2010 Marsh study by vegetation class.

Refuge staff was also able to provide NHI with a list of adjustment factors for those polygons for which they had sufficient local knowledge to feel comfortable making recommendations. The remaining polygons were either intersected by the 2010 Marsh Study or were in the mostly upland or developed areas.

Next, the 2010 Marsh Study GIS data (Figure 3) was overlaid onto the baseline condition polygons to determine proportions of each polygon covered by invasive species. Once determined for each Marsh Study polygon with a pepperweed component, the invasive

adjustment factor from Table 2 (above) was applied. The sum of the Invasive Adjustment Factors contained within the baseline condition polygon was then calculated. Finally, the proportional values were summed for each polygon and normalized (Table 3). For example, if a polygon's total invasive scored was 0.85, then the discount class in Table 3 would be 0.8. This would mean that 20% of the total polygon value would be reduced because of the amount of invasive species present within the polygon. For example, if a total baseline condition polygon score is 24 and has an adjustment factor of 0.8, it would yield a baseline condition corrected value of 19.2.

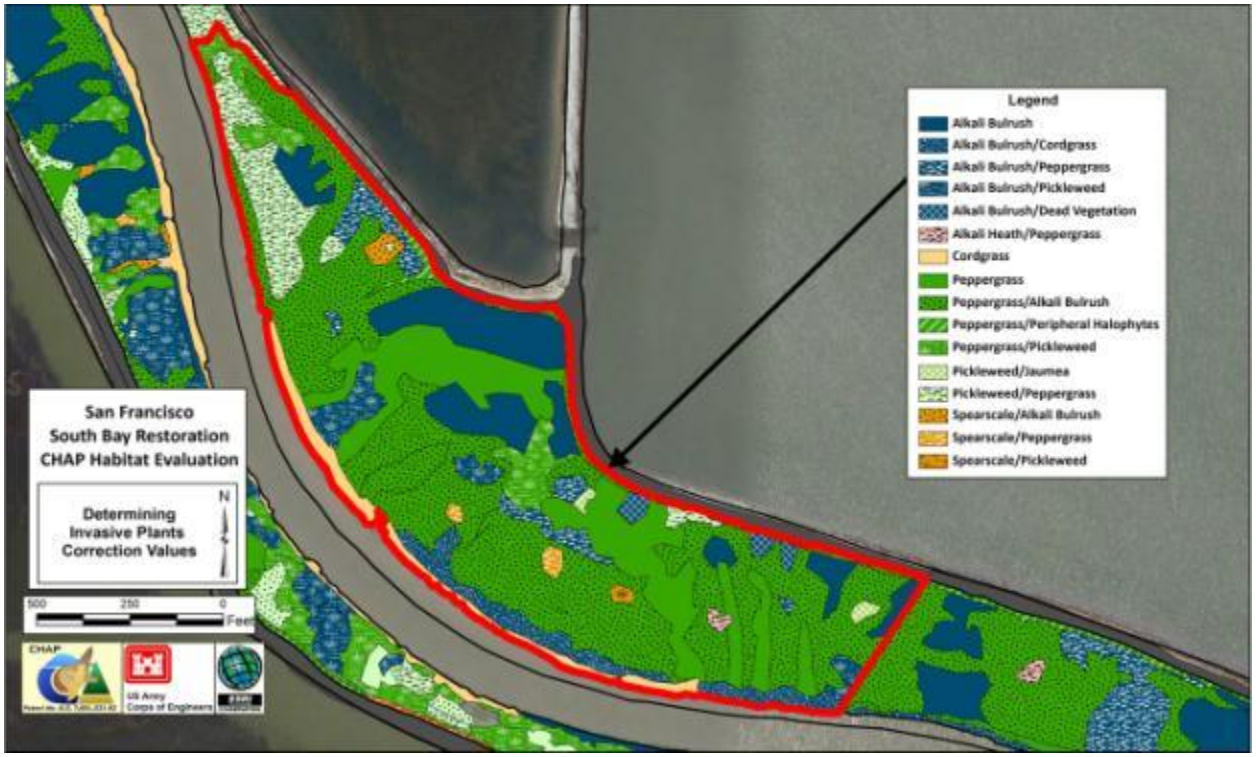

Figure 3. An example of the 2010 Marsh Study data depicting the various categories, spatial distribution and amounts of the various invasive species.

Determined Invasive Adjustment (based on area percent)	Discount Class
1 - 0.95	1
0.94 - 0.90	0.9
0.89 - 0.80	0.8
0.79 - 0.70	0.7
0.69 - 0.60	0.6
0.59 -0.50	0.5
0.49 - 0.40	0.4

Table 3. Normalizing table used to determine the appropriate discounting value for the presence and abundance of invasive species.

Areas within the study area that were not intersected by the 2010 Marsh Study or not commented on by Refuge staff did not have enough information available to allow us to apply an adjustment value. Forty-four polygons fell into the unknown category and are shown in black in Figure 5.

Results

Two hundred and fifty-three wildlife species were evaluated concurrently. The 173 polygons on the SF South Shoreline site were determined by delineating the various wildlife habitat types that occur within the project area. These include: batch pond, brackish marsh, developed area, freshwater marsh, landfill, levee, managed pond, mudflat, muted tidal/diked marsh, open water, park/upland grassland, riparian creek corridor, saline marsh, seasonal wetland, upland vegetation and water sewage treatment (see Table 4). In total these polygons account for about 6,674 acres or 2,700 ha. A complete breakout of the habitat units per polygon can be found in Table 5. The information in Table 5 illustrates by polygon that higher habitat unit scores have a higher habitat quality associated with them; conversely those with a low score would have lesser habitat quality.

Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Mudflat
825.74	328.37	573.65	119.49	67.32	197.55	2297.93	220.51
Muted Tidal / Diked Marsh	**Open Water**	**Parks / Upland Grassland**	**Riparian/ Creek Corridor**	**Saline Marsh**	**Seasonal Wetland**	**Upland Vegetation**	**Water / Sewage Treatment**
545.46	349.75	251.91	14.24	413.13	33.64	26.13	409.13

Table 4. Shoreline study areas breakout of acreage of habitat type.

Polygon ID	Acres	Habitat Type	Habitat Units	Polygon ID	Acres	Habitat Type	Habitat Units
SB_001	1.58	Developed	8.33	SB_012	0.77	Upland Vegetation	12.07
SB_002	1.59	Levee	28.00	SB_013	0.90	Saline Marsh	10.16
SB_003	6.95	Upland Vegetation	98.46	SB_014	4.80	Levee	84.48
SB_004	4.87	Upland Vegetation	76.68	SB_015	8.64	Mudflat	161.72
SB_005	2.79	Freshwater Marsh	59.52	SB_016	4.57	Mudflat	59.93
SB_006	1.20	Upland Vegetation	18.86	SB_017	2.03	Mudflat	37.91
SB_007	0.81	Open Water	24.10	SB_018	1.72	Mudflat	29.02
SB_008	0.14	Open Water	3.86	SB_019	0.42	Levee	7.43
SB_009	1.57	Levee	27.66	SB_020	0.25	Levee	4.41
SB_010	0.58	Upland Vegetation	9.17	SB_021	0.17	Levee	3.02
SB_011	0.68	Saline Marsh	6.15	SB_022	0.12	Levee	2.19

Polygon ID	Acres	Habitat Type	Habitat Units	Polygon ID	Acres	Habitat Type	Habitat Units
SB_023	13.79	Levee	242.86	SB_070	0.16	Upland Vegetation	2.47
SB_024	8.29	Developed	43.83	SB_071	0.03	Upland Vegetation	0.48
SB_025	3.41	Upland Vegetation	53.74	SB_072	0.07	Upland Vegetation	1.05
SB_026	1.07	Freshwater Marsh	22.87	SB_073	16.38	Muted Tidal / Diked Marsh	165.22
SB_027	12.09	Riparian/Creek Corridor	274.50	SB_074	0.24	Upland Vegetation	3.77
SB_028	2.14	Riparian/Creek Corridor	48.63	SB_075	0.29	Open Water	8.79
SB_029	14.65	Managed Pond	323.81	SB_076	41.87	Brackish Marsh	824.30
SB_030	6.07	Developed	32.09	SB_077	34.88	Brackish Marsh	600.87
SB_031	2.54	Seasonal Wetland	40.81	SB_078	0.35	Levee	6.11
SB_032	3.49	Open Water	104.16	SB_079	0.30	Open Water	8.91
SB_033	0.51	Open Water	15.21	SB_080	0.39	Upland Vegetation	6.11
SB_034	0.39	Open Water	11.69	SB_081	0.52	Freshwater Marsh	11.07
SB_035	0.26	Open Water	7.73	SB_082	1.65	Freshwater Marsh	35.28
SB_036	29.28	Seasonal Wetland	470.47	SB_083	11.16	Freshwater Marsh	214.28
SB_037	1.00	Muted Tidal / Diked Marsh	14.41	SB_084	0.19	Upland Vegetation	3.04
SB_038	0.66	Muted Tidal / Diked Marsh	9.58	SB_085	0.69	Upland Vegetation	10.84
SB_039	0.21	Levee	3.69	SB_086	27.64	Brackish Marsh	408.10
SB_040	85.39	Levee	1504.19	SB_087	4.04	Brackish Marsh	89.47
SB_041	62.73	Mudflat	1174.01	SB_088	3.98	Saline Marsh	89.96
SB_042	6.17	Mudflat	92.40	SB_089	19.26	Brackish Marsh	474.06
SB_043	3.82	Mudflat	71.57	SB_090	18.81	Saline Marsh	339.64
SB_044	0.76	Open Water	20.38	SB_091	0.23	Upland Vegetation	3.55
SB_045	1.83	Seasonal Wetland	29.36	SB_092	29.07	Brackish Marsh	500.69
SB_046	2.27	Levee	32.01	SB_093	3.99	Brackish Marsh	68.72
SB_047	22.88	Levee	403.07	SB_094	2.14	Brackish Marsh	47.39
SB_048	11.15	Levee	196.35	SB_095	10.88	Brackish Marsh	214.13
SB_049	0.54	Open Water	16.20	SB_096	19.39	Open Water	578.59
SB_050	0.95	Freshwater Marsh	20.23	SB_097	1.70	Brackish Marsh	41.95
SB_051	15.37	Saline Marsh	312.21	SB_098	30.55	Freshwater Marsh	651.78
SB_052	41.38	Saline Marsh	934.16	SB_099	45.99	Saline Marsh	1038.31
SB_053	11.40	Saline Marsh	205.88	SB_100	16.81	Saline Marsh	379.53
SB_054	8.39	Saline Marsh	170.44	SB_101	0.25	Upland Vegetation	3.86
SB_055	15.01	Saline Marsh	271.14	SB_102	3.49	Freshwater Marsh	74.48
SB_056	0.27	Saline Marsh	6.05	SB_103	9.72	Freshwater Marsh	207.45
SB_057	4.67	Saline Marsh	105.50	SB_104	15.62	Brackish Marsh	269.13
SB_058	0.20	Saline Marsh	4.44	SB_105	14.32	Freshwater Marsh	305.55
SB_059	59.18	Saline Marsh	1335.94	SB_106	0.32	Open Water	9.41
SB_060	1.23	Saline Marsh	27.87	SB_107	2.28	Freshwater Marsh	48.55
SB_061	7.12	Saline Marsh	160.77	SB_108	3.34	Developed	17.69
SB_062	2.17	Saline Marsh	48.97	SB_109	5.53	Levee	97.46
SB_063	7.08	Saline Marsh	159.80	SB_110	0.58	Open Water	17.16
SB_064	33.20	Saline Marsh	674.56	SB_111	6.80	Parks / Upland Grassland	80.55
SB_065	13.49	Saline Marsh	243.59	SB_112	13.95	Parks / Upland Grassland	165.38
SB_066	80.58	Saline Marsh	1637.25	SB_113	20.99	Parks / Upland Grassland	248.77
SB_067	14.75	Saline Marsh	299.74	SB_114	3.30	Parks / Upland Grassland	39.15
SB_068	0.34	Upland Vegetation	5.35	SB_115	27.51	Parks / Upland Grassland	326.04
SB_069	0.47	Upland Vegetation	7.37	SB_116	0.30	Freshwater Marsh	6.50

Polygon ID	Acres	Habitat Type	Habitat Units	Polygon ID	Acres	Habitat Type	Habitat Units
SB_117	5.90	Open Water	176.16	SB_146	140.53	Muted Tidal / Diked Marsh	2024.28
SB_118	3.66	Freshwater Marsh	78.03	SB_147	198.53	Muted Tidal / Diked Marsh	2859.77
SB_119	2.84	Freshwater Marsh	60.49	SB_148	6.05	Muted Tidal / Diked Marsh	87.08
SB_120	0.38	Freshwater Marsh	8.02	SB_149	11.37	Muted Tidal / Diked Marsh	163.79
SB_121	2.29	Freshwater Marsh	48.88	SB_150	1.41	Muted Tidal / Diked Marsh	20.36
SB_122	2.55	Levee	44.98	SB_151	15.15	Parks / Upland Grassland	179.59
SB_123	9.45	Levee	166.48	SB_152	9.34	Parks / Upland Grassland	110.75
SB_124	1.01	Freshwater Marsh	21.59	SB_153	211.03	Developed	1116.24
SB_125	27.87	Brackish Marsh	480.11	SB_154	4.36	Muted Tidal / Diked Marsh	62.78
SB_126	13.45	Mudflat	251.73	SB_155	31.33	Levee	551.86
SB_127	117.37	Mudflat	2196.72	SB_156	6.38	Freshwater Marsh	122.41
SB_128	0.19	Open Water	5.75	SB_157	81.90	Parks / Upland Grassland	970.78
SB_129	4.48	Saline Marsh	60.63	SB_158	174.24	Developed	921.65
SB_130	5.99	Saline Marsh	108.27	SB_159	79.88	Developed	422.53
SB_131	75.92	Brackish Marsh	1681.33	SB_160	68.12	Muted Tidal / Diked Marsh	981.24
SB_132	33.49	Brackish Marsh	576.86	SB_161	96.98	Water / Sewage Treatment	0.00
SB_133	17.50	Freshwater Marsh	373.25	SB_162	67.32	Landfill	243.16
SB_134	1.28	Muted Tidal / Diked Marsh	18.38	SB_163	20.89	Muted Tidal / Diked Marsh	300.92
SB_135	315.87	Open Water	9423.89	SB_164	24.14	Muted Tidal / Diked Marsh	347.68
SB_136	3.71	Levee	65.44	SB_A9	365.92	Managed Pond	8087.34
SB_137	6.63	Freshwater Marsh	141.33	SB_A10	249.81	Managed Pond	5521.11
SB_138	1.66	Developed	8.77	SB_A11	261.70	Managed Pond	5783.91
SB_139	0.44	Upland Vegetation	6.96	SB_A12	308.20	Batch Pond	6763.60
SB_140	58.81	Developed	311.07	SB_A13	266.65	Batch Pond	5851.71
SB_141	50.75	Muted Tidal / Diked Marsh	731.04	SB_A14	336.92	Managed Pond	7446.24
SB_142	28.76	Developed	152.12	SB_A15	250.89	Batch Pond	5505.87
SB_143	312.15	Water / Sewage Treatment	0.00	SB_A16	242.06	Managed Pond	5349.83
SB_144	72.97	Parks / Upland Grassland	864.87	SB_A18	826.87	Managed Pond	18274.69
SB_145	4.86	Upland Vegetation	76.55				

Table 5. Acreage and habitat value (HUs) for each of the CHAP habitat evaluation polygons.

Because Ponds A9 thru 15 are a focal point of the Shoreline Study, there was some interest expressed by Habitat Evaluation Team members to break out the ponds by seasonal use for just the bird species that are known to use them. Table 6 shows the habitat units by season for each pond. During different times of the year, the habitat value changes based on the diversity of 165 bird species; habitat value is not static throughout a year. This is the first time we are aware of that the year round seasons of use by a large diversity of bird can quantify habitat values throughout the year. Table 7 shows the per-acre value by season by pond based on the diversity of the bird species that use them. Figures 4 display the same information by season by pond. Interest was also expressed in how CHAP would address abundance of species using each pond. Utilizing a weighting scale is a possible way to handle this question. For example, based on the information recorded at each site by USGS Western Ecological Research Center staff, the number of birds could be grouped by increments of 1000 to determine a weighting scale. For instance, 1-1,000 would have a weighting of 1, 1001-2,000 a 2, 2,001-3,000 a 3, etc. Weighting

has not been agreed to by the Habitat Evaluation Team; hence this information is only suggested as a possible solution to the question of considering the number of birds using each pond.

SITE_ID	Acres	Habitat Units
Spring		
SF_Pond A09	365.92	7,146.4
SF_Pond A10	249.81	4,626.3
SF_Pond A11	261.70	4,937.6
SF_Pond A12	308.20	5,662.5
SF_Pond A13	266.65	4,937.3
SF_Pond A14	336.92	6,563.2
SF_Pond A15	250.89	4,738.6
SF_Pond A16	242.06	4,778.4
SF_Pond A17*	130.88	2,583.0
SF_Pond A18	826.87	16,222.3
Total	**3,240**	**62,195.7**

SITE_ID	Acres	Habitat Units
Fall		
SF_Pond A09	365.92	7,678.3
SF_Pond A10	249.81	4,948.0
SF_Pond A11	261.70	4,766.6
SF_Pond A12	308.20	5,757.0
SF_Pond A13	266.65	5,334.2
SF_Pond A14	336.92	6,635.9
SF_Pond A15	250.89	4,963.1
SF_Pond A16	242.06	4,555.4
SF_Pond A17*	130.88	2,731.0
SF_Pond A18	826.87	16,002.5
Total	**3,240**	**63,372.1**

SITE_ID	Acres	Habitat Units
Summer		
SF_Pond A09	365.92	6,359.4
SF_Pond A10	249.81	4,196.7
SF_Pond A11	261.70	4,321.4
SF_Pond A12	308.20	5,123.7
SF_Pond A13	266.65	4,219.3
SF_Pond A14	336.92	5,756.5
SF_Pond A15	250.89	4,455.5
SF_Pond A16	242.06	4,587.8
SF_Pond A17*	130.88	2,492.3
SF_Pond A18	826.87	14,127.7
Total	**3,240**	**55,640.5**

SITE_ID	Acres	Habitat Units
Winter		
SF_Pond A09	365.92	7,437.2
SF_Pond A10	249.81	4,795.1
SF_Pond A11	261.70	4,799.4
SF_Pond A12	308.20	6,061.6
SF_Pond A13	266.65	5,130.1
SF_Pond A14	336.92	6,769.1
SF_Pond A15	250.89	4,624.6
SF_Pond A16	242.06	4,881.8
SF_Pond A17*	130.88	2,538.7
SF_Pond A18	826.87	16,543.9
Total	**3,240**	**63,581.6**

For a list of bird species associated with each pond by season, see Appendix 3. [*Note: Pond A17 is not part of this study and is shown only for informational purposes].

Table 6. Habitat unit value by pond; determined using the diversity of bird species and number of key environmental correlates associated with each pond by season

	Fall	Winter	Spring	Summer
Pond_A09	13.06	12.40	11.61	9.45
Pond_A10	11.88	11.27	10.59	8.88
Pond_A11	10.29	10.41	10.94	8.59
Pond_A12	9.47	10.46	9.16	7.41
Pond_A13	10.79	10.03	9.31	6.61
Pond_A14	11.77	12.17	11.56	9.16
Pond_A15	10.57	9.22	9.68	8.55
Pond_A16	10.89	12.24	11.82	11.03
Pond_A17	12.94	11.47	11.81	11.12
Pond_A18	11.43	12.08	11.69	9.16

Table 7. Baseline per-acre values by season by pond based on bird diversity.

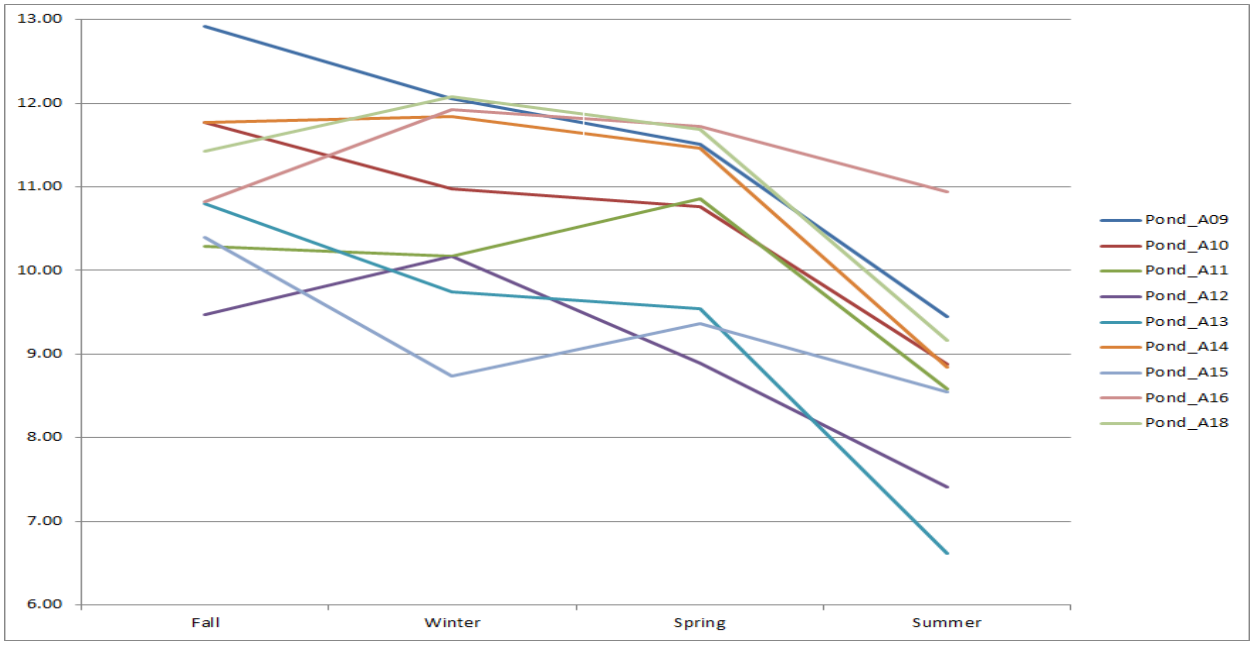

Figure 4. Baseline per-acre values by season by pond based on bird diversity.

Figures 5 & 6 further characterize the baseline conditions by showing the number of acres by habitat type and the average per-acre value for those habitat types, respectively. Figures 7 to 10 also inform baseline conditions by illustrating the spatial extent of the various habitat types (Figure 7), the amount and location of the invasive discounting (Figure 8), visual depiction of the per-acre habitat value from high to low scores (Figure 9), and finally an illustration showing the number of habitat units associated with each polygon (Figure 10).

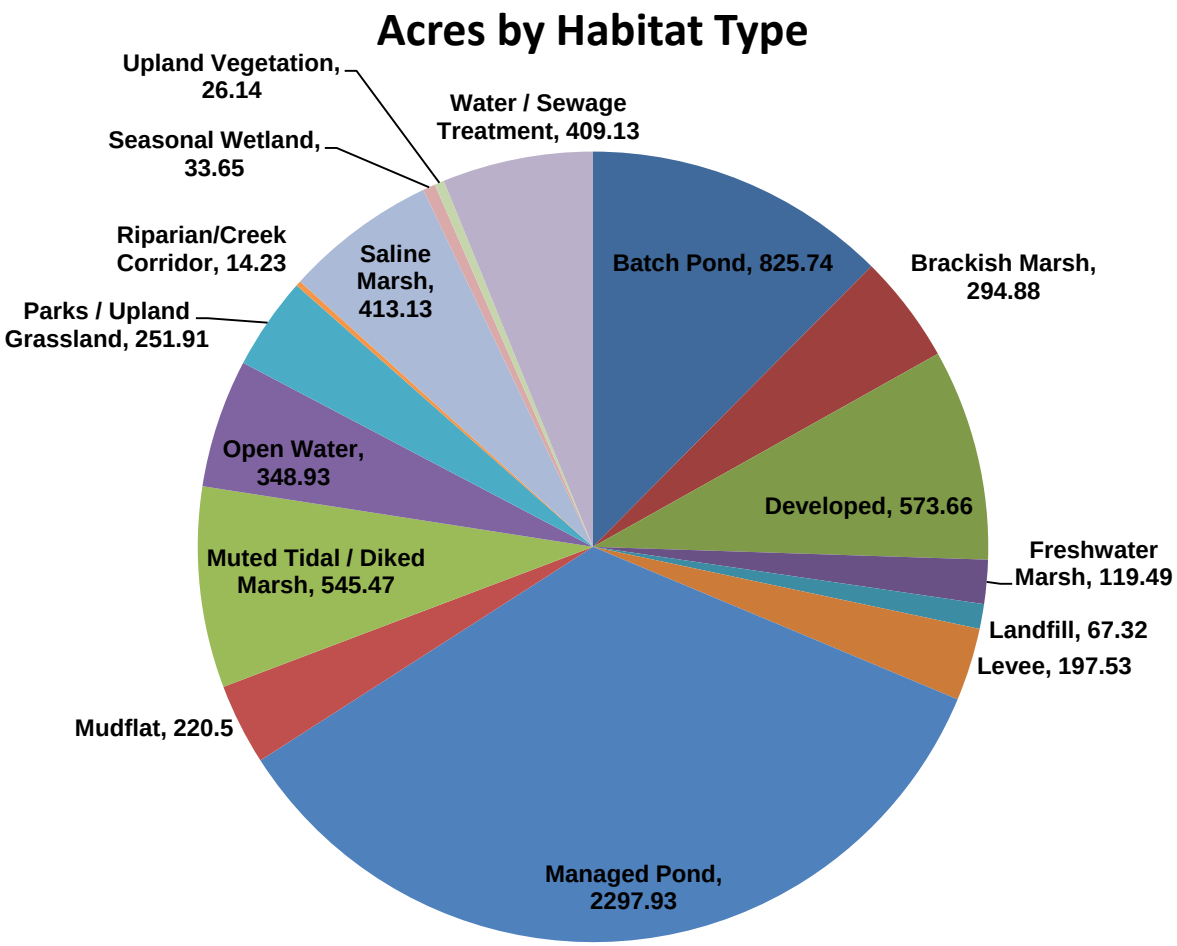

Figure 5. Breakout of baseline condition acreage by habitat type.

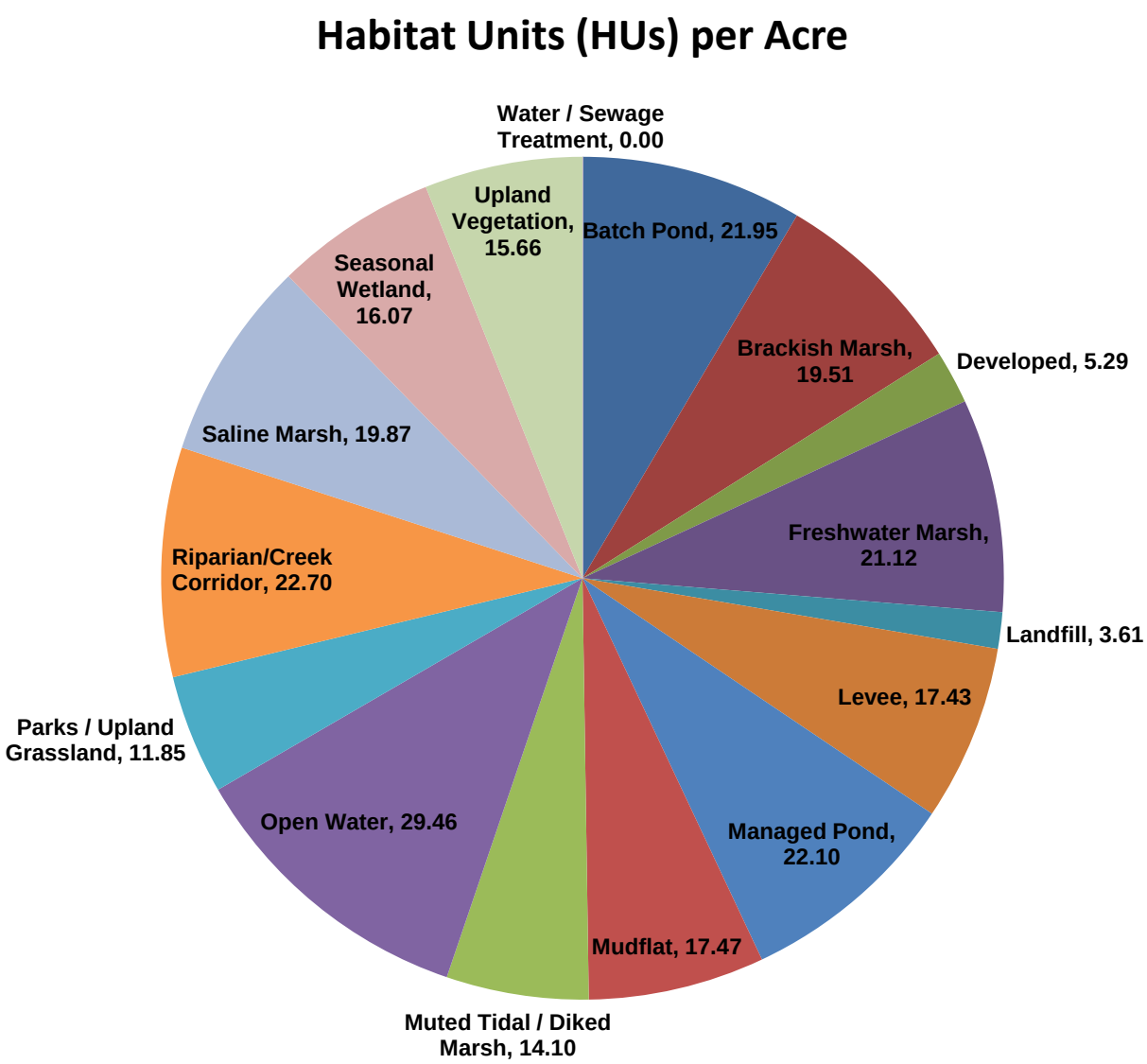

Figure 6. Breakout of the average baseline per-acre habitat value by habitat type.

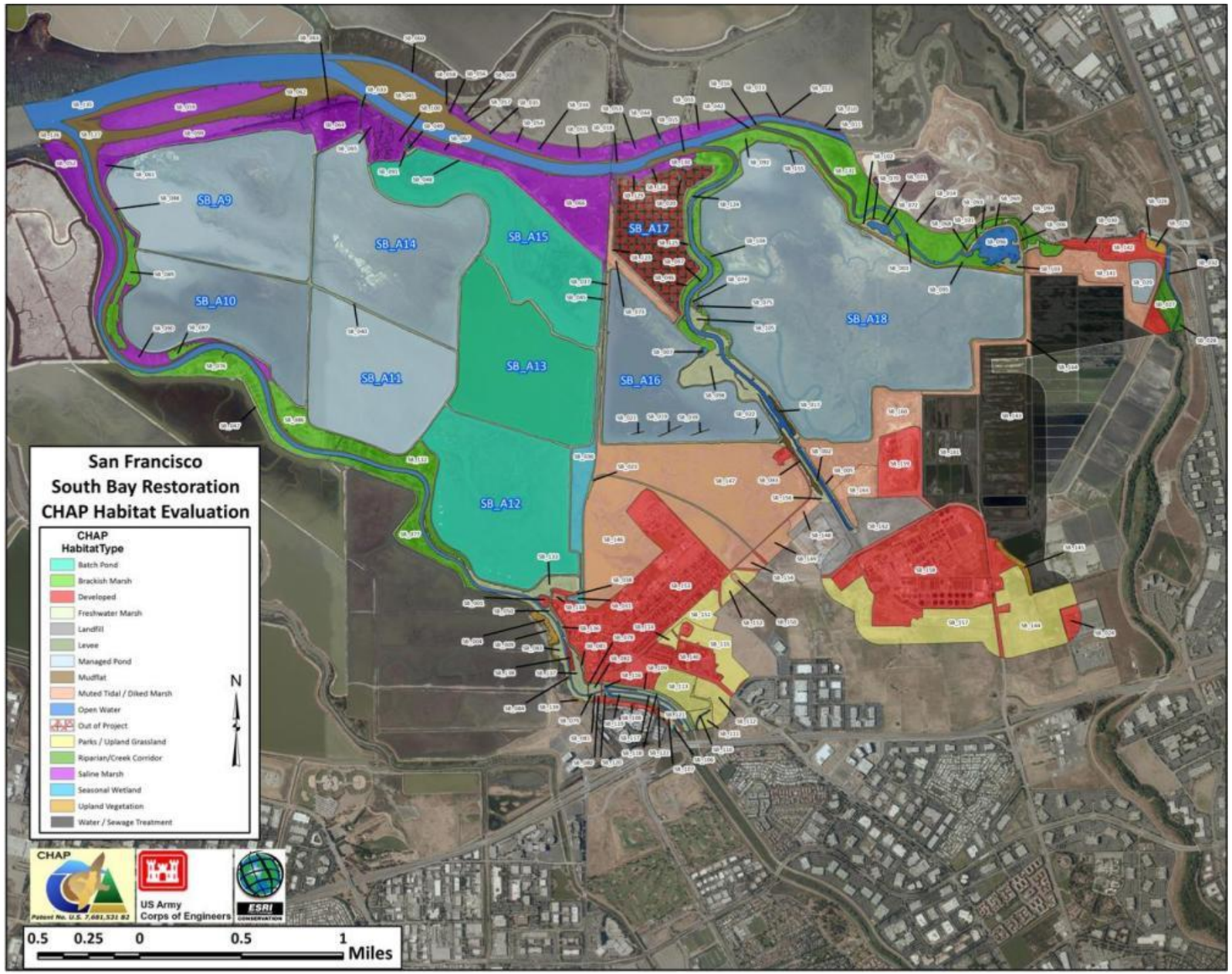

Figure 7. Shoreline study habitat assessment area showing the break out of polygons classified into the wildlife habitat types.

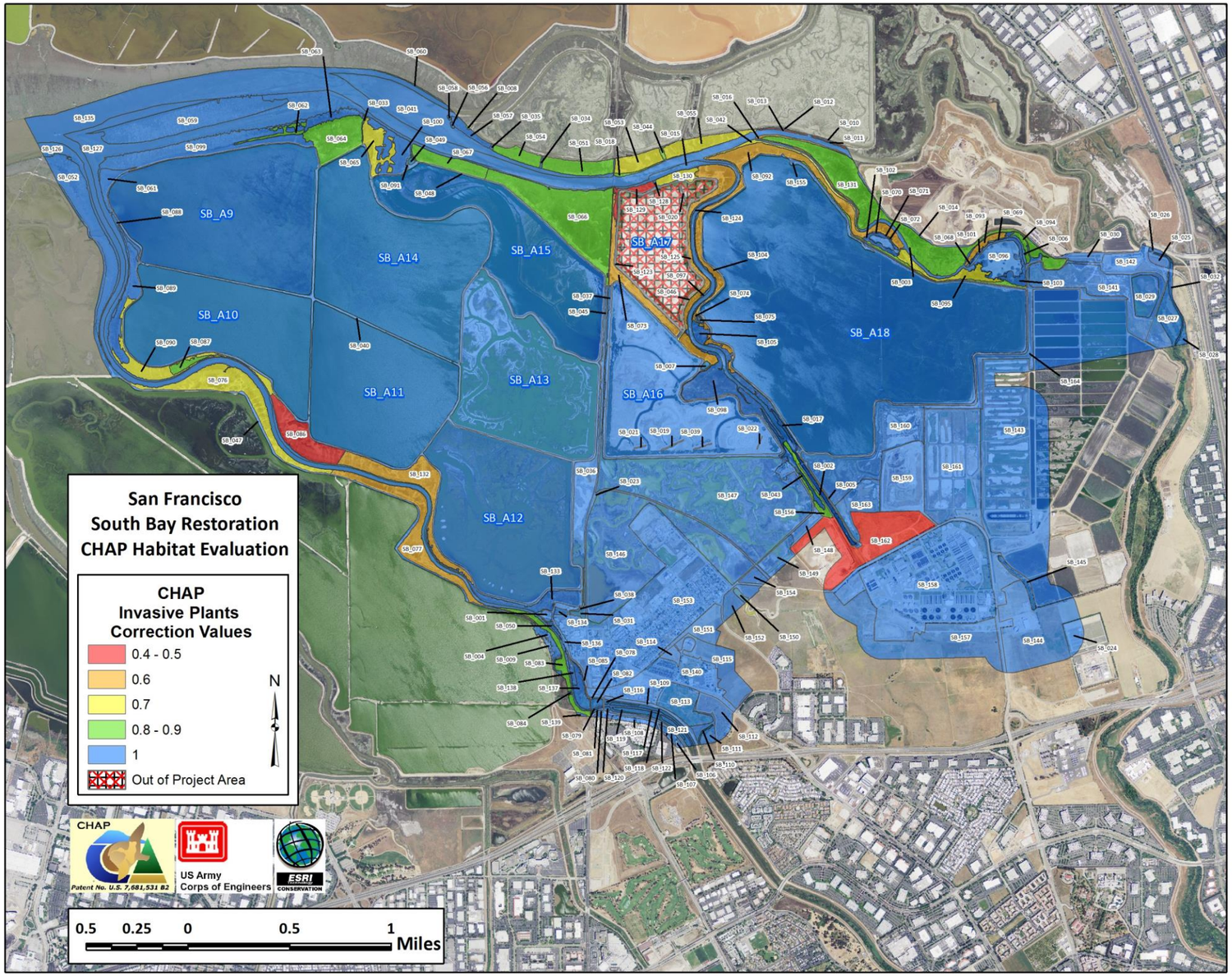

Figure 8. Depiction of the amount of invasive species as colored by their discounting value by polygon; these values were used in calculating overall habitat value within the Shoreline study project boundary.

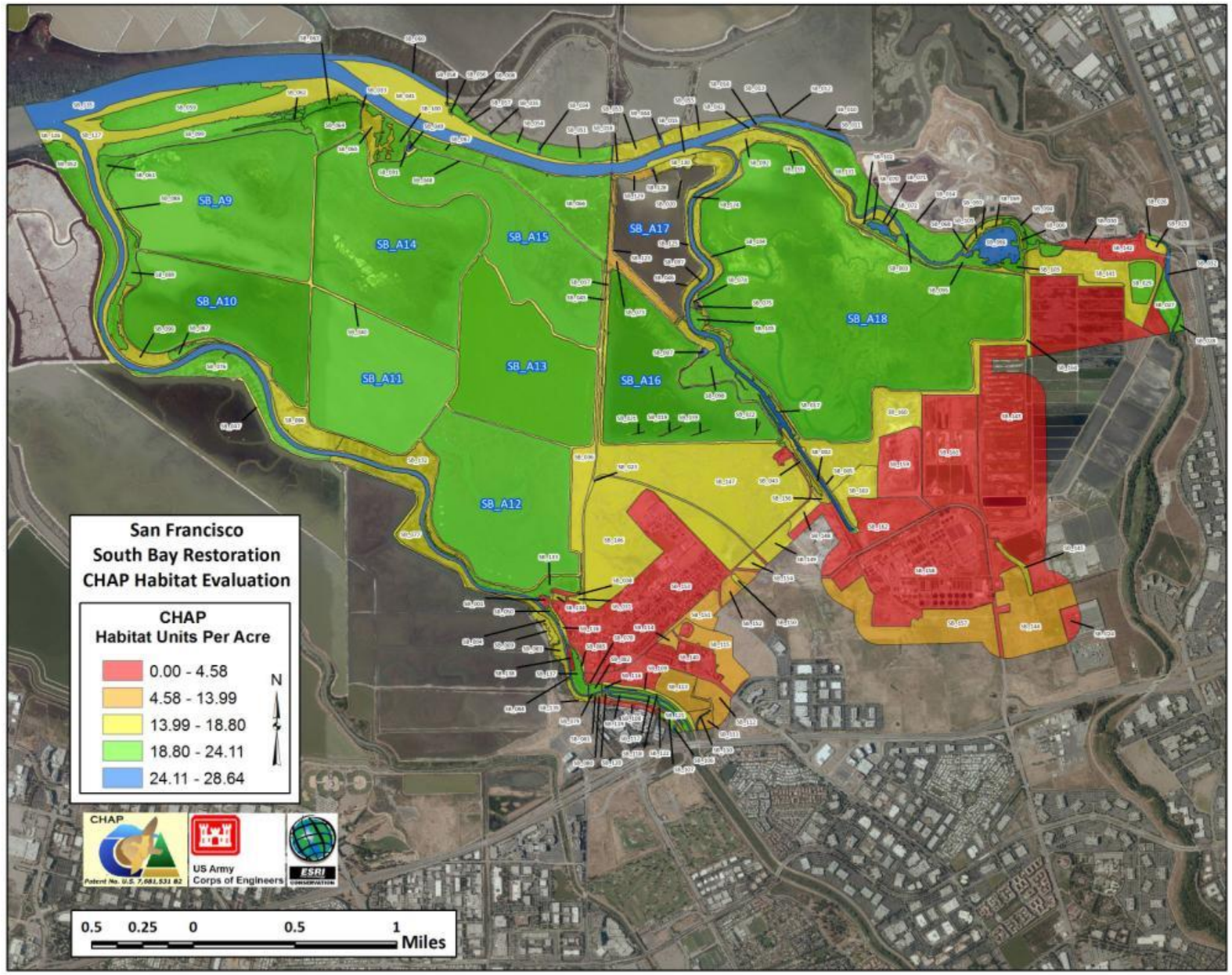

Figure 9. Illustrates the per-acre values for each polygon identified at Shoreline study project. [Note: Pond SB_A17 is not in this study. For zoom-in maps, see Appendix C]

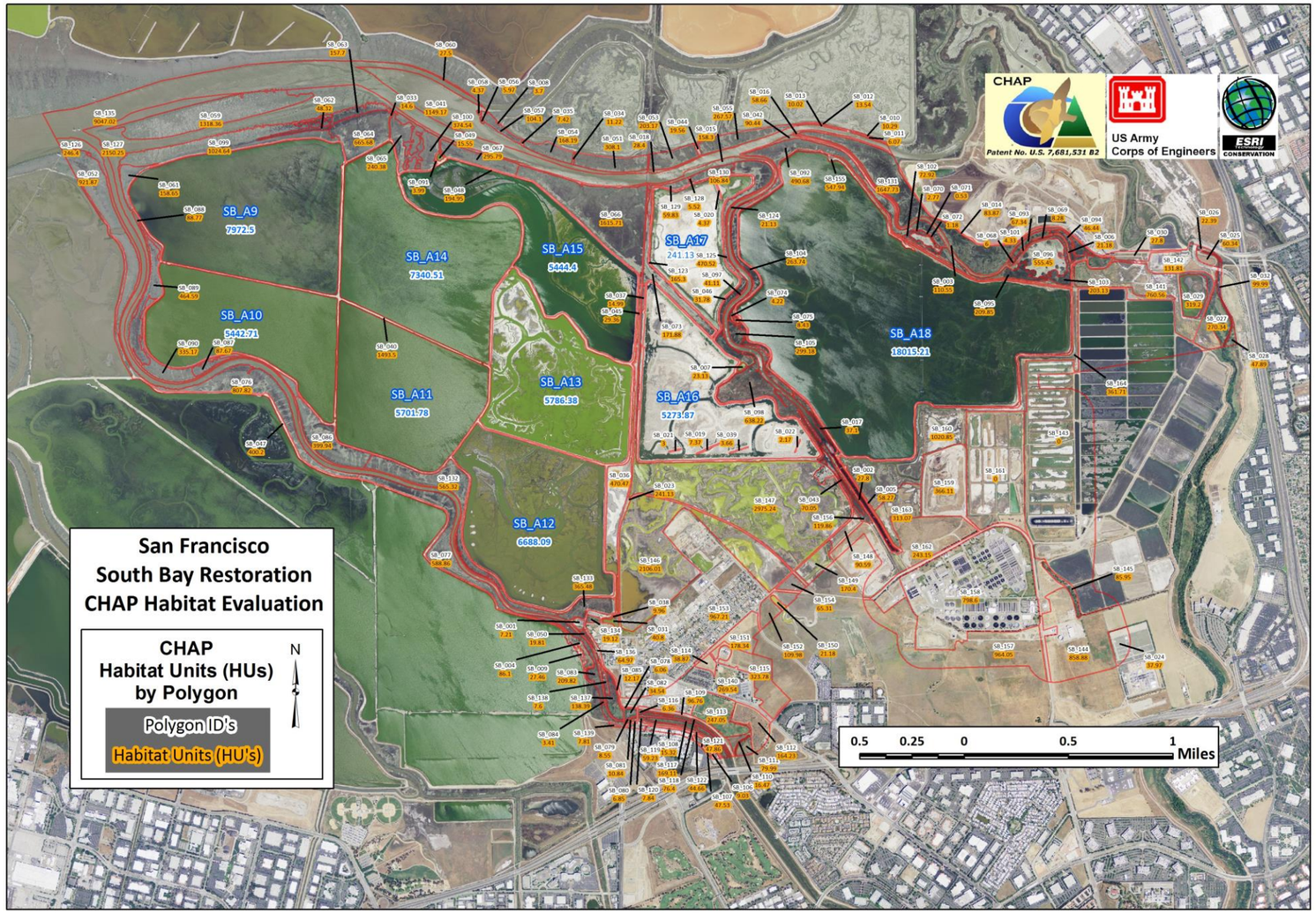

Figure 10. Shoreline study project showing the polygon number and associated habitat units (HUs). [Note: Pond SB_A17 is not in this study. For zoom-in maps, see Appendix D]

Validation

Species List - The development of the species list occurred in a series of steps. Refuge staff was able to generate a species list for both fish and wildlife by working with colleagues or based on their own knowledge of the Shoreline Study project area for baseline conditions, alternatives and without-project conditions. To help with quality control of these data, a potential species list was generated by accessing the California Wildlife Habitat Relationships (CWHR) geographic information system (GIS). A query of the site's potential species was done by accessing the peer-reviewed wildlife-species range maps that overlapped with the project boundary. Additionally, Refuge staff was also able to review the CWHR-generated species list. Refuge staff developed specific bird lists for each pond and determined their presence during the four seasons based on USGS Western Ecological Research Center. These data had been collected at the ponds and adjacent areas in 2011 by staff.. Lastly, the Refuge staff was also able to confirm the non-native species identified on the baseline condition species list can be found in Table 8.

ID	Common Name
10121	Striped bass
10149	Common carp
10177	Goldfish
10189	Western mosquito fish
10233	American shad
10234	Threadfin shad
10361	Cabezon
41190	Ring-necked Pheasant
42380	Rock Pigeon
43740	European Starling
44970	House Sparrow
50010	Virginia opossum
51070	Black rat
51080	Norway rat
51090	House mouse
51160	Red fox

Table 8. Non-native species evaluated as part of the baseline condition evaluation.

Habitat Findings – No separate vegetation transects were run to help verify the results from past habitat inventory for this project site. The data received was well attributed and based on maps that were developed and passed out for a prior review.

Conclusion

The wildlife habitat assessment of the Shoreline study evaluated 173 polygons to determine baseline conditions that consisted of 16 different habitat types to describe the 6,674 acres (or 2,700 ha) site. The number of fish and wildlife species associated with the project totaled 253, of which 51 were fish, 165 birds, 30 terrestrial mammals, 6 reptiles, and 1 marine mammal. The baseline condition evaluation for the Shoreline Study showed a total of 117,811 habitat units of which about 60,000 habitat units are associated with Ponds A9 – A18. Breaking out the different habitat types revealed that there are 2,298 managed ponds within the study site. Of these, there are 826 batch ponds, 413 saline marsh ponds, 545 muted tidal or diked marsh ponds, and 119 freshwater marsh ponds. The average per-acre value of managed ponds overall is 22.1. By type, the values are 22.0 for batch ponds, 19.9 for saline marsh, 14.4 for muted tidal and diked marsh ponds, and 21.3 for freshwater marsh ponds. All habitat types' per-acre values fell within the range of 0 and 29.8.

Year 50 Future Without-Project Condition

Introduction

CHAP habitat value utilizes species habitat functions to derive current habitat values. To determine a change in these values over time, projections are needed to alter either the species, habitat, or function parameters. Applying these changes over several time periods requires some conjecture to deduce the amount of influence that might be expected during each time period. To display the future condition outcomes and help visualize these changes in value over time, the habitat changes are applied to either a coarse or fine scale habitat map, while the species and function changes are applied to their respective data sets.

Originally, the baseline analysis of projected future conditions for the shoreline ecosystem restoration project was conducted at 25 and 50 years from the present as part of the project feasibility study. However, once the project moved onto the alternatives phase it was decided that there should be six breakpoints in time that would be studied. To keep consistent with the alternatives report, this portion of the without project analysis has been updated to reflect how this was done. The baseline year of analysis was 2017 with further analysis breakpoints occurring during 2020, 2025, 2030, 2037, 2047 and 2067. The assumptions NHI used for the without project analysis was that there would be permanent breaching of the ponds at various time intervals, which would lead to the managed ponds being restored to tidal action. This assumption has been revised to show that the managed ponds will be maintained as non-tidal in the without-project scenario throughout all six breakpoints. Breaches may occur due to heightened flood risk over time, but would be quickly repaired to avoid unacceptable risks to developed areas. The main assumption here is that because of the resilience of pond and marsh habitats in the South Bay, along with levee repairs as needed, there would be little change in habitat value over time.

Due to the uncertainties present and the high cost of developing accurate models to reflect these small changes in habitat value, it was decided that the baseline value would be used to represent the habitat value through the 2030 breakpoint. In the 2037 breakpoint onward the alternatives species list was used to re-calculate CHAP HU's for baseline to come up with an approximation of future conditions taking into account the species relationships developed for future conditions in the alternatives process. This yielded a slightly smaller total CHAP HU value for the project site in these later breakpoints.

Potential species decline

The habitat evaluation team discussed a reduction in the number of fish and wildlife taxa present within the project area over time. However, in this case, it was the consensus of the habitat evaluation team that most of the current landscape conditions in and around the project area would mostly prevail over time. Therefore, when reviewing the number of species that may decline over the 50 year period, several were discussed but the Refuge staff felt that given their current data, only 4 species might be identified as possibly declining within the project area (see Table 9). Thus, 2 species were randomly removed in the first 25 years interval and the remaining 2 species were removed in the later 25 years to reflect this potential decline over the 50 year period.

SPP ID	Common Name	Interval Species Removed
42510	Burrowing Owl	First 25 Year Period
41410	Western Snowy Plover	First 25 Year Period
41321	California Clapper Rail	Second 25 Year Period
40780	Redhead Duck	Second 25 Year Period

Table 9. Species that may decline over the next 50 year period

Because it is assumed that the remaining fish and wildlife species currently identified in the project would likely persist into the future, it was thought best to establish the current level of functional resiliency. This was done by comparing species functional redundancy between historic (343 species, Appendix A-5) and current baseline conditions (253 species, Appendix A-1). The top 20 functional categories in both time intervals are shown in Figures 11 & 12. Next, when these values are compared side-by-side, they show the potential resiliency levels for each functional category (Figure 13). A comparison of species that only perform a few functions was also done but there was little difference between the time periods. However, in a few categories in Figure 12, there is a higher level of functional resiliency occurring in the current baseline than the historic time period. This occurs in the categories of egg eaters, tertiary consumers and fish prey. This is the result of accounting for the non-native species (Table 8). These species are

mostly generalists that did not occur in the past but are now common or widespread. Examples of functions each species may perform can be found in Appendix A-4.

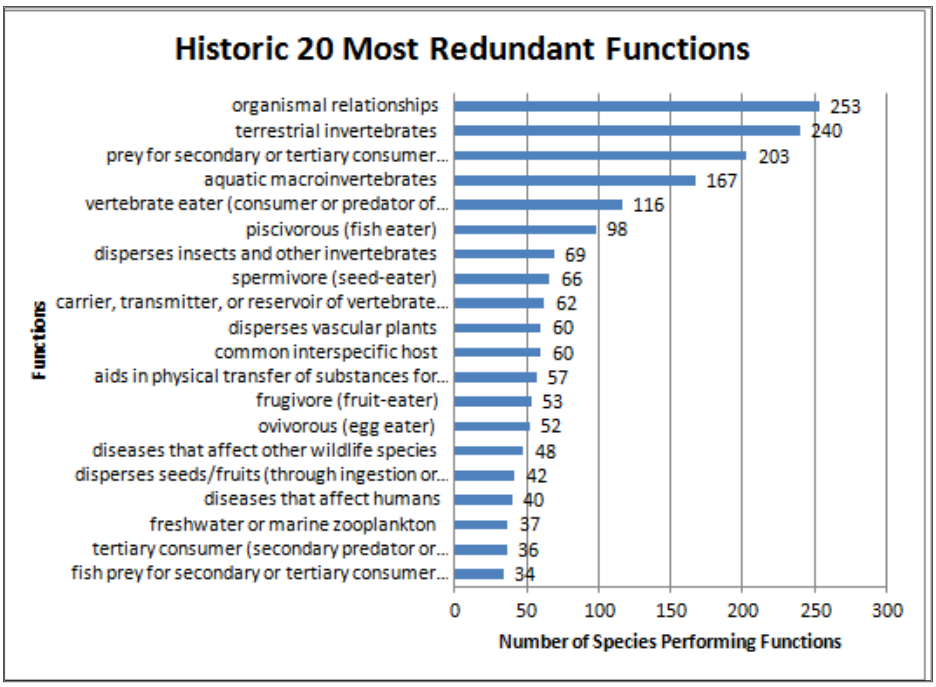

Figure 11. Top 20 key ecological functions for historic period.

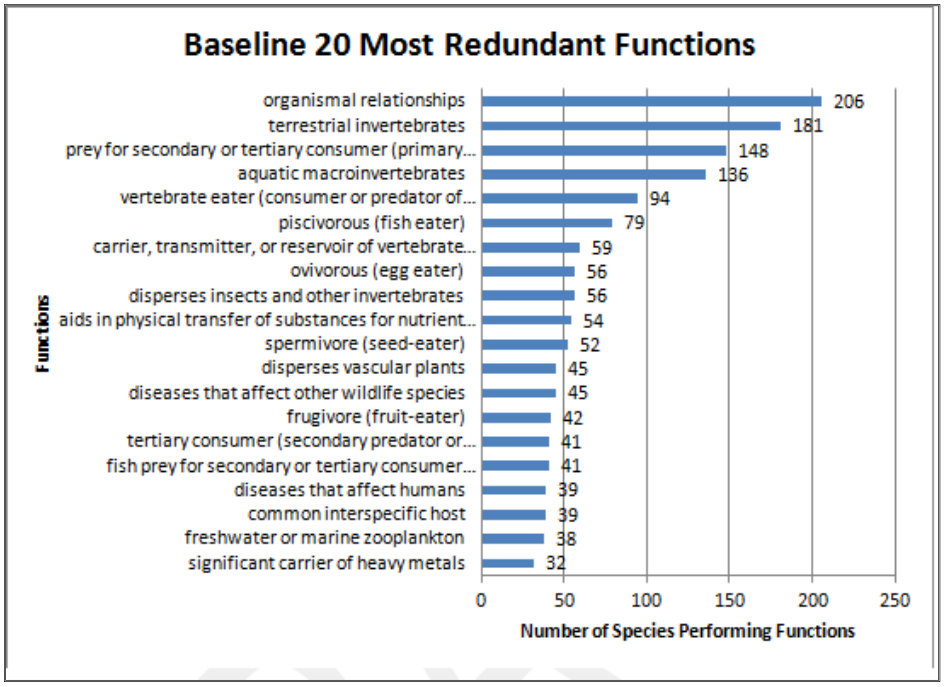

Figure 12. Top 20 key ecological functions for the current baseline.

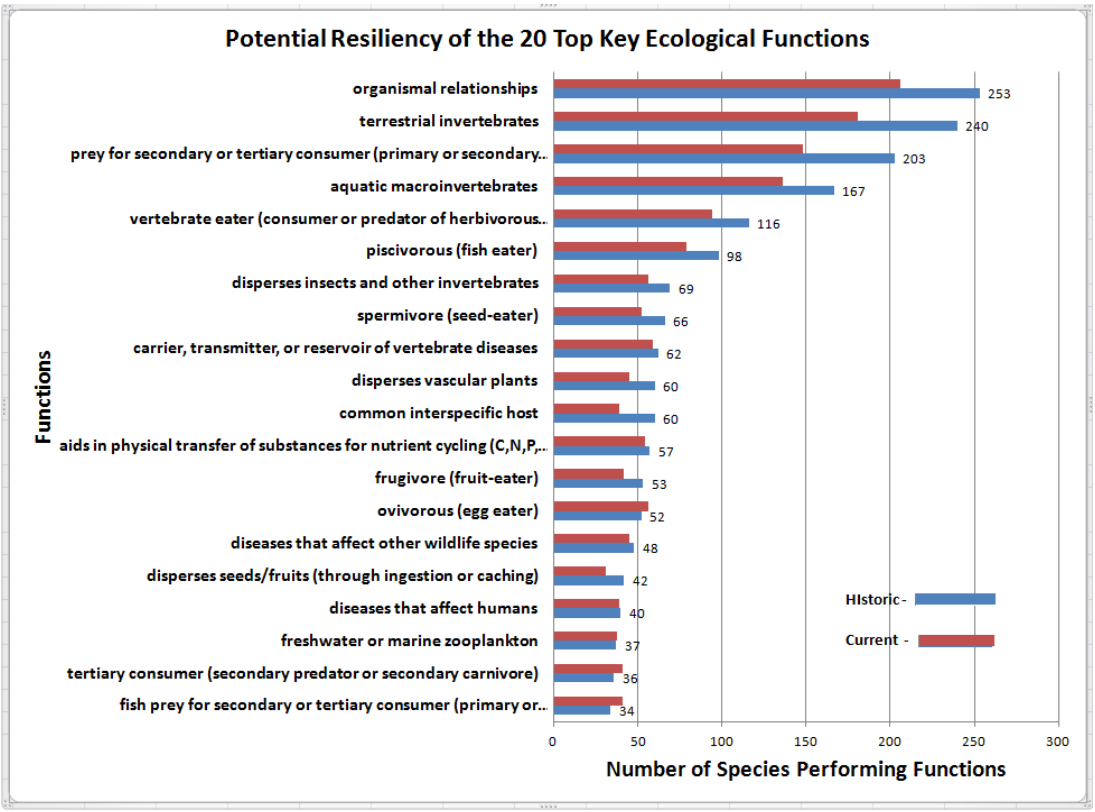

Figure 13. A comparison between historic and current baseline conditions for the Top 20 key ecological functions

Next, a quick coarse-level assessment of potential cumulative impacts can be shown by comparing San Francisco Bay habitats from historic to modern times (Figure 15). This allows a trajectory to be established that helps frame the current setting and give a general idea of how far we have come from a historical perspective. That is, a coarse-scale assessment from then to now will show approximately the change that has occurred in the San Francisco Bay area.

To determine the amount of change in habitat values, it is necessary to establish a species list for each habitat type that was mapped for both time periods. A map showing both historic and modern times can be found at the San Francisco Estuary Institute (SFEI) and is depicted in Figure 14. A species list and their habitat associations, which were determined by professional opinion (Refuge & NHI staff and IBIS data system) for the historic and modern time periods, can be found in Appendices A-5 and A-6 respectively. Table 10 shows the two separate habitat classifications (as mapped by SFEI) that were developed to allow the comparison from one time period to the other. In doing this exercise, there was a concern that the vast amount of tidal marsh shown in the historic map would receive an unrealistically high value. Hence, 2 historic species lists were generated; one consisting of 205 species and the other includes 171 species (see Appendix A-5). Table 10a shows the amount of change in habitat types from historic to modern times, while Table 10b depicts the range in habitat value change between those two time periods.

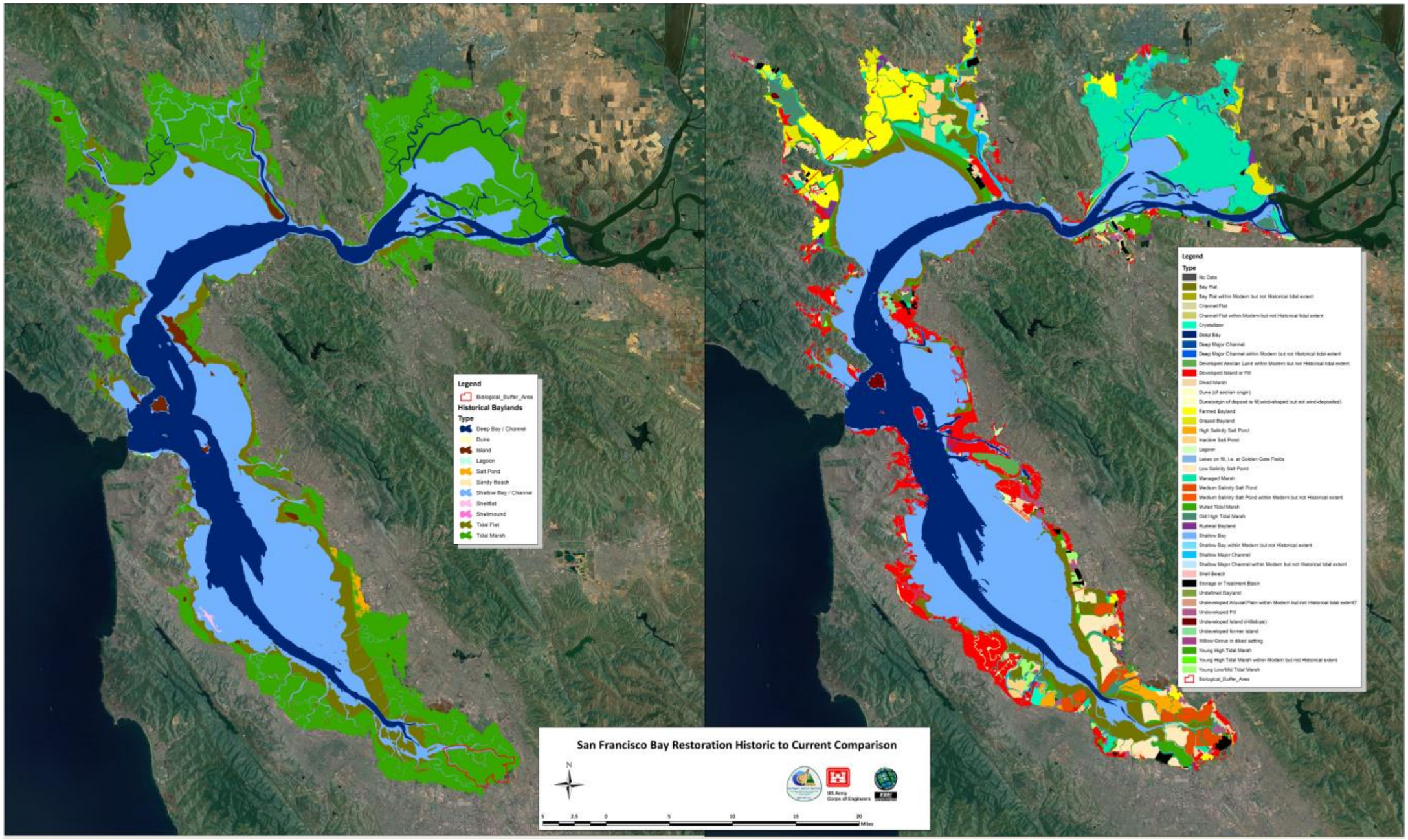

Figure 14. San Francisco Bay comparison between historic (ca. 1800) and modern times (ca. 2001) habitats (source: SFEI).

Historic Conditions San Francisco Bay	Modern Conditions San Francisco Bay
Deep Bay / Channel	Deep Bay / Channel
Dune	Dune
Island	Lagoon
Lagoon	Salt Pond
Natural Salt Pond	Shallow Bay / Channel
Sandy Beach	Tidal Flat
Shallow Bay / Channel	Tidal Marsh
Shellflat	Developed
Shell Mound	Agriculture
Tidal Flat	
Tidal Marsh	

Table 10. Habitat classifications used to compare historic (ca. 1800) to modern times (ca. 2001).

Historic Habitat Value Acreages and Proportions

Habitats	Deep Bay / Channel	Dune	Lagoon	Salt Pond	Sandy Beach	Shallow Bay / Channel	Tidal Flat	Tidal Marsh	Island	Shellflat	Shell Mmound
Acres	99,527.68	54.75	84.17	1,594.53	199.33	174,440.54	50,054.73	189,985.90	4,823.86	395.34	12.01
Proportions	0.19	0.00	0.00	0.00	0.00	0.33	0.10	0.36	0.01	0.00	0.00
											Total Acres**
											521,172.83

Modern Habiat Value Acreages and Proportions

Habitats	Deep Bay / Channel	Dune	Lagoon	Salt Pond	Shellflat	Shallow Bay / Channel	Tidal Flat	Tidal Marsh	Developed	Agriculture	No Correlation
Acres	82,530.76	2,254.80	2,325.53	29,738.39	12.41	171,838.91	35,313.67	103,501.19	50,341.78	31,738.89	13,789.87
Proportions	0.16	0.00	0.00	0.06	0.00	0.33	0.07	0.20	0.10	0.06	0.03
											Total Acres
**Note: there is a 2,213 acre discrepancy between Historic to Modern timeframe because of a gap not mapped in the Historic map											523,386.19

Table 10a. Acreage change in habitat types from historic (ca. 1800) to modern times (ca. 2001).

	Habitat Value	Difference Historic to Modern
Historic (High Range Habitat Value)	9,130,514	-2,343,419
Historic (Low Range Habitat Value)	8,516,173	-1,729,077
Modern Times Habitat Value	6,787,095	0

Table 10b. Overall habitat value change from historic (ca. 1800) to modern times (ca. 2001).

Invasive species would expand in area and abundance

Invasive plant species information for current conditions was originally collected from past studies or from knowledgeable staff on site. A value was determined and recorded for each polygon using the percent breakout in Table 11.The greater the adjustment value, the greater the discount applied.

Determined Invasive Adjustment (based on area percent)	Discount Class
1 - 0.95	1
0.94 - 0.90	0.9
0.89 - 0.80	0.8
0.79 - 0.70	0.7
0.69 - 0.60	0.6
0.59 -0.50	0.5
0.49 - 0.40	0.4

Table 11. Invasive plant species deduction factors

To determine the influence of invasive species for the without-project conditions, the habitat evaluation team expected that the presence and abundance of the invasive species would increase over time. Therefore, the percent invasive species for each polygon at the baseline condition should advance to the next highest percent level for the first 25 years, and to the next level beyond that for the next 25 years. In other words, if the current baseline condition of a polygon has .89-.80 invasive cover, then the condition at Year 25 would be assessed at .79-.70 invasive cover while the condition at Year 50 would be reflected as .69-.60 invasive cover. We recognize that these assumptions may not reflect real outcomes because salinity values within the ponds may check the spread of some invasive plants. Thus, increases in invasive plants may be more likely to occur in above-shoreline habitats.

Planned development

We used the city of San Jose Planning Services Division's future land use and transportation plan to determine future development in the project area. This document, known as *Envision San Jose 2040 General Plan* (http://www.sanjoseca.gov/planning/gp_update/default.asp) shows what the city planners envision over the next several decades. Below is their planning map for the Alviso area that would cover the project site (Figure 15). This information was overlaid onto the existing environment and shows that most of the anticipated change through 2040 will occur in the already developed area. The only significant development action proposed in Alviso aside from the Master Plan is a proposed height increase for Newby Island Landfill. Finally, there is also a recent San Jose/Santa Clara Water Pollution Control Plant Master Plan that was published in December 2011. This master plan updates the San Jose 2040 Plan. A further discussion of the Water Pollution Control Plant Master Plan can be found in the Climate Change section that follows.

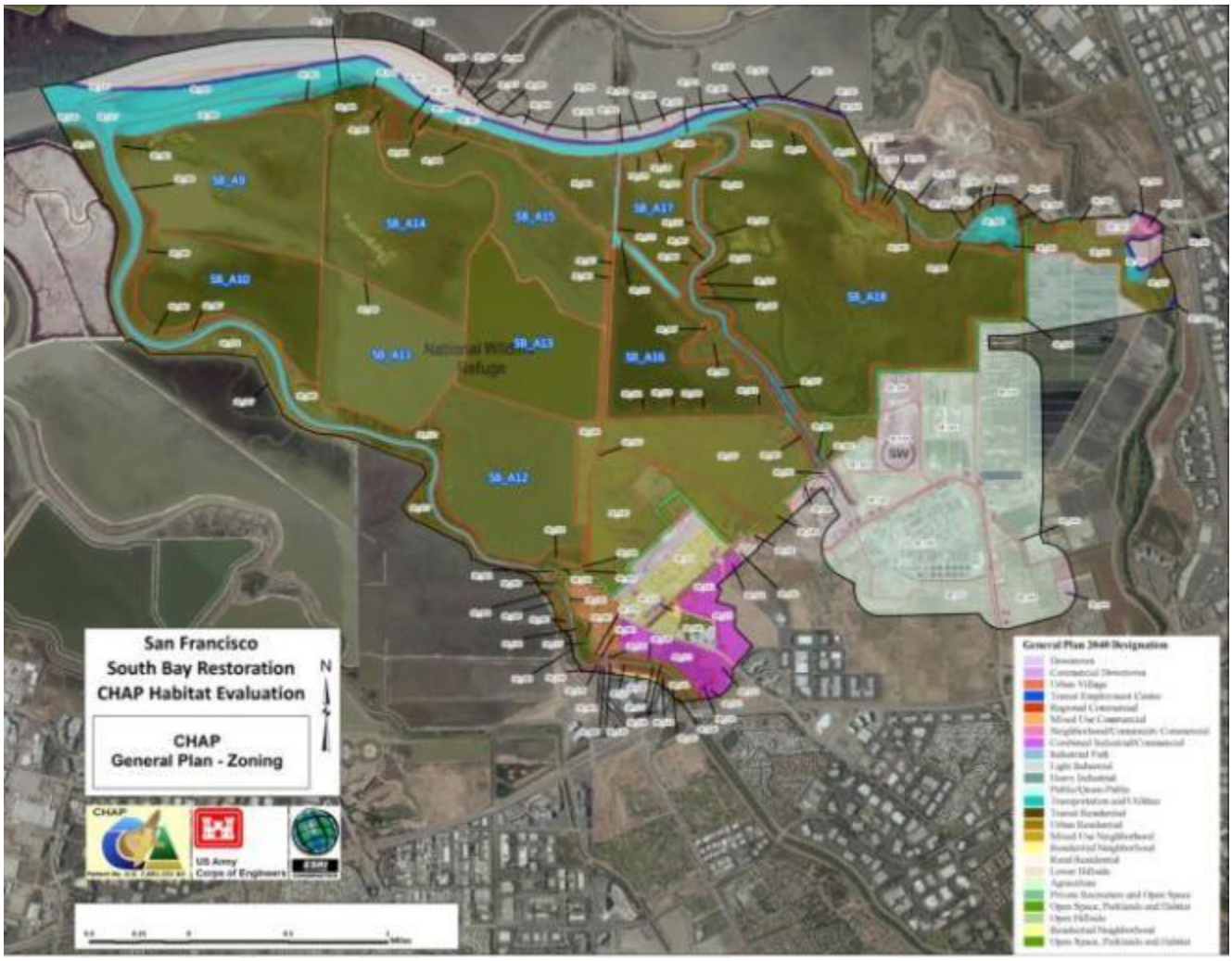

Figure 15. Alviso planning area until 2040. (Source: San Jose Services Planning Division - *Envision San Jose 2040 General Plan*).

Climate change increasing water level

The current distribution, abundance, and vitality of species and habitats are strongly dependent on climatic (and microclimatic) conditions. Climate change is expected to result in warmer temperatures year-round with most precipitation falling during winter from North Pacific storms. One of four climate model projects associated with *Cal-Adapt* shows slightly wetter winters, while others shows slightly drier winters with a 10 to 20 percent decrease in total annual precipitation. Nonetheless, even modest changes may have a significant impact to California ecosystems (http://cal-adapt.org/precip/decadal; last accessed 6-6-2012). Rising water level will significantly affect coastal wetlands because they are mostly within a few feet of sea level. As the sea level rises, these wetlands will move inland, or they will be lost if they abut development or high ground. Part of the current Climate Change Implementation Plan for Adaptation is a strategy to complete a statewide sea-level rise vulnerability assessment every five years. In 2006, the California Climate Change Center reported a historic sea-level rise of 7 inches in the last century and projected an additional rise of 4–35 inches by the end of this century. Their report uses the 20-55 inch projection, as it was the best available science at the time of the 2009 impacts assessment, but in so doing noted that future sea-level rise estimates will vary based on future greenhouse gas emissions (http://resources.ca.gov/climate_adaptation/docs/Statewide_Adaptation_Strategy_-_Chapter_6_-_Ocean_and_Coastal_Resources.pdf; last accessed 5-2-2012).

To assess the influence of the potential increase in sea level, the Shoreline Study used the National Research Council's (NRC) Curve III and the following comments apply only to the area south of Dumbarton Straits. This curve simulates a high rate or 1.5 meter rise in the water depth over the project area and adjacent lands (Figure 16), and we anticipated this event may likely occur once within the 50 year time period and any damage would be mitigated quickly. Under favorable sediment availability conditions, tidal marshes may be able to keep up with sea level rise; in addition, if a breach in a levee were to occur it would be quickly repaired. Thus there is a potential for an increase in aquatic habitats though the duration maybe short lived. By the end of the 50 years, it is thought that current without-project conditions might be roughly the same. This is based on past experience with relative sea level rise (due to ground subsidence) whereby tidal marshes were able to keep up with accumulating sediment fast enough; this process may be able to keep pace with the expected sea level rise over a 50-year period. However, this ability is not unlimited and that faster rates of sea level rise later in the century (after the 50-year period) may have different results for tidal marsh persistence. Additionally, USGS modeling of the non-vegetated tidal portions of the area south of the Dumbarton Bridge show it more or less has kept up with sea level rise over a 50-year period.

The City is working with the Shoreline Study to ensure that the Water Pollution Control Plant is protected from future sea-level rise, and hence are evaluating minimum and maximum levee build-out as well as other fortification options. The City is also evaluating 3 land use alternatives: Back to the Bay, Necklaces of Lakes, and Riparian Corridor (San Jose/Santa Clara Water Pollution Control Plant Master Plan, 2011). However, the City does not have funding to implement these plans. They will focus their funding on the plant makeover. Currently, habitat restoration will only occur on plant lands or in Pond A18 with the involvement of additional partners.

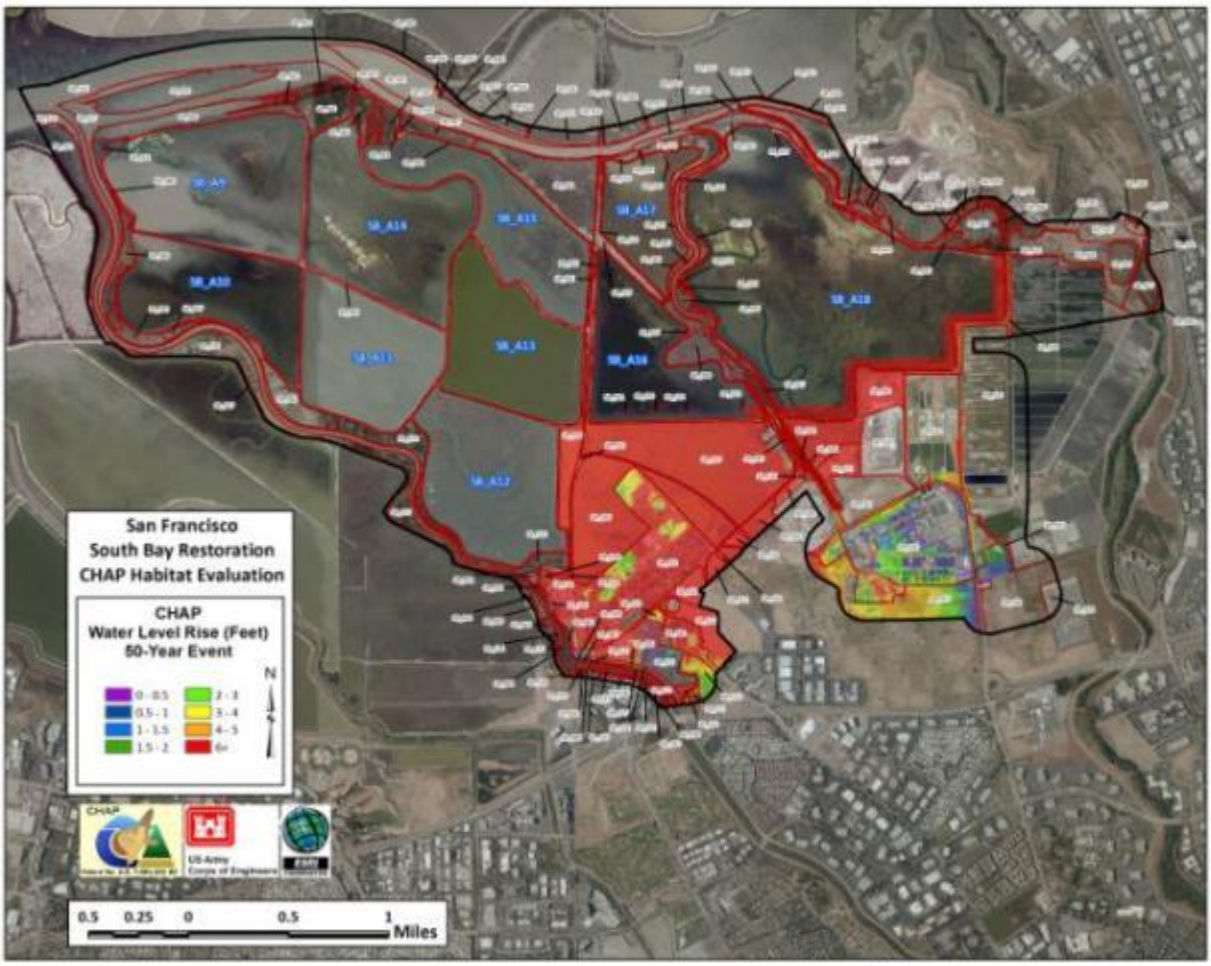

Figure 16. Depiction of the potential impact area from a 50 year flood event over the project area and adjacent lands.

Earthquakes

Earthquakes and their tremors are not uncommon in the San Francisco area. Figures 17a &17b depict the potential earthquake risk in and around the San Francisco area. If an earthquake occurred, the primary impact would be to infrastructure on the site. Salt pond levee/dikes are not engineered and might fail, but this risk is difficult to quantify and should be considered unquantifiable. That is, there is some risk of these structures failing, but during the 50-year evaluation period they are expected to be repaired after such an event even in the absence of a Corps project. Since the outermost levee is the highest one, this levee would be repaired to restore flood protection for urbanized areas and infrastructure, which would have the effect of maintaining non-tidal conditions for all the ponds. Also, liquefaction risk is high for current levees due to Bay mud that underlies the levees. Nonetheless, if this infrastructure failed, some flooding may occur and surface water is expected to flow back in the San Francisco South Bay.

The California Geological Survey has online a Probabilistic Seismic Hazards Mapping Ground Motion (Figure 17a). The USGS also indicated that the south segment of the Hayward Fault and the Peninsula segment of the San Andreas Fault are at high risk of a magnitude-7 quake in coming

decades. Such an earthquake might shake the study area more strongly than the 1989 quake. For a reasonable map of shaking potential, see http://redirect.conservation.ca.gov/cgs/rghm/pshamap/psha12237.html (last accessed 06/ 08/2012). Lastly, the USGS also depicts the likelihood of a 6.7 or greater earthquake from 2007 to 2036.

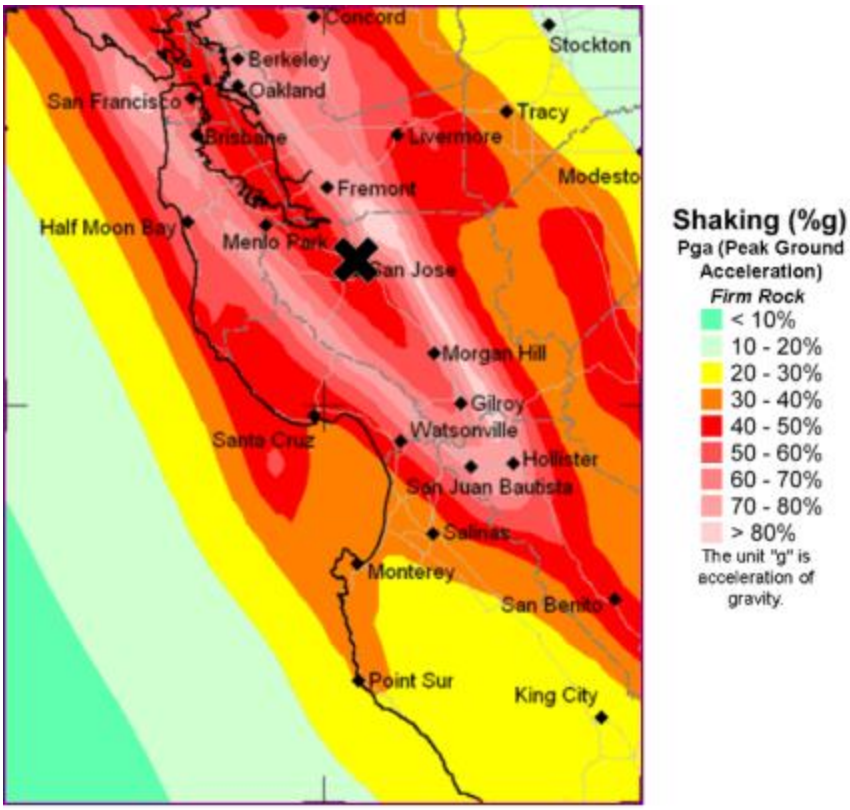

Figure 17a. Potential for ground motion within and near the project area as shown by California Geological Survey.
(Source: http://redirect.conservation.ca.gov/cgs/rghm/pshamap/psha12237.html; last accessed 06/ 08/2012).



Figure 17b. USGS map depicting the probability of a 6.7 or greater earthquake from 2007 to 2036 **(**Source: http://earthquake.usgs.gov/regional/nca/ucerf/images/2008probabilities-lrg.jpg; last accessed 6/15/2012).

Conclusion

To examine the future conditions that might exist without the proposed project, we began to put the project site into perspective by conducting a coarse evaluation of the amount of change in land use that has occurred from historic to modern times for the shoreline around the entire San Francisco Bay. To do this, the San Francisco Estuary Institute's Historic and Modern Bayland maps were used. This assessment showed an apparent loss in value that ranges from about 1.7 to 2.3 million habitat units for the area. To develop the future perspective for the next 50 years, additional steps were taken to obtain information on fish and wildlife species populations, invasive plant species, planned development, climate change influences and earthquake frequencies. Evaluating this information shows that there may be low turnover in species composition. Salinity levels will likely continue to control the spread of some of the invasive plants. Future planned development will occur in already developed areas. Sea level rise due to climate change may periodically expand the bay's aquatic footprint for short time periods in the Alviso area, and the design and engineering of the current levees and dikes are expected to withstand predictive earthquakes for the area.

However, if this infrastructure failed, some flooding may occur though the surface water is expected to flow back in the San Francisco South Bay.

Regarding uncertainty, any time we try to predict future conditions, whether for 10, 25 or 50 years from the present, there is a underlying degree of uncertainty associated with the above statements. Projections may change dramatically with further information in the future. In addition, information sources are not perfect. Planned development is closely associated with the economic conditions for an area;, although stated as a vision for 2040 we must remember that planning is dynamic and is also subject to change. For other outcomes that maybe affected by climate change, as mentioned 1 model out of 4 shows the potential for wetter conditions while that other 3 suggest drier conditions. Lastly, regarding prediction of potential catastrophic events such as earthquakes is extremely inexact and relies heavily on professional opinion; the likelihood of occurrence has a wide time interval associated with the predictions.

Citations

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Appendix A-1

Shoreline Study Project Species List for Baseline Conditions

[253 Fish and Wildlife Species]

SPP ID	Common Name	Scientific Name
10001	Pacific lamprey	*Lampetra tridentata*
10071	Sacramento sucker	*Catostomus occidentalis occidentalis*
10073	Threespine stickleback	*Gasterosteus aculeatus*
10081	Prickly sculpin	*Cottus asper*
10121	Striped bass	*Morone saxatilis*
10149	Common carp	*Cyprinus carpio*
10173	Starry flounder	*Platichthys stellatus*
10177	Goldfish	*Carassius auratus auratus*
10189	Western mosquito fish	*Gambusia affinis*
10221	Pacific staghorn sculpin	*Leptocottus armatus*
10233	American shad	*Alosa sapidissima*
10234	Threadfin shad	*Dorosma petenense*
10237	Shiner perch	*Cymatogaster aggregata*
10245	Longfin smelt	*Spirinchus thaleichthys*
10249	Green sturgeon	*Acipenser medirostris*
10295	Steelhead	*Oncorhynchus mykiss*
10325	Leopard shark	*Triakis semifasciata*
10326	Brown smoothhound	*Mustelus henlei*
10329	Soupfin shark	*Galeorhinus galeus*
10333	Spiny dogfish	*Squalus acanthias*
10337	Big skate	*Raja binoculata*
10341	California skate	*Raja inornata*
10361	Cabezon	*Scorpaenichthys marmoratus*
10405	Brown rockfish	*Sebastes auriculatus*
10537	English sole	*Parophrys vetulus*
10538	California tonguefish	*Symphurus atricaudus*
10539	Diamond turbot	*Hypsopsetta guttulata*
10545	Pacific sanddab	*Citharichthys sordidus*
10561	Sand sole	*Psettichthys melanostictus*
10585	Chinook salmon	*Oncorhynchus tshawytscha*
10589	Pink salmon	*Oncorhynchus gorbuscha*
10593	Chum salmon	*Oncorhynchus keta*
10628	Longjawed mudsucker	*Gillichthys mirabilis*

SPP ID	Common Name	Scientific Name
10629	Bay goby	*Lepidogobius lepidus*
10633	Arrow goby	*Clevelandia ios*
10634	Cheekspot goby	*Ilypnus gilberti*
10637	Speckled sanddab	*Citharichthys stigmaeus*
10641	Pacific herring	*Clupea pallasii*
10648	Barred surfperch	*Amphistichus argenteus*
10653	Surf Smelt	*Hypomesus pretiosus*
10657	Whitebait smelt	*Allosmerus elongatus*
10669	Bay pipefish	*Syngnathus leptorhynchus*
10686	Dwarf surfperch	*Micrometrus minimus*
10729	Plainfin midshipman	*Porichthys notatus*
10757	Topsmelt	*Atherinops affinis*
10758	Jack smelt	*Atherinopsis californiensis*
10765	Pacific sardine	*Sardinops sagax*
10808	Bat ray	*Myliobatis californica*
10817	Northern anchovy	*Engraulis mordax*
11113	White croaker	*Genyonemus lineatus*
11197	California halibut	*Paralichthys californicus*
30100	Southern alligator lizard	*Elgaria multicarinata*
30160	Western fence lizard	*Sceloporus occidentalis*
30290	Gopher snake	*Pituophis melanoleuca*
30320	Western terrestrial garter snake	*Thamnophis elegans*
30340	Common garter snake	*Thamnophis sirtalis*
30350	Western rattlesnake	Crotalus oreganus
40050	Pied-billed Grebe	*Podilymbus podiceps*
40060	Horned Grebe	*Podiceps auritus*
40070	Red-necked Grebe	*Podiceps grisegena*
40080	Eared Grebe	*Podiceps nigricollis*
40090	Western Grebe	*Aechmophorus occidentalis*
40100	Clark’s Grebe	*Aechmophorus clarkii*
40320	American White Pelican	*Pelecanus erythrorhynchos*
40330	Brown Pelican	*Pelecanus occidentalis*
40350	Double-crested Cormorant	*Phalacrocorax auritus*
40380	American Bittern	*Botaurus lentiginosus*
40390	Least Bittern	*Ixobrychus exilis*
40400	Great Blue Heron	*Ardea herodias*

SPP ID	Common Name	Scientific Name
40410	Great Egret	*Ardea alba*
40420	Snowy Egret	*Egretta thula*
40450	Cattle Egret	*Bubulcus ibis*
40460	Green Heron	*Butorides virescens*
40470	Black-crowned Night-Heron	*Nycticorax nycticorax*
40500	Turkey Vulture	*Cathartes aura*
40530	Greater White-fronted Goose	*Anser albifrons*
40570	Canada Goose	*Branta canadensis*
40640	Gadwall	*Anas strepera*
40660	Eurasian Wigeon	*Anas penelope*
40670	American Wigeon	*Anas americana*
40690	Mallard	*Anas platyrhynchos*
40700	Blue-winged Teal	*Anas discors*
40710	Cinnamon Teal	*Anas cyanoptera*
40720	Northern Shoveler	*Anas clypeata*
40730	Northern Pintail	*Anas acuta*
40760	Green-winged Teal	*Anas crecca*
40770	Canvasback	*Aythya valisineria*
40780	Redhead	*Aythya americana*
40790	Ring-necked Duck	*Aythya collaris*
40810	Greater Scaup	*Aythya marila*
40820	Lesser Scaup	*Aythya affinis*
40860	Surf Scoter	*Melanitta perspicillata*
40870	White-winged Scoter	*Melanitta fusca*
40880	Black Scoter	*Melanitta nigra*
40890	Long-tailed Duck	*Clangula hyemalis*
40900	Bufflehead	*Bucephala albeola*
40910	Common Goldeneye	*Bucephala clangula*
40920	Barrow's Goldeneye	*Bucephala islandica*
40940	Hooded Merganser	*Lophodytes cucullata*
40950	Common Merganser	*Mergus merganser*
40970	Ruddy Duck	*Oxyura jamaicensis*
40980	Osprey	*Pandion haliaetus*
40990	White-tailed Kite	*Elanus coeruleus*
41010	Northern Harrier	*Circus cyaneus*
41020	Sharp-shinned Hawk	*Accipiter striatus*

SPP ID	Common Name	Scientific Name
41030	Cooper's Hawk	*Accipiter cooperii*
41050	Red-shouldered Hawk	*Buteo lineatus*
41080	Red-tailed Hawk	*Buteo jamaicensis*
41090	Ferruginous Hawk	*Buteo regalis*
41110	Golden Eagle	*Aquila chrysaetos*
41120	American Kestrel	*Falco sparverius*
41130	Merlin	*Falco columbarius*
41150	Peregrine Falcon	*Falco peregrinus*
41190	Ring-necked Pheasant	*Phasianus colchicus*
41290	California Quail	*Callipepla californica*
41311	California Black Rail	*Laterallus jamaicensis coturniculus*
41320	Virginia Rail	*Rallus limicola*
41321	California Clapper rail	*Rallus longirostris obsoletus*
41330	Sora	*Porzana carolina*
41340	Common Moorhen	*Gallinula chloropus*
41350	American Coot	*Fulica americana*
41370	Black-bellied Plover	*Pluvialis squatarola*
41380	American Golden-Plover	*Pluvialis dominica*
41410	Western Snowy Plover	*Charadrius alexandrinus nivosus*
41420	Semipalmated Plover	*Charadrius semipalmata*
41440	Killdeer	*Charadrius vociferus*
41480	Black-necked Stilt	*Himantopus mexicanus*
41490	American Avocet	*Recurvirostra americana*
41500	Greater Yellowlegs	*Tringa melanoleuca*
41510	Lesser Yellowlegs	*Tringa flavipes*
41540	Willet	*Catoptrophorus semipalmatus*
41570	Spotted Sandpiper	*Actitis macularia*
41590	Whimbrel	*Numenius phaeopus*
41610	Long-billed Curlew	*Numenius americanus*
41640	Marbled Godwit	*Limosa fedoa*
41650	Ruddy Turnstone	*Arenaria interpres*
41700	Sanderling	*Calidris alba*
41710	Semipalmated Sandpiper	*Calidris pusilla*
41720	Western Sandpiper	*Calidris mauri*
41760	Least Sandpiper	*Calidris minutilla*
41820	Dunlin	*Calidris alpina*

SPP ID	Common Name	Scientific Name
41860	Ruff	*Philomachus pugnax*
41870	Short-billed Dowitcher	*Limnodromus griseus*
41880	Long-billed Dowitcher	*Limnodromus scolopaceus*
41900	Wilson's Phalarope	*Phalaropus tricolor*
42010	Bonaparte's Gull	*Larus Philadelphia*
42020	Heermann's Gull	*Larus heermanni*
42030	Mew Gull	*Larus canus*
42040	Ring-billed Gull	*Larus delawarensis*
42050	California Gull	*Larus californicus*
42060	Herring Gull	*Larus argentatus*
42070	Thayer's Gull	*Larus thayeri*
42100	Western Gull	*Larus occidentalis*
42110	Glaucous-winged Gull	*Larus glaucescens*
42120	Glaucous Gull	*Larus hyperboreus*
42130	Sabine's Gull	*Xena sabini*
42180	Caspian Tern	*Sterna caspia*
42201	Black Skimmer	*Rynchops niger*
42220	Forster's Tern	*Sterna forsteri*
42230	California Least Tern	*Sterna antillarum browni*
42380	Rock Pigeon	*Columba livia*
42390	Band-tailed Pigeon	*Columba fasciata*
42410	Mourning Dove	*Zenaida macroura*
42440	Barn Owl	*Tyto alba*
42470	Great Horned Owl	*Bubo virginianus*
42510	Burrowing Owl	*Athene cunicularia*
42560	Short-eared Owl	*Asio flammeus*
42650	Anna's Hummingbird	*Calypte anna*
42700	Allen's Hummingbird	*Selasphorus sasin*
42710	Belted Kingfisher	*Ceryle alcyon*
42840	Northern Flicker	*Colaptes auratus*
42940	Pacific-slope Flycatcher	*Empidonax difficilis*
42960	Black Phoebe	*Sayornis nigricans*
42980	Say's Phoebe	*Sayornis saya*
43060	Loggerhead Shrike	*Lanius ludovicianus*
43200	Western Scrub-Jay	*Aphelocoma californica*
43240	American Crow	*Corvus brachyrhynchos*

SPP ID	Common Name	Scientific Name
43260	Common Raven	*Corvus corax*
43280	Horned Lark	*Eremophila alpestris*
43300	Tree Swallow	*Tachycineta bicolor*
43310	Violet-green Swallow	*Tachycineta thalassina*
43320	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
43330	Bank Swallow	*Riparia riparia*
43340	Cliff Swallow	*Petrochelidon pyrrhonota*
43350	Barn Swallow	*Hirundo rustica*
43380	Chestnut-backed Chickadee	*Poecile rufescens*
43400	Oak Titmouse	Baeolophus inornatus
43420	Bushtit	*Psaltriparus minimus*
43490	Bewick's Wren	*Thryomanes bewickii*
43500	House Wren	*Troglodytes aedon*
43520	Marsh Wren	*Cistothorus palustris*
43550	Ruby-crowned Kinglet	*Regulus calendula*
43640	Hermit Thrush	*Catharus guttatus*
43660	American Robin	*Turdus migratorius*
43700	Northern Mockingbird	*Mimus polyglottos*
43740	European Starling	*Sturnus vulgaris*
43820	Cedar Waxwing	*Bombycilla cedrorum*
43970	Yellow-rumped Warbler	*Dendroica coronata*
44000	Townsend's Warbler	*Dendroica townsendi*
44180	Common Yellowthroat	*Geothlypis trichas*
44180	San Francisco Common Yellowthroat	*Geothlypis trichas sinuosa*
44270	Spotted Towhee	*Pipilo maculatus*
44280	California Towhee	*Pipilo crissalis*
44390	Bryant's savannah sparrow	*Passerculus sandwichensis alaudinus*
44430	Fox Sparrow	*Passerella iliaca*
44440	Alameda song sparrow	*Melospiza melodia pusillula*
44440	Song sparrow	*Melospiza melodia*
44490	White-crowned Sparrow	*Zonotrichia atricapilla*
44500	Golden-crowned Sparrow	*Zonotrichia atricapilla*
44510	Dark-eyed Junco	*Junco hyemalis*
44590	Black-headed Grosbeak	*Pheucticus melanocephalus*
44660	Red-winged Blackbird	*Agelaius phoeniceus*

SPP ID	Common Name	Scientific Name
44670	Tricolored Blackbird	*Agelaius tricolor*
44680	Western Meadowlark	*Sturnella neglecta*
44710	Brewer's Blackbird	*Euphagus cyanocephalus*
44740	Brown-headed Cowbird	*Molothrus ater*
44760	Hooded Oriole	*Icterus cucullatus*
44790	Bullock's Oriole	*Icterus bullockii*
44870	House Finch	*Carpodacus mexicanus*
44930	Lesser Goldfinch	*Carduelis psaltria*
44950	American Goldfinch	*Carduelis tristis*
44970	House Sparrow	*Passer domesticus*
50010	Virginia opossum	Didelphis virginiana
50035	Ornate Shrew	Sorex ornatus
50040	Salt marsh wandering shrew	*Sorex vagrans halicoetes*
50110	Trowbridge's Shrew	Sorex trowbridgii
50200	Yuma myotis	*Myotis yumanensis*
50285	Western red bat	*Lasirurs blossevillii*
50290	Hoary bat	*Lasiurus cinereus*
50330	Mexican free-tailed bat	*Tadarida brasiliensis*
50360	Brush rabbit	*Sylvilagus bachmani*
50381	Audubon's cottontail	*Sylvilagus audubonii*
50420	Black-tailed jackrabbit	*Lepus californicus*
50610	California ground squirrel	*Spermophilus beecheyi*
50730	Botta's pocket gopher	*Thomomys bottae*
50820	Western harvest mouse	*Reithrodontomys megalotis*
50821	Salt marsh harvest mouse	*Reithrodontomys raviventris raviventris*
50830	Deer mouse	*Peromyscus maniculatus*
50990	California vole	*Microtus californicus*
51050	Common muskrat	*Ondatra zibethicus*
51070	Black rat	*Rattus rattus*
51080	Norway rat	*Rattus norvegicus*
51090	House mouse	*Mus musculus*
51140	Coyote	*Canis latrans*
51160	Red fox	*Vulpes vulpes*
51180	Gray fox	*Urocyon cinereoargenteus*
51220	Raccoon	*Procyon lotor*

SPP ID	Common Name	Scientific Name
51260	Long-tailed weasel	*Mustela frenata*
51300	Western spotted skunk	*Spilogale gracilis*
51310	Striped skunk	*Mephitis mephitis*
51330	Mountain lion	*Felis concolor*
51405	Mule Deer	*Odocoileus hemionus*
60040	Pacific harbor seal	*Phoca vitulina richardsi*

Appendix A-2
Species and Habitat Associations for Baseline Conditions

[253 Fish and Wildlife Species]

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Pacific lamprey		1								1					
Sacramento sucker										1					
Threespine stickleback	1	1		1			1	1		1			1		
Prickly sculpin		1		1				1		1					
Striped bass		1		1				1		1			1		
Common carp		1		1						1					
Starry flounder		1		1						1			1		
Goldfish				1						1					
Western mosquito fish		1		1						1					
Pacific staghorn sculpin	1	1					1	1		1			1		
American shad		1		1				1		1					
Threadfin shad		1		1				1		1					
Shiner perch	1	1					1	1		1			1		
Longfin smelt		1						1		1					
Green sturgeon				1						1					
Steelhead				1						1					
Leopard shark	1						1	1		1			1		
Brown smoothhound	1						1			1					

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Soupfin shark										1					
Spiny dogfish										1					
Big skate										1					
California skate										1					
Cabezon										1					
Brown rockfish								1		1					
English sole										1			1		
California tonguefish										1					
Diamond turbot	1						1			1					
Pacific sanddab										1					
Sand sole										1					
Chinook salmon		1		1						1			1		
Pink salmon		1		1						1					
Chum salmon		1		1						1					
Longjawed mudsucker	1	1					1	1		1					
Bay goby	1							1		1					
Arrow goby	1							1		1			1		
Cheekspot goby										1					
Speckled sanddab							1			1					
Pacific herring	1	1						1		1			1		
Barred surfperch	1						1	1		1			1		
Surf Smelt		1								1					

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Whitebait smelt										1					
Bay pipefish		1					1			1			1		
Dwarf surfperch										1					
Plainfin midshipman	1							1		1					
Topsmelt	1	1					1	1		1			1		
Jack smelt	1	1						1		1			1		
Pacific sardine										1					
Bat ray	1	1					1	1		1			1		
Northern anchovy	1	1					1	1		1			1		
White croaker										1					
California halibut										1					
Southern alligator lizard					1						1				1
Western fence lizard					1						1				1
Gopher snake					1						1	1			1
Western terrestrial garter snake					1						1	1			1
Common garter snake					1						1	1			1
Western rattlesnakes					1						1				1
Pied-billed Grebe	1			1			1			1		1	1		
Horned Grebe	1			1			1			1		1	1		
Red-necked Grebe	1			1			1								
Eared Grebe	1						1			1			1	1	
Western Grebe	1			1			1			1					

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Clark's Grebe	1			1			1			1					
American White Pelican	1					1	1			1					
Brown Pelican	1					1	1								
Double-crested Cormorant	1					1	1			1					
American Bittern		1		1								1	1		
Least Bittern		1		1					1			1	1		
Great Blue Heron	1	1		1	1	1	1	1	1			1	1	1	
Great Egret		1		1		1	1	1	1			1	1	1	
Snowy Egret	1	1		1		1	1	1				1	1		
Cattle Egret		1		1		1						1			
Green Heron		1		1								1			
Black-crowned Night-Heron		1		1	1							1			
Turkey Vulture	1				1	1			1						1
Greater White-fronted Goose						1	1		1		1				
Canada Goose		1	1	1		1	1		1	1	1		1	1	1
Gadwall	1	1		1		1	1			1		1	1	1	
Eurasian Wigeon							1		1	1					
American Wigeon				1					1	1			1	1	
Mallard	1	1		1		1	1		1	1	1	1	1	1	
Blue-winged Teal		1		1					1	1		1	1		
Cinnamon Teal		1		1					1	1		1	1	1	
Northern Shoveler	1	1		1		1	1		1	1			1	1	

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Northern Pintail	1			1					1	1			1	1	
Green-winged Teal	1	1		1			1		1	1			1	1	
Canvasback		1		1			1			1					
Redhead				1			1			1				1	
Ring-necked Duck							1			1					
Greater Scaup	1						1								
Lesser Scaup	1	1					1								
Surf Scoter							1								
White-winged Scoter							1								
Black Scoter							1								
Long-tailed Duck							1								
Bufflehead	1			1			1			1					
Common Goldeneye							1			1					
Barrow's Goldeneye							1								
Hooded Merganser				1			1			1		1			
Common Merganser				1			1			1		1			
Ruddy Duck	1			1		1	1			1				1	
Osprey										1		1			1
White-tailed Kite		1							1			1			1
Northern Harrier		1		1									1		1
Sharp-shinned Hawk												1			1
Cooper's Hawk					1							1			1

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Red-shouldered Hawk					1							1			1
Red-tailed Hawk					1							1			1
Ferruginous Hawk					1							1			1
Golden Eagle					1										1
American Kestrel													1		1
Merlin															1
Peregrine Falcon					1								1		1
Ring-necked Pheasant					1						1	1			1
California Quail											1	1			1
California Black Rail									1				1		
Virginia Rail		1		1					1				1		
California Clapper rail													1		
Sora		1		1									1		
Common Moorhen		1		1					1			1	1		
American Coot	1	1		1			1	1		1	1	1	1	1	1
Black-bellied Plover	1					1	1	1						1	
American Golden-Plover						1	1	1							
Western Snowy Plover						1	1	1							
Semipalmated Plover						1	1	1					1	1	
Killdeer	1		1			1	1	1	1					1	1
Black-necked Stilt	1					1	1	1	1				1	1	
American Avocet	1	1				1	1	1	1				1	1	

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Greater Yellowlegs	1					1	1	1	1				1	1	
Lesser Yellowlegs	1					1	1	1					1	1	
Willet	1					1	1	1	1				1	1	
Spotted Sandpiper								1					1		
Whimbrel	1					1	1	1	1						
Long-billed Curlew	1					1	1	1	1				1	1	
Marbled Godwit	1					1	1	1					1	1	
Ruddy Turnstone						1	1	1							
Sanderling	1						1	1							
Semipalmated Sandpiper						1	1	1							
Western Sandpiper						1	1	1					1	1	
Least Sandpiper	1					1	1	1					1	1	
Dunlin	1					1	1	1	1				1	1	
Ruff	1							1							
Short-billed Dowitcher	1					1	1	1						1	
Long-billed Dowitcher	1					1	1	1						1	
Wilson's Phalarope	1			1			1							1	
Bonaparte's Gull	1					1	1							1	
Heermann's Gull						1	1								
Mew Gull	1					1	1							1	
Ring-billed Gull	1		1		1	1	1		1	1	1		1	1	
California Gull	1		1		1	1	1			1	1		1	1	

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Herring Gull	1				1	1	1			1			1	1	
Thayer's Gull	1				1	1	1			1				1	
Western Gull	1		1		1	1	1			1	1		1		
Glaucous-winged Gull					1	1	1			1	1				
Glaucous Gull					1	1	1								
Sabine's Gull						1	1								
Caspian Tern	1			1		1	1			1					
Black Skimmer						1	1			1					
Forster's Tern	1			1		1	1			1					
California Least Tern						1	1			1					
Rock Pigeon			1		1						1				1
Band-tailed Pigeon			1								1				1
Mourning Dove			1		1						1				1
Barn Owl											1	1			1
Great Horned Owl									1		1	1			1
Burrowing Owl					1						1				1
Short-eared Owl															1
Anna's Hummingbird											1	1			1
Allen's Hummingbird											1	1			1
Belted Kingfisher		1		1								1			
Northern Flicker											1	1			1
Pacific-slope Flycatcher									1			1			1

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Black Phoebe			1								1	1	1		1
Say's Phoebe											1	1			1
Loggerhead Shrike											1	1			1
Western Scrub-Jay			1		1						1	1			1
American Crow			1		1						1	1			1
Common Raven	1		1		1						1	1			1
Horned Lark					1										1
Tree Swallow				1						1		1	1		1
Violet-green Swallow				1						1		1	1		1
Northern Rough-winged Swallow				1						1		1	1		1
Bank Swallow				1						1		1	1		1
Cliff Swallow				1						1		1	1		1
Barn Swallow				1						1		1	1		1
Chestnut-backed Chickadee											1	1			1
Oak Titmouse											1	1			1
Bushtit											1	1			1
Bewick's Wren												1			1
House Wren			1						1		1	1			1
Marsh Wren				1								1	1		
Ruby-crowned Kinglet											1	1			1
Hermit Thrush											1	1			1
American Robin			1								1	1			1

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Northern Mockingbird			1		1						1	1			1
European Starling			1		1						1	1			1
Cedar Wa1wing											1	1			1
Yellow-rumped Warbler											1	1			1
Townsend's Warbler									1		1	1			1
Common Yellowthroat		1		1					1		1	1			1
San Francisco common yellowthroat		1		1								1			
Spotted Towhee											1	1			1
California Towhee											1	1			1
Bryant's savannah sparrow											1	1		1	1
Fox Sparrow									1		1	1			1
Alameda song sparrow		1		1								1	1		1
Song sparrow		1		1					1		1	1	1		
White-crowned Sparrow		1							1		1	1			1
Golden-crowned Sparrow		1									1	1			1
Dark-eyed Junco											1	1			1
Black-headed Grosbeak											1	1			1
Red-winged Blackbird		1		1								1	1	1	1
Tricolored Blackbird		1		1								1			1
Western Meadowlark		1		1							1	1			1
Brewer's Blackbird			1		1						1	1			1
Brown-headed Cowbird											1	1			1

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
Hooded Oriole											1	1			1
Bullock's Oriole											1	1			1
House Finch			1								1	1			1
Lesser Goldfinch											1	1			1
American Goldfinch											1	1			1
House Sparrow			1		1						1	1			1
Virginia opossum			1		1				1		1	1			1
Ornate Shrew		1							1				1		1
Salt marsh wandering shrew		1											1		1
Trowbridge's Shrew															1
Yuma myotis				1							1	1	1		1
Western red bat											1	1	1		1
Hoary bat				1							1	1	1		1
Mexican free-tailed bat				1							1	1	1		1
Brush rabbit											1	1			1
Audubon's cottontail											1	1			1
Black-tailed jackrabbit					1							1			1
California ground squirrel					1						1				1
Botta's pocket gopher					1				1		1				1
Western harvest mouse		1							1				1	1	
Salt marsh harvest mouse		1							1				1	1	
Deer mouse				1					1				1		1

Common Name	Batch Pond	Brackish Marsh	Developed	Freshwater Marsh	Landfill	Levee	Managed Pond	Tidal Flats/ Mudflat	Muted Tidal / Diked Marsh	Open Water /Slough Channel	Parks / Upland Grassland	Riparian/Creek Corridor	Saline Marsh	Seasonal Wetland	Upland Vegetation
California vole		1			1				1		1	1	1		1
Common muskrat		1		1						1		1	1		1
Black rat			1		1				1			1			1
Norway rat			1		1				1				1	1	1
House mouse			1		1								1	1	1
Coyote											1	1			1
Red fox												1			1
Gray fox												1			1
Raccoon			1	1	1						1	1	1		1
Long-tailed weasel												1			1
Western spotted skunk												1			1
Striped skunk			1	1	1							1			1
Mountain lion												1			1
Mule Deer											1	1			1
Pacific harbor seal								1		1			1		

Appendix A-3
Pond Species by Season (present=1, not present=0)

SPPID	Common Name	Season	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18
40050	Pied-billed Grebe	Fall	1	1	1	1	1	1	1	1	1	1
40060	Horned Grebe	Fall	1	1	1	0	1	1	1	1	1	1
40080	Eared Grebe	Fall	1	1	1	1	1	1	1	1	1	1
40090	Western Grebe	Fall	1	1	1	1	1	1	1	1	1	1
40100	Clark's Grebe	Fall	1	1	1	1	1	1	1	1	1	1
40320	American White Pelican	Fall	1	1	1	1	1	1	1	1	1	1
40330	Brown Pelican	Fall	1	1	1	1	1	1	0	1	1	1
40350	Double-crested Cormorant	Fall	1	1	1	1	1	1	1	1	1	1
40400	Great Blue Heron	Fall	1	1	1	1	1	1	1	1	1	1
40410	Great Egret	Fall	1	1	1	1	1	1	1	1	1	1
40420	Snowy Egret	Fall	1	1	1	1	1	1	1	1	1	1
40470	Black-crowned Night-Heron	Fall	1	0	0	0	0	1	0	1	1	1
40500	Turkey Vulture	Fall	1	1	1	1	1	1	1	1	1	1
40571	Canada Goose	Fall	1	1	0	0	0	0	0	1	1	0
40640	Gadwall	Fall	1	1	1	0	1	1	1	1	1	1
40660	Eurasian Wigeon	Fall	1	0	0	0	0	0	0	0	1	0
40670	American Wigeon	Fall	1	1	1	1	0	1	0	1	1	1
40690	Mallard	Fall	1	1	1	1	1	1	1	1	1	1
40700	Blue-winged Teal	Fall	1	0	0	0	0	0	0	1	1	0
40710	Cinnamon Teal	Fall	1	1	0	0	0	0	0	0	1	0
40720	Northern Shoveler	Fall	1	1	1	1	1	1	1	1	1	1
40730	Northern Pintail	Fall	1	1	1	0	1	1	0	1	1	1
40760	American Green-winged Teal	Fall	1	1	0	0	0	0	1	1	1	0
40770	Canvasback	Fall	1	1	1	0	1	1	0	0	1	1
40780	Redhead	Fall	1	1	1	0	0	1	0	1	0	1
40810	Greater scaup	Fall	1	1	1	0	1	1	1	1	1	1
40820	Lesser scaup	Fall	1	1	1	0	1	1	1	1	1	0

SPPID	Common Name	Season	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18
40860	Surf Scoter	Fall	1	1	1	0	0	0	0	0	0	0
40870	White-winged scoter	Fall	0	0	1	0	0	0	0	0	0	0
40900	Bufflehead	Fall	1	1	1	0	0	9	1	1	1	1
40910	Common Goldeneye	Fall	1	1	1	0	0	1	1	1	1	1
40940	Hooded Merganser	Fall	0	1	0	0	0	0	0	0	0	0
40950	Common Merganser	Fall	0	1	0	0	0	1	0	0	0	1
40960	Red-breasted Merganser	Fall	1	1	1	1	1	1	0	0	1	1
40970	Ruddy Duck	Fall	1	1	1	1	1	1	1	1	1	1
40990	White-tailed Kite	Fall	1	0	0	0	0	0	0	0	0	0
41010	Northern Harrier	Fall	1	0	0	0	1	1	1	2	1	1
41080	Red-tailed Hawk	Fall	1	1	1	1	1	1	1	0	0	1
41130	Merlin	Fall	0	0	0	0	0	0	0	0	0	0
41150	Peregrine Falcon	Fall	1	1	0	1	1	1	1	0	1	1
41350	American Coot	Fall	1	1	1	1	1	1	1	1	1	1
41370	Black-bellied Plover	Fall	1	0	1	1	1	1	1	1	1	1
41420	Semipalmated Plover	Fall	1	0	0	1	0	0	0	1	1	0
41440	Killdeer	Fall	0	0	0	1	0	0	1	1	1	0
41480	Black-necked Stilt	Fall	1	0	0	1	1	1	1	1	1	1
41490	American Avocet	Fall	1	1	1	1	1	1	1	1	1	1
41500	Greater Yellowlegs	Fall	1	1	1	1	1	1	1	1	1	1
41510	Lesser Yellowlegs	Fall	1	0	0	1	1	1	1	1	1	1
41540	Willet	Fall	1	1	1	1	1	1	1	1	1	1
41590	Whimbrel	Fall	1	1	0	0	0	0	1	0	0	0
41610	Long-billed Curlew	Fall	1	1	0	0	0	1	1	0	1	1
41640	Marbled Godwit	Fall	1	1	1	0	1	1	1	1	1	1
41700	Sanderling	Fall	0	0	0	1	0	0	1	0	0	0
41720	Western Sandpiper	Fall	1	1	1	1	1	1	1	1	1	1
41760	Least Sandpiper	Fall	1	1	1	1	1	1	1	1	1	1
41790	Pectoral Sandpiper	Fall	0	0	0	0	0	0	0	1	0	0
41820	Dunlin	Fall	1	0	1	1	0	1	1	1	0	1

SPPID	Common Name	Season	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18
41860	Ruff	Fall	0	0	0	0	1	0	0	0	0	0
41870	Short-billed Dowitcher	Fall	1	0	0	0	1	1	1	1	1	1
41880	Long-billed Dowitcher	Fall	1	0	0	0	1	1	1	1	1	0
41910	Red-necked Phalarope	Fall	0	0	0	1	1	1	1	0	0	1
42010	Bonaparte's Gull	Fall	1	1	1	1	1	1	1	1	1	1
42030	Mew Gull	Fall	0	0	1	0	1	0	1	1	0	0
42040	Ring-billed Gull	Fall	1	1	1	1	1	1	1	1	1	1
42050	California Gull	Fall	1	1	1	1	1	1	1	1	1	1
42060	Herring Gull	Fall	1	1	1	1	1	1	1	1	1	1
42070	Thayer's Gull	Fall	0	0	0	0	1	0	0	0	1	0
42100	Western Gull	Fall	1	1	1	1	1	1	1	1	1	1
42110	Glaucous-winged Gull	Fall	0	0	1	0	0	0	0	0	0	0
42180	Caspian Tern	Fall	1	1	1	1	1	1	1	0	1	1
42190	Elegant Tern	Fall	1	1	1	0	1	0	1	1	1	0
42201	Black Skimmer	Fall	0	0	0	0	0	0	0	1	0	0
42220	Forster's Tern	Fall	1	1	1	1	1	1	1	1	1	1
42230	Least Tern	Fall	0	1	0	0	0	0	0	0	0	0
42240	Black Tern	Fall	0	0	1	0	0	0	0	1	0	0
43240	American Crow	Fall	0	0	0	0	0	0	0	0	1	0
43260	Common Raven	Fall	1	1	1	1	1	1	1	1	1	1
40020	Pacific Loon	Winter	0	0	1	0	0	0	0	0	0	0
40050	Pied-billed Grebe	Winter	1	1	1	1	1	1	1	1	1	1
40060	Horned Grebe	Winter	1	1	1	0	1	0	1	1	0	0
40080	Eared Grebe	Winter	1	1	1	1	1	1	1	1	1	1
40090	Western Grebe	Winter	1	1	1	1	1	1	1	1	1	1
40100	Clark's Grebe	Winter	1	1	1	1	1	1	0	1	0	1
40320	American White Pelican	Winter	1	1	1	0	1	1	0	1	1	1
40330	Brown Pelican	Winter	0	1	1	1	1	1	0	1	1	1
40350	Double-crested Cormorant	Winter	1	1	1	1	1	1	1	1	1	1
40400	Great Blue Heron	Winter	1	1	1	1	1	1	1	1	1	1

SPPID	Common Name	Season	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18
40410	Great Egret	Winter	1	1	1	1	1	1	1	1	1	1
40420	Snowy Egret	Winter	1	1	1	1	1	1	0	1	1	1
40470	Black-crowned Night-Heron	Winter	1	0	1	0	0	0	0	1	0	0
40500	Turkey Vulture	Winter	1	1	1	1	1	1	1	1	1	1
40550	Snow Goose	Winter	1	0	0	0	0	0	0	0	0	0
40571	Canada Goose	Winter	1	1	1	1	1	1	1	1	1	1
40640	Gadwall	Winter	1	1	1	1	1	1	1	1	1	1
40660	Eurasian Wigeon	Winter	1	1	0	0	0	1	0	1	1	0
40670	American Wigeon	Winter	1	1	1	1	1	1	0	1	1	1
40690	Mallard	Winter	1	1	1	1	0	1	1	1	1	1
40700	Blue-winged Teal	Winter	0	0	0	0	0	0	0	0	1	0
40710	Cinnamon Teal	Winter	1	1	0	0	0	0	0	1	1	0
40720	Northern Shoveler	Winter	1	1	1	1	1	1	1	1	1	1
40730	Northern Pintail	Winter	1	1	1	1	1	1	0	1	1	1
40760	American Green-winged Teal	Winter	1	1	1	0	1	1	0	1	1	1
40770	Canvasback	Winter	1	1	1	1	0	1	0	0	0	1
40780	Redhead	Winter	1	1	1	0	0	1	1	1	1	1
40810	Greater scaup	Winter	1	1	1	1	1	1	1	1	1	1
40820	Lesser scaup	Winter	1	1	1	1	1	1	1	1	1	1
40860	Surf Scoter	Winter	0	1	1	0	0	1	0	1	1	1
40870	White-winged scoter	Winter	0	1	1	0	0	1	0	0	0	1
40900	Bufflehead	Winter	1	1	1	1	1	1	1	1	1	1
40910	Common Goldeneye	Winter	1	1	1	1	1	1	1	1	1	1
40950	Common Merganser	Winter	0	1	0	1	0	1	0	0	0	1
40960	Red-breasted Merganser	Winter	1	1	1	1	1	1	1	1	1	1
40970	Ruddy Duck	Winter	1	1	1	1	1	1	1	1	1	1
40990	White-tailed Kite	Winter	0	0	1	0	0	1	0	0	0	1
41010	Northern Harrier	Winter	1	1	1	0	0	1	2	1	3	1
41080	Red-tailed Hawk	Winter	1	1	1	0	1	1	1	1	1	1
41120	American Kestrel	Winter	0	0	0	0	0	1	0	0	0	1

SPPID	Common Name	Season	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18
41130	Merlin	Winter	1	1	0	0	0	0	0	0	0	0
41150	Peregrine Falcon	Winter	0	1	1	1	1	1	1	0	1	1
41350	American Coot	Winter	1	1	1	1	1	1	0	1	1	1
41370	Black-bellied Plover	Winter	1	1	1	1	0	1	1	1	0	1
41420	Semipalmated Plover	Winter	1	0	0	0	0	1	1	1	0	1
41440	Killdeer	Winter	0	0	0	1	0	0	0	1	0	0
41480	Black-necked Stilt	Winter	1	1	0	1	1	1	1	1	1	1
41490	American Avocet	Winter	1	1	1	1	1	1	1	1	1	1
41500	Greater Yellowlegs	Winter	1	0	1	1	1	1	1	1	1	1
41510	Lesser Yellowlegs	Winter	1	1	0	1	0	1	0	1	1	1
41540	Willet	Winter	1	1	1	1	1	1	1	1	1	1
41590	Whimbrel	Winter	1	0	0	0	0	1	1	0	0	1
41610	Long-billed Curlew	Winter	1	0	0	0	0	1	1	1	1	1
41640	Marbled Godwit	Winter	1	1	0	0	0	1	1	1	1	1
41700	Sanderling	Winter	1	0	0	1	1	1	1	1	0	1
41720	Western Sandpiper	Winter	1	1	1	1	1	1	1	1	1	1
41760	Least Sandpiper	Winter	1	1	1	1	1	1	1	1	1	1
41820	Dunlin	Winter	1	0	0	1	1	1	1	1	1	1
41870	Short-billed Dowitcher	Winter	1	0	0	1	0	1	1	1	1	1
41880	Long-billed Dowitcher	Winter	1	0	0	1	0	1	1	1	1	1
41910	Red-necked Phalarope	Winter	0	0	1	0	0	0	0	0	0	0
42010	Bonaparte's Gull	Winter	0	0	1	1	1	1	1	1	1	1
42030	Mew Gull	Winter	0	1	1	1	1	1	1	1	1	1
42040	Ring-billed Gull	Winter	1	1	1	1	1	1	1	1	1	1
42050	California Gull	Winter	1	1	1	1	1	1	1	1	1	1
42060	Herring Gull	Winter	1	1	1	1	1	1	1	1	1	1
42070	Thayer's Gull	Winter	1	0	0	1	1	0	1	1	1	0
42100	Western Gull	Winter	1	1	1	1	1	1	1	1	1	1
42110	Glaucous-winged Gull	Winter	0	1	1	0	1	1	0	1	1	1
42220	Forster's Tern	Winter	1	1	1	1	1	1	1	1	1	1

SPPID	Common Name	Season	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18
42230	Least Tern	Winter	1	0	0	0	0	0	0	0	0	0
42710	Belted Kingfisher	Winter	0	0	1	0	0	0	0	0	0	0
43240	American Crow	Winter	1	1	1	0	0	0	1	1	0	0
43260	Common Raven	Winter	1	1	1	1	1	1	1	1	1	1
40030	Common Loon	Spring	0	1	0	0	0	0	0	0	0	0
40050	Pied-billed Grebe	Spring	1	1	1	1	0	1	1	1	1	1
40060	Horned Grebe	Spring	0	1	1	0	0	0	1	0	1	0
40080	Eared Grebe	Spring	1	1	1	1	1	1	1	1	1	1
40090	Western Grebe	Spring	1	1	1	1	1	1	1	1	1	1
40100	Clark's Grebe	Spring	1	1	1	1	1	1	0	1	1	1
40320	American White Pelican	Spring	1	1	1	0	1	1	0	1	1	1
40330	Brown Pelican	Spring	0	1	1	0	0	0	0	1	1	0
40350	Double-crested Cormorant	Spring	1	1	1	1	1	1	1	1	1	1
40400	Great Blue Heron	Spring	1	1	1	1	1	1	0	1	1	1
40410	Great Egret	Spring	1	1	1	1	1	1	1	1	1	1
40420	Snowy Egret	Spring	1	1	1	1	1	1	1	1	1	1
40470	Black-crowned Night-Heron	Spring	1	1	0	0	0	1	0	1	1	1
40500	Turkey Vulture	Spring	1	1	1	0	0	0	0	1	0	0
40571	Canada Goose	Spring	1	1	1	1	1	1	1	1	1	1
40640	Gadwall	Spring	1	1	1	1	1	1	1	1	1	1
40660	Eurasian Wigeon	Spring	0	0	0	0	0	1	0	1	1	1
40670	American Wigeon	Spring	1	1	1	0	1	1	0	1	1	1
40690	Mallard	Spring	1	1	1	1	1	1	1	1	1	1
40710	Cinnamon Teal	Spring	1	0	1	0	0	0	0	1	1	0
40720	Northern Shoveler	Spring	1	1	1	0	1	1	1	1	1	1
40730	Northern Pintail	Spring	1	1	1	0	0	1	0	1	1	1
40760	American Green-winged Teal	Spring	1	1	1	0	0	1	0	0	1	1
40770	Canvasback	Spring	1	1	1	0	0	1	0	1	1	1
40780	Redhead	Spring	1	1	1	1	0	0	0	1	1	0
40810	Greater scaup	Spring	1	1	1	1	1	1	1	1	1	1

SPPID	Common Name	Season	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18
40820	Lesser scaup	Spring	1	1	1	1	1	1	1	1	1	1
40860	Surf Scoter	Spring	0	1	1	1	0	0	0	0	1	0
40870	White-winged scoter	Spring	0	1	1	0	0	0	0	0	0	0
40900	Bufflehead	Spring	1	1	1	1	1	1	1	1	1	1
40910	Common Goldeneye	Spring	1	1	1	1	0	1	1	1	1	1
40950	Common Merganser	Spring	1	1	0	0	0	0	0	0	0	0
40960	Red-breasted Merganser	Spring	1	1	1	1	1	1	1	1	1	1
40970	Ruddy Duck	Spring	1	1	1	1	1	1	1	1	1	1
40990	White-tailed Kite	Spring	0	0	0	0	0	0	1	0	0	0
41010	Northern Harrier	Spring	1	1	1	1	0	1	1	1	1	1
41080	Red-tailed Hawk	Spring	0	1	0	0	0	0	1	1	1	0
41150	Peregrine Falcon	Spring	1	1	0	0	1	1	1	0	0	1
41350	American Coot	Spring	1	1	1	1	0	1	0	1	1	1
41370	Black-bellied Plover	Spring	1	0	1	1	1	1	0	1	0	1
41410	Snowy Plover	Spring	0	0	0	0	1	0	0	0	0	1
41420	Semipalmated Plover	Spring	0	0	0	1	0	0	0	0	0	0
41440	Killdeer	Spring	0	0	0	0	0	0	1	1	0	0
41480	Black-necked Stilt	Spring	0	0	0	1	1	0	1	1	1	0
41490	American Avocet	Spring	1	0	0	1	1	1	1	1	1	1
41500	Greater Yellowlegs	Spring	1	0	1	1	1	1	1	0	1	1
41510	Lesser Yellowlegs	Spring	1	0	0	1	1	0	1	0	1	0
41540	Willet	Spring	1	0	0	1	1	1	1	1	1	1
41590	Whimbrel	Spring	1	0	0	0	0	1	0	0	0	1
41610	Long-billed Curlew	Spring	1	0	0	0	0	1	1	0	0	1
41640	Marbled Godwit	Spring	1	0	0	0	0	1	0	0	1	1
41690	Red Knot	Spring	0	0	0	0	0	1	0	0	0	1
41700	Sanderling	Spring	0	0	0	0	1	1	0	0	0	1
41720	Western Sandpiper	Spring	1	1	1	1	1	1	1	1	1	1
41760	Least Sandpiper	Spring	1	1	1	1	1	1	1	1	1	1
41820	Dunlin	Spring	1	1	0	1	1	1	1	1	1	1

SPPID	Common Name	Season	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18
41870	Short-billed Dowitcher	Spring	1	0	0	1	1	1	1	1	1	1
41880	Long-billed Dowitcher	Spring	1	0	0	1	1	1	1	1	1	1
41910	Red-necked Phalarope	Spring	1	0	0	1	1	1	1	1	1	1
41980	Franklin's Gull	Spring	0	0	0	0	0	0	0	1	0	0
42010	Bonaparte's Gull	Spring	1	0	1	1	1	1	1	1	1	1
42030	Mew Gull	Spring	1	1	0	1	1	1	1	1	0	1
42040	Ring-billed Gull	Spring	1	1	1	1	1	1	1	1	1	1
42050	California Gull	Spring	1	1	1	1	1	1	1	1	1	1
42060	Herring Gull	Spring	1	1	1	1	1	1	1	1	1	1
42070	Thayer's Gull	Spring	0	1	1	0	1	0	0	1	0	0
42100	Western Gull	Spring	1	1	1	1	1	1	1	1	1	1
42110	Glaucous-winged Gull	Spring	1	0	1	0	1	1	1	1	1	1
42120	Glaucous Gull	Spring	0	0	0	0	0	1	0	0	0	1
42180	Caspian Tern	Spring	1	1	1	1	1	1	0	1	1	1
42201	Black Skimmer	Spring	0	0	0	0	0	0	0	1	0	0
42220	Forster's Tern	Spring	1	1	1	1	1	1	1	1	1	1
42240	Black Tern	Spring	0	0	0	0	0	0	0	0	1	0
43240	American Crow	Spring	1	1	1	1	0	0	1	1	0	0
43260	Common Raven	Spring	1	1	1	1	1	1	1	1	1	1
40050	Pied-billed Grebe	Summer	1	1	1	1	0	1	1	1	1	1
40080	Eared Grebe	Summer	1	1	1	1	1	0	1	1	1	0
40090	Western Grebe	Summer	0	1	1	1	0	1	0	1	0	1
40100	Clark's Grebe	Summer	1	1	1	1	0	1	0	1	1	1
40320	American White Pelican	Summer	1	1	1	1	1	1	1	1	1	1
40330	Brown Pelican	Summer	1	1	1	1	1	1	0	1	1	1
40350	Double-crested Cormorant	Summer	1	1	1	1	1	1	1	1	1	1
40400	Great Blue Heron	Summer	1	1	1	1	1	1	1	1	1	1
40410	Great Egret	Summer	1	1	1	1	1	1	1	1	1	1
40420	Snowy Egret	Summer	1	1	1	1	1	1	1	1	1	1
40430	Little Blue Heron	Summer	0	1	0	0	0	0	0	0	0	0

SPPID	Common Name	Season	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18
40470	Black-crowned Night-Heron	Summer	1	1	1	0	0	1	1	1	1	1
40500	Turkey Vulture	Summer	1	0	0	0	1	1	0	1	1	1
40571	Canada Goose	Summer	0	0	0	0	0	1	0	1	1	1
40640	Gadwall	Summer	1	1	1	1	1	1	1	1	1	1
40670	American Wigeon	Summer	0	0	0	0	0	0	0	1	1	0
40690	Mallard	Summer	1	1	1	1	0	1	1	1	1	1
40710	Cinnamon Teal	Summer	0	0	0	0	0	0	0	1	1	0
40720	Northern Shoveler	Summer	1	0	0	0	0	1	0	1	1	1
40730	Northern Pintail	Summer	1	0	0	0	0	0	1	1	1	0
40760	American Green-winged Teal	Summer	0	0	0	0	0	0	0	0	1	0
40770	Canvasback	Summer	0	0	1	0	0	0	0	1	0	0
40810	Greater scaup	Summer	1	1	1	0	0	0	0	1	1	0
40820	Lesser scaup	Summer	1	1	1	0	0	0	0	1	1	0
40860	Surf Scoter	Summer	0	1	0	0	0	0	0	0	0	0
40870	White-winged scoter	Summer	0	1	0	0	0	0	0	0	0	0
40900	Bufflehead	Summer	1	0	0	0	0	0	0	0	0	0
40910	Common Goldeneye	Summer	0	0	0	0	0	0	0	0	1	0
40970	Ruddy Duck	Summer	1	1	1	0	0	1	0	1	1	1
41010	Northern Harrier	Summer	1	1	0	1	0	0	0	0	1	0
41150	Peregrine Falcon	Summer	0	1	0	0	0	0	1	0	0	0
41350	American Coot	Summer	1	1	1	0	0	0	0	1	1	0
41370	Black-bellied Plover	Summer	1	0	1	1	1	1	1	0	1	1
41410	Snowy Plover	Summer	0	0	1	1	0	0	0	0	0	0
41420	Semipalmated Plover	Summer	1	0	0	1	0	1	1	1	1	1
41440	Killdeer	Summer	0	0	0	0	1	0	1	1	1	0
41480	Black-necked Stilt	Summer	1	1	1	1	1	1	1	1	1	1
41490	American Avocet	Summer	1	1	1	1	1	1	1	1	1	1
41500	Greater Yellowlegs	Summer	1	1	0	0	0	1	1	1	1	1
41510	Lesser Yellowlegs	Summer	1	1	0	0	0	1	0	1	1	1
41540	Willet	Summer	1	1	1	1	1	1	1	1	1	1

SPPID	Common Name	Season	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18
41590	Whimbrel	Summer	0	0	0	0	0	1	1	1	1	1
41610	Long-billed Curlew	Summer	1	1	1	0	0	1	1	0	1	1
41640	Marbled Godwit	Summer	1	1	1	0	0	1	1	1	1	1
41650	Ruddy Turnstone	Summer	0	0	0	1	0	0	0	0	0	0
41690	Red Knot	Summer	0	0	0	0	1	0	0	0	0	0
41720	Western Sandpiper	Summer	1	1	1	1	1	1	1	1	1	1
41760	Least Sandpiper	Summer	1	1	0	1	1	1	1	1	1	1
41820	Dunlin	Summer	1	0	0	1	1	1	1	0	0	1
41870	Short-billed Dowitcher	Summer	1	0	1	0	1	1	1	1	1	1
41880	Long-billed Dowitcher	Summer	1	0	1	0	1	1	1	1	1	1
41900	Wilson's Phalarope	Summer	0	0	0	1	1	1	1	1	1	1
41910	Red-necked Phalarope	Summer	0	1	1	1	1	1	1	1	1	1
41980	Franklin's Gull	Summer	0	0	0	0	0	0	0	0	0	0
42010	Bonaparte's Gull	Summer	0	1	1	0	0	0	1	1	1	0
42040	Ring-billed Gull	Summer	1	0	0	1	1	1	1	1	1	1
42050	California Gull	Summer	1	1	1	1	1	1	1	1	1	1
42060	Herring Gull	Summer	0	0	0	0	0	1	0	1	1	1
42100	Western Gull	Summer	1	1	1	1	0	1	1	1	1	1
42180	Caspian Tern	Summer	1	1	1	0	1	1	1	1	0	1
42201	Black Skimmer	Summer	0	0	0	0	0	0	0	1	1	0
42220	Forster's Tern	Summer	1	1	1	1	1	1	1	1	1	1
42230	Least Tern	Summer	0	1	0	0	0	0	0	0	0	0
42240	Black Tern	Summer	0	0	1	0	0	0	0	1	0	0
43240	American Crow	Summer	1	0	0	0	1	0	0	0	0	0
43260	Common Raven	Summer	1	1	1	0	1	1	1	1	1	1

Data Source: USGS Western Ecological Research Center and a review by USFWS Refuge staff.

Appendix A-4
Example Species Performing Functions for Select Key Ecological Functions (KEFs)

SppID	Common Name	KEFCode	KEFDescription
40640	Gadwall	1.1.1.2	spermivore (seed-eater)
40670	American Wigeon	1.1.1.2	spermivore (seed-eater)
40690	Mallard	1.1.1.2	spermivore (seed-eater)
40700	Blue-winged Teal	1.1.1.2	spermivore (seed-eater)
40710	Cinnamon Teal	1.1.1.2	spermivore (seed-eater)
40730	Northern Pintail	1.1.1.2	spermivore (seed-eater)
40760	Green-winged Teal	1.1.1.2	spermivore (seed-eater)
41260	Wild Turkey	1.1.1.2	spermivore (seed-eater)
41290	California Quail	1.1.1.2	spermivore (seed-eater)
41330	Sora	1.1.1.2	spermivore (seed-eater)
41360	Sandhill Crane	1.1.1.2	spermivore (seed-eater)
41390	Pacific Golden-Plover	1.1.1.2	spermivore (seed-eater)
41670	Surfbird	1.1.1.2	spermivore (seed-eater)
41690	Red Knot	1.1.1.2	spermivore (seed-eater)
41850	Buff-breasted Sandpiper	1.1.1.2	spermivore (seed-eater)
41860	Ruff	1.1.1.2	spermivore (seed-eater)
41900	Wilson's Phalarope	1.1.1.2	spermivore (seed-eater)
42030	Mew Gull	1.1.1.2	spermivore (seed-eater)
42390	Band-tailed Pigeon	1.1.1.2	spermivore (seed-eater)
42410	Mourning Dove	1.1.1.2	spermivore (seed-eater)
42700	Allen's Hummingbird	1.1.1.2	spermivore (seed-eater)
42730	Acorn Woodpecker	1.1.1.2	spermivore (seed-eater)
42770	Red-breasted Sapsucker	1.1.1.2	spermivore (seed-eater)
42900	Least Flycatcher	1.1.1.2	spermivore (seed-eater)
42940	Pacific-slope Flycatcher	1.1.1.2	spermivore (seed-eater)
43200	Western Scrub-Jay	1.1.1.2	spermivore (seed-eater)

SppID	Common Name	KEFCode	KEFDescription
43240	American Crow	1.1.1.2	spermivore (seed-eater)
43280	Horned Lark	1.1.1.2	spermivore (seed-eater)
43380	Chestnut-backed Chickadee	1.1.1.2	spermivore (seed-eater)
43550	Ruby-crowned Kinglet	1.1.1.2	spermivore (seed-eater)
43670	Varied Thrush	1.1.1.2	spermivore (seed-eater)
43880	Nashville Warbler	1.1.1.2	spermivore (seed-eater)
44270	Spotted Towhee	1.1.1.2	spermivore (seed-eater)
44280	California Towhee	1.1.1.2	spermivore (seed-eater)
44300	Chipping Sparrow	1.1.1.2	spermivore (seed-eater)
44310	Clay-colored Sparrow	1.1.1.2	spermivore (seed-eater)
44320	Brewer’s Sparrow	1.1.1.2	spermivore (seed-eater)
44340	Vesper Sparrow	1.1.1.2	spermivore (seed-eater)
44350	Lark Sparrow	1.1.1.2	spermivore (seed-eater)
44370	Sage Sparrow	1.1.1.2	spermivore (seed-eater)
44390	Bryant's savannah sparrow	1.1.1.2	spermivore (seed-eater)
44430	Fox Sparrow	1.1.1.2	spermivore (seed-eater)
44440	Alameda song sparrow	1.1.1.2	spermivore (seed-eater)
44450	Lincoln’s Sparrow	1.1.1.2	spermivore (seed-eater)
44460	Swamp Sparrow	1.1.1.2	spermivore (seed-eater)
44470	White-throated Sparrow	1.1.1.2	spermivore (seed-eater)
44490	White-crowned Sparrow	1.1.1.2	spermivore (seed-eater)
44500	Golden-crowned Sparrow	1.1.1.2	spermivore (seed-eater)
44510	Dark-eyed Junco	1.1.1.2	spermivore (seed-eater)
44590	Black-headed Grosbeak	1.1.1.2	spermivore (seed-eater)
44610	Lazuli Bunting	1.1.1.2	spermivore (seed-eater)
44660	Red-winged Blackbird	1.1.1.2	spermivore (seed-eater)
44670	Tricolored Blackbird	1.1.1.2	spermivore (seed-eater)
44680	Western Meadowlark	1.1.1.2	spermivore (seed-eater)
44710	Brewer’s Blackbird	1.1.1.2	spermivore (seed-eater)
44740	Brown-headed Cowbird	1.1.1.2	spermivore (seed-eater)

SppID	Common Name	KEFCode	KEFDescription
44870	House Finch	1.1.1.2	spermivore (seed-eater)
44920	Pine Siskin	1.1.1.2	spermivore (seed-eater)
44930	Lesser Goldfinch	1.1.1.2	spermivore (seed-eater)
44950	American Goldfinch	1.1.1.2	spermivore (seed-eater)
50610	California ground squirrel	1.1.1.2	spermivore (seed-eater)
50820	Western harvest mouse	1.1.1.2	spermivore (seed-eater)
50821	Salt marsh harvest mouse	1.1.1.2	spermivore (seed-eater)
50830	Deer mouse	1.1.1.2	spermivore (seed-eater)
50890	Dusky-footed woodrat	1.1.1.2	spermivore (seed-eater)
51220	Raccoon	1.1.1.2	spermivore (seed-eater)
40530	Greater White-fronted Goose	1.1.1.4	grazer (grass, forb eater)
40550	Snow Goose	1.1.1.4	grazer (grass, forb eater)
40570	Canada Goose	1.1.1.4	grazer (grass, forb eater)
40670	American Wigeon	1.1.1.4	grazer (grass, forb eater)
41360	Sandhill Crane	1.1.1.4	grazer (grass, forb eater)
41390	Pacific Golden-Plover	1.1.1.4	grazer (grass, forb eater)
50360	Brush rabbit	1.1.1.4	grazer (grass, forb eater)
50420	Black-tailed jackrabbit	1.1.1.4	grazer (grass, forb eater)
50610	California ground squirrel	1.1.1.4	grazer (grass, forb eater)
50730	Botta's pocket gopher	1.1.1.4	grazer (grass, forb eater)
50890	Dusky-footed woodrat	1.1.1.4	grazer (grass, forb eater)
41260	Wild Turkey	1.1.1.5	frugivore (fruit-eater)
41290	California Quail	1.1.1.5	frugivore (fruit-eater)
41360	Sandhill Crane	1.1.1.5	frugivore (fruit-eater)
41590	Whimbrel	1.1.1.5	frugivore (fruit-eater)
42390	Band-tailed Pigeon	1.1.1.5	frugivore (fruit-eater)
42730	Acorn Woodpecker	1.1.1.5	frugivore (fruit-eater)
42770	Red-breasted Sapsucker	1.1.1.5	frugivore (fruit-eater)
42890	Willow Flycatcher	1.1.1.5	frugivore (fruit-eater)
42900	Least Flycatcher	1.1.1.5	frugivore (fruit-eater)

SppID	Common Name	KEFCode	KEFDescription
42940	Pacific-slope Flycatcher	1.1.1.5	frugivore (fruit-eater)
42980	Say's Phoebe	1.1.1.5	frugivore (fruit-eater)
43000	Ash-throated Flycatcher	1.1.1.5	frugivore (fruit-eater)
43020	Western Kingbird	1.1.1.5	frugivore (fruit-eater)
43120	Cassin's Vireo	1.1.1.5	frugivore (fruit-eater)
43130	Hutton's Vireo	1.1.1.5	frugivore (fruit-eater)
43140	Warbling Vireo	1.1.1.5	frugivore (fruit-eater)
43200	Western Scrub-Jay	1.1.1.5	frugivore (fruit-eater)
43240	American Crow	1.1.1.5	frugivore (fruit-eater)
43260	Common Raven	1.1.1.5	frugivore (fruit-eater)
43380	Chestnut-backed Chickadee	1.1.1.5	frugivore (fruit-eater)
43420	Bushtit	1.1.1.5	frugivore (fruit-eater)
43540	Golden-crowned Kinglet	1.1.1.5	frugivore (fruit-eater)
43550	Ruby-crowned Kinglet	1.1.1.5	frugivore (fruit-eater)
43630	Swainson's Thrush	1.1.1.5	frugivore (fruit-eater)
43640	Hermit Thrush	1.1.1.5	frugivore (fruit-eater)
43660	American Robin	1.1.1.5	frugivore (fruit-eater)
43670	Varied Thrush	1.1.1.5	frugivore (fruit-eater)
43680	Wrentit	1.1.1.5	frugivore (fruit-eater)
43700	Northern Mockingbird	1.1.1.5	frugivore (fruit-eater)
43710	Sage Thrasher	1.1.1.5	frugivore (fruit-eater)
43800	American Pipit	1.1.1.5	frugivore (fruit-eater)
43820	Cedar Waxwing	1.1.1.5	frugivore (fruit-eater)
43870	Orange-crowned Warbler	1.1.1.5	frugivore (fruit-eater)
43970	Yellow-rumped Warbler	1.1.1.5	frugivore (fruit-eater)
44250	Western Tanager	1.1.1.5	frugivore (fruit-eater)
44270	Spotted Towhee	1.1.1.5	frugivore (fruit-eater)
44280	California Towhee	1.1.1.5	frugivore (fruit-eater)
44390	Bryant's savannah sparrow	1.1.1.5	frugivore (fruit-eater)
44430	Fox Sparrow	1.1.1.5	frugivore (fruit-eater)

SppID	Common Name	KEFCode	KEFDescription
44440	Alameda song sparrow	1.1.1.5	frugivore (fruit-eater)
44470	White-throated Sparrow	1.1.1.5	frugivore (fruit-eater)
44490	White-crowned Sparrow	1.1.1.5	frugivore (fruit-eater)
44500	Golden-crowned Sparrow	1.1.1.5	frugivore (fruit-eater)
44590	Black-headed Grosbeak	1.1.1.5	frugivore (fruit-eater)
44710	Brewer's Blackbird	1.1.1.5	frugivore (fruit-eater)
44790	Bullock's Oriole	1.1.1.5	frugivore (fruit-eater)
44870	House Finch	1.1.1.5	frugivore (fruit-eater)
44930	Lesser Goldfinch	1.1.1.5	frugivore (fruit-eater)
44950	American Goldfinch	1.1.1.5	frugivore (fruit-eater)
50820	Western harvest mouse	1.1.1.5	frugivore (fruit-eater)
50821	Salt marsh harvest mouse	1.1.1.5	frugivore (fruit-eater)
50830	Deer mouse	1.1.1.5	frugivore (fruit-eater)
51220	Raccoon	1.1.1.5	frugivore (fruit-eater)
10073	Threespine stickleback	1.1.2.3	ovivorous (egg eater)
10081	Prickly sculpin	1.1.2.3	ovivorous (egg eater)
10221	Pacific staghorn sculpin	1.1.2.3	ovivorous (egg eater)
10237	Shiner perch	1.1.2.3	ovivorous (egg eater)
10238	Tule perch	1.1.2.3	ovivorous (egg eater)
10249	Green sturgeon	1.1.2.3	ovivorous (egg eater)
10405	Brown rockfish	1.1.2.3	ovivorous (egg eater)
10537	English sole	1.1.2.3	ovivorous (egg eater)
10538	California tonguefish	1.1.2.3	ovivorous (egg eater)
10539	Diamond turbot	1.1.2.3	ovivorous (egg eater)
10561	Sand sole	1.1.2.3	ovivorous (egg eater)
10628	Longjawed mudsucker	1.1.2.3	ovivorous (egg eater)
10629	Bay goby	1.1.2.3	ovivorous (egg eater)
10633	Arrow goby	1.1.2.3	ovivorous (egg eater)
10634	Cheekspot goby	1.1.2.3	ovivorous (egg eater)
10637	Speckled sanddab	1.1.2.3	ovivorous (egg eater)

SppID	Common Name	KEFCode	KEFDescription
10641	Pacific herring	1.1.2.3	ovivorous (egg eater)
10648	Barred surfperch	1.1.2.3	ovivorous (egg eater)
10653	Surf Smelt	1.1.2.3	ovivorous (egg eater)
10686	Dwarf surfperch	1.1.2.3	ovivorous (egg eater)
10729	Plainfin midshipman	1.1.2.3	ovivorous (egg eater)
10757	Topsmelt	1.1.2.3	ovivorous (egg eater)
10758	Jack smelt	1.1.2.3	ovivorous (egg eater)
10808	Bat ray	1.1.2.3	ovivorous (egg eater)
10817	Northern anchovy	1.1.2.3	ovivorous (egg eater)
11113	White croaker	1.1.2.3	ovivorous (egg eater)
30100	Southern alligator lizard	1.1.2.3	ovivorous (egg eater)
30290	Gopher snake	1.1.2.3	ovivorous (egg eater)
30350	Western rattlesnakes	1.1.2.3	ovivorous (egg eater)
40470	Black-crowned Night-Heron	1.1.2.3	ovivorous (egg eater)
41000	Bald Eagle	1.1.2.3	ovivorous (egg eater)
41350	American Coot	1.1.2.3	ovivorous (egg eater)
41360	Sandhill Crane	1.1.2.3	ovivorous (egg eater)
41610	Long-billed Curlew	1.1.2.3	ovivorous (egg eater)
41650	Ruddy Turnstone	1.1.2.3	ovivorous (egg eater)
41950	Parasitic Jaeger	1.1.2.3	ovivorous (egg eater)
42020	Heermann's Gull	1.1.2.3	ovivorous (egg eater)
42040	Ring-billed Gull	1.1.2.3	ovivorous (egg eater)
42050	California Gull	1.1.2.3	ovivorous (egg eater)
42060	Herring Gull	1.1.2.3	ovivorous (egg eater)
42070	Thayer's Gull	1.1.2.3	ovivorous (egg eater)
42100	Western Gull	1.1.2.3	ovivorous (egg eater)
42110	Glaucous-winged Gull	1.1.2.3	ovivorous (egg eater)
42120	Glaucous Gull	1.1.2.3	ovivorous (egg eater)
43200	Western Scrub-Jay	1.1.2.3	ovivorous (egg eater)
43240	American Crow	1.1.2.3	ovivorous (egg eater)

SppID	Common Name	KEFCode	KEFDescription
43260	Common Raven	1.1.2.3	ovivorous (egg eater)
50610	California ground squirrel	1.1.2.3	ovivorous (egg eater)
51180	Gray fox	1.1.2.3	ovivorous (egg eater)
51220	Raccoon	1.1.2.3	ovivorous (egg eater)
51300	western spotted skunk	1.1.2.3	ovivorous (egg eater)
51310	Striped skunk	1.1.2.3	ovivorous (egg eater)

Appendix A-5

Shoreline Study Project Without Project Conditions Species List

[343 Fish and Wildlife Species used for Historic Functional Redundancy & Resiliency]

SPP ID	Common Name	Scientific Name	Classification
10001	Pacific lamprey	*Lampetra tridentata*	native
10071	Sacramento sucker	*Catostomus occidentalis occidentalis*	native
10073	Threespine stickleback	*Gasterosteus aculeatus*	native
10081	Prickly sculpin	*Cottus asper*	native
10173	Starry flounder	*Platichthys stellatus*	native
10221	Pacific staghorn sculpin	*Leptocottus armatus*	native
10237	Shiner perch	*Cymatogaster aggregata*	native
10238	Tule perch	*Hysterocarpus traski*	native
10245	Longfin smelt	*Spirinchus thaleichthys*	native
10249	Green sturgeon	*Acipenser medirostris*	native
10295	Steelhead	*Oncorhynchus mykiss*	native
10325	Leopard shark	*Triakis semifasciata*	native
10326	Brown smoothhound	*Mustelus henlei*	native
10329	Soupfin shark	*Galeorhinus galeus*	native
10333	Spiny dogfish	*Squalus acanthias*	native
10337	Big skate	*Raja binoculata*	native
10341	California skate	*Raja inornata*	native
10405	Brown rockfish	*Sebastes auriculatus*	native
10537	English sole	*Parophrys vetulus*	native
10538	California tonguefish	*Symphurus atricaudus*	native
10539	Diamond turbot	*Hypsopsetta guttulata*	native
10545	Pacific sanddab	*Citharichthys sordidus*	native
10561	Sand sole	*Psettichthys melanostictus*	native
10585	Chinook salmon	*Oncorhynchus tshawytscha*	native
10589	Pink salmon	*Oncorhynchus gorbuscha*	native
10593	Chum salmon	*Oncorhynchus keta*	native
10628	Longjawed mudsucker	*Gillichthys mirabilis*	native

SPP ID	Common Name	Scientific Name	Classification
10629	Bay goby	*Lepidogobius lepidus*	native
10633	Arrow goby	*Clevelandia ios*	native
10634	Cheekspot goby	*Ilypnus gilberti*	native
10637	Speckled sanddab	*Citharichthys stigmaeus*	native
10641	Pacific herring	*Clupea pallasii*	native
10648	Barred surfperch	*Amphistichus argenteus*	native
10653	Surf Smelt	*Hypomesus pretiosus*	native
10657	Whitebait smelt	*Allosmerus elongatus*	native
10669	Bay pipefish	*Syngnathus leptorhynchus*	native
10686	Dwarf surfperch	*Micrometrus minimus*	native
10729	Plainfin midshipman	*Porichthys notatus*	native
10757	Topsmelt	*Atherinops affinis*	native
10758	Jack smelt	*Atherinopsis californiensis*	native
10765	Pacific sardine	*Sardinops sagax*	native
10808	Bat ray	*Myliobatis californica*	native
10817	Northern anchovy	*Engraulis mordax*	native
11113	White croaker	*Genyonemus lineatus*	native
11197	California halibut	*Paralichthys californicus*	native
20010	California tiger salamander	*Ambystoma californiense*	native
20210	California slender salamander	*Batrachoseps attenuatus*	native
20217	Arboreal salamander	*Aneides lugubris*	native
20260	Pacific tree frog	*Pseudacris regilla*	native
30030	Western pond turtle	*Clemmys marmorata*	native
30100	Southern alligator lizard	*Elgaria multicarinata*	native
30160	Western fence lizard	*Sceloporus occidentalis*	native
30180	Western skink	*Eumeces skiltonianus*	native
30290	Gopher snake	*Pituophis melanoleuca*	native
30320	Western terrestrial garter snake	*Thamnophis elegans*	native
30340	Common garter snake	*Thamnophis sirtalis*	native
30350	Western rattlesnakes	*Crotalus oreganus*	native

SPP ID	Common Name	Scientific Name	Classification
40010	Red-throated Loon	*Gavia stellata*	native
40020	Pacific Loon	*Gavia pacifica*	native
40030	Common Loon	*Gavia immer*	native
40050	Pied-billed Grebe	*Podilymbus podiceps*	native
40060	Horned Grebe	*Podiceps auritus*	native
40070	Red-necked Grebe	*Podiceps grisegena*	native
40080	Eared Grebe	*Podiceps nigricollis*	native
40090	Western Grebe	*Aechmophorus occidentalis*	native
40100	Clark's Grebe	*Aechmophorus clarkii*	native
40300	Brown Booby	*Sula leucogaster*	native
40320	American White Pelican	*Pelecanus erythrorhynchos*	native
40330	Brown Pelican	*Pelecanus occidentalis*	native
40340	Brandt's Cormorant	*Phalacrocorax penicillatus*	native
40350	Double-crested Cormorant	*Phalacrocorax auritus*	native
40360	Pelagic Cormorant	*Phalacrocorax pelagicus*	native
40370	Magnificent Frigatebird	*Fregata magnificens*	native
40380	American Bittern	*Botaurus lentiginosus*	native
40390	Least Bittern	*Ixobrychus exilis*	native
40400	Great Blue Heron	*Ardea herodias*	native
40410	Great Egret	*Ardea alba*	native
40420	Snowy Egret	*Egretta thula*	native
40430	Little Blue Heron	*Egretta caerulea*	native
40450	Cattle Egret	*Bubulcus ibis*	native
40460	Green Heron	*Butorides virescens*	native
40470	Black-crowned Night-Heron	*Nycticorax nycticorax*	native
40490	White-faced Ibis	*Plegadis chihi*	native
40490	Glossy Ibis	*Plegadis falcinellus*	native
40500	Turkey Vulture	*Cathartes aura*	native
40530	Greater White-fronted Goose	*Anser albifrons*	native
40550	Snow Goose	*Chen hyperborea*	native

SPP ID	Common Name	Scientific Name	Classification
40560	Ross's Goose	*Chen rossii*	native
40570	Canada Goose	*Branta canadensis*	native
40575	Cackling Goose	*Branta hutchinsii*	native
40580	Brant	*Branta bernicla*	native
40610	Tundra Swan	*Cygnus columbianus*	native
40640	Gadwall	*Anas strepera*	native
40660	Eurasian Wigeon	*Anas penelope*	native
40670	American Wigeon	*Anas americana*	native
40690	Mallard	*Anas platyrhynchos*	native
40700	Blue-winged Teal	*Anas discors*	native
40710	Cinnamon Teal	*Anas cyanoptera*	native
40720	Northern Shoveler	*Anas clypeata*	native
40730	Northern Pintail	*Anas acuta*	native
40760	Green-winged Teal	*Anas crecca*	native
40770	Canvasback	*Aythya valisineria*	native
40780	Redhead	*Aythya americana*	native
40790	Ring-necked Duck	*Aythya collaris*	native
40810	Greater Scaup	*Aythya marila*	native
40820	Lesser Scaup	*Aythya affinis*	native
40860	Surf Scoter	*Melanitta perspicillata*	native
40870	White-winged Scoter	*Melanitta fusca*	native
40880	Black Scoter	*Melanitta nigra*	native
40890	Long-tailed Duck	*Clangula hyemalis*	native
40900	Bufflehead	*Bucephala albeola*	native
40910	Common Goldeneye	*Bucephala clangula*	native
40940	Hooded Merganser	*Lophodytes cucullata*	native
40950	Common Merganser	*Mergus merganser*	native
40960	Red-breasted Merganser	*Mergus serrator*	native
40970	Ruddy Duck	*Oxyura jamaicensis*	native
40980	Osprey	*Pandion haliaetus*	native

SPP ID	Common Name	Scientific Name	Classification
40990	White-tailed Kite	*Elanus coeruleus*	native
41000	Bald Eagle	*Haliaeetus leucocephalus*	native
41010	Northern Harrier	*Circus cyaneus*	native
41020	Sharp-shinned Hawk	*Accipiter striatus*	native
41030	Cooper's Hawk	*Accipiter cooperii*	native
41050	Red-shouldered Hawk	*Buteo lineatus*	native
41080	Red-tailed Hawk	*Buteo jamaicensis*	native
41090	Ferruginous Hawk	*Buteo regalis*	native
41100	Rough-legged Hawk	*Buteo lagopus*	native
41110	Golden Eagle	*Aquila chrysaetos*	native
41120	American Kestrel	*Falco sparverius*	native
41130	Merlin	*Falco columbarius*	native
41150	Peregrine Falcon	*Falco peregrinus*	native
41160	Prairie Falcon	*Falco mexicanus*	native
41260	Wild Turkey	*Meleagris gallopavo*	native
41290	California Quail	*Callipepla californica*	native
41311	California Black Rail	*Rallus longirostris obsoletus*	native
41320	Virginia Rail	*Laterallus jamaicensis coturniculus*	native
41321	California Clapper Rail	*Rallus limicola*	native
41330	Sora	*Porzana carolina*	native
41340	Common Moorhen	*Gallinula chloropus*	native
41350	American Coot	*Fulica americana*	native
41360	Sandhill Crane	*Grus canadensis*	native
41370	Black-bellied Plover	*Pluvialis squatarola*	native
41380	American Golden-Plover	*Pluvialis dominica*	native
41390	Pacific Golden-Plover	*Pluvialis fulva*	native
41410	Western Snowy Plover	*Charadrius alexandrinus nivosus*	native
41420	Semipalmated Plover	*Charadrius semipalmata*	native
41440	Killdeer	*Charadrius vociferus*	native
41470	Black Oystercatcher	*Haematopus bachmani*	native

SPP ID	Common Name	Scientific Name	Classification
41480	Black-necked Stilt	*Himantopus mexicanus*	native
41490	American Avocet	*Recurvirostra americana*	native
41500	Greater Yellowlegs	*Tringa melanoleuca*	native
41510	Lesser Yellowlegs	*Tringa flavipes*	native
41530	Solitary Sandpiper	*Tringa solitaria*	native
41540	Willet	*Catoptrophorus semipalmatus*	native
41550	Wandering Tattler	*Heteroscelus incanus*	native
41570	Spotted Sandpiper	*Actitis macularia*	native
41590	Whimbrel	*Numenius phaeopus*	native
41610	Long-billed Curlew	*Numenius americanus*	native
41620	Hudsonian Godwit	*Limosa haemastica*	native
41630	Bar-tailed Godwit	*Limosa lapponica*	native
41640	Marbled Godwit	*Limosa fedoa*	native
41650	Ruddy Turnstone	*Arenaria interpres*	native
41660	Black Turnstone	*Arenaria melanocephala*	native
41670	Surfbird	*Aphriza virgata*	native
41690	Red Knot	*Calidris canutus*	native
41700	Sanderling	*Calidris alba*	native
41710	Semipalmated Sandpiper	*Calidris pusilla*	native
41720	Western Sandpiper	*Calidris mauri*	native
41740	Little Stint	*Calidris minuta*	native
41760	Least Sandpiper	*Calidris minutilla*	native
41780	Baird's Sandpiper	*Calidris bairdii*	native
41790	Pectoral Sandpiper	*Calidris melanotos*	native
41800	Sharp-tailed Sandpiper	*Calidris acuminata*	native
41820	Dunlin	*Calidris alpina*	native
41830	Curlew Sandpiper	*Calidris ferruginea*	native
41840	Stilt Sandpiper	*Calidris himantopus*	native
41850	Buff-breasted Sandpiper	*Tryngites subruficollis*	native
41860	Ruff	*Philomachus pugnax*	native

SPP ID	Common Name	Scientific Name	Classification
41870	Short-billed Dowitcher	*Limnodromus griseus*	native
41880	Long-billed Dowitcher	*Limnodromus scolopaceus*	native
41890	Wilson's Snipe	*Gallinago delicata*	native
41900	Wilson's Phalarope	*Phalaropus tricolor*	native
41910	Red-necked Phalarope	*Phalaropus lobatus*	native
41920	Red Phalarope	*Phalaropus fulicaria*	native
41950	Parasitic Jaeger	*Stercorarius parasiticus*	native
41980	Franklin's Gull	*Larus pipixcan*	native
41990	Little Gull	*Larus minutus*	native
42000	Black-headed Gull	*Larus ridibundus*	native
42010	Bonaparte's Gull	*Larus Philadelphia*	native
42020	Heermann's Gull	*Larus heermanni*	native
42030	Mew Gull	*Larus canus*	native
42040	Ring-billed Gull	*Larus delawarensis*	native
42050	California Gull	*Larus californicus*	native
42060	Herring Gull	*Larus argentatus*	native
42070	Thayer's Gull	*Larus thayeri*	native
42090	Slaty-backed Gull	*Larus schistisagus*	native
42100	Western Gull	*Larus occidentalis*	native
42110	Glaucous-winged Gull	*Larus glaucescens*	native
42120	Glaucous Gull	*Larus hyperboreus*	native
42130	Sabine's Gull	*Xena sabini*	native
42180	Caspian Tern	*Sterna caspia*	native
42190	Elegant Tern	*Sterna elegans*	native
42200	Common Tern	*Sterna hirundo*	native
42201	Black Skimmer	*Rynchops niger*	native
42210	Arctic Tern	*Sterna paradisaea*	native
42220	Forster's Tern	*Sterna forsteri*	native
42230	California Least Tern	*Sterna antillarum browni*	native
42240	Black Tern	*Chlidonias niger*	native

SPP ID	Common Name	Scientific Name	Classification
42250	Common Murre	*Uria aalge*	native
42270	Pigeon Guillemot	*Cepphus columba*	native
42320	Ancient Murrelet	*Synthliboramphus antiquus*	native
42390	Band-tailed Pigeon	*Columba fasciata*	native
42410	Mourning Dove	*Zenaida macroura*	native
42440	Barn Owl	*Tyto alba*	native
42470	Great Horned Owl	*Bubo virginianus*	native
42510	Burrowing Owl	*Athene cunicularia*	native
42560	Short-eared Owl	*Asio flammeus*	native
42620	Vaux's Swift	*Chaetura vauxi*	native
42630	White-throated Swift	*Aeronautes saxatalis*	native
42640	Black-chinned Hummingbird	*Archilochus alexandri*	native
42650	Anna's Hummingbird	*Calypte anna*	native
42690	Rufous Hummingbird	*Selasphorus rufus*	native
42700	Allen's Hummingbird	*Selasphorus sasin*	native
42710	Belted Kingfisher	*Ceryle alcyon*	native
42730	Acorn Woodpecker	*Melanerpes formicivorus*	native
42770	Red-breasted Sapsucker	*Sphyrapicus ruber*	native
42780	Nuttall's Woodpecker	*Picoides nuttallii*	native
42790	Downy Woodpecker	*Picoides pubescens*	native
42840	Northern Flicker	*Colaptes auratus*	native
42870	Western Wood-Pewee	*Contopus sordidulus*	native
42890	Willow Flycatcher	*Empidonax traillii*	native
42900	Least Flycatcher	*Empidonax minimus*	native
42910	Hammond's Flycatcher	*Empidonax hammondii*	native
42930	Dusky Flycatcher	*Empidonax oberholseri*	native
42940	Pacific-slope Flycatcher	*Empidonax difficilis*	native
42960	Black Phoebe	*Sayornis nigricans*	native
42980	Say's Phoebe	*Sayornis saya*	native
43000	Ash-throated Flycatcher	*Myiarchus cinerascens*	native

SPP ID	Common Name	Scientific Name	Classification
43010	Tropical Kingbird	*Tyrannus melancholicus*	native
43020	Western Kingbird	*Tyrannus verticalis*	native
43060	Loggerhead Shrike	*Lanius ludovicianus*	native
43120	Cassin's Vireo	*Vireo cassinii*	native
43130	Hutton’s Vireo	*Vireo huttoni*	native
43140	Warbling Vireo	*Vireo gilvus*	native
43200	Western Scrub-Jay	*Aphelocoma californica*	native
43240	American Crow	*Corvus brachyrhynchos*	native
43260	Common Raven	*Corvus corax*	native
43280	Horned Lark	*Eremophila alpestris*	native
43290	Purple Martin	*Progne subis*	native
43300	Tree Swallow	*Tachycineta bicolor*	native
43310	Violet-green Swallow	*Tachycineta thalassina*	native
43320	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	native
43330	Bank Swallow	*Riparia riparia*	native
43340	Cliff Swallow	*Petrochelidon pyrrhonota*	native
43350	Barn Swallow	*Hirundo rustica*	native
43380	Chestnut-backed Chickadee	*Poecile rufescens*	native
43420	Bushtit	*Psaltriparus minimus*	native
43470	Rock Wren	*Salpinctes obsoletus*	native
43490	Bewick’s Wren	*Thryomanes bewickii*	native
43500	House Wren	*Troglodytes aedon*	native
43520	Marsh Wren	*Cistothorus palustris*	native
43540	Golden-crowned Kinglet	*Regulus satrapa*	native
43530	American Dipper	*Cinclus mexicanus*	native
43550	Ruby-crowned Kinglet	*Regulus calendula*	native
43560	Blue-gray Gnatcatcher	*Polioptila caerulea*	native
43630	Swainson’s Thrush	*Catharus ustulatus*	native
43640	Hermit Thrush	*Catharus guttatus*	native
43660	American Robin	*Turdus migratorius*	native

SPP ID	Common Name	Scientific Name	Classification
43670	Varied Thrush	*Ixoreus naevius*	native
43680	Wrentit	*Chamaea fasciata*	native
43700	Northern Mockingbird	*Mimus polyglottos*	native
43710	Sage Thrasher	*Oreoscoptes montanus*	native
43770	White Wagtail	*Motacilla alba*	native
43800	American Pipit	*Anthus rubescens*	native
43820	Cedar Waxwing	*Bombycilla cedrorum*	native
43870	Orange-crowned Warbler	*Vermivora celata*	native
43880	Nashville Warbler	*Vermivora ruficapilla*	native
43920	Yellow Warbler	*Dendroica petechia*	native
43940	Magnolia Warbler	*Dendroica magnolia*	native
43970	Yellow-rumped Warbler	*Dendroica coronata*	native
44000	Townsend's Warbler	*Dendroica townsendi*	native
44060	Palm Warbler	*Dendroica palmarum*	native
44080	Blackpoll Warbler	*Dendroica striata*	native
44100	American Redstart	*Setophaga ruticilla*	native
44140	Northern Waterthrush	*Seiurus noveboracensis*	native
44180	San Francisco common yellowthroat	*Geothlypis trichas sinuosa*	native
44200	Wilson's Warbler	*Wilsonia pusilla*	native
44220	Yellow-breasted Chat	*Icteria virens*	native
44250	Western Tanager	*Piranga ludoviciana*	native
44270	Spotted Towhee	*Pipilo maculatus*	native
44280	California Towhee	*Pipilo crissalis*	native
44300	Chipping Sparrow	*Spizella passerina*	native
44310	Clay-colored Sparrow	*Spizella pallida*	native
44320	Brewer's Sparrow	*Spizella breweri*	native
44340	Vesper Sparrow	*Pooecetes gramineus*	native
44350	Lark Sparrow	*Chondestes grammacus*	native
44370	Sage Sparrow	*Amphispiza belli*	native

SPP ID	Common Name	Scientific Name	Classification
44390	Bryant's savannah sparrow	*Passerculus sandwichensis alaudinus*	native
44420	Nelson’s Sharp-tailed Sparrow	*Ammodramus nelsoni*	native
44430	Fox Sparrow	*Passerella iliaca*	native
44440	Alameda song sparrow	*Melospiza melodia pusillula*	native
44450	Lincoln’s Sparrow	*Melospiza lincolnii*	native
44460	Swamp Sparrow	*Melospiza georgiana*	native
44470	White-throated Sparrow	*Zonotrichia leucophrys*	native
44490	White-crowned Sparrow	*Zonotrichia atricapilla*	native
44500	Golden-crowned Sparrow	*Zonotrichia atricapilla*	native
44510	Dark-eyed Junco	*Junco hyemalis*	native
44540	Chestnut-collared Longspur	*Calcarius ornatus*	native
44590	Black-headed Grosbeak	*Pheucticus melanocephalus*	native
44610	Lazuli Bunting	*Passerina amoena*	native
44660	Red-winged Blackbird	*Agelaius phoeniceus*	native
44670	Tricolored Blackbird	*Agelaius tricolor*	native
44680	Western Meadowlark	*Sturnella neglecta*	native
44710	Brewer’s Blackbird	*Euphagus cyanocephalus*	native
44740	Brown-headed Cowbird	*Molothrus ater*	native
44760	Hooded Oriole	*Icterus cucullatus*	native
44790	Bullock’s Oriole	*Icterus bullockii*	native
44870	House Finch	*Carpodacus mexicanus*	native
44920	Pine Siskin	*Spinus pinus*	native
44930	Lesser Goldfinch	*Carduelis psaltria*	native
44950	American Goldfinch	*Carduelis tristis*	native
50040	Salt marsh wandering shrew	*Sorex vagrans halicoetes*	native
50180	California myotis	*Myotis californicus*	native
50200	Yuma myotis	*Myotis yumanensis*	native
50220	Long-legged myotis	*Myotis volans*	native
50250	Long-eared myotis	*Myotis septentrionalis*	native
50280	Big brown bat	*Eptesicus fuscus*	native

SPP ID	Common Name	Scientific Name	Classification
50285	Western red bat	*Lasirurs blossevillii*	native
50290	Hoary bat	*Lasiurus cinereus*	native
50310	Townsend's big-eared bat	*Corynorhinus townsendii*	native
50320	Northern river otter	*Lontra canadensis*	native
50330	Mexican free-tailed bat	*Tadarida brasiliensis*	native
50360	Brush rabbit	*Sylvilagus bachmani*	native
50381	Desert cottontail	*Sylvilagus audubonii*	native
50420	Black-tailed jackrabbit	*Lepus californicus*	native
50610	California ground squirrel	*Spermophilus beecheyi*	native
50730	Botta's pocket gopher	*Thomomys bottae*	native
50820	Western harvest mouse	*Reithrodontomys megalotis*	native
50821	Salt marsh harvest mouse	*Reithrodontomys raviventris raviventris*	native
50830	Deer mouse	*Peromyscus maniculatus*	native
50890	Dusky-footed woodrat	*Neotoma fuscipes*	native
50990	California vole	*Microtus californicus*	native
51050	Muskrat	*Ondatra zibethicus*	native
51180	Gray fox	*Urocyon cinereoargenteus*	native
51220	Raccoon	*Procyon lotor*	native
51260	Long-tailed weasel	*Mustela frenata*	native
51300	Western spotted skunk	*Spilogale gracilis*	native
51310	Striped skunk	*Mephitis mephitis*	native
51330	Mountain lion	*Felis concolor*	native
60030	California sea lion	Zalophus californianus	native
60040	Pacific harbor seal	*Phoca vitulina richardsi*	native

Appendix A-6
Species Associations with Historic Habitats for Without Project Assessment

[Total species listed 205 used to determine higher habitat value level // 171 species used to determine the lower habitat value level (indicates which species were removed)]

Spp ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Island	Lagoon	Salt Pond	Sandy Beach	Shallow Bay / Channel (intertidal)	Shellflat	Tidal Flat	Tidal Marsh	Shell Mounds
10001	Pacific lamprey	1				1		1	1	1	1	
10071	Sacramento sucker					1					1	
10073	Threespine stickleback	1				1		1	1	1	1	
10081	Prickly sculpin	1				1		1	1	1	1	
10173	Starry flounder	1				1			1	1	1	
10221	Pacific staghorn sculpin	1			1	1	1	1	1	1	1	
10237	Shiner perch	1			1	1		1	1	1	1	
10238	Tule perch	1			1	1		1	1	1	1	
10245	Longfin smelt	1				1		1	1	1	1	
10249	Green sturgeon	1						1	1	1	1	
10295	Steelhead	1						1	1	1	1	
10325	Leopard shark	1						1	1	1	1	
10326	Brown smoothhound	1						1	1	1	1	
10329	Soupfin shark								1	1	1	
10333	Spiny dogfish	1						1	1	1	1	
10337	Big skate	1						1	1	1	1	
10341	California skate	1						1	1	1	1	
10405	Brown rockfish	1			1			1	1	1	1	
10537	English sole	1						1	1	1	1	
10538	California tonguefish	1						1	1	1	1	
10539	Diamond turbot	1						1	1	1	1	
10545	Pacific sanddab								1	1	1	

Spp ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Island	Lagoon	Salt Pond	Sandy Beach	Shallow Bay / Channel (intertidal)	Shellflat	Tidal Flat	Tidal Marsh	Shell Mounds
10561	Sand sole	1						1	1	1	1	
10585	Chinook salmon	1				1		1	1	1	1	
10589	Pink salmon	1				1		1	1	1	1	
10593	Chum salmon	1				1		1	1	1	1	
10628	Longjawed mudsucker	1				1		1			1	
10629	Bay goby	1						1			1	
10633	Arrow goby	1						1			1	
10634	Cheekspot goby	1						1			1	
10637	Speckled sanddab				1				1	1	1	
10641	Pacific herring				1	1			1	1	1	
10648	Barred surfperch	1			1			1	1	1	1	
10653	Surf Smelt					1			1	1	1	
10657	Whitebait smelt	1						1	1	1	1	
10669	Bay pipefish	1				1		1	1	1	1	
10686	Dwarf surfperch	1			1			1	1	1	1	
10729	Plainfin midshipman	1						1	1	1	1	
10757	Topsmelt	1				1		1	1	1	1	
10758	Jack smelt	1				1		1	1	1	1	
10765	Pacific sardine	1						1	1	1	1	
10808	Bat ray	1				1			1	1	1	
10817	Northern anchovy	1				1		1	1	1	1	
11113	White croaker	1						1	1	1	1	
11197	California halibut	1						1	1	1	1	
30100	Southern alligator lizard											1
30160	Western fence lizard											1
30290	Gopher snake										1	1
30320	Western terrestrial garter snake							1			1	1

Spp ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Island	Lagoon	Salt Pond	Sandy Beach	Shallow Bay / Channel (intertidal)	Shellflat	Tidal Flat	Tidal Marsh	Shell Mounds
30340	Common garter snake										1	1
30350	Western rattlesnakes											1
40010	Red-throated Loon	1							1			
40020	Pacific Loon	1							1			
40030	Common Loon	1							1			
40050	Pied-billed Grebe	1			1	1		1	1		1	
40060	Horned Grebe	1				1			1		1	
40070	Red-necked Grebe	1							1			
40080	Eared Grebe	1				1		1	1		1	
40090	Western Grebe	1							1		1	
40100	Clark's Grebe	1							1		1	
40320	American White Pelican			1	1	1			1		1	
40330	Brown Pelican	1			1	1	1		1			
40350	Double-crested Cormorant	1		1		1		1	1	1	1	
40380	American Bittern				1						1	
40390	Least Bittern				1						1	
40400	Great Blue Heron			1	1	1				1	1	1
40410	Great Egret			1	1	1				1	1	
40420	Snowy Egret			1	1	1					1	
40460	Green Heron				1						1	
40470	Black-crowned Night-Heron			1							1	1
40500	Turkey Vulture											1
40530	Greater White-fronted Goose							1			1	
40570	Canada Goose			1	1	1		1			1	
40640	Gadwall				1	1		1			1	
40660	Eurasian Wigeon				1	1		1	1		1	

Spp ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Island	Lagoon	Salt Pond	Sandy Beach	Shallow Bay / Channel (intertidal)	Shellflat	Tidal Flat	Tidal Marsh	Shell Mounds
40670	American Wigeon				1	1		1	1		1	
40690	Mallard			1	1	1		1			1	
40700	Blue-winged Teal				1			1			1	
40710	Cinnamon Teal				1			1			1	
40720	Northern Shoveler				1	1		1			1	
40730	Northern Pintail				1	1		1	1		1	
40760	Green-winged Teal				1	1		1	1		1	
40770	Canvasback	1			1	1		1	1	1	1	
40780	Redhead	1			1	1		1	1	1	1	
40790	Ring-necked Duck	1			1	1		1	1	1	1	
40810	Greater Scaup	1			1	1			1	1	1	
40820	Lesser Scaup	1			1	1			1	1	1	
40860	Surf Scoter	1							1	1	1	
40870	White-winged Scoter	1							1	1	1	
40880	Black Scoter	1							1	1	1	
40890	Long-tailed Duck	1							1	1	1	
40900	Bufflehead	1			1	1			1	1	1	
40910	Common Goldeneye	1			1	1			1	1	1	
40920	Barrow's Goldeneye					1					1	
40940	Hooded Merganser				1				1	1	1	
40950	Common Merganser	1			1				1	1	1	
40960	Red-breasted Merganser				1						1	
40970	Ruddy Duck	1			1	1			1	1	1	
40980	Osprey	1							1	1	1	
40990	White-tailed Kite										1	
41000	Bald Eagle	1		1	1		1				1	1
41010	Northern Harrier					1					1	
41030	Cooper’s Hawk										1	1

Spp ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Island	Lagoon	Salt Pond	Sandy Beach	Shallow Bay / Channel (intertidal)	Shellflat	Tidal Flat	Tidal Marsh	Shell Mounds
41050	Red-shouldered Hawk										1	1
41080	Red-tailed Hawk										1	1
41090	Ferruginous Hawk										1	1
41110	Golden Eagle										1	1
41120	American Kestrel										1	
41130	Merlin										1	
41150	Peregrine Falcon				1		1	1			1	1
41311	California Black Rail										1	
41320	Virginia Rail										1	
41321	California Clapper Rail										1	
41330	Sora				1						1	
41340	Common Moorhen				1						1	
41350	American Coot				1	1		1		1	1	
41370	Black-bellied Plover				1	1	1		1	1		
41380	American Golden-Plover		1		1	1	1		1	1		
41390	Pacific Golden-Plover		1		1	1	1		1	1		
41410	Western Snowy Plover				1	1	1		1	1		
41420	Semipalmated Plover		1	1	1	1	1		1	1		
41440	Killdeer		1	1	1	1	1		1	1	1	
41470	Black Oystercatcher					1	1		1	1		
41480	Black-necked Stilt			1	1	1			1	1	1	
41490	American Avocet			1	1	1			1	1	1	
41500	Greater Yellowlegs		1	1	1	1			1	1	1	
41510	Lesser Yellowlegs		1	1	1	1			1	1	1	
41540	Willet			1	1	1	1		1	1	1	
41550	Wandering Tattler					1	1		1	1		
41570	Spotted Sandpiper			1	1	1			1	1	1	
41590	Whimbrel				1	1			1	1	1	

Spp ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Island	Lagoon	Salt Pond	Sandy Beach	Shallow Bay / Channel (intertidal)	Shellflat	Tidal Flat	Tidal Marsh	Shell Mounds
41610	Long-billed Curlew			1		1	1		1	1	1	
41640	Marbled Godwit				1	1	1		1	1	1	
41650	Ruddy Turnstone		1		1	1	1		1	1	1	
41660	Black Turnstone				1	1	1		1	1	1	
41670	Surfbird					1			1	1	1	
41690	Red Knot				1	1	1		1	1	1	
41700	Sanderling		1			1	1		1	1	1	
41710	Semipalmated Sandpiper			1	1	1	1		1	1		
41720	Western Sandpiper			1	1	1	1		1	1	1	
41760	Least Sandpiper		1		1	1	1		1	1	1	
41780	Baird's Sandpiper		1	1	1	1	1		1	1	1	
41790	Pectoral Sandpiper			1	1	1			1	1	1	
41800	Sharp-tailed Sandpiper			1	1	1			1	1		
41820	Dunlin			1	1	1	1		1	1	1	
41840	Stilt Sandpiper			1		1			1	1		
41850	Buff-breasted Sandpiper					1	1		1	1		
41860	Ruff				1	1			1	1		
41870	Short-billed Dowitcher			1	1	1	1		1	1	1	
41880	Long-billed Dowitcher			1	1	1	1		1	1	1	
41890	Wilson's Snipe			1					1		1	
41900	Wilson's Phalarope	1		1		1		1				
41910	Red-necked Phalarope			1	1	1		1			1	
41980	Franklin's Gull			1			1					
42010	Bonaparte's Gull	1	1	1	1		1	1	1	1	1	1
42020	Heermann's Gull		1		1		1		1	1		
42030	Mew Gull	1		1	1		1	1			1	1
42040	Ring-billed Gull	1		1	1		1	1			1	1
42050	California Gull	1		1	1		1	1			1	1

Spp ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Island	Lagoon	Salt Pond	Sandy Beach	Shallow Bay / Channel (intertidal)	Shellflat	Tidal Flat	Tidal Marsh	Shell Mounds
42060	Herring Gull	1		1	1		1	1			1	1
42070	Thayer's Gull	1	1	1	1		1	1			1	1
42100	Western Gull	1	1	1	1		1	1	1	1	1	1
42110	Glaucous-winged Gull	1	1	1	1		1	1	1	1	1	1
42120	Glaucous Gull		1	1	1		1		1	1	1	1
42180	Caspian Tern	1		1	1		1	1	1	1	1	
42190	Elegant Tern						1					
42200	Common Tern	1						1			1	
42210	Arctic Tern						1					
42220	Forster's Tern			1	1			1	1	1	1	
42230	California Least Tern								1	1		
42390	Band-tailed Pigeon						1				1	
42410	Mourning Dove										1	1
42440	Barn Owl					1					1	
42560	Short-eared Owl		1								1	
42710	Belted Kingfisher				1						1	
43200	Western Scrub-Jay										1	1
43280	Horned Lark		1				1					
43300	Tree Swallow										1	
43310	Violet-Green Swallow										1	
43320	Northern Rough-winged Swallow										1	
43350	Barn Swallow		1		1						1	
43520	Marsh Wren										1	
43700	Northern Mockingbird											1
43800	American Pipit										1	
44180	San Francisco common yellowthroat					1					1	

Spp ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Island	Lagoon	Salt Pond	Sandy Beach	Shallow Bay / Channel (intertidal)	Shellflat	Tidal Flat	Tidal Marsh	Shell Mounds
44390	Savannah Sparrow										1	
44440	Alameda song sparrow										1	
44490	White-crowned Sparrow										1	
44660	Red-winged Blackbird										1	
44680	Western Meadowlark										1	
44710	Brewer's Blackbird											1
50040	Salt marsh wandering shrew										1	
50200	Yuma myotis				1	1		1			1	
50285	Western red bat				1	1						
50290	Hoary Bat					1					1	
50820	Western harvest mouse										1	
50821	Salt marsh harvest mouse										1	
50830	Deer mouse										1	1
50990	California vole										1	1
51050	Muskrat					1					1	
51220	Raccoon		1	1		1	1				1	1
51260	Long-tailed weasel					1					1	
51310	Striped skunk					1					1	1
60030	California sea Lion	1						1				
60040	Pacific harbor seal	1					1	1		1	1	

Appendix A-7
Species Associations with Modern Habitats for Without Project Assessment [240 species]

SPP ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Lagoon	Salt Pond	Shallow Bay / Channel (intertidal)	Tidal Flat	Tidal Marsh	Developed	Agriculture
10001	Pacific lamprey	1				1				
10071	Sacramento sucker									
10073	Threespine stickleback	1			1	1	1	1		
10081	Prickly sculpin	1			1	1	1	1		
10121	Striped bass	1			1	1	1	1		
10149	Common carp				1					
10173	Starry flounder	1						1		
10177	Goldfish				1					
10189	Western mosquito fish				1					
10221	Pacific staghorn sculpin	1		1	1	1	1	1		
10233	American shad	1				1	1			
10234	Threadfin shad	1				1	1			
10237	Shiner perch	1		1	1	1	1	1		
10238	Tule perch	1		1		1	1	1		
10245	Longfin smelt	1				1	1			
10249	Green sturgeon	1				1				
10295	Steelhead	1				1				
10325	Leopard shark	1			1	1	1	1		
10326	Brown smoothhound	1			1	1				
10329	Soupfin shark	1								
10333	Spiny dogfish	1				1				
10337	Big skate	1				1				
10341	California skate	1				1				
10361	Cabezon	1				1				
10405	Brown rockfish	1		1		1	1			

SPP ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Lagoon	Salt Pond	Shallow Bay / Channel (intertidal)	Tidal Flat	Tidal Marsh	Developed	Agriculture
10537	English sole	1				1		1		
10538	California tonguefish	1				1				
10539	Diamond turbot	1			1	1				
10545	Pacific sanddab	1								
10561	Sand sole	1				1				
10585	Chinook salmon	1				1		1		
10589	Pink salmon	1				1				
10593	Chum salmon	1				1				
10628	Longjawed mudsucker				1	1	1	1		
10629	Bay goby					1	1			
10633	Arrow goby					1	1	1		
10634	Cheekspot goby					1				
10637	Speckled sanddab	1		1	1					
10641	Pacific herring	1		1			1	1		
10648	Barred surfperch	1		1	1	1	1	1		
10653	Surf Smelt	1								
10657	Whitebait smelt	1				1				
10669	Bay pipefish	1			1	1		1		
10686	Dwarf surfperch	1		1		1				
10729	Plainfin midshipman	1				1	1			
10757	Topsmelt	1			1	1	1	1		
10758	Jack smelt	1				1	1	1		
10765	Pacific sardine	1				1				
10808	Bat ray	1			1		1	1		
10817	Northern anchovy	1			1	1	1	1		
11113	White croaker	1				1				
11197	California halibut	1				1				
30100	Southern alligator lizard									1

SPP ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Lagoon	Salt Pond	Shallow Bay / Channel (intertidal)	Tidal Flat	Tidal Marsh	Developed	Agriculture
30160	Western fence lizard							1		1
30290	Gopher snake									1
30320	Western terrestrial garter snake							1		1
30340	Common garter snake									1
40010	Red-throated Loon	1								
40020	Pacific Loon	1								
40030	Common Loon	1								
40050	Pied-billed Grebe	1		1	1			1		
40060	Horned Grebe	1			1			1		
40080	Eared Grebe	1			1			1		
40090	Western Grebe	1			1			1		
40100	Clark's Grebe	1			1			1		
40320	American White Pelican	1		1	1			1		
40330	Brown Pelican	1		1	1					
40350	Double-crested Cormorant	1			1			1		
40380	American Bittern					1		1		
40390	Least Bittern					1		1		
40400	Great Blue Heron			1	1	1	1	1		1
40410	Great Egret			1	1	1	1	1		1
40420	Snowy Egret				1	1	1	1		1
40450	Cattle Egret							1		1
40460	Green Heron			1				1		
40470	Black-crowned Night-Heron							1	1	1
40500	Turkey Vulture									1
40530	Greater White-fronted Goose					1		1		1
40570	Canada Goose			1	1	1		1	1	1

SPP ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Lagoon	Salt Pond	Shallow Bay / Channel (intertidal)	Tidal Flat	Tidal Marsh	Developed	Agriculture
40640	Gadwall			1	1	1		1		1
40660	Eurasian Wigeon			1	1	1		1		
40670	American Wigeon			1	1	1		1		1
40690	Mallard			1	1	1		1		1
40700	Blue-winged Teal			1		1		1		1
40710	Cinnamon Teal			1		1		1		
40720	Northern Shoveler			1	1	1		1		
40730	Northern Pintail			1	1	1		1		
40760	Green-winged Teal			1	1	1		1		
40770	Canvasback	1		1	1	1		1		
40780	Redhead	1		1	1			1		
40790	Ring-necked Duck	1			1			1		
40810	Greater Scaup	1			1					
40820	Lesser Scaup	1		1	1					
40860	Surf Scoter	1			1					
40870	White-winged Scoter	1			1					
40880	Black Scoter	1			1					
40890	Long-tailed Duck	1			1					
40900	Bufflehead	1		1	1					
40910	Common Goldeneye	1		1	1					
40920	Barrow's Goldeneye	1			1					
40940	Hooded Merganser	1		1	1			1		
40950	Common Merganser	1		1	1			1		
40970	Ruddy Duck	1		1	1			1		
40980	Osprey	1						1		
40990	White-tailed Kite							1		
41010	Northern Harrier				1			1		1
41020	Sharp-shinned Hawk								1	

SPP ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Lagoon	Salt Pond	Shallow Bay / Channel (intertidal)	Tidal Flat	Tidal Marsh	Developed	Agriculture
41030	Cooper's Hawk								1	
41050	Red-shouldered Hawk									1
41080	Red-tailed Hawk									1
41090	Ferruginous Hawk									1
41110	Golden Eagle									1
41120	American Kestrel									1
41130	Merlin									1
41150	Peregrine Falcon			1	1	1		1	1	1
41190	Ring-necked Pheasant									1
41290	California Quail									1
41311	California Black Rail							1		
41320	Virginia Rail							1		
41321	California Clapper rail							1		
41330	Sora			1				1		
41340	Common Moorhen			1				1		
41350	American Coot			1	1	1	1	1		
41370	Black-bellied Plover			1	1		1	1		
41380	American Golden-Plover		1	1	1		1	1		
41410	Western Snowy Plover			1	1		1	1		
41420	Semipalmated Plover		1	1	1		1	1		
41440	Killdeer			1	1		1	1	1	1
41480	Black-necked Stilt			1	1		1	1		
41490	American Avocet			1	1		1	1		
41500	Greater Yellowlegs		1	1	1		1	1		
41510	Lesser Yellowlegs		1	1	1		1	1		
41540	Willet			1	1		1	1		
41570	Spotted Sandpiper			1			1	1		
41590	Whimbrel			1	1		1			

SPP ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Lagoon	Salt Pond	Shallow Bay / Channel (intertidal)	Tidal Flat	Tidal Marsh	Developed	Agriculture
41610	Long-billed Curlew			1	1		1	1		1
41640	Marbled Godwit			1	1		1	1		
41650	Ruddy Turnstone		1	1	1		1	1		
41700	Sanderling		1		1		1			
41710	Semipalmated Sandpiper			1	1		1			
41720	Western Sandpiper			1	1		1	1		
41760	Least Sandpiper		1	1	1		1	1		
41820	Dunlin			1	1		1	1		
41860	Ruff						1	1		
41870	Short-billed Dowitcher			1	1		1	1		
41880	Long-billed Dowitcher			1	1		1	1		
41900	Wilson's Phalarope	1			1	1				
41910	Red-necked Phalarope	1			1	1				
42010	Bonaparte's Gull	1	1	1	1			1		
42020	Heermann's Gull	1	1	1	1			1		
42030	Mew Gull			1	1			1		
42040	Ring-billed Gull			1	1	1		1	1	
42050	California Gull			1	1	1		1	1	
42060	Herring Gull			1	1	1		1		
42070	Thayer's Gull		1	1	1	1		1		
42100	Western Gull	1	1	1	1	1		1	1	
42110	Glaucous-winged Gull	1	1	1	1			1		
42120	Glaucous Gull	1	1	1	1			1		
42130	Sabine's Gull				1			1		
42180	Caspian Tern	1			1	1		1		
42201	Black Skimmer	1			1					
42220	Forster's Tern	1		1	1	1		1		
42230	California Least Tern	1			1	1				

SPP ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Lagoon	Salt Pond	Shallow Bay / Channel (intertidal)	Tidal Flat	Tidal Marsh	Developed	Agriculture
42380	Rock Pigeon								1	1
42390	Band-tailed Pigeon								1	
42410	Mourning Dove								1	1
42440	Barn Owl				1			1		1
42470	Great Horned Owl				1			1		1
42510	Burrowing Owl				1			1		
42560	Short-eared Owl							1		1
42650	Anna's Hummingbird								1	
42700	Allen's Hummingbird								1	
42710	Belted Kingfisher							1		
42840	Northern Flicker								1	
42960	Black Phoebe							1	1	
43060	Loggerhead Shrike									1
43200	Western Scrub-Jay								1	
43240	American Crow								1	1
43260	Common Raven								1	1
43280	Horned Lark		1							1
43300	Tree Swallow							1		
43310	Violet-green Swallow							1		
43320	Northern Rough-winged Swallow							1		
43330	Bank Swallow							1		
43340	Cliff Swallow							1		
43350	Barn Swallow		1	1				1		1
43380	Chestnut-backed Chickadee								1	
43420	Bushtit								1	
43490	Bewick's Wren							1		
43500	House Wren								1	

SPP ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Lagoon	Salt Pond	Shallow Bay / Channel (intertidal)	Tidal Flat	Tidal Marsh	Developed	Agriculture
43520	Marsh Wren							1		
43550	Ruby-crowned Kinglet								1	
43660	American Robin								1	1
43700	Northern Mockingbird								1	
43740	European Starling								1	1
43820	Cedar Waxwing								1	
43970	Yellow-rumped Warbler								1	
44000	Townsend's Warbler								1	
44180	San Francisco common yellowthroat							1		
44270	Spotted Towhee								1	
44280	California Towhee							1	1	
44390	Bryant's savannah sparrow							1		1
44440	Alameda song sparrow							1		
44490	White-crowned Sparrow							1	1	
44500	Golden-crowned Sparrow							1	1	
44510	Dark-eyed Junco								1	
44660	Red-winged Blackbird							1		1
44670	Tricolored Blackbird							1		1
44680	Western Meadowlark							1		1
44710	Brewer's Blackbird								1	1
44740	Brown-headed Cowbird									1
44790	Bullock's Oriole								1	
44870	House Finch								1	1
44970	House Sparrow								1	1
50010	Virginia opossum				1			1	1	1
50035	Ornate Shrew							1		
50040	Salt marsh wandering shrew							1		

SPP ID	Common Name	Deep Bay / Channel (subtidal)	Dune	Lagoon	Salt Pond	Shallow Bay / Channel (intertidal)	Tidal Flat	Tidal Marsh	Developed	Agriculture
50110	Trowbridge's Shrew							1		
50200	Yuma myotis			1	1					
50285	Western red bat			1	1					1
50290	Hoary bat				1					
50330	Mexican free-tailed bat				1					
50420	Black-tailed jackrabbit				1					
50610	California ground squirrel				1					1
50730	Botta's pocket gopher									1
50820	Western harvest mouse							1		1
50821	Salt marsh harvest mouse							1		
50830	Deer mouse									1
50990	California vole							1		1
51050	Common muskrat				1			1		
51070	Black rat								1	
51080	Norway rat				1			1	1	1
51090	House mouse							1	1	1
51160	Red fox				1			1		1
51180	Gray fox				1			1		1
51220	Raccoon		1		1			1	1	1
51260	Long-tailed weasel				1					
51310	Striped skunk				1			1	1	1
60040	Pacific harbor seal	1				1	1	1		

Relationship Matrix Descriptions

MATRIX 1: Potential Species by Function Matrix

The potential species list generated by IBIS (see Appendix A) is aligned with Key Ecological Functions (KEFs) that could potentially be performed in the habitat type and structural condition represented by the polygon. For example, if the polygon represents a "shrub-steppe" habitat type, the KEFs thought to be performed in that habitat type by the potential species are included in the relationship matrix. This information is generated from IBIS. The result of this matrix is the number of potential species performing key functions in that habitat type. Example follows:

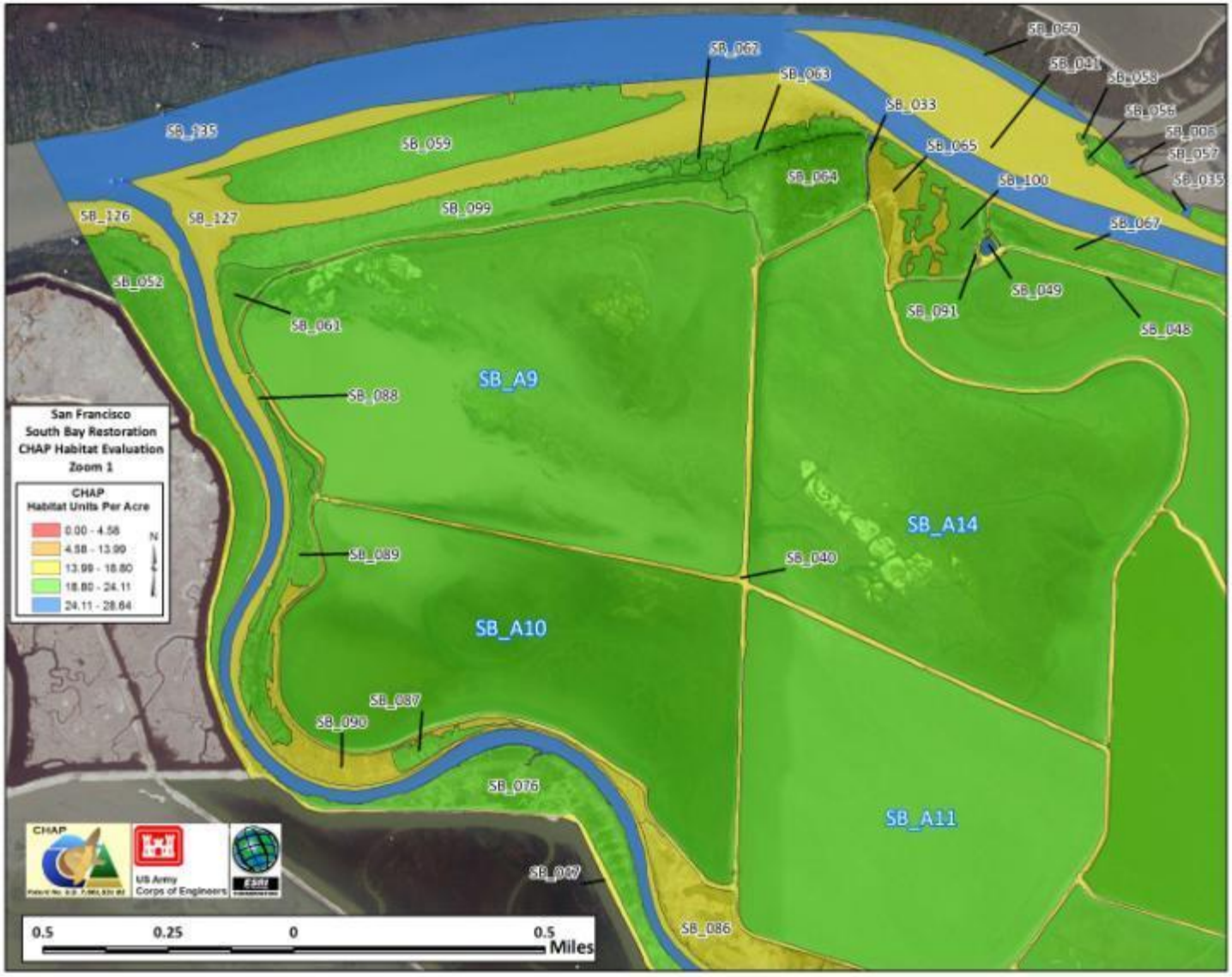
Lowland Mixed Conifer Habitat Type *Species Value (Potential)*	**Function 1** ***Secondary Consumer***	**Function 2** ***Breaks up Down Wood***	**Function 3** ***Primary Excavator***	**Function 4** ***Eats Terrestrial Insects***
Downey Woodpecker	**0**	**1**	**1 (tree)**	**1**
Bobcat	**1**	**0**	**0**	**0**
Belted Kingfisher	**1**	**0**	**1 (burrows)**	**1**
Great Blue Heron	**1**	**0**	**0**	**1**

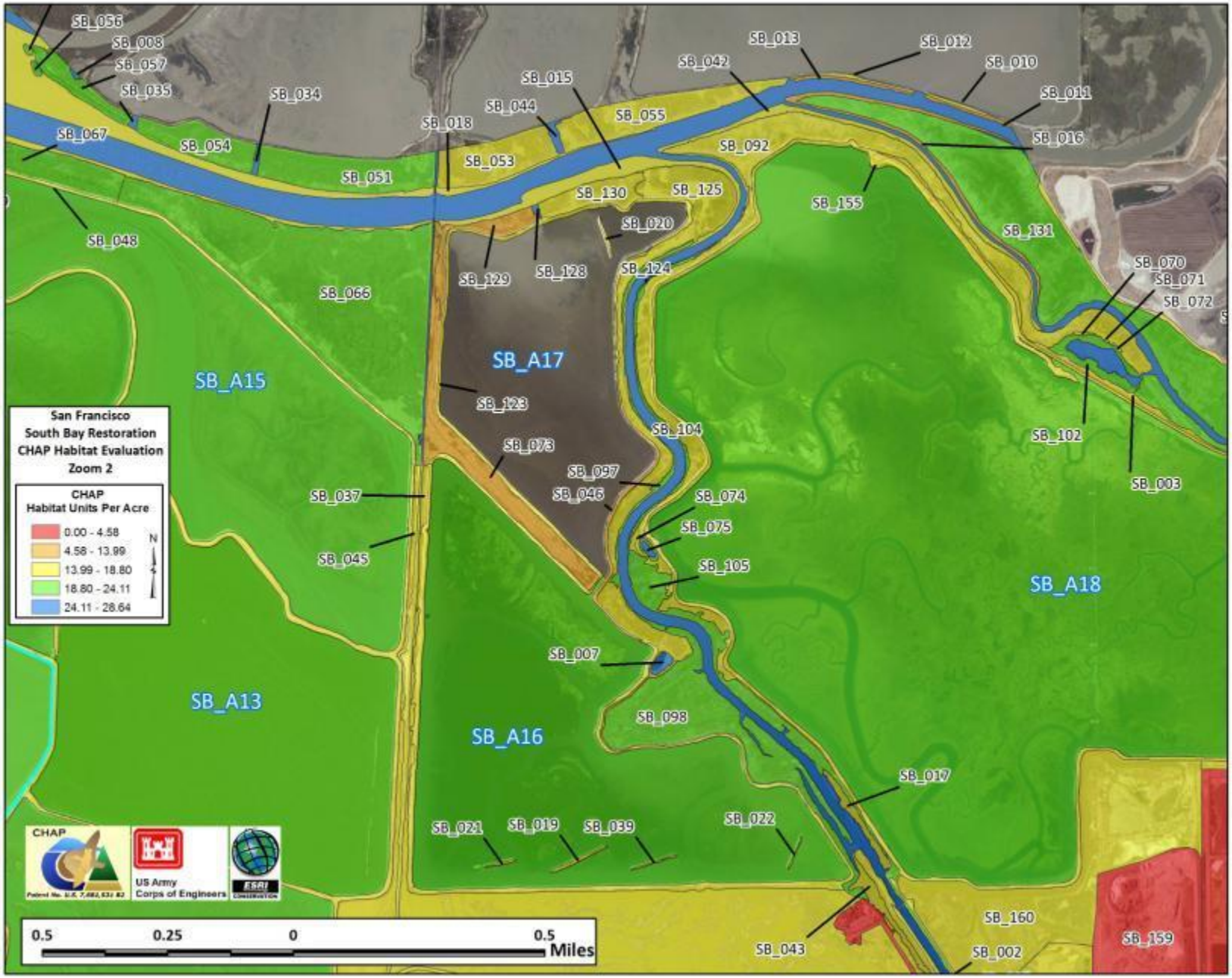
MATRIX 2: Actual KEC by Function Matrix

In this matrix, the functions, or KEFs, are again related to Key Environmental Correlates (KECs), but this time the KECs are actually present at the site (based on field data inventory). Because this is an actual account, those KEFs not correlated to an actual KEC are then removed. The result of this matrix is the number of KEFs characterized by KECs specific to that polygon. Example follows:

Lowland Mixed Conifer Habitat Type *KEC Value (Potential)*	**Function 1** ***Creates Snags***	**Function 2** ***Breaks up Down Wood***	**Function 3** ***Primary Excavator***	**Function 4** ***Eats Terrestrial Insects***	**Function 5** ***Eats Aquatic MacroInvertebrates***
KEC 1 down wood	**0**	**1**	**0**	**1**	**0**
KEC 2 snags	**1**	**0**	**1**	**1**	**0**
KEC 3 tree cavities	**1**	**1**	**1**	**1**	**0**
KEC 4 intertidal	**0**	**0**	**0**	**1**	**1**
KEC 5 Aquatic substrate cobble	**0**	**0**	**0**	**0**	**1**

Appendix C
Zoom-in maps of corrected per-acre values by polygon

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SB_002
San Francisco
South Bay Restoration
CHAP Habitat Evaluation
Zoom 2
CHAP
Habitat Units Per Acre
0.00 - 4.58
4.58 - 13.99
13.99 - 18.80
18.80 - 24.11
24.11 - 28.64
N
CHAP
US Army
Corps of Engineers
ESRI
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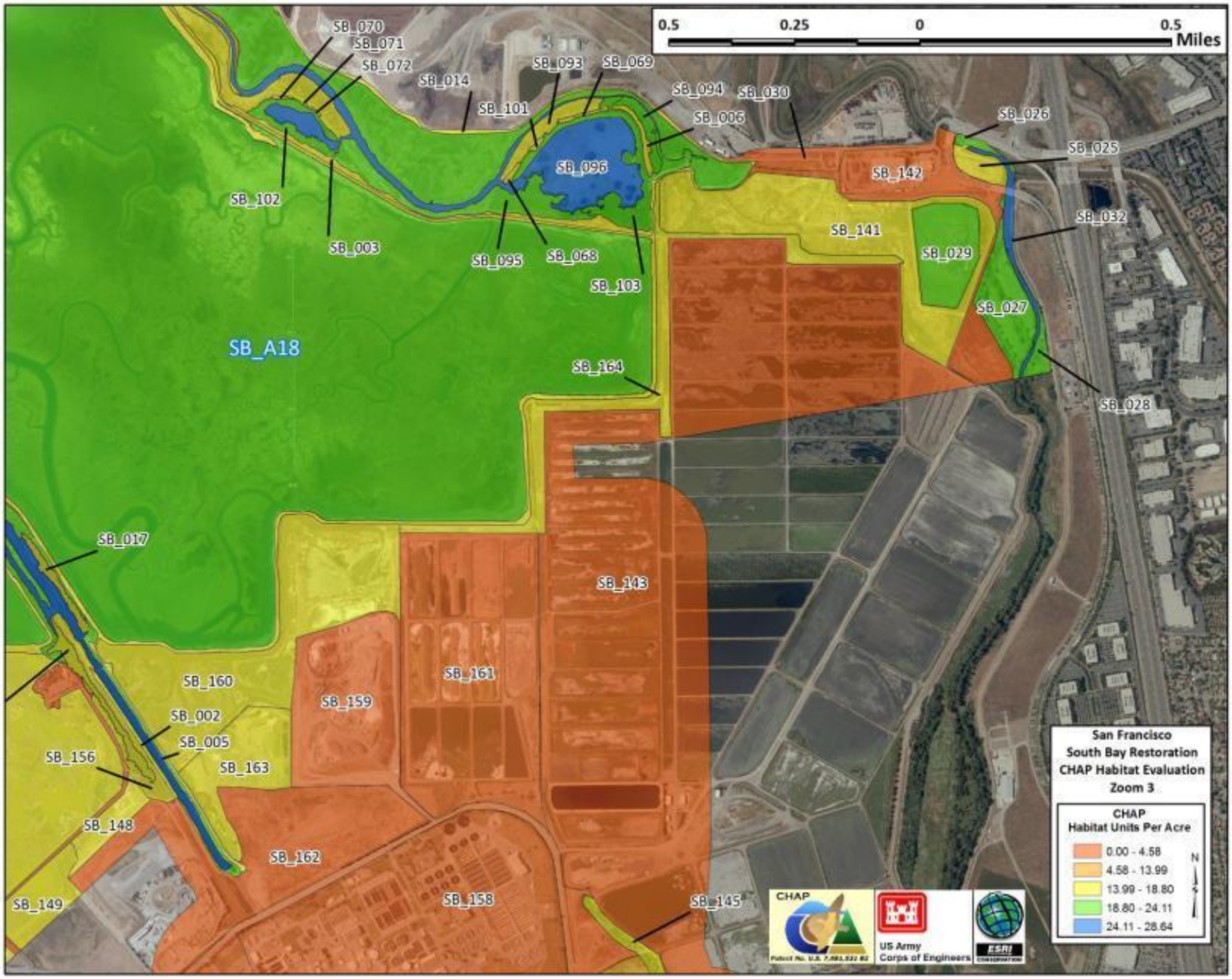
Miles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SB_160
SB_161
SB_159
SB_002
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SB_156
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San Francisco
South Bay Restoration
CHAP Habitat Evaluation
Zoom 3
CHAP
Habitat Units Per Acre
0.00 - 4.58
4.58 - 13.99
13.99 - 18.80
18.80 - 24.11
24.11 - 28.64
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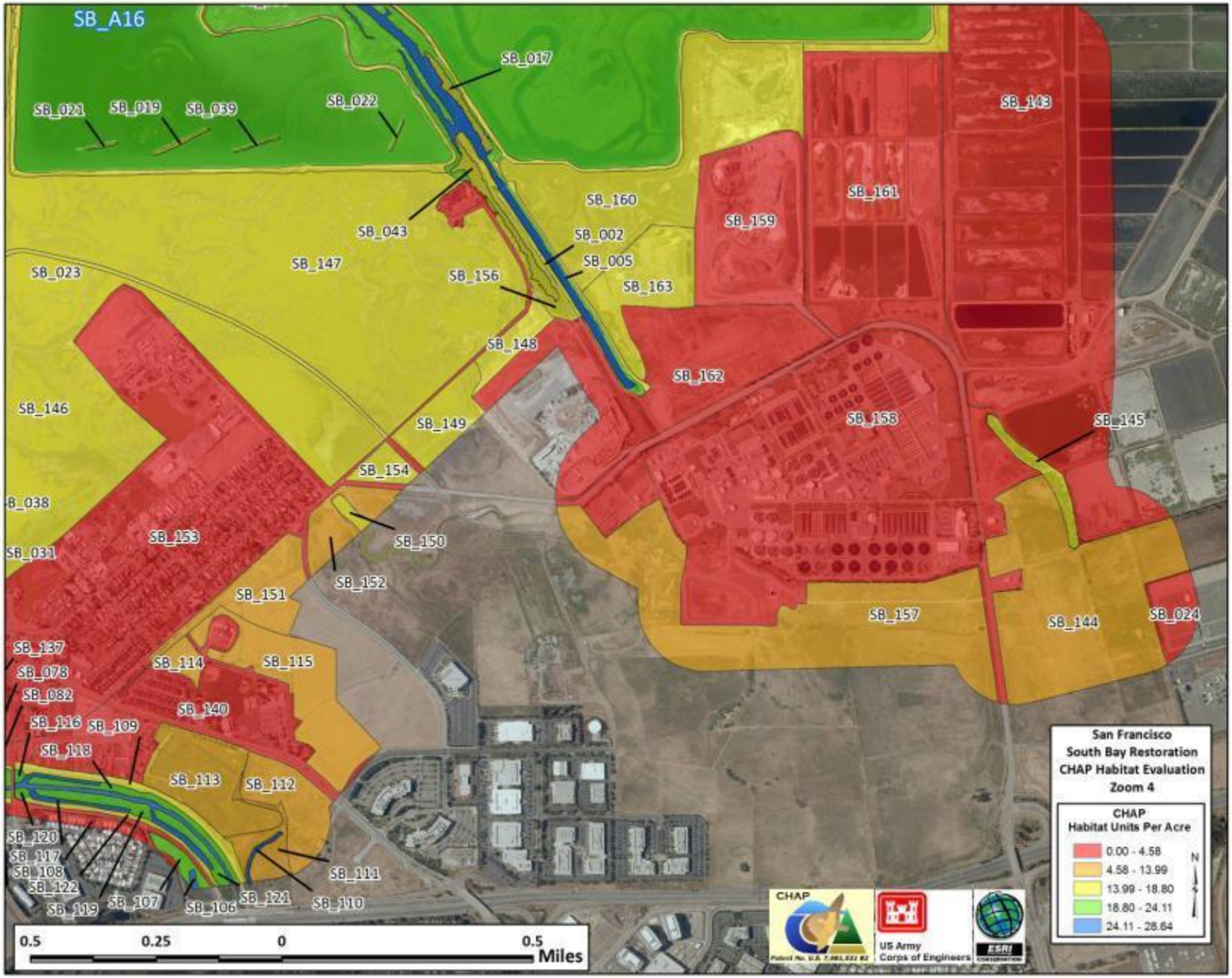
CHAP
US Army
Corps of Engineers
ESRI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SB_147
SB_023
SB_156
SB_163
SB_148
SB_162
SB_146
SB_158
SB_145
SB_149
SB_154
SB_038
SB_153
SB_150
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SB_112
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SB_122
SB_111
SB_119
SB_107
SB_106
SB_121
SB_110
0.5
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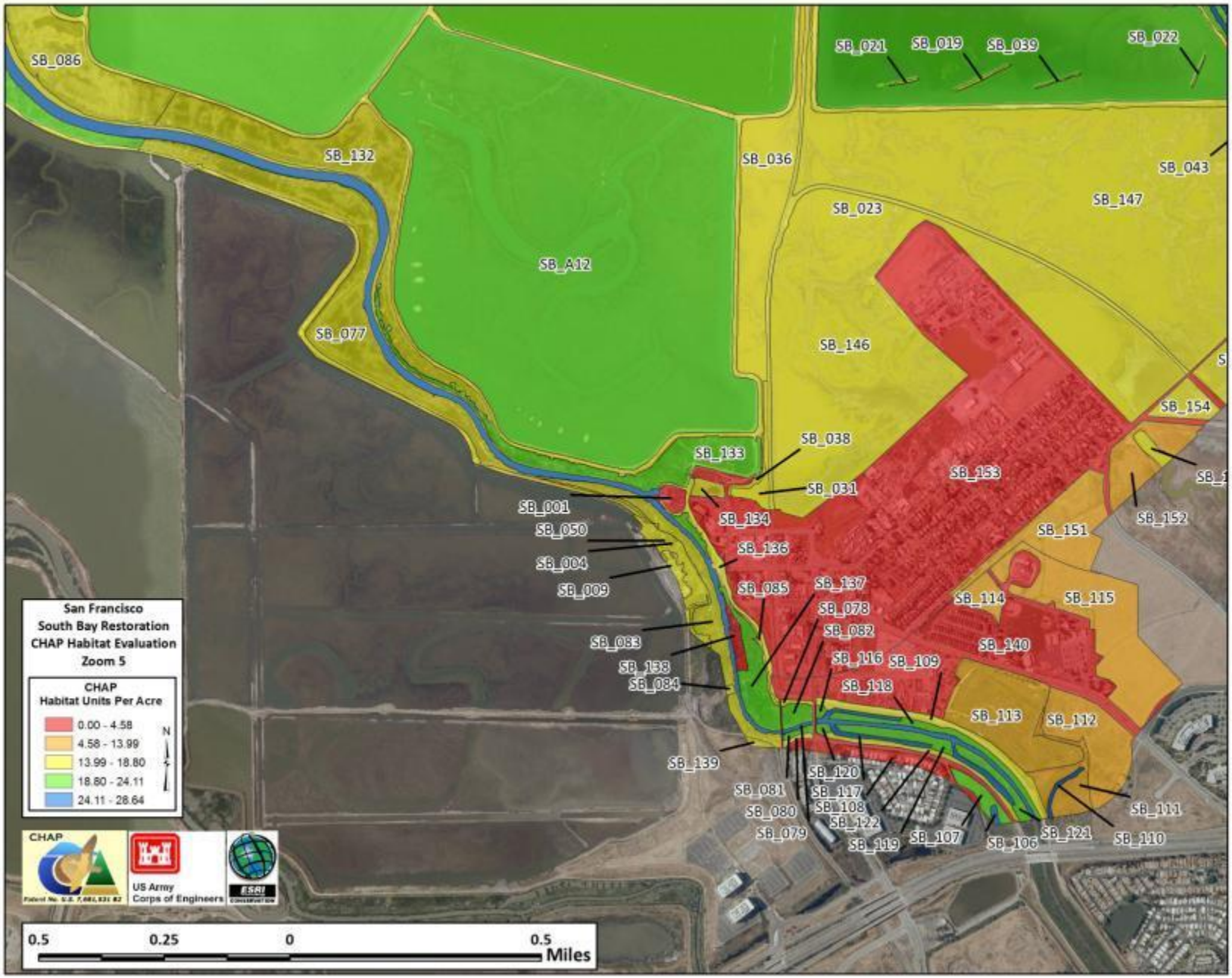
Miles
San Francisco
South Bay Restoration
CHAP Habitat Evaluation
Zoom 4
CHAP
Habitat Units Per Acre
0.00 - 4.58
4.58 - 13.99
13.99 - 18.80
18.80 - 24.11
24.11 - 28.64
N
CHAP
US Army
Corps of Engineers
ESRI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SB_154
SB_038
SB_133
SB_153
SB_031
SB_001
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SB_152
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SB_050
SB_136
SB_004
SB_009
SB_085
SB_137
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SB_114
SB_115
SB_082
SB_083
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SB_116
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SB_138
SB_084
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SB_120
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SB_111
SB_080
SB_122
SB_079
SB_107
SB_106
SB_121
SB_119
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San Francisco
South Bay Restoration
CHAP Habitat Evaluation
Zoom 5
CHAP
Habitat Units Per Acre
0.00 - 4.58
4.58 - 13.99
13.99 - 18.80
18.80 - 24.11
24.11 - 28.64
N
CHAP
US Army
Corps of Engineers
ESRI
0.5
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Miles

Appendix D
Zoom-in maps of habitat unit values by polygon




SB_041
149.17
SB_100
374.54
SB_049
15.55
SB_067
295.79
SB_048
194.95
4.37
5.97
SB_008
3.7
SB_057
104.1
SB_035
7.42
SB_054
168.19
SB_034
11.22
SB_051
308.1
SB_018
28.4
SB_053
203.17
SB_044
19.56
SB_015
158.3
SB_055
267.57
SB_042
90.44
SB_016
58.66
SB_013
10.02
SB_012
13.54
SB_010
10.29
SB_011
6.07
SB_130
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SB_092
490.68
SB_155
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1647.73
SB_102
72.92
SB_128
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4.37
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SB_007
23.13
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37.1
SB_021
3
SB_019
7.37
SB_039
3.66
SB_022
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SB_002
27.8
SB_036
San Francisco
South Bay Restoration
CHAP Habitat Evaluation
Zoom 2
CHAP
Habitat Units (HUs)
by Polygon
Polygon ID's
Habitat Units (HU's)
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CHAP
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ESRI
0.5
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SB_A18
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SB_071 0.53
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SB_005 58.27
SB_043 70.05
SB_163 313.07
SB_156 119.86
SB_162 243.15
SB_148 90.59
SB_145
San Francisco
South Bay Restoration
CHAP Habitat Evaluation
Zoom 3
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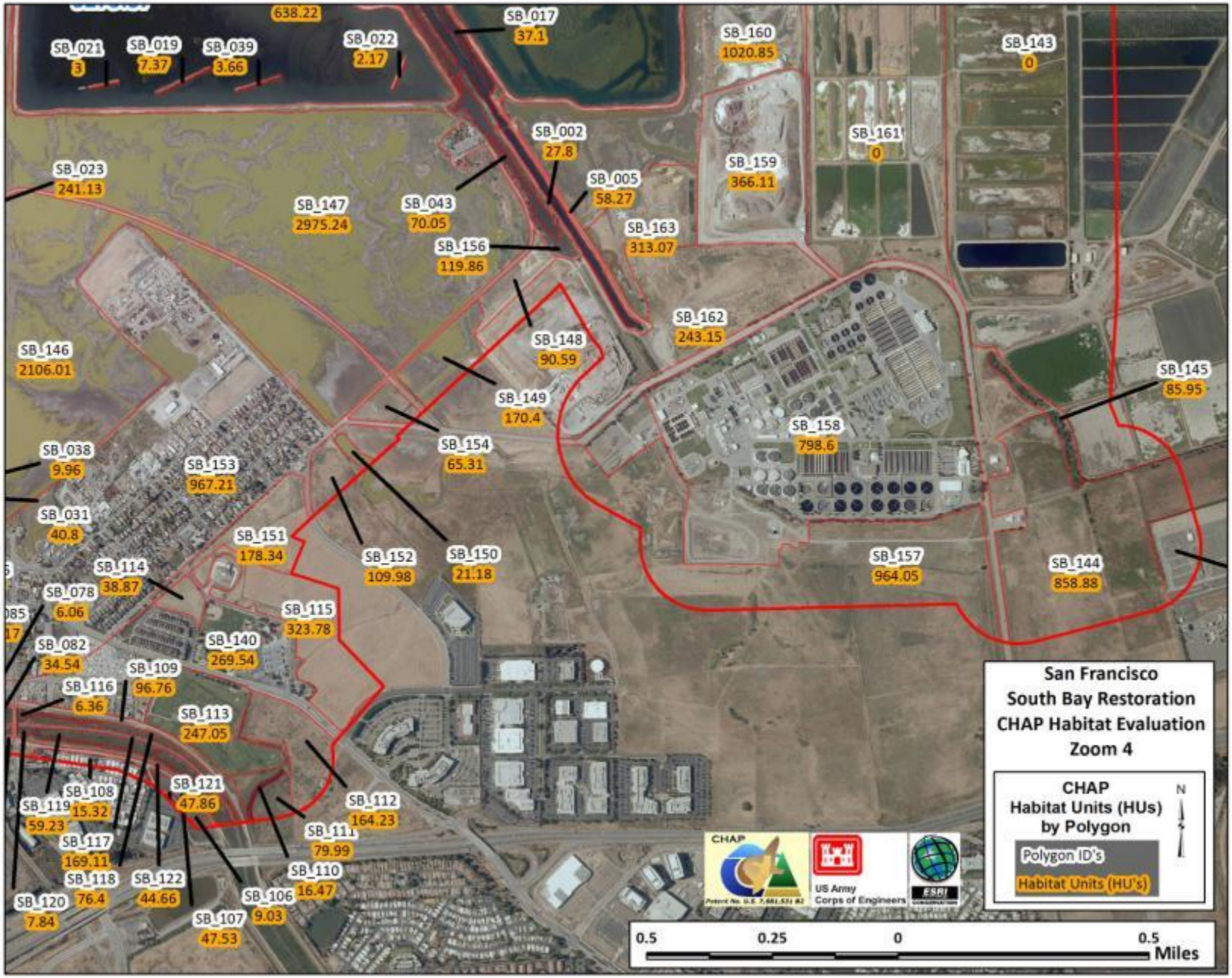
Habitat Units (HUs)
by Polygon
Polygon ID's
Habitat Units (HU's)
N
CHAP
US Army
Corps of Engineers
ESRI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SB_107
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San Francisco
South Bay Restoration
CHAP Habitat Evaluation
Zoom 4
CHAP
Habitat Units (HUs)
by Polygon
Polygon ID's
Habitat Units (HU's)
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CHAP
US Army
Corps of Engineers
ESRI
0.5
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Miles


SB_A12
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San Francisco
South Bay Restoration
CHAP Habitat Evaluation
Zoom 5
CHAP
Habitat Units (HUs)
by Polygon
Polygon ID's
Habitat Units (HU's)
N
US Army
Corps of Engineers
ESRI
0.5
0.25
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Miles
SB_132 565.32
SB_077 588.86
SB_036 470.47
SB_023 241.13
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SB_019 7.37
SB_039 3.66
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SB_043 70.05
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SB_085 12.17
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SB_118 76.4
SB_122 44.66
SB_106 9.03
SB_080 6.85
SB_120 7.84
SB_107 47.53

Appendix B3

Flood Risk Management Coordination with the USFWS

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, California 94555

September 10, 2015

LTC John Morrow, District Commander
Attn: Caleb Conn, Project Manager U.S. Army Corps of Engineers
San Francisco District
1455 Market Street, 17th Floor
San Francisco, California 94103

Dear LTC Morrow,

The purpose of this letter is to clarify what is intended by our Compatibility Determination (CD) for the South San Francisco Bay Shoreline Phase I Study, dated September 4, 2015. First and foremost, nothing in the CD is intended to be inconsistent with the roles and responsibilities outlined in the recommended plan set out in the Final Integrated Document (Final Interim Feasibility Study With Environmental Impact Statement/Environmental Impact Report) and in the Draft Memorandum of Understanding (MOU) between the United States Fish and Wildlife Service (FWS), the Santa Clara Valley Water District (SCVWD), and the California State Coastal Conservancy (SCC).

As such, it is understood that the flood risk management, ecosystem restoration and recreational features in the recommended plan, to be constructed by the Corps, will be operated, maintained, repaired, replaced and rehabilitated by the SCVWD and SCC, the non-Federal Sponsors (NFS) for the South San Francisco Bay Shoreline Phase I Study Project, under sections 103(i) and 103(j) of the Water Resources Development Act of 1986, 33 U.S.C. § 2213(i)(j), and USACE regulations and policies. Please refer to Chapter 9 of the Integrated Document and paragraphs 2 and 3.B. of the draft MOU, attached, that discusses the operations, maintenance, repair, replacement and rehabilitation of the project .

The FWS recognizes that the subsequent restoration activities, i.e., the conversion of Refuge Ponds A9-15 to tidal marsh habitat and the enhancement of recreational features (replacing trails and interpretive signs along levee), that will follow the levee construction are Refuge Management Activities and therefore from our perspective do not require a CD.

The term “Refuge Management Activities” is from our own policy and is not a reference to the specific activities of the Shoreline project but rather refers to a category of “refuge uses.” A “Refuge Management Activity” is a specific term defined by our policy as: “An activity conducted by the Service or a Service-authorized agent to fulfill one or more purposes of the national wildlife refuge, or the National Wildlife Refuge System mission. Service-authorized agents include contractors, cooperating agencies, cooperating associations, refuge support groups, and volunteers.” Even though USACE and the sponsors are funding the ecosystem restoration and recreation features and have control over the project features, including mitigation, monitoring, and adaptive management activities, those activities fulfill one or more purposes of the refuge; therefore, we consider those to be “Refuge Management Activities.” Fortunately for all involved, those “general” (not specific) uses have already been evaluated in prior planning documents and have been determined to be compatible.

Also note that although the "Description of Use" section of the CD refers to USACE being responsible for levee construction and the NFS as being responsible for levee operation and maintenance, it was not intended to limit any other responsibilities or authorities in any manner, shape or form. The other components of the South San Francisco Bay Shoreline Phase I Study Project, i.e., ecosystem restoration and recreation, have already been deemed to be compatible and thus were not included in the CD. As described in the MOU, access for the design and construction of the levee, ecosystem restoration, and recreation features will be granted to USACE through issuance of a Special Use Permit and access for operation and maintenance of the features will be granted to the NFS in the form of a Right of Way without term limitations.

To ensure that there is no doubt of the FWS intentions, we will ensure that our Record of Decision is sufficiently robust to include all three major project elements of flood control, ecosystem restoration, and recreation. Additionally, we will discuss the OMRR&R responsibilities of the NFSs. Should you have any further questions, please do not hesitate to contact me by telephone on (510) 792-0222 extension 123 or by email at anne_morkill@fws.gov.

Sincerely,

Anne E. Morkill
Refuge Complex Manager

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, California 94555

Compatibility Determination
for the South San Francisco Bay Shoreline Phase I Study,
Don Edwards San Francisco Bay National Wildlife Refuge, California

Use: Issuance of a Special Use Permit to the U.S. Corps of Engineers and a Right of Way to the Santa Clara Valley Water District for the construction and operation of an engineered flood risk management levee as a component of the South San Francisco Bay Shoreline Phase I Study.

Refuge Name: Don Edwards San Francisco Bay National Wildlife Refuge, Alameda, Santa Clara and San Mateo Counties, California (see Figure 1).

Date Established: June 30, 1972

Establishing and Acquisition Authorities: 86 Stat. 399, dated June 30, 1972, An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes (16 U.S.C. 667b); Endangered Species Act of 1973 (16 U.S.C. 1534); Fish and Wildlife Act of 1956 (16 U.S.C. 742f)

Refuge Purpose(s):

"...for the preservation and enhancement of highly significant wildlife habitat...for the protection of migratory waterfowl and other wildlife, including species known to be threatened with extinction, and to provide an opportunity for wildlife-oriented recreation and nature study..." (86 Stat. 399, dated June 30, 1972).

"...particular value in carrying out the national migratory bird management program" 16 U.S.C. 667b (An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes).

"...to conserve (A) fish or wildlife which are listed as endangered species or threatened species....or (B) plants ..." 16 U.S.C. 1534 (Endangered Species Act of 1973).

"...for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. 742f(a)(4) "...for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. 742f (b)(1) (Fish and Wildlife Act of 1956).

National Wildlife Refuge System Mission: The mission of the National Wildlife Refuge System is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd- 668ee]).

Description of Use: The proposed use is the issuance of permits to grant access for the construction and operation of an engineered flood risk management levee on the Don Edwards San Francisco Bay NWR, including pre-construction engineering and design activities, geotechnical and hydrological analyses, equipment staging, construction of project features, and the long-term operations, maintenance, repair, replacement, and rehabilitation of the levee. The levee is part of the South San Francisco Bay Shoreline Study (Study), a multi-purpose flood risk management, ecosystem restoration, and recreation enhancement project led by the U.S. Corps of Engineers (USACE) in coordination with California State Coastal Conservancy (SCC), Santa Clara Valley Water District (SCVWD), U.S. Fish and Wildlife Service (USFWS), and City of San Jose. Access for the proposed use would be granted through issuance of a Special Use Permit to the USACE (levee design and construction) and a Right Of Way to the SCVWD (levee operation and maintenance).

The engineered levee would be constructed on an existing pond dike alignment along the eastern border of Refuge Ponds A12-13 and the southern border of Refuge Pond A16 and cross Artesian Slough onto city property where it would continue along the southern border of the city's Pond A18. The engineered levee would be built to 15.2 feet high (approximately 6-8 feet higher than existing pond dikes) to provide protection against a 100- year storm event, meet local requirements for flood risk management within Santa Clara County, and allow for continued Federal Emergency Management Agency (FEMA) accreditation at the end of the Study's period of analysis (the year 2067). The proposed use also includes construction of a 30:1 (1 foot of elevation rise for each 30 feet of horizontal distance) broad-sloping ecotone along the levee alignment adjacent to Refuge Ponds A12-13 (Figure 2).

The subsequent restoration activities (conversion of Refuge Ponds A9-15 to tidal marsh habitat) and enhancement of recreational features (replacing trails and interpretive signs along levee) that will follow the levee construction are Refuge Management Activities, and therefore do not require a compatibility determination.

Availability of Resources:

Adequacy of existing resources: Existing resources are adequate to administer the special use permit and the right of way. The primary staff responsible is the Refuge Manager (and other staff as appropriate) of the Don Edwards San Francisco Bay NWR, with support as necessary from the Project Leader for the San Francisco Bay National Wildlife Refuge Complex, headquartered in Fremont, California.

Needed resources: No additional fiscal resources are needed to manage this use. The Refuge Manager will be using regular base allocations for the long-term operations and maintenance of the ecosystem restoration features and associated recreational features on Refuge lands (Ponds A9- 16). Operations and maintenance costs will be reduced significantly once Ponds A9-15 are restored to tidal marsh, negating the need to maintain the system of earthen dikes and water control structures that currently exist. Further, the USFWS will no longer be responsible for maintaining the levee along Refuge Ponds A12-13 and A16 as they will be placed under a right-of-way permit for the SCVWD to operate and maintain once it is re-constructed to the proposed engineered flood risk management levee height of 15.2 feet.

Anticipated Impacts of the Use:

Water Quality: Negative short-term impacts from temporary increase in salinity in sloughs and remobilization of mercury in ponds and sloughs. Potential positive long-term benefits to surface water and sediment quality. Restoration of the ponds would reduce turbidity of waters flowing into the bay, provide energy dissipation that will reduce erosion and flooding, provide higher levels of dissolved oxygen in some ponds in the short term, and sequester water pollutants in the South San Francisco Bay.

Air Quality/Greenhouse Gases: Moderate but short-term negative construction-related impacts.

Subtidal Marsh and Mudflat Habitat Values: Minor negative construction-related impacts; potential positive long-term effects. Proposed use would not have a substantial adverse effect on or cause a substantial decrease in the abundance or distribution of steelhead, Chinook salmon, green sturgeon, longfin smelt, estuarine species, or bay shrimp populations, nor result in the substantial loss or degradation of designated essential fish habitat. The proposed use would not interfere substantially with the movement of any native or migratory fish or impede the use of aquatic nursery sites.

Tidal Marsh Habitat Value: Substantial positive mid- and long-term effects; additional ecotone provides for early evolution of marsh communities in former ponds and provides high-tide refugia for marsh-dependent species during high tide events, storm events, and accelerating rates of sea level rise.

Upland Habitat Value: Minor negative temporary construction-related impacts. Minor permanent increases from levee construction.

Threatened and Endangered Species: Substantial positive mid- and long-term effects; potential for minor and temporary negative effects during construction. Restoration of the ponds, which will be facilitated by the construction of the flood risk management levee, and the additional ecotone will provide for early evolution of marsh communities in former ponds and provide high-tide refugia for marsh-dependent listed species during high tide events, storm events, and accelerating rates of sea level rise.

Cultural Resources: No documented sites in the project area. Potential disturbance to unknown sites; however, any previously unknown sites that are discovered during construction activities will be handled in compliance with cultural resources consultation process.

Aesthetics: Minor negative temporary construction-related impacts. The expanded ecotone would provide shallow slopes along certain segments bayside of the levee, would include vegetation on these slopes, and would soften the contrast in form in contrast to a more traditional sharp-sloped concrete or rocked sterile-like engineered levee. The project could also result in long-term impacts to the viewshed from the Refuge's Environmental Education Center; but those impacts would be ameliorated by the addition of new trails leading up to and along the crest of the levee to provide new opportunities for views.

Land Use: Project would benefit adjacent land use by providing high level of flood risk management. There is potential for temporary construction nuisance impacts— such as noise, dust, and visual impacts—on Refuge visitors, Alviso residents, and the use of the Alviso County Marina. Construction activities may require temporary closure of public trails and the Refuge's Environmental Education Center.

Recreation: The ecosystem restoration component will result in a net loss of approximately 2.2 miles of Refuge trails once levees are breached to facilitate tidal marsh restoration, but would still support a useful Refuge trail system and a connection to other regional trails such as the San Francisco Bay Trail system. The project would result in long-term enhancements for Refuge visitors by providing providing benches, interpretive displays, and observation platforms, and facilitating connections to other trail systems with the addition of new pedestrian crossings of Artesian Slough and the Union Pacific Railroad tracks.

Public Review and Comment:

Public review and comment was solicited on the draft CD for 30 days. The draft CD was available to the public for review during June 8-July 10, 2015 while posted on the Refuge website and as hard copy at the Refuge headquarters on 1 Marshlands Road, Fremont, California. No public comment was received on the draft CD.

For additional consideration, public comment received on the Draft EIS was also evaluated. The USACE and USFWS are acting as the co–lead agencies under the National Environmental Policy Act (NEPA), and the SCVWD is acting as the lead agency under the California Environmental Quality Act (CEQA). Additionally, the SCC serves as a non-Federal cost-share partner and CEQA responsible agency for this project. The interagency project team commenced the South San Francisco Bay Shoreline Study's Phase 1 Interim Feasibility Study and Environmental Impact Statement/Environmental Impact Report (EIS/EIR) process in January 2006. The public involvement program for the project included a formal pubic scoping meeting on January 25, 2006 in Milpitas, CA, as well as ongoing stakeholder coordination and opportunities to comment on the scope and content of the proposed project through a stakeholder forum originally convened for the South Bay Salt Pond Restoration Project (SBSPRP). Forum

meetings occurred once a year and were open to the public. The Draft Interim Feasibility Study and EIS/EIR (Integrated Document) was released for public review and comment from December 19, 2014 through February 2, 2015. A public meeting on the Draft Integrated Document was held on January 14, 2015 in Alviso, CA. The comment period was subsequently extended until February 23, 2015. A total of 40 comment letters were received, including 9 letters requesting a time extension for the public comment period. The comments represented a variety of stakeholder groups as follows: Fed/State/County/City Agencies – 17, for-profit business – 2 (PG&E, Cargill), non-profit business – 12, private citizens - 9. A full description of the previous public review and comment process can be found in Chapter 6.0, Public Involvement, Review, and Consultation in the Draft Integrated Document (December 2014); and the response to comments will be included in the Final Integrated Document (December 21015).

Determination:

___ Use is Not Compatible

XX Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility:

The general conservation measures that will be implemented during project activities to avoid and minimize adverse effects on sensitive species and habitats are listed in the South San Francisco Bay Shoreline Study's Draft Interim Feasibility Study and Environmental Impact Statement/Environmental Impact Report (December 18, 2014) and Intra-Service Section 7 Endangered Species Act Final Biological Opinion/Conference Opinion (April 27, 2015), and incorporated herein by reference.

Justification:

With the acquisition of some 11,000 acres for former commercial solar salt ponds (including new fee title and salt-making rights on existing fee title) from Cargill, Inc. in 2003, the Don Edwards San Francisco Bay NWR gained responsibility for more than 70 miles of non- engineered dikes (earthen berms) and associated water control structures that were originally designed and constructed for commercial salt ponds. The dikes, which were created as early as the 1920s, were generally maintained to protect the salt pond production from tidal flooding, but were not meant to prevent flooding of adjacent communities. To date, the USFWS has received insufficient funds to adequately maintain the non-engineered dike system, resulting in an extremely degraded condition of many of the dikes with capability of only periodic spot-repairs as needed. Currently, much of the land south of the ponds is urbanized, including the residential and historic community of Alviso (within the limits of the City of San Jose), Silicon Valley tech business parks, transportation corridors, landfills, the City of San Jose's wastewater treatment plant, and other critical infrastructure. Much of this area has subsided as much as 13 feet below sea level due to extensive groundwater withdrawal for agricultural uses. There is considerable risk for tidal flooding caused by having large areas of low-lying terrain that are bordered by severely degraded non-engineered dikes, which are inadequate to provide reliable flood risk management for the urbanized areas south of the ponds. Sea level rise will further exacerbate risks from tidal

flooding caused by higher waters stressing the dikes. Flood benefits (damages reduced) from the project will be fully realized simply as a function of levee height and engineered design features, replacing the non-engineered dikes that currently exist.

Addressing flood risk in the Alviso area would also allow for the restoration of some 3,000 acres of former salt-production ponds to tidal marsh habitats along with associated ecological functions and habitat for threatened and endangered species. San Francisco Bay is one of the most extensive wetland ecosystems along the Pacific Coast, providing habitat for millions of migratory waterfowl and shorebirds along the Pacific Flyway as well as resident fish and wildlife. Since the area was settled in the 1880s, more than 85% of the tidal marshes have been filled, diked, or drained to support development, agricultural, and commercial solar salt-making. Since the 1960s, the trend shifted towards protection and restoration of the estuary, including the establishment of the Don Edwards San Francisco Bay NWR for the purposes of conserving and restoring tidal marsh habitats and supporting the recovery of endangered species, including the salt marsh harvest mouse (*Reithrodontomys r. raviventris*) and California Ridgway's rail (*Rallus obsoletus*, formerly *Rallus longirostris obsoletus*). The USFWS is consequently an active partner in the South Bay Salt Pond Restoration Project, the largest wetland restoration program on the West Coast that seeks to restore and enhance a mix of wetland habitats, provide wildlife-oriented public access and recreation, and provide for flood risk management in the South Bay. The proposed use described herein meets all of these goals in addition to the goals and objectives of the Don Edwards San Francisco Bay NWR Comprehensive Conservation Plan (2012) and the USFWS's Recovery Plan for Tidal Marsh Ecosystems in Northern and Central California (2014).

Reevaluation Date: In accordance with Compatibility Policy (603 FW 2.11 H), we will reevaluate compatibility when the conditions under which the special use permit or right of way permit are authorized change significantly, if there is significant new information regarding the effects of the use, and/or upon extension or termination of the permits. In addition, we will periodically monitor and review for compliance with permit terms and conditions.

NEPA Compliance for Refuge Use Decision:

____ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

_____ Environmental Assessment and Finding of No Significant Impact

__X__ Environmental Impact Statement and Record of Decision

Refuge Determination

Prepared by:

Sept 3, 2015

Project Leader (Signature) (Date)

Concurrence:

9/4/2015

Refuge Supervisor (Signature) (Date)

9.4.2015

Assistant Regional Director, Refuges (Signature) (Date)

Figure 1. Don Edwards San Francisco Bay National Wildlife Refuge (location of proposed use indicated by yellow arrow)

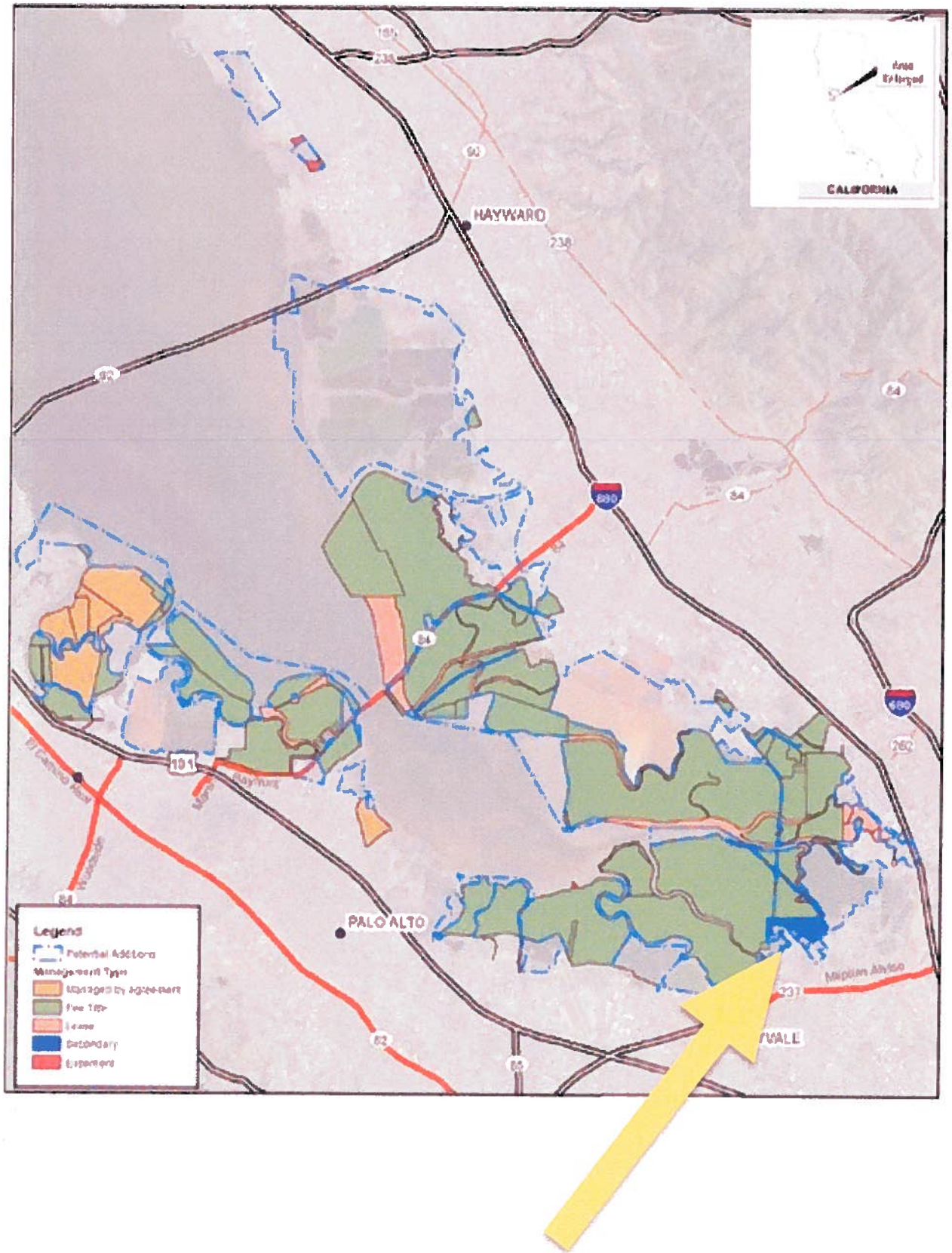
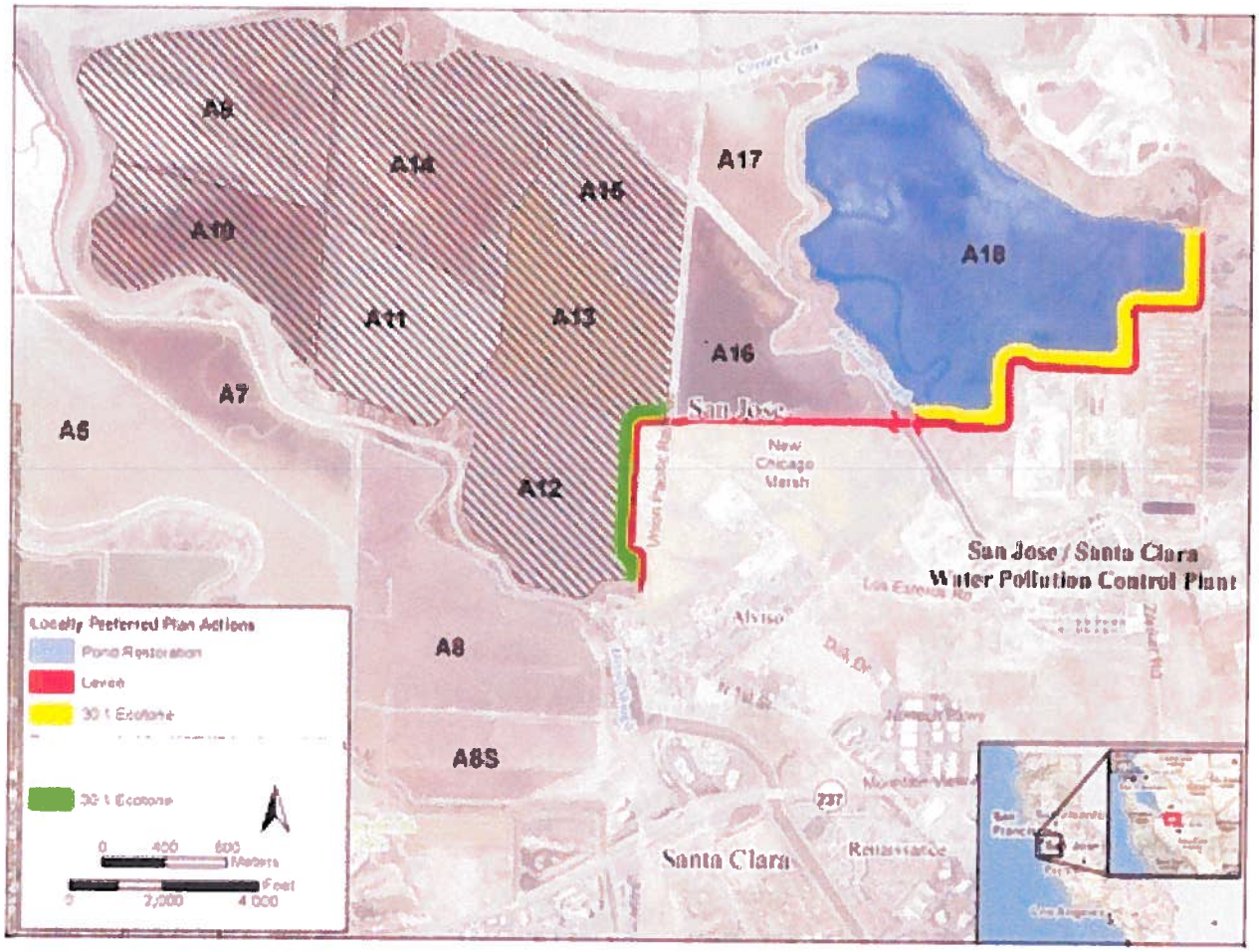


Figure 2. Proposed alignment for engineered flood risk management levee and associated ecosystem restoration features (Tentatively Selected Plan/Locally Preferred Plan for South San Francisco Bay Shoreline Study). The levee alignment and associated ecotone along Ponds A12-13 and A-16 are on Service property. The remaining levee alignment and ecotone along Pond A-18 ares on city property.



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Bay Delta Fish and Wildlife Office
650 Capitol Mall 8th floor 8-300
Sacramento, California 95814

In Reply Refer to:
08ESMF00-
2013-CPA-0002

MAR 31 2015

Lt. Col. John C. Morrow
Commander
Attn: William DeJager
U.S. Army Corps of Engineers
San Francisco District
1455 Market Street
San Francisco, California 94103-1398

Dear Lt. Colonel Morrow:

This letter revises and supersedes the U.S. Fish and Wildlife Service's (Service) letter dated October 21, 2014, which described the Service's position and recommendations regarding the U.S. Army Corps of Engineers' (Corps) South San Francisco Bay Shoreline Phase I Study.

The Service has participated in planning efforts associated with the South San Francisco Bay Shoreline Phase I study for a number of years. The Service has also participated as a federal co-lead agency on this study pursuant to the National Environmental Policy Act since the project is proposed to occur on a portion of Don Edwards San Francisco Bay National Wildlife Refuge (Refuge). In addition, the Service's Sacramento and Bay Delta Fish and Wildlife Offices provide guidance and support regarding federally listed species pursuant to the Endangered Species Act and on proposed water resource development projects pursuant to the Fish and Wildlife Coordination Act (FWCA).

The Service's efforts under FWCA are supported by transfer funding from the Corps. Transfer funding to date has been inadequate to support the type of detailed evaluation and develop recommendations such as would be in a Coordination Act Report (CAR) for a project of this scope. The Corps recently informed us that such funds will soon be provided for continued coordination including development of a CAR. Up to the time of our October 21, 2014, letter, we used the limited funds available for initial document review and informal coordination. Since our October 21, 2014, letter, we have had further opportunity to coordinate with Refuge and Corps staff and to review the alternative levee alignments and other information discussed in the Corps' December 2014 draft interim Feasibility Study/Environmental Impact Statement (FS/EIS) (Corps 2014). Based on this review, we have developed the following revised comments and recommendations. The content of this letter is still to be considered preliminary and subject to confirmation or further revision as needed pending the completion of a CAR.

Comments and recommendations

In our October 21, 2014, letter, we expressed concern that the Alviso North levee alignment, now a component of the Corps' tentatively selected plan and proposed project (FS/EIS Alternative 3), would permanently isolate New Chicago Marsh (NCM) from the San Francisco Bay, limiting the extent to which the project could restore full tidal marsh. At that time, we supported a project similar to that shown in FS/EIS Alternative 4 involving the more southerly Alviso Railroad Spur alignment for levee improvements to the west, which would expose part of NCM to tidal action, in combination with the Water Pollution Control Plant (WPCP) south alignment to the east. Among other reasons, we believed then that this alternative would result in a more comprehensive restoration and would incur reduced long term management costs. Our recommendations also differed from the earlier locally-preferred alternative that included a WPCP north alignment which would have reduced the extent of tidal restoration. These recommendations were previously discussed in our earlier letter of December 26, 2012, which is included in the FS/EIS (Appendix H *in* Corps 2014). We acknowledge that the WPCP North levee alignment has since been eliminated from the proposed project and locally preferred alternative and was not included in the final alternatives analysis in the FS/EIS.

Like many parts of the study area, NCM has experienced significant subsidence. Based on reasonable estimates of suspended sediment concentration, modeling of areas adjacent to NCM indicate that it would take several decades or more after initial exposure to tidal action for accretion to raise elevations to the point where vegetation could colonize the surface (ESA PWA 2012). This modeling indicates that the interior, more deeply subsided areas such as pond A12, would need to be restored first in order to maximize the rate of sediment accretion in these locations; otherwise, they would remain subtidal habitat. The NCM was not included in the area modeled by ESA PWA (2012) and is not under consideration for any of the alternatives. Nevertheless, it is reasonable to suggest that if tidal restoration of NCM were modeled, it would probably indicate a need for treatment sequence and marsh plain evolution similar to pond A12 (i.e., early breaching; decades needed for restoration). Inclusion of NCM, while maximizing the overall extent of tidal restoration, could affect or delay restoration of other areas.

Additionally, we have reconsidered the effect of retaining NCM versus opening it to full tidal action on fish and wildlife resources. Currently, NCM is a muted tidal marsh with water control structures that limit the amount of Bay water that enters and exits the marsh. Because of the reduction in tidal level and range, muted tidal marsh of this type generally has a lower diversity of vegetation and habitat types than full tidal marsh. Nevertheless, NCM in its present form constitutes one of the largest intact blocks of tidal marsh vegetation in the project vicinity and provides habitat that supports a number of rare species, including the federally listed salt marsh harvest mouse and western snowy plover, and others such as Forster's tern, black-necked stilt, and American avocet (Appendix Q *in* Corps 2014). If NCM were to be exposed to full tidal action under the levee configuration we had recommended, it would become open water at the expense of the marsh vegetation and the populations of these important wildlife species and would likely remain open water for a considerable time (decades).

Conversely, if NCM were retained in its present form or enhanced, it would provide continued habitat for these species. The populations in NCM, if preserved and protected, could then serve as a nearby source to expand onto the tidally restored habitat as it becomes available. Although the majority of the tidal restoration would occur over the long term, the proposed project does include a

significant component of 30:1 ecotone created by gently sloping fill placed on the outboard side of significant portions of the levee. We expect this ecotone to be rapidly colonized once exposed to full tidal action and provide more immediate additional tidal marsh and upland habitat adjacent to NCM. The proposed project, while perpetuating the muted tidal condition of NCM, provides protection from flood risks (including sea level rise) to that habitat which does not exist currently. Finally, the proposed project (also the locally preferred project) now includes the WPCP south alignment, which would maximize tidal restoration of pond A18. Both the ecotone and WPCP south components of the proposed project remain consistent with our October 21, 2014, recommendations regarding those elements.

The Service is sensitive to the need to adequately inspect and maintain the proposed levee improvements, which would also protect habitat in NCM and incorporate habitat enhancement in the form of the ecotone element in this case. Based on recent information provided by the Corps (February 20, 2015 email from Bill DeJager, San Francisco District), we now understand that most of the 30:1 ecotone element, to be composed of non-engineered fill, would be allowed to have maintenance-free marsh vegetation for nearly its entire length. As described to us, only the first 15 feet of that fill from the point it meets the levee would be maintained as a vegetation-free zone under current Corps policy (Engineering Technical Letter 1110-2-583). We expect this allowance to preserve most of the potential value of the ecotone as transitional habitat. We anticipate further coordination with the Corps and Service Refuge staff to understand and make further recommendations on maintenance needs as well as to formulate measures to minimize the effect of maintenance on listed species.

As we discussed initially in our October 21, 2014, letter, there are inherent difficulties in the application and interpretation of the Combined Habitat Assessment Protocol (CHAP) habitat evaluation methodology for this project. In principle, CHAP is based on biodiversity and places a higher value on those habitats which support greater species numbers and functions. This principle may not be appropriate to this project. Additionally, the CHAP study as provided in the FS/EIS appears to be incomplete and inadequate for present evaluation. Specifically, the FS/EIS includes only a baseline condition report and not evaluation of the alternatives (Appendix J *in* Corps 2014). Elsewhere, the FS/EIS (e.g., main report p. 3-39 and Appendix D pp. 4-5 *in* Corps 2014) makes inferences regarding evaluation of the alternatives, but the documentation of this alternative evaluation does not appear to be included in the FS/EIS. The Service would need full documentation as well as additional time and transfer funding to better evaluate the results of the CHAP effort. However, independent of the habitat evaluation, we believe that the project as proposed will result in near term protection of existing habitat on NCM from flood risks, an increment of additional enhanced habitat in the intermediate term on the ecotone, and a much more significant amount of habitat over the long term as the restored areas attain elevations needed for vegetation establishment.

Based on all of these considerations, it is the Service's preliminary finding to withdraw our previous support of the Alviso Railroad Spur and WPCP south alignment, and instead recommend Alternative 3 with its Alviso Slough North and WPCP south alignment, the Corps' tentatively selected plan and locally-preferred alternative. We now believe that Alternative 3 represents a reasonable and supportable combination of tidal restoration for the majority of the study area together with maintenance and protection of current habitat within NCM.

If you have any further questions on the Service's revised position and recommendations regarding the South San Francisco Bay Shoreline Phase I Study as described in this letter, please contact Steven Schoenberg of my staff at (916) 414-6564.

Sincerely,

Larry Rabin
Acting Field Supervisor

cc:
Joseph Terry, Sacramento Fish and Wildlife Office, Sacramento, California
Melisa Amato, Refuge Manager, Don Edwards NWR, Fremont, California
William DeJager, San Francisco Corps of Engineers, San Francisco, California
Judy McCrea, San Francisco Corps of Engineers, San Francisco, California
Brenda Buxton, California Coastal Conservancy, Oakland, California

REFERENCES

ESA PWA. 2012. Shoreline Study Preliminary Alternatives and Landscape Evolution. Memorandum prepared for the U.S. Army Corps of Engineers San Francisco District. ESA PWA. San Francisco, California. February 10, 2012. 16 pp + appendix + figures.

U.S. Army Corps of Engineers (Corps). 2014. Draft Interim Feasibility Study and Environmental Impact Statement/Report. South San Francisco Bay Shoreline Study Phase 1 Project. Santa Clara County, CA. December, 2014. U.S. Army Corps of Engineers San Francisco District.

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1398

CESPN-ET-P 14 March 2014

Memorandum for Record: South San Francisco Bay Shoreline Study Supplemental Analyses on Sea Level Change and Flood Risk Associated with U.S. Fish & Wildlife Service's (USFWS) Refuge Lands

ISSUE: The recently completed supplemental analyses for the South San Francisco Bay Shoreline Study suggest greater flood risks to the community of Alviso, fronted by USFWS's dikes, than previously determined under this study.
The USFWS's San Francisco Bay National Wildlife Refuge Complex includes a former Cargill, Incorporated salt harvesting operation that includes a series of ponds and dikes to manage water levels primarily for wildlife benefits, but which historically have also peripherally reduced the risk of tidal flooding to the community of Alviso. USFWS has assumed maintenance responsibilities nominally to the same level as those once practiced by Cargill, Incorporated and is committed to continuing this practice. Increasing sea level and associated storm events will increase tidal flooding risk to Alviso, which sits behind these unengineered dikes. Recent analysis of the flood risk has identified that the risk of some tidal flooding to Alviso, even at project year zero (2017, prior to significant sea level rise), may be as high as 1 in 3 (0.33 annual chance exceedance). While this is not a surprising finding relative to the National Flood Insurance Rate Map program mapping that currently attributes no flood protection to these dikes, this nonetheless could be an alarming message to residents and certainly one that USFWS is considering when budgeting for management of their complex. USFWS's limited capacities on dike maintenance are a fundamental aspect of the future without-project conditions assumed for the South San Francisco Bay Shoreline Study and needed to be confirmed following the results of the supplemental analyses.

ASSESSMENT: On 4 March 2014, a meeting was held with Anne Morkill, San Francisco Bay National Wildlife Refuge Complex Manager, Eric Mruz, Refuge Manager for the Don Edwards San Francisco Bay National Wildlife Refuge, Craig Conner, CESPN Flood Risk Program Manager, Caleb Conn, CESPN Project Manager, and the undersigned to discuss the flood risk findings and the USFWS's response.

The USFWS is aware of the results of the new analysis, which shows the higher likelihood of inner dike failure and an associated increased chance (over previous analyses) of flood waters reaching Alviso (perhaps as high as a 0.33 annual chance in 2017). These analyses do recognize that USFWS has assumed the maintenance responsibilities once practiced by Cargill, Incorporated; however, USFWS efforts to perform maintenance are to the best of their abilities and within their means. This situation has meant prioritizing work on the outboard dikes and de-prioritizing the inner ones. The USFWS does not propose to take on a major flood risk management investment in levee upgrades in the foreseeable future, only to perform continued maintenance consistent with the current regime.

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1398

Given the potential sensitivities of this message, and as part of the ongoing study partnership and in their co-lead role for Environmental Impact Statement (EIS), the USFWS will review the Draft EIS as well as talking points for any public meeting where flood risks to Alviso are discussed for the South San Francisco Bay Shoreline Study.

CONCLUSION: The USFWS is not planning to change their maintenance actions based on any perception of increased liability stemming from the flood risk analyses. The USACE's geotechnical assumptions (or "fragility curves") used for the dikes in the current and future without-project condition are therefore consistent with the current and proposed maintenance practices by the USFWS. A "risk communication strategy" on USFWS dike maintenance should be prepared and vetted with USFWS.

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Date: 2014.04.22 18:56:18 -07'00'

Thomas R. Kendall, P.E.
Chief of Planning
San Francisco District, U.S. Army Corps of Engineers

United States Department of the Interior

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

In Reply Refer To:
08ESMF00-2013-CPA-0002

DEC 26 2012

Lt. Col. John K. Baker P.E.,
Commander,
U.S. Army Corps of Engineers, San Francisco District
1455 Market Street
San Francisco, California 94103-1398

Dear Colonel Baker:

This letter is in response to a request received via email from Bill DeJager of your office on December 11, 2012, for the U.S. Fish and Wildlife Service (Service) to document our position regarding the selection of levee alignment alternatives to be studied by the San Francisco Bay Shoreline Study.

On June 5, 2012, the Service participated in a meeting attended by the Corps of Engineers (Corps) and California Coastal Conservancy, in which several levee alignment alternatives were discussed. During the course of the meeting, two alternatives were proposed to be dropped from further consideration by the Corps as they were not supported by the local sponsors. These two alternatives were the Alviso Railroad Spur and WPCP South, which borders Pond A18 and the San Jose Waste Water Treatment Plant (see Attachment 1). The Service did not support removing these two alternatives from further consideration as proposed by the Corps and local sponsors. We continue to recommend that the Alviso Railroad Spur and WPCP South levee alignments remain part of the ongoing NEPA/CEQA process. It is our position that the implementation of these two alternatives would have less impact on fish and wildlife resources, including endangered species, and would allow for a more sustainable restoration project.

The Service recommended retaining the Alviso Railroad Spur alignment in the EIS/EIR in order to minimize effects to New Chicago Marsh and to evaluate a full range of alternatives pursuant to NEPA. Based on the Service's current understanding of the New Chicago Marsh, implementation of the Alviso Railroad Spur alignment would potentially minimize impacts to fish and wildlife resources, including federally listed species protected under the Endangered Species Act. In contrast the construction of the Alviso North levee alignment would continue to isolate the remaining portion of New Chicago Marsh from the San Francisco Bay, limit the ability to restore the area to a fully functioning tidal marsh, and result in a largely fresh water or brackish marsh.

Based on our review of materials presently available, the Service is concerned that the WPCP North levee alignment would have potentially unacceptable effects to listed species. The WPCP

South alignment would have less impact on existing habitat functions and would potentially result in a more comprehensive restoration of Pond A18. The WPCP South alignment may also better support the long-term management of the pond as fish and wildlife habitat by reducing management costs and minimizing human disturbance as a result of creating a larger intact habitat area. Furthermore, the WPCP South alignment has been identified in the Service's draft Tidal Marsh Recovery Plan as providing habitat functions (i.e., high marsh refugia) which would help contribute to the recovery of salt marsh harvest mouse, California clapper rail, and snowy plover.

If you have any further questions please contact Mark Littlefield, Chief, Watershed Planning Branch, at (916) 414-6520.

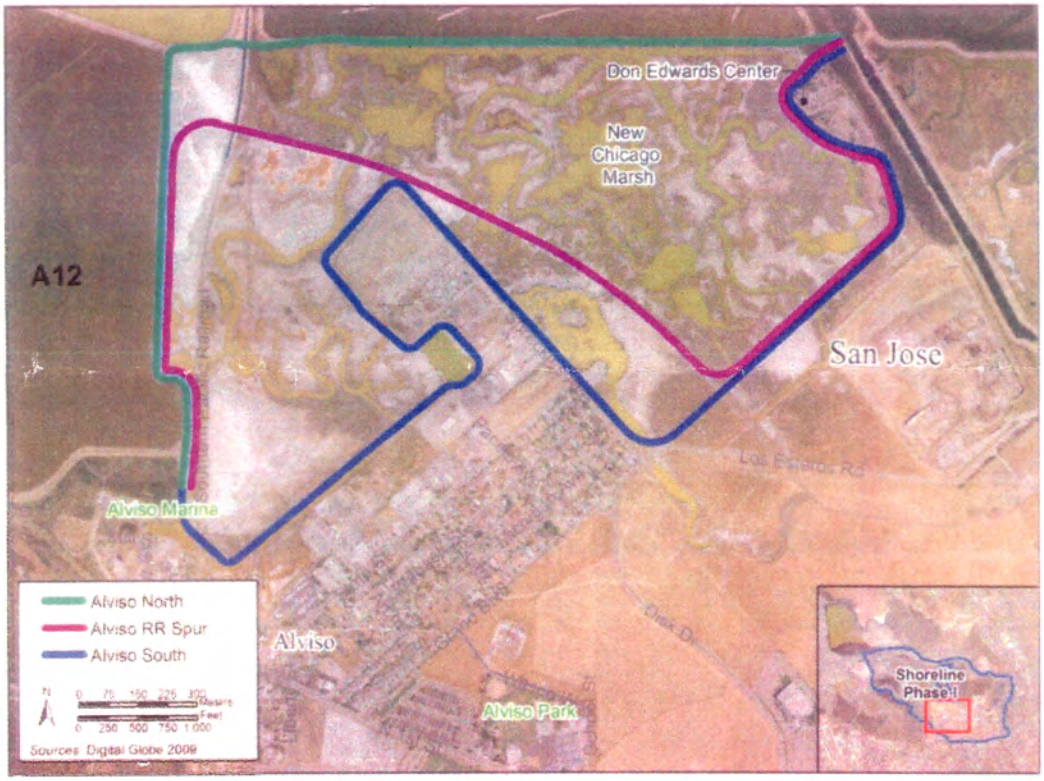
Sincerely

Daniel Welsh
Assistant Field Supervisor

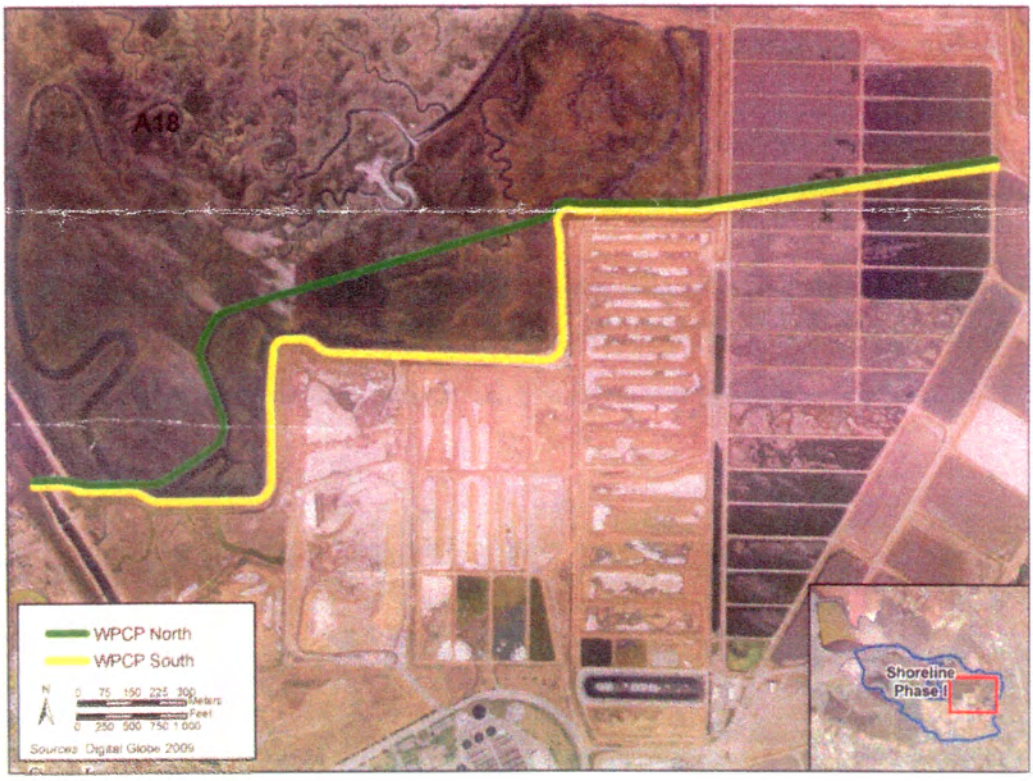
cc:
Joseph Terry, Sacramento Fish and Wildlife Office, Sacramento, California
Eric Mruz, Refuge Manager, Don Edwards NWR, Fremont, California
William DeJager, San Francisco Corps of Engineers, San Francisco, California
Judy Sheen, San Francisco Corps of Engineers, San Francisco, California
Brenda Buxton, California Coastal Conservancy, Oakland, California

ATTACHMENT 1

Map 1. Alviso Levee Alignments



Map 2. WPCP Levee Alignments



Appendix B4

Draft Memorandum Regarding Shoreline Study Ecosystem Restoration Phasing Alternatives (Ponds A9–A15)

South Bay Salt Pond Restoration Project

Restoring the Wild Heart of the South Bay

Memorandum

To: Shoreline Study planning team

From: South Bay Salt Pond planning team

Date: 17 November 2011

Re: Shoreline Study Ecosystem Restoration Phasing Alternatives (Ponds A9-15)
(*Draft*)

DRAFT

Below is the consensus preferred approach for the phasing of Ponds A9-A15 as they relate to the Shoreline Study planning. All of these alternatives assume that the project will be able to proceed beyond the 50:50 scenario based on the adaptive management plan, particularly regarding the issues of waterbird use and mercury.

Preferred Phasing Alternative

The different starting times for each breach event (phase) place the restored ponds on a different part of the sea level rise curve. This means that without substantial suspended sediment, if delayed, Ponds A12-15 will end up at lower elevations because they have fewer years to accrete sediment and their restoration begins on a steeper part of the sea level rise curve.

Therefore, the preferred alternative phasing sequence would be to expedite the restoration of Pond A12 (the most deeply subsided pond). This will help scour out Alviso Slough and will also provide an area to construct upland ecotone areas from the beginning of the project. Subsequent phases may then include Ponds A9-A11, and finally A13-A15. Upland refugia areas would be designed into each phase, with the upland ecotone areas located on the landward side of restored ponds that are adjacent to flood protection levees.

The ecosystem features proposed under the “less fill” to “more fill” scenarios still apply to this Alternative.

Issues to be addressed under Adaptive Management

If the adaptive management plan indicates that we are not ready to open Pond A12 due to waterbird and/or mercury concerns, options for capturing sediment in A12 include:

- Installing a new water control structure in Pond A12 to begin capturing sediment.
- Importing clean fill to raise the pond bottom to accelerate marsh evolution (as was done with Inner Bair Island).

The potential import of fill could be done in advance, after, or simultaneously with breaching other ponds in the A9-15 complex. The filling of A12 (and possibly the other deeply subsided Ponds A13 and A15) may reduce scour in Alviso Slough, bury any in situ mercury, and reduce the material volumes needed for future construction of a broad upland ecotone area.

If concerns about Pond A12 persist, the project could then proceed with breaching Ponds A9-A10. The division between the restored and managed ponds includes the realignment of the internal berm between Pond A9 and A11 to more accurately reflect the historic marsh drainage patterns. Subsequent phases may include restoration of Ponds A11-A15.

Upland refugia areas would be designed into the original phase. If the first phase (A9 and A10) alone remains the ultimate configuration of the restoration in these ponds, then a broad upland ecotone area can be added to the realigned internal berm described above. If further phases of tidal restoration are constructed, then the upland ecotone areas would be located on the landward side of all restored ponds as described above.

Proposed Timing

For purposes of habitat evolution modeling, we propose the following timing for the preferred alternative:
Pond A12: breached in 2017
Ponds A9-A11: breached in 2022
Ponds A13-A15: breached in 2030

ESA-PWA will be providing updated habitat maps of this scenario.

New Chicago Marsh

New Chicago Marsh (NCM) will not be analyzed as part of the ecosystem benefits for the proposed project. However, the Refuge has spelled out below their long term vision for NCM to assist the team in understanding the rationale behind some of the proposed levee alignments.

For the foreseeable future (next 10 to 20 years), the ecological goal for NCM will be to maintain or improve the quality of the existing managed marsh for the salt marsh harvest mouse (SMHM) and nesting bird species in NCM and A16. This goal is unlikely to change until sufficient replacement habitat for the SMHM and breeding birds has been created in the adjacent areas. However, in the longer term, once there is high-quality marsh habitat in the project area to support SMHM populations and nesting birds, the Refuge could change the management or configuration of NCM. These future changes would need to be defined through an adaptive management process and are not proposed to be part of the Shoreline Study alternatives. Rather this alternative acknowledges that the future management options for NCM greatly depend on the alignment of the flood protection levee build by the Shoreline Study. By constructing a levee alignment "behind" NCM (Alignments 2 and 3) the Shoreline Study would avoid impacts to NCM and allow for future habitat enhancement by allowing the Refuge to:

1. Continue existing management for the SMHM and maintain the connection between the nesting islands in Pond A16 and forage/cover for chicks in NCM; or
2. Connect NCM to the tides and create a deep water pond; or
3. Connect NCM to the tides and manage flows with a water control structure to accumulate sediment and raise existing elevation to marsh plain.

DRAFT

If the levee is constructed on the existing pond berm alignment (Alignment 1), the Refuge's future options will be constrained to the existing management régime with the additional impact of degraded connectivity between Pond A16 and NCM.

DRAFT

Appendix B5

Biological Resources: Species Scientific Names, CNDDB Report, and CRPR Report

Appendix B5. Scientific Names of Plants, Fish, and Wildlife Mentioned in the Integrated Document

Common Name	Latin Name
Plants	
Alkali bulrush	*Schoenoplectus robustus* (former *Scirpus robustus)*
Alkali heath	*Frankenia salina*
Annual pickleweed (slender pickleweed, glasswort)	*Salicornia europaea*
Atlantic cordgrass	*Spartina alterniflora*
Black mustard	*Brassica nigra*
Brass buttons	*Cotula coronopifolia*
Bristly ox-tongue	*Picris echioides*
Broad-leaved cattail	*Typha latifolia*
Bull thistle	*Cirsium vulgare*
California blackberry	*Rubus sp.*
California bulrush	*Schoenoplectus californicus* (former *Scirpus californicus)*
California cordgrass	*Spartina foliosa*
Chilean cordgrass	*Spartina densiflora*
Cocklebur	*Xanthim strumarium*
Common sow thistle	*Sonchus oleraceus*
Congdon's tarplant	*Centromadia parryi ssp. Congdonii*
Cordgrass species	*Spartina spp.*
Coyote brush	*Baccharis pilularis*
Curly dock	*Rumex crispus*
Elderberry	*Sambucus mexicana*
English cordgrass	*Spartina anglica*
Fremont cottonwood	*Populus fremontii*
French broom	*Genista monspessulana*
Giant reed	*Arundo donax*
Hall's bush-mallow	*Malacothamnus halli*
Hardstem bulrush	*Schoenoplectus acutus* (former *Scirpus acutus)*
Hyssop loosestrife	*Lythrum hyssopifolium*
Italian ryegrass	*Lolium multiflorum*
Italian thistle	*Carduus pycnocephalus*
Marsh gumplant	*Grindelia stricta var. angustifolia*
Mediterranean barley	*Hordeum marinum ssp. gussoneanum*
Pampas grass	*Cortaderia sp.*
Perennial pepperweed	*Lepidium latifoium*
Perennial pickleweed	*Sarcocornia pacifica (*former *Salicornia virginica)*
Purple star-thistle	*Centaurea calcitrapa*
Rabbits foot grass	*Polypogon monspeliensis*

Common Name	Latin Name
Ripgut brome	*Bromus diandrus*
Saltmarsh bulrush	*Bolboschoenus maritimus* (former *Scirpus maritimus)*
Saltmeadow cordgrass	*Spartina patens*
Scotch broom	*Cytisus scoparius*
Sweet fennel	*Foeniculum vulgare*
Wild oats	*Avena fatua*
Wild radish	*Raphanus sativus*
Wild rose	*Rosa californica*
Willow	*Salix sp.*
Yellow star-thistle	*Centaurea solstitialis*
********	*Eliocharis ******
Fishes	
American shad	*Alosa sapidissima*
Arrow goby	*Clevelandia ios*
Bay goby	*Lepidogobius lepidus*
Bay pipefish	*Syngnathus leptorhynchus*
Black bullhead	*Ameiurus melas*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Brown bullhead	*Ictalurus nebulosus*
California bat ray	*Myliobatis californica*
California central coast DPS steelhead	*Oncorhynchus mykiss irideus*
California halibut	*Paralichthys californicus*
California roach	*Lavinia symmetricus*
California skate	*Raja inornata*
Carp	*Cyprinus carpio*
Chameleon goby	*Tridentiger trigonocephalus*
Channel catfish	*Ictalurus punctatus*
Chinook salmon (Central Valley)	*Oncorhynchus tshawytscha*
Coho salmon	*Oncorhynchus kisutch*
English sole	*Parophrys vetulus*
Fathead minnow	*Pimephales promelas*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Green sturgeon	*Acipenser medirostris*
Green sunfish	*Lepomis cyanellus*
Hitch	*Lavinia exilicauda*
Inland silverside	*Menidia beryllina*
Jack mackerel	*Trachurus symmetricus*
Jacksmelt	*Atherinopsis californiensis*

Common Name	Latin Name
Largemouth bass	*Micropterus salmoides*
Leopard shark	*Trikakis semifasciata*
Longfin smelt	*Spirinchus thaleichthys*
Longjaw mudsucker	*Gillichthys mirabilis*
Mississippi silverside	*Menidia audens*
Mosquitofish	*Gambusia affinis*
Northern anchovy	*Engraulis mordax*
Pacific herring	*Clupea pallasii*
Pacific lamprey	*Lampetra tridentata*
Pacific sardine	*Sardinops sagax*
Pacific staghorn sculpin	*Leptocottus armatus*
Plainfin midshipman	*Porichthys notatus*
Prickly sculpin	*Cottus asper*
Rainwater killifish	*Lucania parva*
Red shiner	*Notropis lutrensis*
Redear sunfish	*Lepomis microlophus*
Riffle sculpin	*Cottus gulosus*
Sacramento blackfish	*Orthodon microlepidotus*
Sacramento perch	*Archoplites interruptus*
Sacramento pikeminnow	*Ptychocheilus grandis*
Sacramento sucker	*Catostomus occidentalis occidentalis*
Shimofuri goby	*Tridentiger bifasciatus*
Shiner surfperch	*Cymatogaster aggregata*
Shokahaze goby	*Tridentiger barbatus*
Speckled dace	*Rhinichthys osculus*
Speckled sanddab	*Citharichthys stigmaeus*
Splittail	*Pogonichthys macrolepidotus*
Starry flounder	*Platichthys stellatus*
Striped bass	*Morone saxatilis*
Surf smelt	*Hypomesus pretiosus*
Thicktail chub	*Gila crassicauda*
Threadfin shad	*Dorosma petenense*
Three-spined stickleback	*Gasterosteus aculeatus*
Topsmelt	*Atherinops affinis*
Tule perch	*Hysterocarpus traski*
White crappie	*Pomoxis annularis*
White sturgeon	*Acipenser transmontanus*
Yellow bullhead	*Ameiurus natakis*
Yellowfin goby	*Acanthogobius flavimanus*

Common Name	Latin Name
Invertebrates	
(Amphipod)	*Grandidierella japonica*
(Amphipod)	*Corophium sp.*
(Amphipod)	*Ampelisca abdita*
Asian clam	*Corbula amurensis*
Asian cumacean	*Nippoleucon hinumensis*
Asian mussel	*Musculista sp.*
Atlantic clam	*Gemma sp.*
Atlantic ribbed marsh mussel	*Arcuatula demissa*
Baltic clam	*Macoma petalum*
Blackspotted bay shrimp	*Crangon nigromaculata*
Blacktrail bay shrimp	*Crangon nigricauda*
Brine flies	Family Ephydridae
Brine shrimp	*Artemia* sp.
Brine shrimp	*Artemia franciscana*
California bay shrimp	*Crangdon franciscorum*
Capet shell, littleneck clam	*Venerupis sp.*
Chinese mitten crab	*Eriocheir sinensis*
European green crab	*Carcinus maenas*
Miniature spinyhead	*Mesocrangon munitella*
Mud snail	*Illyanassa obsoleta*
New Zealand burrowing isopod	*Sphaeroma quoyanum*
Opossum shrimp	*Mysida sp.*
Oriental shrimp	*Palaemon macrodactylus*
Reticulate water boatmen	*Trichocorixa reticulate*
Ribbed mussel	*Ischadium demissum*
Ridgetail prawn	*Exopalaemon carinicauda*
Soft-shell clam	*Mya arenaria*
Stout coastal shrimp	*Heptacarpus brevirostris*
Visored shrimp	*Betasus longidactylus*
Yellow shore crab	*Hemigrapsus oregonensis*
Reptiles and Amphibians	
Arboreal salamander	*Aneides lugubris*
Bullfrog	*Rana catesbeiana*
California slender salamander	*Batrachoseps attenuatus*
California tiger salamander	*Ambystoma californiense*
Garter snake	*Thamnophis couchi, T. elegans,* and *T. sirtalis*
Gopher snake	*Pituophis melanoleucus*
Pacific treefrog	*Hyla regilla*
Southern alligator lizard	*Elgaria multicaranata*

Common Name	Latin Name
Western fence lizard	*Sceloporus occidentialis*
Western pond turtle	*Emys marmorata*
Western toad	*Bufo boreas*
Mammals	
Audubon's cottontail	*Sylvilagus audubonii*
Black rat	*Rattus rattus*
Black-tailed jack rabbit	*Lepus californicus*
Botta's (valley) pocket gopher	*Thomomys bottae*
Brush rabbit	*Sylvilagus bachmani*
California ground squirrel	*Spermophilus beecheyi*
California vole	*Microtus californicus*
Common muskrat	*Ondatra zibethicus*
Deer mouse	*Peromyscus maniculatus*
Feral cat	*Felis catus*
Hoary bat	*Lasiurus cinereus*
House mouse	*Mus musculus*
Long-tailed weasel	*Mustela frenata*
Mexican free-tailed bat	*Tadarida brasiliensis*
Norway rat	*Rattus norvegicus*
Pacific harbor seal	*Phoca vitulina richardsi*
Raccoon	*Procyon lotor*
Red fox	*Vulpes vulpes regalis*
Salt marsh harvest mouse	*Reithrodontomys raviventris raviventris*
Salt marsh wandering shrew	*Sorex vagrans halicoetes*
Shrew	*Sorex sp.*
Striped skunk	*Mephitis mephitis*
Virginia opossum	*Didelphis virginiana*
Western harvest mouse	*Reithrodontomys megalotis*
Western red bat	*Lasirurs blossevillii*
Yuma myotis	*Myotis yumanensis*
Birds	
Alameda song sparrow	*Melospiza melodia pusillula*
American avocet	*Recurvirostra americana*
American coot	*Fulica americana*
American crow	*Corvus brachyrhynchos*
American goldfinch	*Carduelis tristis*
American kestrel	*Falco sparverius*
American pipit	*Anthus rubescens*
American white pelican	*Pelecanus erythrorhynchos*
American wigeon	*Anas americana*

Common Name	Latin Name
Anna's hummingbird	*Calypte anna*
Barn swallow	*Hirundo rustica*
Belted kingfisher	*Ceryle alcyon*
Black phoebe	*Sayornis nigricans*
Black skimmer	*Rynchops niger*
Black-bellied plover	*Pluvialis squatarola*
Black-chinned hummingbird	*Archilochus alexandri*
Black-crowned night-heron	*Nycticorax nycticorax*
Black-necked stilt	*Himantopus mexicanus*
Bonaparte's gull	*Chroicocephalus philadelphia*
Brown pelican	*Pelecanus occidentalis*
Bufflehead	*Bucephala albeola*
Burrowing owl (western burrowing owl)	*Athene cunicularia*
Bushtit	*Psaltriparus minimus*
California black rail	*Laterallus jamaicensis coturniculus*
California clapper rail	*Rallus longirostris obsoletus*
California gull	*Larus californicus*
California least tern	*Sterna antillarum browni*
California yellow warbler	*Dendroica petechia brewsteri*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Caspian tern	*Hydroprogne caspia*
Chestnut-backed chickadee	*Poecile rufescens*
Cinnamon teal	*Anas cyanoptera*
Clark's grebe	*Aechmophorus clarkii*
Cliff swallow	*Petrochelidon pyrrhonota*
Common goldeneye	*Bucephala clangula*
Common loon	*Gavia immer*
Common moorhen	*Gallinula chloropus*
Common raven	*Corvus corax*
Common tern	*Sterna hirundo*
Cooper's hawk	*Accipiter cooperii*
Double-crested cormorant	*Phalacrocorax auritus*
Downy woodpecker	*Picoides pubescens*
Dunlin	*Calidris alpina*
Eared grebe	*Podiceps nigricollis*
Elegant tern	*Sterna elegans*
European starling	*Sturnus vulgaris*
Forster's tern	*Sterna forsteri*
Fox sparrow	*Passerella iliaca*

Common Name	Latin Name
Gadwall	*Anas strepera*
Glaucous-winged gull	*Larus glaucescens*
Golden-crowned sparrow	*Zonotrichia atricapilla*
Great blue heron	*Ardea herodias*
Great egret	*Ardea alba*
Greater scaup	*Aythya marila*
Greater yellowlegs	*Tringa melanoleuca*
Green heron	*Butorides virescens*
Herring gull	*Larus argentatus*
Horned lark	*Eremophila alpestris actia*
House finch	*Haemorhous mexicanus*
House sparrow	*Passer domesticus*
Killdeer	*Charadrius vociferus*
Least sandpiper	*Calidris minutilla*
Lesser goldfinch	*Carduelis psaltria*
Lesser scaup	*Aythya affinis*
Lincoln's sparrow	*Melospiza lincolnii*
Little blue heron	*Egretta caerulea*
Loggerhead shrike	*Lanius ludovicianus*
Long-billed curlew	*Numenius americanus*
Long-billed dowitcher	*Limnodromus scolopaceus*
Mallard	*Anas platyrhynchos*
Marbled godwit	*Limosa fedoa*
Marsh wren	*Cistothorus palustris*
Merlin	*Falco columbarius*
Mew gull	*Larus canus*
Mourning dove	*Zenaida macroura*
Northern harrier	*Circus cyaneus*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Orange-crowned warbler	*Oreothlypis celata*
Pacific-slope flycatcher	*Empidonax difficilis*
Peregrine falcon (American peregrone falcon)	*Falco peregrinus*
Pied-billed grebe	*Podilymbus podiceps*
Red knot	*Calidris canutus*
Red-breasted merganser	*Mergus serrator*
Red-shouldered hawk	*Buteo lineatus*
Red-tailed hawk	*Buteo jamaicensis*
Ring-billed gull	*Larus delawarensis*
Rock pigeon	*Columba livia*

Common Name	Latin Name
Ruddy duck	*Oxyura jamaicensis*
Saltmarsh common yellowthroat	*Geothlypis trichas sinuosa*
Savannah sparrow	*Passerculus sandwichensis*
Semipalmated plover	*Charadrius semipalmatus*
Short-billed dowitcher	*Limnodromus griseus*
Short-eared owl	*Asio flammeus*
Snowy egret	*Egretta thula*
Song sparrow	*Melospiza melodia*
Sora	*Porzana carolina*
Surf scoter	*Melanitta perspicillata*
Swainson's thrush	*Catharus ustulatus*
Thayer's gull	*Larus thayeri*
Tricolored blackbird	*Agelaius tricolor*
Virginia rail	*Rallus limicola*
Warbling vireo	*Vireo gilvus*
Western grebe	*Aechmophorus occidentalis*
Western gull	*Larus occidentalis*
Western meadowlark	*Sturnella neglecta*
Western sandpiper	*Calidris mauri*
Western snowy plover	*Charadrius alexandrinus nivosus*
Whimbrel	*Numenius phaeopus*
White-crowned sparrow	*Zonotrichia leucophrys*
White-faced ibis	*Plegadis chihi*
White-tailed kite	*Elanus leucurus*
Willet	*Tringa semipalmata*
Wilson's warbler	*Wilsonia pusilla*

Appendix B6

South San Francisco Bay Shoreline Study
Existing Biological Conditions Report

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

SOUTH SAN FRANCISCO BAY SHORELINE STUDY
EXISTING BIOLOGICAL CONDITIONS REPORT

DRAFT

Prepared for:

U.S. ARMY CORPS OF ENGINEERS
CALIFORNIA STATE COASTAL CONSERVANCY

Prepared by:

H. T. HARVEY & ASSOCIATES

05 November 2007 Project No. 2606-01

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ACRONYMS AND ABBREVIATIONS

CDFG	California Department of Fish and Game
CIR	Color infrared
ESU	Evolutionary Significant Unit
GIS	Geographic Information Systems
ISP	Interim Stewardship Plan
PG&E	Pacific Gas & Electric
PRBO	PRBO Conservation Science
SBSP	South Bay Salt Ponds
SCVWD	Santa Clara Valley Water District
MHW	Mean High Water
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
SFBBO	San Francisco Bay Bird Observatory
SFBNWR	Don Edwards San Francisco Bay National Wildlife Refuge
USACOE	U.S. Army Corp of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WPCP	Water Pollution Control Plant

1. EXECUTIVE SUMMARY

The San Francisco Estuary is an extremely productive, diverse ecosystem. Despite the loss of more than 90% of historic tidal wetlands in the Bay Area to diking, draining, and filling (Goals Project 1999), wildlife diversity is high, with more than 250 species of birds, 120 species of fish, 81 species of mammals, 30 species of reptiles, and 14 species of amphibians regularly occurring in the estuary (Siegel and Bachand 2002). More importantly, the San Francisco Bay supports populations of a number of species of regional, hemispheric, or even global importance. Numerous endemic, endangered, threatened, and rare wildlife species or subspecies reside in the San Francisco Bay Area.

The South San Francisco Bay (South Bay) is a vital component of the larger estuary. The South Bay supports some of the most important habitat remaining in the entire Bay Area for a number of wildlife species, in spite of the surrounding areas being highly urbanized and the Bay itself having been dramatically altered by the diking and filling of wetlands for salt production and urban development (Goals Project 1999).

This report characterizes the existing biological conditions related to the Shoreline Study which focuses on ecosystem restoration and flood damage reduction for the entire Study Area. The principal biological components of concern are the vegetation and habitats, and the wildlife. This report outlines the current state of understanding of these resources in the South Bay. The description of existing biological conditions is an important step in the early stages of planning as this description provides a foundation from which to evaluate and contrast a wide range of flood control and restoration alternatives, will serve to help inform the selection of the preferred alternative, and will provide baseline data for monitoring and adaptive management.

Habitats and Vegetation. The Shoreline Study Area (approximately 44,624 total acres) encompasses a variety of habitat types due to its land use history, its hydrologic placement within the landscape, and the extreme range of abiotic soil variables present within the area. Habitats vary from urbanized areas lined with concrete culverts to riparian fluvial drainages to freshwater, brackish, and salt marsh habitat. The dominant habitats that occur in the Study Area include approximately:

- 14,480 acres of developed area;
- 7498 acres of intertidal mudflat habitat (at –0.9 ft Mean Lower Low Water);
- 7135 acres of former and current salt production ponds;
- 3679 acres of wetland and riparian areas; and
- 2664 acres of open water/bay habitat.

Numerous occurrences of six special-status plant species, including Point Reyes bird's-beak, Hoover's button-celery, Congdon's tarplant, alkali milk-vetch, Contra Costa goldfields, and San Joaquin spearscale, have been documented in the immediate vicinity of the Study Area; the latter five species are known from the Study Area primarily from the Warm Springs Unit of the Don Edwards San Francisco Bay National Wildlife Refuge (SFBNWR) and the adjacent Pacific Commons Preserve in Fremont. Historical (likely

extirpated) populations of alkali milk-vetch and Point Reyes bird's-beak are documented in the vicinity of Alviso.

Wildlife Resources. This report includes discussions of the species composition and structure of invertebrate, fish, reptile, amphibian, mammal, bird, and plant communities in the South Bay. These species' life histories (as they pertain to their use of the South Bay), habitat requirements and habitat use in the South Bay, and the spatial and temporal variation in these species' presence/distribution in the region are summarized, as are the occurrence and use of the South Bay by special-status plant and wildlife species.

In summary, the ecology of South Bay wildlife communities is characterized by:

- High productivity of tidal marshes, with export of organic matter from tidal marshes to tidal sloughs, channels, and mudflats, and to the Bay, supporting high abundance of invertebrates, fish, and birds.
- High productivity of salt ponds and former salt ponds, supporting an abundance of invertebrates (particularly in higher-salinity ponds) and high numbers of fish in lower-salinity ponds, but with virtually no export of organic matter to other habitats aside from variable (and at times, very heavy) use of the salt ponds by birds.
- A heavily invaded aquatic invertebrate community dominated by non-native species, particularly in the estuarine and salt pond habitats.
- Heavy use of South Bay habitats by waterbirds, including significant proportions of Pacific Coast migratory shorebird populations.
- Highly dynamic bird and fish communities, with use of different areas varying several times a day with tide height, and with abundance and community composition varying seasonally depending on migration, precipitation, temperature, salinity, and other factors. In particular, large numbers of shorebirds forage on intertidal mudflats at low tide and use salt ponds and other alternative habitats (e.g., water treatment plant ponds) for roosting and/or foraging, particularly at high tide, and steelhead use bay habitats during their migrations as adults to spawn in tributaries and as juveniles moving from tributaries to the sea .
- The presence of rare San Francisco Bay endemics, including the California clapper rail and salt marsh harvest mouse, in remnant tidal marsh habitat.
- The presence of rare vernal pool-associated species, including the vernal pool tadpole shrimp and California tiger salamander, in vernal pools within the Warm Springs unit of the SFBNWR.
- The presence of several freshwater streams flowing into the South Bay; woody riparian habitat is limited to narrow corridors, or is highly degraded or even absent, along these streams, although moderately high-quality riparian habitat is present along lower Coyote Creek, and riparian habitats in the Study Area support very high densities of birds.

2. INTRODUCTION

This document describes the existing biological conditions of the South San Francisco Bay Shoreline (Shoreline Study) Study Area. The purposes of the Shoreline Study are to investigate the feasibility of a federally cost-shared project to meet the objectives of flood damage reduction, ecosystem restoration, and related purposes such as public access, and, if a potential project can be justified through existing Corps policy, to recommend such a project for Congressional authorization. An understanding of the existing natural landscape is necessary to accomplish these goals.

Other existing documents that are relevant to this report include the South Bay Salt Ponds (SBSP) Initial Stewardship Plan (ISP) (Life Science 2003), SBSP Biology and Habitats Existing Conditions Report (H. T. Harvey & Associates 2005), and the SBSP Draft Programmatic Environmental Impact Statement/Environmental Impact Report (PWA 2007).

To help guide the ecosystem restoration and flood protection aspects of the planning effort, the Shoreline Study will incorporate findings from the SBSP Restoration Project, a California Coastal Conservancy-led effort to restore historical wetlands on 15,100 acres of former salt-harvesting ponds in the South Bay. The U.S. Army Corps of Engineers (USACOE) and the Santa Clara Valley Water District (SCVWD) are active project management team members of the SBSP Restoration Project. Extensive coordination has occurred, and will continue to occur, between the Shoreline Study and SBSP projects.

This existing conditions report documents the current conditions within the Shoreline Study Area, including portions of this area that have not already been investigated for the SBSP Restoration Project. Therefore, in preparing this report, existing conditions information for the relevant portions of the SBSP project area were augmented by compiling information for the baylands area outside of the SBSP project area, but within the Alviso Ponds and Santa Clara County Interim Feasibility Study area, at the same level of detail as for the SBSP Restoration Project.

The existing biological conditions described in this document include habitat type, plant species composition, and potential wildlife use within the Shoreline Study Area at the onset of planning. This report contains the following sections:

Section 3. Habitats and Vegetation. Here, the existing conditions for habitats and vegetation in the Shoreline Study Area are presented, including an overall habitat assessment, the presence of non-native plant species, and the occurrence and potential for reintroduction of special-status plant species along with associated maps.

Section 4. Wildlife Resources. In this section, the existing conditions for wildlife in the Shoreline Study Area are documented. Included here are discussions of the composition and structure of invertebrate, fish, reptile, amphibian, mammal, and bird communities in the Study Area. Details of these species' life histories (as they pertain to their use of the South Bay), habitat requirements and use, and the spatial and

temporal variation in these species' distributions in the region are also included. Further, the occurrence and use of the Shoreline Study Area by special-status wildlife species is summarized.

2.1 Regional Setting

The San Francisco Estuary is an extremely productive, diverse ecosystem. Despite the loss of more than 90% of historic tidal wetlands in the Bay Area to diking, draining, and filling (Goals Project 1999), wildlife diversity is high, with more than 250 species of birds, 120 species of fish, 81 species of mammals, 30 species of reptiles, and 14 species of amphibians regularly occurring in the estuary (Siegel and Bachand 2002). More importantly, the San Francisco Bay supports populations of a number of species of regional, hemispheric, or even global importance. Numerous endemic, endangered, threatened, and rare wildlife species or subspecies reside in the San Francisco Bay Area.

The South San Francisco Bay (South Bay) is a vital component of the larger estuary. The South Bay supports some of the most important habitat remaining in the entire Bay Area for a number of wildlife species, in spite of the surrounding areas being highly urbanized and the Bay itself having been dramatically altered by the diking and filling of wetlands for salt production and urban development (Goals Project 1999).

The term "South Bay" is typically used to refer to the portion of the San Francisco Bay south of Coyote Point on the western shore of the Bay and San Leandro Marina on the eastern shore of the Bay (Goals Project 1999). This region differs in several physical and ecological aspects from the Central Bay, North Bay, San Pablo and Suisun Bays, and the Delta portions of the San Francisco Estuary. The Shoreline Study Area, for this existing conditions document, includes the open waters of the Bay up to the upper reaches of tidal action, the tidal and nontidal wetlands adjacent to the Bay, the former salt evaporation ponds adjacent to the Bay, the upland areas adjacent to and surrounding these features, developed areas, and the fluvial riparian inputs into the South Bay (Figure 1). This Study Area is bordered by the open waters of the South Bay to the northwest and by urban development on all other sides. While this Study Area is likely larger than what would be included in an actual Shoreline Study project, this landscape-level description of potentially impacted areas will be integral to the consideration of feasible restoration options and the concomitant benefits and impacts of those options.

2.2 Study Area

Broadly, the Study Area includes the Palo Alto/Mountain View area (south of San Francisquito Creek); Moffet Field, and the Alviso Ponds (and the areas inland to them) owned by the USFWS, SCVWD (Pond A4), and the City of San Jose (Pond A18) (Figure 1). It includes all of the Shoreline Study geographic area in Santa Clara County, as well as a small area in Alameda County that is part of the Coyote Creek/Mud Slough drainage from Santa Clara County. For aquatic Bay habitats, the Dumbarton Bridge is used as the northern boundary of the Study Area.

The Shoreline Study will focus on ecosystem restoration and flood damage reduction for the entire Study Area, though ecosystem restoration will most likely occur within the Alviso Ponds. The drainages in this

Study Area all flow through Santa Clara County and include: Coyote Creek/Mud Slough, Artesian Slough, Guadalupe River/Alviso Slough, Guadalupe Slough/Moffett Channel/Sunnyvale East and West Channels, Stevens Creek, Permanente Creek/Mountain View Slough, Charleston Slough/Barron Creek/Adobe Creek, and Matadero Creek/Mayfield Slough. The Study Are also includes the lower reaches of Laguna Creek and its watershed in Alameda County. The Alviso ponds occur at the base of several watersheds formed by the following drainages: Coyote watershed, Guadalupe watershed, San Tomas/Calabazas watersheds, Sunnyvale East/West watersheds, Permanente/Stevens watersheds, Adobe/Matedero watersheds and the San Francisquito watershed**.** Flood protection for San Francisquito Creek is being studied under separate authorization. San Francisquito Creek serves as the northern edge of the Study area, dividing the Santa Clara County and Alviso Ponds from San Mateo County and the Ravenswood Ponds.

3. HABITATS AND VEGETATION

3.1 Introduction

The Shoreline Study, which serves to identify and recommend for Federal funding one or more projects for flood damage reduction, ecosystem restoration and public access, serves as a complementary effort to the SBSP Restoration Project, a programmatic plan for habitat restoration, flood management and wildlife-oriented public access within former salt ponds of the South Bay. The physical boundaries of these two efforts overlap at the Alviso ponds and the open water/mudflats extending north to the Dumbarton Bridge, with the Shoreline Study Area reaching beyond the Alviso ponds into adjacent uplands. To describe existing conditions for habitats and vegetation in the Shoreline Study Area, an analysis of surrounding habitat types (Figure 1) was performed utilizing aerial mapping and site visits. This included a general habitat assessment, along with considerations for the potential occurrence and/or reintroduction of special-status plant species. The assessment of historical habitats in the Shoreline Study Area was also used to provide a baseline for the existing conditions of the ecological communities.

3.2 Methods

3.2.1 Base Imagery

All habitat mapping was rendered on IKONOS satellite imagery. The City of San Jose acquired the IKONOS imagery from a satellite pass that occurred at noon on 8 May 2004. The tidal elevation at this time was –0.9 feet Mean Lower Low Water (MLLW) near the mouth of Coyote Creek in the Alviso complex. The City of San Jose purchased the satellite images and subsequently donated them for use in the SBSP restoration planning. The 1-meter Multispectral (four-bands) CIR & True Color IKONOS satellite imagery is projected in UTM NAD83 (meters) Zone 10 North. Habitat mapping was based upon the imagery obtained and completed at a 1:2400 (1 inch = 200 feet) scale using the IKONOS imagery as a base layer.

3.2.2 Habitat Mapping and Area Calculations

Habitat mapping was completed using laptop computers (Panasonic Toughbook 18) equipped with GIS software (ArcView 9). The computers and software allow the IKONOS imagery to be used for mapping in the field or office.

Initial habitat boundaries and classifications using the IKONOS imagery were identified based on the signatures of the photographic imagery. Topographic features, marsh boundaries, and tentative habitat types (based on photographic signatures) were mapped in the office prior to field visits.

During the site visits in January 2007, extensive ground-truthing of those areas in the Shoreline Study Area that were not included in the original SBSP mapping was conducted. Marshes and riparian corridors were observed primarily from levee trails, unimproved salt pond levees, and Pacific Gas and Electric

(PG&E) walkways. The GIS database was downloaded and backed up weekly, and the digitized boundaries of habitat areas were reviewed for consistency and quality. Habitat acreages and color-coded figures for the entire Study Area were generated in GIS (ArcView 9.0).

3.3 Habitats and Vegetation

The Shoreline Study Area encompasses a variety of habitat types due to its land use history, its hydrologic placement within the landscape, and the extreme range of abiotic soil variables present within the area. Habitats vary from urbanized areas lined with concrete culverts to riparian fluvial drainages to freshwater, brackish, and salt marsh habitat. The Shoreline Study serves to analyze the unique demands placed upon this area of the Bay to balance urban demands for flood protection with restoration efforts and the needs of special-status plant and animal species.

3.3.1 Historical Habitats

The assessment of habitats that historically occurred along the South Bay provides a context in which to examine the existing conditions of South San Francisco Bay. Historical ecological communities of the South Bay are described in detail in the South Bay Salt Ponds Biology and Habitats Existing Conditions Report (H. T. Harvey & Associates 2005), Collins and Grossinger (2004), and Grossinger et al. (2006). Historically, the margins of San Francisco Bay were surrounded by a mosaic of wetland habitats, dominated by tidal salt marsh with large expanses of upland ecotones, intramarsh ponds, salt pannes, sinuous channel networks, beaches, lagoons, and sausals (Collins and Grossinger 2004).

Collins and Grossinger (2004) describe three major historical South Bay landscapes: saline tidal marsh, riparian tidal marsh, and salt pond. The South Bay saline tidal marsh landscape once consisted of marshlands with high channel density, abundant marsh pannes and salinas, moist grasslands along the backshore, large sausals, and extensive tidal flats. The South Bay riparian tidal marsh landscape existed along a salinity gradient from fresh to saline or brackish waters, influenced by perennial creeks such as Coyote Creek and the Guadalupe River. These areas had large marsh pannes and a less dense channel network in the vicinity of major freshwater sources. The South Bay salt pond landscape comprised tidal marshlands dominated by salt ponds. Native Americans developed these early ponds from salinas and marsh pannes by using low berms and weirs to control their hydroperiod. Tidal marsh and salt ponds were roughly equal in area, with minimal tidal channel network development. Small salinas and marsh pannes were adjacent to the salt ponds, with moist grasslands occurring along the backshore. Saltgrass-alkali meadow habitat existed in the complex transition zone between the tidal marsh and the wet meadows of the bottomlands of the South Bay. Unusually high concentrations of salt in alluvial soils created favorable conditions for unique plant communities with characteristics of high tidal marsh, alkali flats, and vernal pools (Grossinger et al. 2006).

Most of these historical communities have been greatly reduced in size due to land use changes in the South Bay, including residential development, agricultural use, salt production, and flood protection. More recently, South Bay marshes were significantly modified via diking to retain and concentrate Bay

water for salt production. Beginning in the mid- to late 1800's through the 1940's, levee construction led to the direct loss of tens of thousands of acres of tidal marsh in the South Bay (Collins and Grossinger 2004). Apart from these direct impacts, this construction led to dramatic changes in the physical processes influencing marsh development. By diking off these large expanses of marsh habitat, the tidal prism (volume of water that moves in and out of an area during a tidal cycle) was drastically reduced. The results of this decrease in tidal prism are still being observed in the South Bay, particularly in the Alviso pond complex (H. T. Harvey & Associates 2006).

3.3.2 Current Habitat Mapping Results

To generally assess existing conditions, broad-scale mapping for the Shoreline Study area included the Alviso pond complex, Moffett Field and the Palo Alto/Mountain View area south of San Francisquito Creek in Santa Clara County. In addition, a small area in Alameda County that is part of the Coyote Creek/Mud Slough drainage from Santa Clara County was also included in the Shoreline Study area. All habitats within the Shoreline Study Area were mapped at the scale shown in Figure 1.

During the mapping of the Shoreline Study Area, 25 different habitat categories were utilized. These habitat types included open water, mudflat, salt marsh, brackish marsh, freshwater marsh, riparian/creek corridor, muted tidal/diked marsh, active salt ponds, restored tidal salt ponds (under ISP Management) [1], seasonal ponds (under ISP Management), high salinity ponds (under ISP Management), system ponds (under ISP Management), seasonal ponds/high salinity ponds (under ISP Management), related projects (ponds), vernal pools, peripheral halophytes, landfill, water/sewage treatment, golf course, upland vegetation, parks/upland grassland, levee, airport, unvegetated, and developed (Figure 1). Each of these habitats is briefly described below, with survey results, and the locations of each habitat type are shown in Figure 1. It is important to note that small inclusions of differing habitat types may occur within a mapped section; however, these inclusions do not change the overall value or use of the habitat as described. For example, golf courses and/or airports probably contain areas of annual grassland or other such habitat types. Summary tables including all habitat types follow at the end of this section (Tables 1 and 2).

Open Water. Approximately 2664 acres of open water are found in the Study Area (Figure 1). The open waters of South San Francisco Bay, to the north of the Study Area, extend from a maximum depth of 25+ feet in the channel between the San Mateo and Dumbarton Bridges up to the MLLW elevation. However, water depth across the majority of the South Bay, particularly in the area southeast of the Dumbarton Bridge in the Study Area, is six to12 feet deep or less. Open water exists along Mountain View Slough, Charleston Slough, Stevens Creek, Alviso Slough, Artesian Slough, Guadalupe Slough, and in Coyote Creek and extends into their corresponding drainages. The open water category includes a variety of habitat types, including subtidal Bay waters, tidal sloughs and channels, and areas of standing or flowing

[1] The Initial Stewardship Plan (ISP)(Life Sciences 2003) describes the operation and maintenance of the ponds prior to the long-term restoration plan and, as such the ISP represents the existing condition. Since the ISP implementation began in July 2004 and will continue to be implemented through 2007, assumptions have been made regarding biological functions and values that will be present once the ISP is fully operational, but prior to the implementation of the SBSP Restoration plan. The ISP will continue beyond 2007 for many ponds, until tidal restoration or managed pond condition is "implemented" in phases of the SBSP Restoration Project.

waters within all of the salt ponds as well as within tidal marshes. Despite lacking terrestrial or emergent vegetation, deep bays and channels support large aquatic invertebrates, fishes, waterbirds, and marine mammals and, in a few areas within the upper reaches of shallow bays, eelgrass (*Zostera pacifica*), an important submerged plant species.

Open water habitat that was mapped in detail occurs within the low-flow channel of adjacent creeks and slough channels that drain to the Bay, within the borrow ditches and former tidal meanders found within the salt ponds throughout the Study Area, and within the interior marsh ponds. The tidal sloughs and channels that carry water between and through salt ponds and marsh remnants 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 resident fish as well as migratory species such as the migratory life stages (adult, juveniles) of Central California Coast steelhead (*Oncorhynchus mykiss*), Chinook salmon (*Oncorhynchus tshawytscha*), and green sturgeon (*Acipenser medirostris*). Shorebirds, waterfowl, and other waterbirds utilize the channels and marsh ponds while the open waters of the Bay support a high diversity of benthic and pelagic macroinvertebrates. Piscivorous (fish-eating) birds such as the Forster's tern (*Sterna forsteri*), California least tern (*Sterna antillarum browni*), and double-crested cormorant (*Phalacrocorax auritus*) fly over open water in search of fish, while diving ducks such as greater scaup (*Aythya marila*), lesser scaup (*Aythya affinis*), canvasbacks (*Aythya valisineria*), and surf scoters (*Melanitta perspicillata*) dive in shallower water for bivalves, crustaceans, and other invertebrates. Only birds that can forage from the air (e.g., terns) or that are able to swim can exploit subtidal areas of the Bay, resulting in low bird diversity in the open waters. However, large densities of diving ducks occur in some areas where appropriate depths and concentrations of benthic invertebrates, particularly bivalves, provide a rich food source. Some wildlife species, such as gulls, also roost on the Bay, especially at night.

Mudflats. Approximately 7498 acres of intertidal mudflat habitat (based on the satellite imagery obtained during a –0.9 feet MLLW tide condition) are found in the Study Area (Figure 1). Mudflat habitat occurs in intertidal areas from below MLLW to Mean Tide Level (MTL) just beyond the edge of wetlands along the Bay and between the low-flow channel and edge of wetlands within the tidal reaches of slough and creek channels that drain to the Bay. Intertidal mudflats are expanses of unvegetated mud lying between MLLW and the lower marsh zone. These flats are generally covered by shallow water during high tide, but are uncovered at low tide. Narrow mudflats occur along the edges of the tidal sloughs and channels and on the outboard side of some salt pond levees, while much more extensive flats are present at the mouths of the major sloughs and along the edge of the Bay. Mudflats are dynamic depositional features, changing in extent and location depending on the nature of erosion and deposition of sediments.

Large expanses of newly formed mudflat habitat exist downstream of the Island Ponds (A19, A20, and A21), including a large, newly formed mudflat island at the mouth of Alviso Slough adjacent to Pond A9. Mudflat habitat also occurs at the mouth of Guadalupe Slough and along Charleston Slough and accreting mudflat occurs adjacent to Calaveras Point, the mouth of Mountain View Slough, and the mouth of Stevens Creek adjacent to Ponds A1 and A2W. Small areas of mudflat surrounded by open water are

adjacent to Pond A12. Additional small areas of mudflat are surrounded by freshwater marsh at the upper end of the reach of Coyote Slough to the south of the Island Ponds.

Mudflats are located on the bayside of ponds and provide important habitat for resident and migratory bird populations in the South Bay as well as foraging habitat for Bay fishes and invertebrates. Shorebirds, gulls, terns, American white pelicans (*Pelecanus erythrorhynchos*), and ducks often use exposed mudflats as roosting or loafing areas when they are available, as will Pacific harbor seals (*Phoca vitulina richardsi*).

This habitat typically supports less than 10% cover of vascular emergent vegetation, typically in the form of cordgrass (*Spartina* spp.) and annual pickleweed (*Salicornia europaea*) that is too sparse to map as distinct salt marsh habitat. The mudflat substrate comprises primarily fine-grained silts and clays that support an extensive community of diatoms, worms, shellfish, and algal flora. Inundated mudflats provide foraging habitat for many species of fish, and, during low tides, these mudflats additionally provide a primary food source for shorebirds.

High productivity of benthic invertebrates on mudflats is a result of nutrient availability resulting from detritus from tidal marshes, phytoplankton that settle in the water column, algae, and diatoms growing on the intertidal mudflats (Life Science 2003; Warwick and Price 1975). Crustaceans, polychaete worms, mollusks, and other invertebrates live on or just below the surface of the mud. During daily high tides, fish school over mudflats to feed on these invertebrates. As the tide recedes and the flats emerge, the fish retreat to subtidal areas while large numbers of birds, primarily shorebirds, leave their high-tide roosts to feed on the flats. These mudflats are primarily what make the San Francisco Bay Area important to West Coast shorebird populations; an average of 67% of all the shorebirds on the West Coast of the U.S. use San Francisco Bay wetlands (Page et al. 1999). Gulls and some dabbling ducks forage on the exposed mudflats as well. Because benthic invertebrates often recede deeper into the mud as the tidal elevation drops, especially large concentrations of foraging birds usually occur at the edge of the receding or rising tideline. 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. The smaller channels in the brackish and salt marshes are the favored foraging areas for the state and federally endangered California clapper rail (*Rallus longirostris obsoletus*).

Tidal Wetlands. For purposes of this study, tidal wetlands were divided into salt marsh, brackish marsh, and freshwater marsh. Although not fully tidal, muted tidal and diked marsh habitat is also discussed in this section. These habitats collectively account for the greatest acreage of vegetated habitat adjacent to the ponds, occupying 3419 acres of the surrounding habitat (Figure 1). Each of these distinct types of tidal wetland habitat is described in further detail, below. The tidal wetlands are mainly located in narrow strips between the mudflats and the Cargill and salt pond levees.

> **Salt Marsh.** Approximately 725 acres of tidal salt marsh occurs on the outboard levees of the Study Area. Areas of tidal salt marsh in the South Bay are characterized by interstitial soil salinities greater than approximately 27 ppt, on average (H. T. Harvey & Associates 2002b). Salt

marsh habitat occurs primarily along the outboard (tidal) side of existing levees separating the salt ponds from the Bay. Salt marshes typically consist of three zones in the Bay: low marsh dominated by cordgrass, middle marsh dominated by pickleweed, and high marsh with a mixture of pickleweed and other moderately halophytic species that can tolerate occasional high tides.

The salt marsh habitat in the South Bay consists primarily of low and middle marsh and is dominated by pickleweed (*Sarcocornia pacifica*, formerly known as *Salicornia virginica*) and cordgrass. Pickleweed and cordgrass salt marsh habitats are separated by elevation; cordgrass typically occurs below the MHW mark and pickleweed occurs above the MHW, often extending up levee banks. Differences in pickleweed and cordgrass salt marsh habitat types also affect wildlife use and sedimentation in the slough and channels draining into the Bay.

There are two species of dominant cordgrass in the South Bay, the native Pacific cordgrass (*Spartina foliosa*) and smooth cordgrass (*S. alterniflora*), a non-native species from the east coast of North America. Smooth cordgrass can easily hybridize with the native cordgrass, causing widespread distribution of the hybridized species within a short amount of time. Smooth cordgrass and its hybrids are the predominant invasive plant species found in the tidal marshes south of the San Francisco Bay Bridge. In the Palo Alto Baylands, a survey conducted by the Coastal Conservancy's San Francisco Estuary Invasive Spartina Project from 2003 to 2006 showed an increase in the size of infestation from 0.61 acres spread over 49 patches in 2005, to 0.94 acres spread over 46 patches in 2006, a 54% increase (Porcella 2007). Total infestation of invasive cordgrass, based on both the SCVWD and Invasive Spartina Project's 2006 survey efforts, is estimated to be 18.9 acres spread amongst 286 patches. This is a 117% increase in acreage from 2005 to 2006 (Porcella 2007). Research has found that these infestations not only affect the foodweb, but that the smooth cordgrass and its hybrids grow lower into channels than the native cordgrass, which can reduce the extent of mudflat edge and possibly result in the loss of channels to vegetation encroachment and subsequent sedimentation (PWA and H.T. Harvey & Associates 2006). Current research and management programs on smooth cordgrass and its hybrids can provide guidance for salt pond restoration work (California State Coastal Conservancy and U.S. Fish and Wildlife Service 2003).

Other halophytic plant species commonly found in salt marsh habitat located within the South Bay include alkali heath (*Frankenia salina*), saltgrass (*Distichlis spicata*), saltmarsh dodder (*Cuscuta salina*), fleshy jaumea (*Jaumea carnosa*), spearscale (*Atriplex triangularis*), sea lavender (*Limonium californicum*), marsh gumplant (*Grindelia stricta* var. *angustifolia*), and the invasive perennial pepperweed (*Lepidium latifolium*). These species typically occur above the MHW mark in the high marsh zone, up to the ecotone between salt marsh and upland habitats. While these species usually occur in areas dominated by pickleweed, species such as marsh gumplant and perennial pepperweed sometimes occur in dense patches with less than 50% aerial coverage of pickleweed--areas assigned the *other salt marsh* classification. Areas with greater than 50% coverage of pickleweed, among any combination of other prevalent species, were classified as pickleweed salt marsh habitat.

Brackish Marsh. Approximately 955 acres of brackish marsh occur throughout the Study Area (Figure 1). This habitat covers the marsh plain in the transition from salt to brackish marsh along Coyote Creek, and also dominates the outboard levees near the junction of Mud Slough and Coyote Creek. Brackish marsh replaces salt marsh moving upstream along Guadalupe Slough, Alviso Slough, Mountain View Slough, and Stevens Creek.

Brackish marsh habitat typically occurs in the low-to-mid intertidal reaches of sloughs and creeks draining into the Bay where vegetation is subject to tidal inundation diluted by freshwater flows from upstream. As such, the average interstitial soil salinity of tidal brackish marsh is lower than in salt marshes, ranging from 15 to 20 ppt in the South Bay (H. T. Harvey & Associates 2002b). The water-surface elevation within reaches of brackish marsh in the Study Area (primarily located in the upper reaches of the Study Area) can vary by as much as ten feet, depending on daily tidal activity, seasonal freshwater flows from upstream, and their location within this estuary system.

The vegetation in brackish marsh habitat is dominated by emergent, vascular plant species adapted to intermediate (brackish) interstitial soil salinities including short bulrushes such as alkali bulrush (*Schoenoplectus robustus,* formerly known as *Scirpus robustus*) and saltmarsh bulrush (*Bolboschoenus maritimus,* formerly known as *Scirpus maritimus*). These species dominate lower brackish marsh habitat where sediment deposits have formed terraced floodplains between the low-flow channels and levees. The middle reaches of these channels are also dominated by shorter bulrushes, but in addition may have dense stands of tall bulrushes such as California bulrush (*Schoenoplectus californicus,* formerly known as *Scirpus californicus*) and hard-stem bulrush (*Schoenoplectus acutus*, formerly known as *Scirpus acutus*) adjacent to the low-flow channel of creeks and sloughs. Large, dense patches of invasive perennial pepperweed may also occur within terraced areas in middle reaches otherwise exclusively dominated by alkali bulrush. Other plants that can occur in brackish marshes include alkali heath, spearscale, and, along the high marsh/upland ecotone, pickleweed. Higher-order slough channels and upper-creek reaches dominated by these species may also be considered brackish marsh, depending on the extent of intrusion of fresher water in these areas.

Muted Tidal/Diked Marsh. There are a number of muted tidal/diked marsh areas occupying approximately 1250 acres in total in the vicinity of the Study Area, including New Chicago Marsh, the Palo Alto Flood Basin, and several smaller, adjacent areas (Figure 1). Muted tidal/diked marshes have limited tidal exchange due to the presence of levees around the perimeter of Bay waters/salt ponds. Water exchange is limited, so that the range in water level in the muted tidal marsh is small (usually a few inches) compared to the range of tidal change in other marsh areas (several feet). Muted tidal marshes exhibit many of the same features as fully tidal marshes, but they often have lower plant diversity due to the limited range in tidal action. The muted tidal and diked marshes in the Study Area represent the gradient from fresh to brackish to saline marsh habitat. For example, New Chicago Marsh is dominated by salt marsh, while the Palo Alto Flood Basin ranges from freshwater marsh habitat in the south to salt marsh habitat in the north.

Freshwater Marsh. Approximately 489 acres of freshwater marsh habitat occur throughout the Study Area (Figure 1). The majority of this habitat type is tidal freshwater marsh found in the upper reaches of Coyote Creek, Artesian Slough, Alviso Slough, and Guadalupe Slough where it transitions from brackish marsh. Freshwater marsh vegetation then extends from the upper reaches of Alviso Slough into the Guadalupe River and from the upper reaches of Guadalupe Slough into San Tomas Aquino and Calabazas Creeks. Freshwater marsh habitat typically occurs in the upper reaches of sloughs and creeks draining into the Bay. While these reaches may be subject to occasional tidal influence associated with high (usually spring) tides, and/or have somewhat saline historical sediments, these reaches are otherwise flushed with fresh water on a daily basis and therefore support mostly freshwater emergent vegetation. The water-surface elevation within reaches of freshwater marsh may also vary by as much as ten feet depending on daily tidal activity and seasonal, freshwater flows from upstream. Other non-tidal freshwater marshes are also present in the Study Area, including the Emily Renzel wetlands in Palo Alto.

Broad-leaf cattail (*Typha latifolia*) and taller bulrushes, including California bulrush and hard-stem bulrush, typically dominate the freshwater marsh habitat. Due to regular inundation, these species often form dense stands covering entire floodplain terraces along channels. Patches of perennial pepperweed and thickets of California blackberry (*Rubus ursinus*) also occur in regions of freshwater marsh.

Tidal marshes in the South Bay are remnants of their former extent, but support high densities of several wildlife species, including several San Francisco Bay endemic wildlife species. The state and federally endangered salt marsh harvest mouse (*Reithrodontomys raviventris*) and the salt marsh wandering shrew (*Sorex vagrans halicoetes*) occur in the salt marshes of the South Bay, particularly where pickleweed is present. The California vole (*Microtus californicus*) occurs here as well and is often the most common small mammal in tidal marshes. California clapper rails nest in cordgrass, denser stands of pickleweed, and marsh gumplant, particularly in the lower marsh zone where numerous small tidal channels are present, in both salt and brackish tidal marshes. The Alameda song sparrow (*Melospiza melodia pusillula*), endemic to the Central and South San Francisco Bay, nests in dense herbaceous vegetation in salt and brackish marshes as well, while the savannah sparrow (*Passerculus sandwichensis*) nests in pickleweed and peripheral halophytes in the upper marsh and upland transitional zones. The saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*) nests in tidal and nontidal brackish and freshwater marshes, and possibly in low densities in salt marsh habitat as well (Ray 1919; Steve Rottenborn, pers. obs.), in the South Bay. Several species of ducks, and in a few locations herons and egrets, also nest in the tidal marshes of the South Bay (Gill 1977), and California black rails (*Laterallus jamaicensis coturniculus*) winter in small numbers in these marshes. Non-breeding birds, including larger shorebirds, swallows, blackbirds, and other species roost, occasionally in large numbers, in the tidal marsh, and tidal marshes (and mudflats) in several South Bay areas are used as haul-outs and pupping sites by harbor seals.

Riparian/Creek Corridor. Approximately 260 acres of fluvial riparian habitat and urban creek corridors are found throughout the Study Area (Figure 1). Riparian habitat is found along the upstream portions of

the majority of the drainages within the Study Area. Riparian habitat includes vegetation that occurs adjacent to freshwater streams, creek, and rivers. The historical riparian landscape found in the South Bay was characterized by perennial creeks that intersect the intertidal zone, producing brackish marsh at the interface with the saline landscape. Currently in the South Bay, riparian habitats that include large, mature riparian trees are limited to select portions of Coyote Creek and the Guadalupe River. Dominant canopy species in the South Bay include willow (*Salix* sp.) and Fremont cottonwood (*Populus fremontii*) while common understory species include elderberry (*Sambucus mexicana*) and wild rose (*Rosa californica*). Many of the creek corridors however, are concrete-lined channels with little to no woody vegetation and are confined by flood control levees.

Salt Ponds (Active and Inactive). Approximately 7612 acres of the Study Area are occupied by active and inactive salt ponds. Approximately 235 acres of Cargill-managed active salt ponds occur within the Study Area (Figure 1) represented by the southeast portions of salt ponds M4 and M5 which border the northern extent of the bayland boundary of the Study Area. The vast majority of salt ponds within the Study Area, referred to as the "Alviso salt ponds" and numbered A1 to A23 on Figure 1, are inactive, meaning that they have been taken out of salt production. These ponds were mapped and described according to their prescribed management regime, and encompass approximately 7377 acres. The salinity and hydrologic circulation regimes outlined in the ISP (Life Science 2003) result in five types of pond management systems: System, Full Tidal, High Salinity (Batch), Seasonal, and Mixed (e.g., Seasonal /High Salinity) Ponds. A sixth pond type, categorized under Related Projects and encompassing approximately 1436 acres, is not under a current management regime; the fate of these ponds is unknown at this time. Each of these pond types is described below:

> **System Ponds (ISP Management).** The System Ponds, with approximately 4638 acres of salt ponds, are second only to mudflat habitat as the most abundant habitat found in the Study Area, and are by far the most extensive type of salt pond in the Study Area (Figure 1). They primarily occur along the east-west extent of the southern portion of the South Bay baylands, with two (Ponds A16 and A17) separated from the other System Ponds by the three high-salinity ponds. System Ponds are managed to have water circulating through a series of ponds linked by water control structures that are controlled to reduce or maintain ambient salinities. Management of these ponds under the ISP focuses primarily on meeting discharge requirements for salinity and dissolved oxygen; management for selected habitat conditions (e.g., shallow water for shorebirds, deeper water for waterfowl and diving birds) occurs as feasible while meeting water quality requirements.
>
> **Full Tidal Ponds (ISP Management).** Approximately 477 acres of former salt ponds fully restored to tidal action occur within the three Island Ponds (A19, A20, A21), which are located between Coyote Creek and Mud Slough in the northern portion of the Alviso Pond complex (Figure 1). Levees were breached in March 2006 to allow full tidal action to be reintroduced to the pond.
>
> **High Salinity Ponds (ISP Management).** Approximately 826 acres of high-salinity ponds (A12, A13, A15) occur within the east-central portion of the Study Area located between Coyote

Creek and Alviso Slough (Figure 1). High-salinity ponds are also referred to as batch ponds. This management strategy consists of a series of ponds, managed to maintain higher salinity levels to provide habitat for salt pond-associated bird species.

Seasonal Ponds (ISP Management). The two seasonal ponds (A22, A23) lie in the northern portion of the Alviso Pond complex and encompass approximately 712 acres (Figure 1). Seasonal ponds have no bay-water inputs; water levels rise and recede depending on precipitation and groundwater hydrology.

Seasonal Ponds/High-Salinity Ponds (ISP Management). Approximately 724 acres of seasonal/high-salinity ponds are located between the upper reaches of Alviso Slough and Guadalupe Slough in the pond complex (A8 North and South) and along the lower reach of Guadalupe Slough around the central portion of the Study Area (A3N) (Figure 1). These ponds are also referred to as mixed ponds. These ponds are managed differently at different times of the year, or managed adaptively.

Related Projects (Ponds). Approximately 1436 acres of former salt ponds in the Study Area, including Ponds A4 and A18 and the Crittenden Marsh area in the northern part of Moffett Field, are associated with related projects (Figure 1). Currently, the management plans for these ponds are actively being designed and future management of these ponds is uncertain. Future habitat enhancement options may include, but are not limited to, tidal restoration, managed pond, and diked or muted tidal wetland.

Generally, salt ponds in the South Bay are characterized by expanses of non-tidal open water, bare mud, or bare salt flats surrounded by mostly barren levees. Vegetation is sparse and where it does occur, it is limited primarily to levees. Due to the paucity of vegetation, salt ponds provide little to no cover for small mammals or reptiles, and provide nesting habitat only for species that nest on the bare levees and the occasional islands that have been created (by breaching of levees or deposition of material dredged from borrow ditches) within the ponds. Furthermore, much of the biomass produced by these ponds is unavailable to birds due to water depth and fish due to high salinity, which precludes these vertebrates' use of most of the invertebrates in the deeper, higher-salinity ponds.

At least 16 species of fish occur in the lower-salinity intake ponds, where they feed on an abundant supply of benthic and pelagic invertebrate prey. The native topsmelt (*Atherinops affinis*), longjaw mudsucker (*Gillichthys mirabilis*), staghorn sculpin (*Leptocottus armatus*), and non-native yellowfin goby (*Acanthogobius flavimanus*) and rainwater killifish (*Lucania parva*), are among the most common fish within these ponds (Takekawa et al. 2005). Because most of these fish cannot tolerate salinity > 70-80 ppt (Carpelan 1957; Lonzarich 1989), piscivorous birds in salt ponds generally forage only in the lower salinity intake ponds. Dabbling ducks are also usually present in highest concentrations in the lower salinity ponds, where they take both invertebrates and aquatic vegetation.

Salt ponds in the San Francisco Bay area provide habitat for more than one million waterbirds each year, including large percentages of the populations of some shorebird, duck, and tern species (Accurso 1992;

Harrington and Perry 1995; Page et al. 1999; Stenzel and Page 1988; Takekawa et al. 2001). Numerous waterbirds use the salt ponds and their associated islands and levees primarily for roosting, either at night or during high tide when their preferred foraging habitats are submerged. Large mixed-species flocks of shorebirds, gulls, terns, cormorants, pelicans, herons, and other birds are often seen roosting or loafing on levees, in shallow water, or on exposed mud in the ponds. A few species, including the black-necked stilt (*Himantopus mexicanus*), American avocet (*Recurvirostra americana*), western snowy plover, Caspian tern (*Sterna caspia*), Forster's tern, black skimmer (*Rhynchops niger*), California Gull (*Larus californicus*), and double-crested cormorant nest on islands or levees within the ponds, particularly those that are not accessible by mammalian predators, or in the case of the western snowy plover and California Gull, on barren salt flats on the bottoms of dried ponds.

The highest-salinity ponds support little, if any, wildlife. Above a salinity of 200 ppt, even brine shrimp cannot survive, and thus there is no prey to support predatory wildlife. Although birds may occasionally roost in these hypersaline ponds, the high salinity may have adverse effects on the birds, such as impairing the waterproofing of their feathers (Rubega and Robinson 1997), and little use is made of such ponds by wildlife (Takekawa et al. 2000).

Unvegetated Areas. Approximately 77 acres of unvegetated islands exist within several of the salt ponds (Figure 1). The majority of this acreage was mapped in ponds A6 and A2E. This habitat occasionally occurs on levee side slopes below approximately MHW. Unvegetated areas are typically confined to salt pond basins and consist of bare ground and salt flat areas. Most of the salt-pond basins were historically subject to regular tidal inundation and were vegetated with salt marsh species, but salinity resulting from their use as salt ponds over decades has resulted in conditions too saline to support even halophytic vegetation. While these areas typically lie below the MHW mark, they are no longer subject to tidal flooding.

Vernal Pool Grassland. There are approximately 481 acres of vernal pool grassland located in the northeastern portion of the Study Area in the Warm Springs area (Figure 1). Here, vernal pools occur within a grassland matrix, and no attempt has been made to map individual pools on Figure 1 or quantify their acreage. The vernal pool complex in the Study Area is adjacent to the backshore of historical tidal marshlands located near Warm Springs and consists mostly of small, distinct depressions among more diffuse swales. These vernal pools harbor the Contra Costa goldfields (*Lasthenia conjugens*) listed as endangered by the federal government. Upland grassland habitat containing vernal pool habitat is located landward from the salt ponds, between the salt ponds and urbanized areas.

Vernal pools are seasonally flooded depressions that occur on ancient soils that thinly cover an impermeable substrate of hardpan, clay, or bedrock above the tideline. The impermeable substrate causes the vernal pools to retain rainwater and local runoff seasonally, but to dessicate as evaporation drains their shallow topography. Because, vernal pools are essentially temporary wetlands, they undergo distinct vegetative phases: aquatic, flowering, and drought. During the aquatic phase of the vernal pool habitat, algae may flourish, along with the aquatic stages of coyote thistle (*Eryngium* sp.) and other vernal pool plant species. Later, after the winter rainstorms have ended, the pool will begin to dry and these plant species will flower, producing rings of color around the reducing pool, with the most water-tolerant

species occurring within the middle portions of the pool. During the drought phase, upland plant species may move into the vernal pool, resulting in an area that contains upland species, bare earth, dessicated hydrophytes, and residual algal matting during the late summer months.

Vernal pools in the Study Area provide important habitat for two rare wildlife species, the vernal pool tadpole shrimp (*Lepidurus packardi*) and California tiger salamander (*Ambystoma californiense*). These pools also provide seasonal foraging habitat for shorebirds, dabbling ducks, and egrets.

Peripheral Halophytes. Approximately 119 acres of peripheral halophytes are found along the banks and tops of levees surrounding the baylands and along the levees separating the salt ponds in the Study Area (Figure 1). The extent of peripheral halophytic vegetation is primarily determined by the salinity of the levee soils and how recently the levee soils were excavated from borrow pits in adjacent salt ponds. Peripheral halophytes typically include non-native, ruderal ("disturbance-loving") species such as iceplant (*Mesembryanthemum nodiflorum*), New Zealand spinach (*Tetragonia tetragonioides*), Russian thistle (*Salsola soda*), and Australian saltbush (*Atriplex semibaccata*), which usually occur only above the MHHW mark. Native high marsh species also occasionally form peripheral halophytic habitat along levee banks as conditions permit. These species include marsh gumplant, alkali heath, spearscale, and saltgrass. In addition, pickleweed may occur on levee banks; assemblages of pickleweed and peripheral halophytes are mapped as salt marsh if pickleweed is dominant in the area. Low-lying, or eroded levees between salt ponds are usually too saline to support halophytes. Levees contiguous with uplands are typically dominated by upland species (described below) rather than peripheral halophytes.

Peripheral halophytes are used as foraging (and occasionally nesting) sites by ducks, song sparrows, and savannah sparrows, and provide foraging habitat and cover for several additional sparrows and finches during the nonbreeding season. In addition, peripheral halophytic vegetation provides important refugial habitat for salt marsh wildlife species during high tides.

Upland Vegetation/Golf Courses. There are approximately 1465 acres of upland habitat within the Study Area (mostly non-native grassland habitat), the majority of which consists of parcels of ruderal vegetation in the eastern and southern undeveloped portions of the Study Area (Figure 1). A small area of upland vegetation was also found bordering sections of freshwater and brackish marshes within the Study Area. In addition, 990 acres of golf course land, primarily within the southern extent of the Study Area, were identified.

Aside from numerous ornamental plant species occurring in landscaped areas, assemblages of annual, non-native plants that thrive in disturbed areas (ruderal species) dominate most of the upland habitat. These species include most tree, shrub, and herbaceous species found in upland areas. The predominant upland species surrounding the ponds include Italian ryegrass (*Lolium multiflorum*), ripgut brome (*Bromus diandrus*), black mustard (*Brassica nigra*), wild radish (*Raphanus sativus*), Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), wild oats (*Avena fatua*), yellow star-thistle (*Centaurea solstitialis*), common sow thistle (*Sonchus oleraceus*), bull thistle (*Cirsium vulgare*), bristly ox-tongue (*Picris echioides*), rabbitsfoot grass, brass buttons, alkali heath, and coyote brush (*Baccharis pilularis*).

Most of the wildlife species found in peripheral upland areas are common species adapted to urban or ruderal habitats. Reptiles such as the western fence lizard (*Sceloporus occidentialis*), gopher snake (*Pituophis melanoleucus*), and southern alligator lizard (*Elgaria multicaranata*), and mammals such as the house mouse (*Mus musculus*), California vole (*Microtus californicus*), western harvest mouse (*Reithrodontomys megalotis*), California ground squirrel (*Spermophilus beecheyi*), black-tailed jack rabbit (*Lepus californicus*), cottontail (*Sylvilagus audubonii*), brush rabbit (*S. bachmani*), valley pocket gopher (*Thomomys bottae*), and striped skunk (*Mephitis mephitis*), all occur in the upland transitional areas along the edge of the Bay. A small, isolated population of western pond turtles (*Emys marmorata*) is present in brackish habitats near the Sunnyvale WPCP and Moffett Field, and California tiger salamanders occur in vernal pool habitats in the Warm Springs area.

In most areas, the bird species that occur in the peripheral habitats are also common, widespread species. These include permanent residents such as the Anna's hummingbird (*Calypte anna*), mourning dove (*Zenaida macroura*), black phoebe (*Sayornis nigricans*), northern mockingbird (*Mimus polyglottos*), bushtit (*Psaltriparus minimus*), California towhee (*Pipilo crissalis*), red-winged blackbird (*Agelaius phoeniceus*), Brewer's blackbird (*Euphagus cyanocephalus*), house finch (*Carpodacus mexicanus*), lesser goldfinch (*Carduelis psaltria*), summer residents such as the barn swallow (*Hirundo rustica*) and cliff swallow (*Petrochelidon pyrrhonota*), transients (some of which breed at higher elevations in the Bay Area), including the orange-crowned warbler (*Vermivora celata*) and Swainson's thrush (*Catharus ustulatus*), and winter residents such as the hermit thrush (*Catharus guttatus*), white-crowned sparrow (*Zonotrichia leucophrys*), golden-crowned sparrow (*Zonotrichia atricapilla*), yellow-rumped warbler (*Dendroica coronata*), and American pipit (*Anthus rubescens*). Burrowing owls (*Athene cunicularia*) are also present in ruderal habitats and non-native grasslands in scattered areas surrounding the South Bay salt ponds and marshes. The extent of the upland fields that once probably provided extensive alternate foraging habitat for shorebirds has been reduced considerably by development. Nevertheless, shorebirds such as killdeer (*Charadrius vociferus*), long-billed curlews (*Numenius americanus*), and dunlin (*Calidris alpina*) occasionally forage in more extensive upland fields in the Alviso, Fremont, and Newark areas during the wet season, and greater yellowlegs (*Tringa melanoleuca*) and least sandpipers (*Calidris minutilla*) may forage around ponded water in such fields in winter.

Parks/Upland Grassland. Approximately 466 acres of parks/upland grassland were found within the survey area, mostly located along the southern extent of the undeveloped portion of the Study Area (Figure 1). Included in this habitat description are areas within the Study Area designated as city or county parkland, including fallowed agricultural fields, manicured irrigation basins, and large areas of landscaped vegetation. Wildlife species in this habitat type are similar to those described for upland vegetation/golf courses above.

Levee. Approximately 416 acres of levees were mapped throughout the Study Area, found along the periphery of the baylands and separating many of the individual ponds in the salt pond complex (Figure 1). Levees are linear, barren, earthen structures that separate salt ponds from tidal areas and adjacent salt ponds. The levees in the South Bay salt pond complexes were typically constructed from soils excavated from borrow pits in former salt marshes which have since been developed into salt ponds; standing water can usually be found in the borrow ditches of otherwise empty salt ponds. The levee substrate is therefore

primarily saline, silty clay. Dirt roadways along the upland perimeters of salt ponds or bayfronts were typically mapped as levee. Portions of levees dominated by peripheral halophytes, or upland vegetation, were categorized as either of those habitat types, rather than as levee habitat.

Developed. Approximately 14,480 acres of developed areas make up the largest land use category within the Study Area. Development is found along the entire periphery of the Study Area boundary and extends towards the South Bay to the outward edge of the baylands (Figure 1). Approximately 1487 acres of lands designated for water/sewage treatment use are found in the Study Area. The majority of this acreage includes the water pollution control plants for the cities of San Jose and Sunnyvale. Approximately 779 acres of lands designated for landfill use are found in the including Newby Island, the Zanker Road Landfill, and Palo Alto Baylands. Approximately 975 acres of lands designated for airport use are found in the Study Area. Moffett Field makes up the majority of this airport designation.

Developed areas within each complex include roadways, parking areas, building complexes, pump facilities, water/sewage treatment areas, landfills, airports, and powerline facilities. Such areas are typically maintained free of vegetation, but may occasionally support isolated ruderal upland vegetation (described above). Larger areas of upland or ornamental (landscaping) vegetation in developed settings are categorized as parks/upland grassland. Sludge ponds, oxidation ponds, drying beds, and associated impoundments at the South Bayside System Authority Wastewater Treatment Works in Redwood City, the San Jose-Santa Clara WPCP in Alviso, and the Sunnyvale WPCP support high densities of breeding dabbling ducks, Canada geese (*Branta canadensis*), and black-necked stilts, and depending on pond conditions can support very high densities of migrant and wintering waterfowl.

Table 1 - Habitat Types mapped in the Shoreline Study Area (acreages).

Habitat Type	**Acres**
Muted Tidal/Diked Marsh	1250
Brackish Marsh	955
Salt Marsh	725
Freshwater Marsh	489
Riparian/Creek Corridor	260
Wetland/Riparian subtotal	**3679**
Mudflat	7498
System Ponds (ISP Management)	4638
Open Water	2664
Water/Sewage Treatment	1487
Related Projects	1436
High Salinity Ponds (ISP Management)	826
Seasonal Ponds/High Salinity Ponds (ISP Management)	724
Seasonal Ponds (ISP Management)	712
Full Tidal (ISP Management)	477
Salt Ponds (Active)	235

Habitat Type	Acres
Pond/Open Water subtotal	**20,697**
Developed	14,480
Parks/Upland Grassland	466
Airport	975
Upland Vegetation	1465
Landfill	779
Golf Course	990
Vernal Pool Grassland	481
Levee	416
Peripheral Halophytes	119
Unvegetated	77
Other subtotal	**20,248**
Total	**44,624**

Table 2 - Summary Table for the Habitat Types in the Shoreline Study Area.

Habitat Type	Acres	Proportion of Total
Wetland/Riparian	3679	8.2%
Pond/Open Water	20,697	46.4%
Other	20,248	45.4%
Total Area Mapped	**44,624**	**100%**

3.4 Special-Status Plant Species

Historically, special-status plant species were neither commonly occurring nor widely distributed within the upper zones of the tidal salt marsh and brackish marshes of the San Francisco Bay. However, those special-status species with broad edaphic tolerances were, and are today, locally common. For example, marsh gumplant (*Grindelia stricta* var. *angustifolia*), is limited to the upper marsh zone of the Bay, but tolerates disturbed fill soils; it is abundant within South Bay marshes and was recently removed from the California Native Plant Society (CNPS) Inventory of Rare and Endangered Plants (2001). Similarly, Congdon's tarplant (*Centromadia parryi* ssp. *congdonii*), while limited in distribution (CNPS List 1b), is associated with alkaline upper marsh habitats as well as with low-lying alkaline soils; large stands occur well east of the San Francisco Bay. Conversely, plants with highly restrictive growth requirements, such as for coarse substrates on high-energy shorelines, salt panne edges, or channel edges within tidal brackish marsh, are now extremely rare in the urban estuary of the Bay due to the limited acreage and distribution of these habitat types within the area. The continued persistence of these plants is further threatened by non-native, invasive plant species, particularly perennial pepperweed, which generally thrive under disturbed conditions with increased urban runoff.

3.4.1 Special-Status Plant Assessment

The California Natural Diversity Database (CNDDB, CDFG 2007) was queried to identify special-status plant species potentially occurring within the Palo Alto, Mountain View, and Milpitas USGS 7.5 minute quadrangles in which the majority of the Study Area occurs, as well as the ten quadrangles surrounding the Study Area, and the Newark and Redwood Point quadrangles that contain very small portions of the Study Area. In addition, to be inclusive of all species that may occur within the Study Area, particularly within grassland fringe areas with saline or alkaline soils, valley and foothill grassland, marsh and swamp, and vernal pool habitats were queried within the CNPS database (http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi, accessed 8 February 2007) for Alameda, San Mateo, and Santa Clara Counties.

Numerous occurrences of six species, including Point Reyes bird's-beak (*Cordylanthus maritimus* ssp. *palustris*), Hoover's button-celery (*Eryngium aristulatum* var. *hooveri*), Congdon's tarplant, alkali milk-vetch (*Astragalus tener* var. *tener*), Contra Costa goldfields (*Lasthenia conjugens*), and San Joaquin spearscale (*Atriplex joaquiniana*), have been documented in the immediate vicinity of the Study Area; the latter five species are known from the Study Area primarily from the Warm Springs Unit of the Don Edwards San Francisco Bay National Wildlife Refuge (SFBNWR) and the adjacent Pacific Commons Preserve in Fremont. Historical (likely extirpated) populations of alkali milk-vetch and Point Reyes bird's-beak are documented in the vicinity of Alviso. One additional species, Pacific cordgrass (*Spartina foliosa*), has been considered for inclusion in the USFWS draft recovery plan and is common in the area, but was not included in this assessment.

CNDDB (2006) records list 22 species as occurring within five miles (eight km) of the Study Area: San Joaquin spearscale, Congdon's tarplant, Contra Costa goldfields, alkali milk-vetch, hairless popcorn flower (*Plagiobotrys glaber*), robust spineflower (*Chorizanthe robusta* var. *robusta*), Hoover's button-celery, California seablight (*Suaeda californica*), arcuate bush mallow (*Malacathamnus arcuatus*), Point Reyes bird's-beak, slender-leaved pondweed (*Potamogeton filiformis*), lost thistle (*Cirsium praeteriens*), San Mateo thorn-mint (*Acanthomintha duttonii*), Marin western flax (*Hesperolinon congestum*), Franciscan onion (*Allium peninsulare* var. *franciscanum*), fragrant fritillary (*Fritillaria liliacea*), caper-fruited tropidocarpum (*Tropidocarpum capparideum*), western leatherwood (*Dirca occidentalis*), San Francisco collinsia (*Collinsia multicolor*), Hall's bush mallow (*Malacothamnus hallii*), most beautiful jewel-flower (*Streptanthus albidus* ssp. *peramoenus*), and Davidson's bush mallow (*Malacothamnus davidsonii*).

From this analysis, 49 special-status plant species have been identified that occur in similar Alameda, San Mateo, and Santa Clara county habitats and elevations, or are found within the USGS quads listed above, based on the query, including 22 special-status plant species that have been recorded within a five mile radius of the Study Area (CNDDB, CDFG 2007). All species selected from these queries were then cross referenced with the most recent state and federal listing update according to the California Department of Fish and Game to verify listing status and identify any recently listed species.

Presence of suitable habitat was the principal criterion used for inclusion in the list of species potentially occurring within the Study Area. Many of the special-status plant species that occur in Alameda, San Mateo, and Santa Clara Counties are associated with habitat or soil types that did not occur in the Study Area historically, or no longer occur in the Study Area due to the extensive removal of soil and addition of fill material. Following an analysis of the microhabitat conditions associated with these species, and the edaphic factors that favor their occurrence, 36 plant species of the original 49 are considered absent from the Study Area (Table 3a). The majority of the species were rejected for occurrence based on one or more of the following reasons:

1. The species would not occur within the Study Area due to the limited extent of degraded, upland habitat within the pond complexes or adjacent to developed areas and the highly saline and/or ruderal nature of these areas
2. The species occurs in chaparral habitat or cismontane woodland habitat, which do not exist within the Study Area.
3. The species nearly always or always occurs on serpentinite outcroppings, of which none were observed within the Study Area. Also, no serpentinite soil series are mapped in this area as being present by SCS (1968), and are not indicated as being present in the region by the Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area.
4. The species' published elevation range is outside the range of elevations found along the Study Area.
5. The species has a highly endemic range that does not include areas within or reasonably near to the Study Area, or the species is considered by CNPS to be extirpated or absent from Alameda, Santa Clara, and San Mateo Counties

Table 3a - Plant Species considered, but rejected for occurrence within the South San Francisco Bay Shoreline Study Area (Santa Clara and Alameda Counties).

Scientific Name	Common Name	Lack of Chaparral or Other Suitable Habitat	Lack of Mesic Habitat	Lack of Serpentine Soils	Other Edaphic Factors Absent from the Site	Associated Species Absent from the Site	CNPS Records List the Species as Extirpated or Never Occurred	Suitable Habitat on Site Disturbed/Degraded
Acanthomintha duttonii	San Mateo thorn-mint	X		X			X	
Allium peninsulare var. *franciscanum*	Franciscan onion			X	X			
Amsinckia lunaris	bent-flowered fiddleneck	X						
Atriplex cordulata	heartscale				X	X		
Atriplex coronata var. *coronata*	crownscale		X			X		
Atriplex depressa	brittlescale		X			X		
Centromadia parryi ssp. *parryi*	pappose tarplant						X	
Chorizanthe robusta var. *robusta*	robust spineflower	X			X			
Cirsium praeteriens	lost thistle						X	

Scientific Name	Common Name	Lack of Chaparral or Other Suitable Habitat	Lack of Mesic Habitat	Lack of Serpentine Soils	Other Edaphic Factors Absent from the Site	Associated Species Absent from the Site	CNPS Records List the Species as Extirpated or Never Occurred	Suitable Habitat on Site Disturbed/Degraded
Collinsia multicolor	San Francisco collinsia	X		X				
Cordylanthus maritimus ssp. *palustris*	Point Reyes bird's-beak						X	
Dirca occidentalis	western leatherwood	X			X			
Eriogonum truncatum	Mt. Diablo buckwheat				X			
Eryngium aristulatum var. *hooveri*	Hoover's button celery					X		X
Erysimum franciscanum	San Francisco wallflower			X				
Eschscholzia rhombipetala	diamond-petaled California poppy					X		X
Fritillaria liliacea	fragrant fritillary			X				
Hesperevax caulescens	hogwallow starfish				X			
Hesperolinon congestum	Marin western flax	X		X			X	
Hordeum intercedens	vernal barley						X	
Leptosiphon grandiflorus	large-flowered leptosiphon							
Lilium maritimum	coast lily	X			X		X	
Limnanthes douglasii ssp. *sulphurea*	Point Reyes meadowfoam				X		X	
Lotus formosissimus	harlequin lotus	X			X		X	
Malacathamnus arcuatus	Arcuate bush mallow	X						
Malacothamnus davidsonii	Davidson's bush mallow	X					X	
Malacothamnus hallii	Hall's bush mallow	X						
Microseris paludosa	marsh microseris	X					X	
Navarretia cotulifolia	cotula navarretia				X			
Perideridia gairdneri ssp. *gairdneri*	Gairdner's yampah					X		X
Plagiobotrys glaber	hairless popcorn flower						X	
Potamogeton filiformis	Slender-leaved pondweed						X	
Streptanthus albidus ssp. *peramoenus*	most beautiful jewel-flower	X		X				
Suaeda californica	California seablite						X	
Trifolium amoenum	showy Indian clover			X			X	
Tropidocarpum capparideum	caper-fruited tropidocarpum						X	

The remaining 13 species considered for occurrence within the Study Area did not match any of the above rejection criteria, and could not be reasonably excluded due to the range of habitat types and ecotones present on-site; these species are considered in Table 3b. These include three species (Contra Costa goldfields, Congdon's tarplant, and prostrate navarretia) that are known to occur in the Study Area;

two species (San Joaquin spearscale and alkali milk-vetch) that are not known to occur in the Study Area but that occur immediately adjacent to the Study Area in the Pacific Commons Preserve, and thus have the potential to occur in the Study Area; one species (Delta tule pea [*Lathyrus jepsonii* var. *jepsonii*]) that is not known from extant occurrences in the South Bay but which could potentially occur in the Study Area; five species (palmate-bracted bird's-beak [*Cordylanthus palmatus*], hispid bird's-beak [*Cordylanthus mollis* ssp. *hispidus*], recurved larkspur [*Delphinium recurvatum*], Delta woolly-marbles [*Psilocarphus brevissimus* var. *multiflorus*], and saline clover [*Trifolium depauperatum* var. *hydrophilum*]) that are unlikely to occur in the Study Area; and two species (Mason's lilaeopsis [*Lilaeopsis masonii*] and Coastal Marsh milk-vetch [*Astragalus pycnostachyus* var. *pycnostachyus*]) that are considered absent from the Study Area, which probably has never provided suitable habitat for these two species. The ecology, distribution, and potential for reintroduction of these species are provided below.

Three terrestrial communities of concern appeared on CNNDB (2007) records within a five mile radius of the Study Area: Northern Coastal Salt Marsh, Serpentine Bunchgrass, and Valley Oak Woodland. Of these habitat types, only Northern Coastal salt marsh habitat occurs within the Study Area, as described above within the listed habitat descriptions.

Table 3b – Special-status plant species, their status, and potential occurrence in the Shoreline Study Area.

NAME	STATUS*	HABITAT/ DESCRIPTION	POTENTIAL FOR OCCURRENCE ON SITE
Federal or State Threatened or Endangered Species			
Palmate-bracted bird's-beak (*Cordylanthus palmatus*)	FE, SE, CNPS 1B	Chenopod scrub, Valley and foothill grassland/alkaline. Known from Alameda, Colusa, Fresno, Glenn, Madera, and Yolo Counties. Believed to be extirpated from San Joaquin County. Annual hemiparasitic herb that blooms May through October.	**Unlikely.** Due to the general degraded nature or lack of alkaline flat substrate within the Study Area, the occurrence of Palmate-bracted bird's-beak within the Study Area is unlikely.
Contra Costa goldfields (*Lasthenia conjugens*)	FE, CNPS 1B	Saline/alkaline vernal pools, mesic areas within grassland. Known from Alameda, Solano, Monterey, Contra Costa, and Napa counties. Annual; blooms March through June.	**Present.** Two large colonies associated with grassy seasonal wetlands in Fremont vicnity; otherwise occurs in disjunct populations in Monterey and North Bay. The Warm Springs portion of the Study Area provides suitable habitat and is included within the vernal pool critical habitat for Contra Costa Goldfields (Unit 8).
Mason's lilaeopsis (*Lilaeopsis masonii*)	SR, CNPS 1B	Exposed banks of tidal meanders and channels within brackish to freshwater marsh. Locally common in Suisun Marsh. Perennial; blooms April through November.	**Absent.** Not known to occur in the South Bay; historical and current records in Suisun Bay only.
State Rare and CNPS Species			
Coastal marsh milk-vetch (*Astragalus pycnostachyus* var. *pycnostachyus*)	FSC, CNPS 1B	Coastal salt marshes, streamsides, and mesic coastal dunes in Marin and San Mateo counties. Perennial; blooms April to October.	**Absent.** Not known to occur in South Bay; no suitable habitat in Shoreline Study Area (Extant populations associated with maritime salt marsh).
Alkali milk-vetch (*Astragalus tener* var. *tener*)	FSC, CNPS 1B	Alkaline soils in playas, vernal pools, and adobe clay areas within grassland. Alameda, Merced, Solano, and Yolo counties. Annual; blooms March to June.	**Potential**. Recently rediscovered in seasonal wetlands near Fremont, on Pacific Commons Preserve immediately outside Shoreline Study Area. Considered extirpated from Santa Clara County. Currently suitable vernal pool habitat occurs within the Warm Springs portion of the Shoreline Study area.
San Joaquin spearscale (*Atriplex joaquiniana*)	FSC, CNPS 1B	Alkaline soils within chenopod scrub, meadows, playas, and grasslands in 14 central California counties. Annual; blooms April through October.	**Potential.** Occurs in seasonal wetlands in Warm Springs vicinity; known from Pacific Commons Preserve. Potential habitat present in Warms Springs portion of Shoreline Study Area.
Congdon's tarplant (*Centromadia parryi* ssp. *congdonii*)	CNPS 1B	Moist, alkaline soils within grassland. Tolerates disturbance. Annual; blooms June through November. Known from Alameda, Monterey, San Luis Obispo, and Santa Clara counties.	**Present.** Occurs in seasonal wetlands in Warm Springs vicinity; known from Pacific Commons Preserve. Also recently recorded in Alviso and at Sunnyvale Baylands Park. May occur in peripheral halophyte or disturbed upland zones in Shoreline Study Area, but not currently associated with salt marsh.

NAME	STATUS*	HABITAT/ DESCRIPTION	POTENTIAL FOR OCCURRENCE ON SITE
Hispid bird's-beak (*Cordylanthus mollis* ssp. *hispidus*)	CNPS 1B	Meadows and seeps, Playas, Valley and foothill grassland/alkaline. Known from Alameda, Fresno, Kern, Merced, Placer, and Solano counties. Annual hemiparasitic herb that bloomsJune through September.	**Unlikely.** Due to the general degraded nature or lack of saline flats substrate within the Study Area, the occurrence of Hispid bird's-beak within the Study Area is unlikely.
Recurved larkspur (*Delphinium recurvatum*)	CNPS 1B	Chenopod scrub, Cismontane woodland, Valley and foothill grassland/alkaline. Known from Alameda, Contra Costa, Fresno, Glenn Glenn, Kings, Kern, Madera, Merced, Monterey, San Joaquin, San Luis Obispo, Solano, and Tulare Counties. It is believed to be extirpated from Butte and Colusa counties. Perennial herb that blooms from March through June.	**Unlikely.** Due to the general degraded nature or lack of grassland habitat with alkaline soils within the Study Area, the occurrence of recurved larkspur within the Study Area is unlikely.
Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*)	CNPS 1B	High marsh zone in brackish and freshwater marshes. Known from Suisun Marsh (Sacramento, San Joaquin, Solano and Contra Costa counties) and Napa marshes. Perennial; blooms May through September.	**Potential.** Historical and current records are from the North Bay only. However, marginal habitat is present within the Study Area, and there is some potential for occurrence.
Prostrate navarretia (*Navarretia prostrata*)	FSC, CNPS 1B	Seasonal wetlands and vernal pools within grassland and coastal scrub. Ranges from Monterey County south to San Diego. Annual; blooms April through July.	**Present.** In South Bay, known only from Pacific Commons Preserve and the Warm Springs unit of the SFBNWR.
Delta woolly-marbles (*Psilocarphus brevissimus* var. *multiflorus*)	CNPS 4	Dried beds of vernal pools and flats, especially in grasslands, in Alameda and Santa Clara counties north to Yolo County. Annual; blooms April to June.	**Unlikely.** Currently the Warm Springs area presents potentially suitable habitat within the Shoreline Study Area.
Saline clover (*Trifolium depauperatum* var. *hydrophilum*)	FSC, CNPS 1B	Edges of salt marshes, alkali meadows, and vernal pools along the coast from Sonoma County south to San Luis Obispo, as well as in the inland counties of Solano and Colusa. Annual; blooms April through June.	**Unlikely.** Historical collection (type locality) from Belmont; not recorded since in South Bay. Currently the Warm Springs area presents potentially suitable habitat within the Shoreline Study Area.

CNPS LISTS:
1A – Plants presumed extinct in California
1B – Plants rare, threatened, or endangered in California and elsewhere
2 – Plants rare, threatened, or endangered in California, but more common elsewhere
3 – Plants about which more information is needed – a review list
4 – Plants of limited distribution – a watch list

Other Listed Status:
FE –Federally Endangered
FSC –Federal Species of Concern
SR –State Rare
SE –State Endangered

Palmate-bracted bird's-beak (*Cordylanthus palmatus*). Federal Status: Endangered; State Status: Endangered; CNPS Status: List 1B. Palmate-bracted bird's-beak is a hemiparasitic annual herb in the Scrophulariaceae typically found in chenopod scrub or alkaline valley and foothill grassland habitat at elevations of five to 155 meters. Plants are between ten to 30 centimeters, gray-green, and soft-hairy. Flowers are whitish and appear from May to October.

Palmate-bracted bird's-beak is known from only nine occurrences (CNPS 2001) and is threatened by agriculture, urbanization, grazing, and industrial development. No local occurrences exist in CNDDB records (2007). It is expected to occur within alkaline flats in the Study Area.

Potential for occurrence in the Study Area. Due to the general degraded nature or lack of alkaline flat substrate within the Study Area, the occurrence of palmate-bracted bird's-beak within the Study Area is unlikely.

Contra Costa goldfields (*Lasthenia conjugens*). Federal Status: Endangered; State Status: None; CNPS Status: List 1B. Contra Costa goldfields is a small, ephemeral annual sunflower typically occurring in mesic depressions within open, grassy habitats. Plants range in height from four to 12 inches and bear one to several flowerheads from March through June. Both ray and disk flowers are yellow. Contra Costa goldfields is distinguished from other common, co-occurring *Lasthenia* species by its lack of a pappus (an appendage arising from the ovary) on individual flowers.

Contra Costa goldfields occurs in 20 widely scattered populations in Alameda, Contra Costa, Mendocino, Monterey, Napa, and Solano Counties (CDFG 2004a). Extant populations in the South Bay area occur at the Pacific Commons Preserve (seasonal wetlands) and at the nearby Don Edwards San Francisco Bay NWR, Warm Springs Unit (vernal pools and swales). Management of both preserve areas focuses on the conservation of the species (USFWS and CDFG 2003; Wetlands Research Associates 1999).

Contra Costa goldfields is not expected to occur within tidal wetlands, but may occur in seasonal wetlands in the upland transition zone. According to the critical habitat designation for this species (Department of the Interior 2003), Contra Costa goldfields is most often found in vernal pools, swales, moist flats and depressions within grassland. However, Baye (2000) discusses the historical association of Contra Costa goldfields with saline seasonal wetlands at the marsh/upland boundary, as well as an apparent collection from a salt evaporator pond. Typical associated species include brass buttons (*Cotula coronipifolia*) and alkali heath, two common species of the upper and middle marsh, as well as the freshwater wetland species downingia (*Downingia* spp.), button celery (*Eryngium* spp.), water starwort (*Callitriche marginata*), and other species of goldfields (*Lasthenia glaberrima, L. fremontii*).

Potential for occurrence in the Study Area. Contra Costa Goldfields is present within the Study Area. Two large colonies associated with grassy seasonal wetlands occur in the Warm Springs unit of the SFBNWR. The Warm Springs portion of the Study Area provides suitable habitat and is included within the vernal pool critical habitat for Contra Costat Goldfields (Unit 8).

Mason's lilaeopsis (*Lilaeopsis masonii*). Federal Status: Species of Concern; State Status: Rare; CNPS Status: List 1B. Mason's lilaeopsis is a small, rhizomatous perennial in the carrot family (Apiaceae). Reaching heights of approximately three inches, plants form dense, turf-like colonies ranging from approximately 50 to over 7500 ft^2 (CDFG 2004a). Inflorescences of white or maroon flowers appear on short (≤1 inch), open umbels from April through November. Mason's lilaeopsis colonizes recently deposited, fine-grained soils on the edges of tidal meanders, sloughs, and saline-influenced reaches of creeks and rivers. This species is not known to occur in the highly saline environment of tidal salt marsh; rather, it favors the edges of marshes with significant fresh water inputs (i.e., the low brackish marsh zone). As such, populations are concentrated in the northern portion of the Bay, particularly in the Delta region, where large expanses of tidal brackish marsh occur.

Mason's lilaeopsis occurs on exposed tidal meanders and flats in the northeastern portion of the San Francisco Bay area. Associated species include marsh pennywort (*Hydrocotyle verticillata*), aquatic pygmy-weed (*Crassula aquatica*), tule (*Schoenoplectus californicus*, formerly known as *Scirpus californicus* var. *acutus*), and rushes (*Juncus* spp.) According to herbarium records catalogued by the University of California, the majority of reported occurrences of Mason's lilaeopsis are in San Joaquin, Sacramento, Contra Costa, and Solano Counties (CalFlora 2004). Although two Alameda County records exist, both apparently refer to a population south of Clifton Court Forebay at the Contra Costa County line (CalFlora 2004; CDFG 2004a).

Historically, creek flows into the South Bay were intermittent, and broad expanses of riparian vegetation and seasonal wetlands ringing the Bay retained runoff of rainwater prior to its reaching the marshes. Extremely high salinities at the edges of South Bay marshes are apparent in the historical distribution of salt pannes and natural salt ponds (San Francisco Estuary Institute 1999). Currently, salinity in the South Bay typically approaches that of seawater (Life Science 2004). This may account for the lack of historical records of Mason's lilaeopsis from the Alameda/San Mateo/Santa Clara counties region, although fringing brackish marshes do occur at Mud Slough, Coyote Creek, Artesian Slough, Alviso Slough, and Guadalupe Slough (Baye et al. 2000), and are currently increasing in extent (H. T. Harvey & Associates 1997b). Furthermore, extensive brackish marsh occurs at Petaluma Marsh, and Mason's lilaeopsis has not been documented there. Detailed studies of the distribution and abundance of this species are not available.

Potential for occurrence in the Study Area. Populations of Mason's lilaeopsis are absent from the South Bay, perhaps due to the lack of appropriate brackish habitat. Because Mason's lilaeopsis has never been documented in the Study Area, it is considered to be absent within the Shoreline Study Area.

Coastal marsh milk-vetch (*Astragalus pycnostachyus* var. *pycnostachyus*). Federal Status: Species of Concern; State Status: None; CNPS Status: List 1B. Coastal marsh milk-vetch is a stout, perennial herb in the pea family (Fabaceae) associated with maritime salt marshes, seeps, and mesic sites within dunes in Humboldt, Marin, and San Mateo counties. Plants have an open, clumping habit and are densely soft-hairy, with long pinnate leaves and distinctive papery, inflated fruits. Many greenish-white or cream colored flowers appear on in the axils of leaves from April through October.

Coastal marsh milk-vetch is known from three locations in coastal San Mateo County (Pescadero Marsh, Pomponio State Beach, San Gregorio State Beach), where plants are associated with sandy-clay or gravelly soils. Little published information is available on the ecological requirements of this plant, but suitable microhabitat apparently occurs within a range of plant communities. One population occurs on a steep slope within coastal scrub, associated with coyote brush (*Baccharis pilularis*), sea lettuce (*Dudleya farinosa*), and sticky monkeyflower (*Mimulus aurentiacus*). The Pescadero Marsh population, on the other hand, persists in a diked area with peripheral halophytes, including alkali heath and marsh gumplant. Approximately ten extant populations/occurrences are documented in Marin and Humboldt counties (CDFG 2004a), predominantly associated with the upper marsh ecotone. Coastal marsh milk-vetch's southern relative, Ventura marsh milkvetch (*A. p.* ssp. *lanosissimus*) is listed as endangered.

Potential for occurrence in the Study Area. Coastal marsh milk-vetch is found exclusively on course substrates such as sandy clay and gravel and has never been observed east of the immediate coast. Despite the relative tolerance of this species to disturbed habitats such as levees, it is considered to be absent from the Study Area due to historical and current patterns of sediment deposition. Furthermore, the Study Area is outside the known range of this species.

Alkali milk-vetch (*Astragalus tener* var. *tener*). Federal Status: None; State Status: None; CNPS Status: List 1B. Alkali milk-vetch is a delicate annual plant associated with vernal pools, alkaline flats, and vernally moist meadows and grasslands in Alameda, Merced, Napa, Solano, and Yolo counties. Plants range in height from two to 12 inches, appearing in late winter as erect or ascending stems with glabrous, pinnately compound leaves. Pinkish-purple flowers appear from March through June, depending on timing of soil saturation/inundation and drying. All taxa within this species complex are associated with moist, vernally mesic soils and are extremely rare.

Alkali milk-vetch is associated with seasonal wetland species such as owl's clover (*Orthocarpus* spp.), downingia, semaphore grass (*Pleuropogon californicus*), and popcorn-flower (*Plagiobothrys* spp.), and occasionally with peripheral halophytes such as salt grass and alkali heath, within alkali meadows. Plants occur on the upper edges of vernal pools, within grasslands underlain by heavy, moisture-retentive clay soils, and within the upper floodplains of rivers. Populations are often associated with, and threatened by, non-native annual grasses and forbs. At least one location, a population of alkali milk-vetch is threatened by management activities for waterfowl, which create perennially-inundated conditions unsuitable for supporting the species (CDFG 2004a). Approximately 30 extant populations/occurrences of alkali milk-vetch are documented by CDFG (2004a). The majority of these occurrences is the result of intensive surveys of historical locations, and is likely an accurate representation of the actual current range of the species.

Potential for Occurrence in the Study Area. Many historical locations of alkali milk-vetch in the South Bay (i.e., Alviso, Milpitas, and "Mayfield", now Palo Alto) are now heavily developed or degraded and, until recently, the species was presumed to be extirpated from the Bay Area. However, a population of alkali milk-vetch was discovered along the upper boundaries of created vernal pools at the Pacific Commons Preserve in 1999 (Wetlands Research Associates 1999). This population has persisted at least through 2006. This site is the location of a historical collection of the species, which likely persisted

through years of unfavorable conditions by remaining dormant in the seedbank. It is therefore possible that other sites along the outer edges of the baylands of the Study Area, particularly those within the marsh/upland transition zone, contain viable alkali milk-vetch propagules. Currently suitable vernal pool habitat occurs within the Warm Springs portion of the Shoreline Study Area.

San Joaquin spearscale (*Atriplex joaquiniana*). Federal Status: None; State Status: None; CNPS Status: List 1B. San Joaquin spearscale is an annual, grey-scaly, ascending plant in the goosefoot family (Chenopodiaceae). Like all *Atriplex* species, San Joaquin spearscale lacks petals, and flowers instead appear as dense clusters of fleshy, grey-green perianth parts in terminal inflorescences. This species flowers over a long period from April to October, depending on hydrological characteristics of the associated mesic habitat.

San Joaquin spearscale occurs on moist alkaline soils within a range of habitats, including non-native annual grassland, alkali meadow and scald, alkali sink, and the cut banks of eroded vernal pools. Huge populations occur in the vicinity of the Springtown Wetlands Preserve (in Livermore, CA, which is outside of the Study Area), most commonly associated with alkali heath, alkali weed (*Cressa truxillensis*), saltgrass, and tarweeds (*Centromadia* spp.) (Boursier 1997.). CDFG documents 69 populations/ occurrences of this species, nearly all of which were observed relatively recently and are presumed to be extant (CDFG 2004a).

Potential for Occurrence in the Study Area. San Joaquin spearscale, like alkali milk-vetch, was recently discovered growing along the margins of created vernal pools at the Pacific Commons Preserve in Fremont, adjacent to the Warm Springs Unit of the SFBNWR. Plants occur along the upper edges of created vernal pools, where they are associated with non-native grasses and forbs. No other occurrences are documented in the Study Area. Because the Pacific Commons population likely resulted from an existing seedbank, areas of suitable habitat in the Study Area may harbor dormant populations.

Congdon's tarplant (*Centromadia parryi* ssp. *congdonii*). Federal Status: None; State Status: None; CNPS Status: List 1B. Congdon's tarplant is a spiny, resinous annual herb in the sunflower family associated with moist, alkaline grasslands. Populations are frequently located within sumps or disturbed areas where water collects, and may be favored by moderate levels of disturbance that reduce the cover of non-native grasses and forbs. Unlike many of its community associates, this species matures in late summer and can flower into mid-fall; tarweeds in general are among the latest-blooming wildflowers of the area. Congdon's tarplant can be differentiated from co-occurring species of tarweed by the lack of tack-shaped glands on the leaves and flower bracts and the structure of its chaff scales (dry bracts among individual flowers).

Known populations of Congdon's tarplant occur in Monterey, San Luis Obispo, and Santa Clara counties, where CNNDB documents 62 occurrences. Congdon's tarplant was once common along salt marsh edges in the South Bay (Munz and Keck 1959) and, as evidenced by recent observations of small, remnant colonies, has a slight potential for occurrence on levees and adjacent upland areas throughout the Alviso Complex. Associated species include Italian rye (*Lolium multiflorum*) alkali heath, and salt grass.

Potential for Occurrence in the Study Area. In the Study Area, several populations are known from disturbed annual grassland habitat in the vicinity of Alviso (H. T. Harvey & Associates 2002b; LSA Associates 1999), in the Warm Springs district of Fremont, near Milpitas, and in the Sunnyvale Baylands Park (CDFG 2004a). Congdon's tarplant has been reported from near the mouth of Stevens Creek, where a small, remnant occurrence of a historical population was observed in hard-packed gravel along the levee road north of the end of Crittenden Road (CDFG 2004a). Populations are also known from slightly saline grasslands in the Warm Springs district, and historical observations are reported from Cooley Landing in Menlo Park and from East Palo Alto (in the vicinity of the Ravenswood Complex). Congdon's tarplant is frequently associated with disturbed, alkaline habitats that pond water in the late winter and spring. As such, suitable habitat occurs on the margins of evaporation ponds or within the peripheral halophyte zone along the levees, and several occurrences are noted within the Study Area.

Hispid bird's-beak (*Cordylanthus mollis* ssp. *hispidus*). Federal Status: None; State Status: None; CNPS Status: List 1B. Hispid bird's-beak is a hemiparasitic annual herb in the Scrophulariaceae typically found in meadows and seeps, playas, or valley and foothill grassland habitats in alkaline soils at elevations of five to 155 meters. Plants are bristly and between ten and 40 centimeters, gray-green, often tinged purple, and long-non-glandular hairy. Flowers are whitish and appear from June to September.

Hispid bird's-beak is extirpated from much of the lower San Joaquin Valley (CNPS 2001) and is threatened by agricultural conversion, development, and grazing. No local occurrences exist in CNDDB records (2007). It is expected to occur within saline marshes and flats in the Study Area.

Potential for Occurrence in the Study Area. Due to the general degraded nature or lack of saline flats substrate within the Study Area, the occurrence of Hispid bird's-beak within the Study Area is unlikely.

Recurved larkspur (*Delphinium recurvatum*). Federal Status: None; State Status: None; CNPS Status: List 1B. Recurved larkspur is a perennial herb in the Ranunculaceae typically found in chenopod scrub, cismontane woodland, and valley and foothill grassland habitats in alkaline soils at elevations of three to 750 meters. Plants are between 18 and 85 centimeters, with flowers generally consisting of light-blue sepals and white petals, blooming from March to May.

Recurved larkspur is known from many historical occurrences (CNPS 2001), although much habitat has been converted to agriculture. It is also threatened by grazing. No local occurrences exist in CNDDB records (2007). It is expected to occur within poorly drained, fine, alkaline soils in grassland habitat in the Study Area.

Potential for Occurrence in the Study Area. Due to the general degraded nature or lack of grassland habitat with alkaline soils within the Study Area, the occurrence of recurved larkspur within the Study Area is unlikely.

Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*). Federal Status: Species of Concern; State Status: None; CNPS Status: List 1B. Delta tule pea is a robust, climbing perennial plant in the Pea family (Fabaceae) associated with freshwater and brackish marsh. Plants often occur in large colonies, where

they are found twining through associated vegetation or as tangled masses; individual plants can reach six feet in length. Rose-purple flowers appear from May through June, after which plants gradually senesce to overwinter as underground rootstocks. Key characters distinguishing Delta tule pea from common taxa, include the co-occurring California tule pea, are compound leaves with elongated tendrils and ten to 16 leaflets, broadly-winged stems, and lack of hairs on the stems and leaves.

Populations of Delta tule pea are restricted to the edges of marshes and sloughs with significant freshwater inputs. Plants typically occur in relatively well-drained areas, often on slight topographic relief above the marsh plain (Baye et al. 2000), and are most frequently associated with cattail, bulrush, California rose (*Rosa californica*), and coyote brush (*Baccharis pilularis*). Several populations are associated with plants more typical of the high salt marsh, including saltgrass, pickleweed, and jaumea. The center of population distribution is in the Delta region, where plants may co-occur with other rare species such as Suisun Marsh aster (*Aster lentus*) and Mason's lilaeopsis. Delta tule pea is reported to occur in the vicinity of Niles in Alameda County, but is considered extirpated in Santa Clara County (CNPS 2001).

*Potential for Occurrence in the Study Area***:** Although reportedly extant in Alameda County (CNPS 2001), no populations of Delta tule pea have been documented in the South Bay area (CDFG 2004a). Like Mason's lilaeopsis, Delta tule pea is associated with a brackish to freshwater marsh habitat that was never common in the Study Area and is considered to be absent from the area.

Prostrate navarretia (*Navarretia prostrata*). Federal Status: Species of Concern; State Status: None; CNPS Status: List 1B. Prostrate navarretia is a small annual herb in the Phlox family (*Polemoniaceae*) associated with vernal pools and mesic, alkaline areas within grassland. Plants have a stalkless, central flower head with many prostrate flowering branches spreading radially from beneath, and leaves are long, narrow, and deeply pinnately-lobed. White to violet flowers appear from April through July as dense clusters surrounded by spiny bracts.

Prostrate navarretia is associated with relatively coarse-grained sediments in small depressions within mesic areas. Associated species include the typical vernal pool indicator species coyote-thistle (*Eryngium vaseyi*), popcorn-flower (*Plagiobothrys* spp.), and spike rush (*Eleocharis macrostachya*). The majority of known populations of prostrate navarretia occur in southern California, where plants are associated with the large vernal pool complexes of the Santa Rosa Plateau, mima mound topography in Los Angeles County, and mesas south through San Diego. Significant populations also occur on military lands in southern Monterey County and at the Kesterson National Wildlife Refuge near Merced. In the South Bay area, prostrate navarretia is known only from the seasonal wetlands and created vernal pools at the Pacific Commons Preserve.

*Potential for Occurrence in the Study Area***:** Populations of prostrate navarretia occur in the Study Area within the Warm Springs unit of the SFBNWR. This species is also present in the immediately adjacent Pacific Commons Preserve. Currently the Warm Springs area presents the only potentially suitable habitat within the Shoreline Study Area.

Delta woolly-marbles (*Psilocarphys brevissimus* var. *multiflorus*). Federal Status: None; State Status: None; CNPS Status: List 4. Delta woolly-marbles is an annual, vernal-pool endemic in the Sunflower family (Asteraceae) with silky-hairy foliage and several spreading stems from the base. Plants are grey-green throughout and produce small (less than 1 centimeter) oval heads of pale, cobweb-like flowers from May through June. Delta woolly-marbles occur along the drying edges of vernal pools within grassland.

Potential for Occurrence in the Study Area: Populations are not known, or expected, to occur in the Study Area. While vernal pool habitat occurs in the Study Area (e.g., in the Warm Springs unit of the SFBNWR) and its vicinity (e.g., in the Pacific Commons Preserve), none of these areas currently support populations of Delta woolly marbles. With no known seed source, it is highly unlikely that this species would naturally colonize the Study Area.

Saline clover (*Trifolium depauperatum* var. *hydrophilum*). Federal Status: Species of Concern; State Status: None; CNPS Status: List 1B. Saline clover is a very small, fleshy annual plant in the Pea family. Plants are decumbent to erect, with pink-purple, white-tipped flowers appearing from April through June. Flowers become inflated as fruits mature.

This species is associated with saline-alkaline soils within grasslands, seasonal wetlands, and, at Moss Landing in Monterey County, along the margins of upper salt marsh habitat. Throughout most of its known range, saline clover is associated with typical seasonal wetland plants such as meadow barley (*Hordeum brachyantherum*), semaphore grass, and downingia, or with alkali associations of brass buttons, saltgrass, and Italian rye. Populations near Moss Landing occur at the brackish marsh-grassland ecotone.

Potential for Occurrence in the Study Area. Historical records of saline clover from seasonal wetlands in the Belmont and Alameda areas document extirpated populations; and no extant populations are known from the South Bay area. While potential habitat is present in the Study Area, there are no known occurrences of the species in the vicinity. With no known seed source, it is highly unlikely that this species would naturally colonize the Study Area, despite the presence of suitable habitat.

3.4.2 Occurrence of Non-native Plant Species within the Shoreline Study Area

Research has shown that a number of variables control the distribution of plant species in coastal marshes, including depth and duration of flooding over the marsh surface (Mendelssohn and McKee 1988; Pennings and Callaway 1992; Webb and Mendelssohn 1996; Webb et al. 1995), accumulation of phytotoxins such as hydrogen sulfide in marsh soils (DeLaune et al. 1983; King et al. 1982; Koch and Mendelssohn 1989; Webb and Mendelssohn 1996; Webb et al. 1995), interstitial nutrient concentrations (Bradley and Morris 1990; Koch and Mendelssohn 1989; Koch et al. 1990; Morris 1980), and soil mineral and organic matter content (DeLaune et al. 1979; Nyman et al. 1990). Natural variability in abiotic factors such as precipitation, tidal fluctuation, and evapotranspiration, as well as anthropogenic changes to those factors such as freshwater discharges, non-point source pollution (nutrients and

sediments), and regional/global climate changes (drought, temperature, sea level) influence these variables (Boyer and Zedler 1999, Kennish 2001). Among these variables, hydroperiod and salinity are the primary abiotic factors that control the distribution of the dominant plant species in a tidal marsh (H. T. Harvey & Associates et al. 1982; Josselyn and San Francisco State Univ. 1983; Zedler et al. 1992; Zedler et al. 1999).

Competition between different plant species (interspecific) with similar environmental tolerances also influences their distribution. Although environmental tolerance and competitive ability are inversely related (Bertness 1991; Grace and Wetzel 1981; Zedler 1982), competition still plays a role among species with similar environmental tolerances (Ervin and Wetzel 2002). For example, Zedler (1982) found that competitive interactions occur in salt marshes, and concluded that pickleweed does compete with cordgrass for light and, to some extent, nutrients. Furthermore, competitive interaction is what allows for the successful invasion of non-indigeneous species into wetland habitat and the subsequent alteration of plant distribution that is commonly observed (Vitousek 1990, Hooper and Vitousek 1997).

Many invasive plant species are known to occur or may potentially occur within the Shoreline Study Area. These species out-compete native plants, displacing entire communities of plants and associated wildlife. Control of these species is important throughout the Shoreline Study Area. While the scope of this analysis does not include a species-by-species prescription for removal, the California Invasive Plant Council (Cal-IPC) publishes the Weed Worker's Handbook (1994) describes the biology and tested methods of removal for 35 of the most noxious weeds in the Bay Area. The following species occur or may occur within the Shoreline Study Area: 1) Salt wheatgrass (*Agropyron elongatum*) has been planted along many levees to stabilize levee banks throughout the San Francisco Bay, and has spread in areas near Union City and along the levee slopes within the Palo Alto floodbasin; 2) Perennial pepperweed (*Lepidium latifoium*) has invaded many wetland areas within the San Francisco Bay, including areas within the Shoreline Study Area, but also occurs in upland areas with ruderal grassland habitat dominated by Italian ryegrass, varius non-native bromes, Mediterranean barley, and wild oats; 3) black mustard (*Brassica nigra*) and wild radish (*Raphanus sativus*) dominate the banks of the levees within much of the Shoreline Study Area; 4) non-native smooth cordgrass (*Spartina alternifolia*) and hybrids between smooth and Pacific cordgrass have spread throughout tidal salt marshes in much of the San Francisco Bay area, and the Invasive Spartina Project is actively engaged in controlling this non-native; 5) pampas grass (*Cortaderia* sp.) occurs in ruderal areas including adjacent to developed areas; 6) French broom (*Genista monspessulana*) and Scotch broom (*Cytisus scoparius*) occur in upland, disturbed areas; 7) giant reed (*Arundo donax*) invades freshwater marsh and creeks; 8) sweet fennel (Foeniculum vulgare) spreads quickly within ruderal areas; 9) common reed (*Phragmites australis*) which may have strains that are not native to California and which has invaded portions of the Palo Alto Flood Basin; and, 9) yellow star-thistle (*Centaurea solstitialis*), purple star-thistle (*Centaurea calcitrapa*), and Italian thistle (*Carduus pycnocephalus*) quickly invade and dominate grassland areas. With the restoration of the SBSP areas and this Shoreline Study, documentation of infestation by non-native plant species should allow for better planning of the removal/containment of these species.

4. WILDLIFE RESOURCES

4.1 Introduction

The San Francisco Estuary is an extremely productive, diverse ecosystem. Despite the loss of more than 90% of its original wetlands to diking, draining, and filling (Goals Project 1999; Harvey et al. 1988), wildlife diversity is high, with more than 250 species of birds, 120 species of fish, 81 mammals, 30 reptiles, and 14 amphibians regularly occurring in the estuary (Siegel and Bachand 2002). More importantly, the San Francisco Bay supports populations of a number of species that are of regional, hemispheric, or even global importance. A number of endemic, endangered, threatened, and rare wildlife species or subspecies reside in the San Francisco Bay area.

Though surrounded by urban development and highly altered by the diking of wetlands for salt production, the South Bay supports some of the most important remaining habitat in the entire estuary for a number of special-status wildlife species. In this section, the existing conditions of wildlife resources in the South Bay are described, specifically pointing to the species composition and structure of invertebrate, fish, reptile, amphibian, mammal, and bird communities. The life histories and habitat requirements of these species are also described, as well as the spatial and temporal variation in their presence/distribution in the region. In addition, the occurrence of special-status wildlife species within the South Bay is summarized.

Slight variations in microhabitat conditions, plant structure, or species composition occur within the various habitat types of the South Bay (see Section 3.3). Such variations may result in important changes in ecological conditions that affect wildlife populations and communities. However, as they pertain to wildlife use of the Study Area, the previously described habitat types can generally be divided into several broad categories: open waters of the Bay, tidal sloughs and channels, intertidal mudflats, vegetated tidal marsh, salt ponds, vernal pool grasslands, riparian habitats, and upland habitats. Note that existing South Bay salt ponds (and former salt ponds) provide habitat that is used by large numbers of a number of wildlife species, particulary birds. Thus, in the descriptions of wildlife habitat use within Shoreline Study Area, salt ponds are included and the interchange that occurs between these and other habitats in the region is discussed. The freshwater stream, riparian, and vernal pool resources within the Study Area are also discussed.

4.1.1 Overview of Wildlife Resources in the South Bay

The ecology of South Bay wildlife communities is characterized by:

- High productivity of tidal marshes, with export of organic matter from tidal marshes to tidal sloughs, channels, and mudflats, and to the Bay, supporting high abundance of invertebrates, fish, and birds.
- High productivity of salt ponds and former salt ponds, supporting an abundance of invertebrates (particularly in higher-salinity ponds) and high numbers of fish in lower-salinity ponds, but with

virtually no export of organic matter to other habitats aside from variable (and at times, very heavy) use of the salt ponds by birds.

- A heavily invaded aquatic invertebrate community dominated by non-native species, particularly in the estuarine and salt pond habitats.
- Heavy use of South Bay habitats by waterbirds, including significant proportions of Pacific Coast migratory shorebird populations.
- Highly dynamic bird and fish communities, with use of different areas varying several times a day with tide height, and with abundance and community composition varying seasonally depending on migration, precipitation, temperature, salinity, and other factors. In particular, large numbers of shorebirds forage on intertidal mudflats at low tide and use salt ponds and other alternative habitats (e.g., water treatment plant ponds) for roosting and/or foraging, particularly at high tide, and steelhead use bay habitats during their migrations as adults to spawn in tributaries and as juveniles moving from tributaries to the sea.
- The presence of rare San Francisco Bay endemics, including the California clapper rail and salt marsh harvest mouse, in remnant tidal marsh habitat.
- The presence of rare vernal pool-associated species, including the vernal pool tadpole shrimp and California tiger salamander, in vernal pools within the Warm Springs unit of the SFBNWR.
- The presence of several freshwater streams flowing into the South Bay; woody riparian habitat is limited to narrow corridors, or is highly degraded or even absent, along these streams, although moderately high-quality riparian habitat is present along lower Coyote Creek, and riparian habitats in the Study Area support very high densities of birds.

In summary, the diversity and high productivity of habitat types present within the South Bay support a diverse assortment of wildlife species in surprisingly large numbers. A detailed discussion of the biology of wildlife species present within the Study Area is provided below.

4.2 Methods

Resource agencies such as the USFWS, CDFG, and the U.S. Geological Survey; non-profit organizations and research groups such as PRBO and SFBBO; consultants working for private landowners, municipalities, and public resource agencies; researchers; and private individuals (e.g., birders) together have collected a vast amount of data on wildlife use of the South Bay. Much of the data on the wildlife species and communities of the South Bay were summarized for the Goals Project (2000). In preparing this existing conditions document, the team relied primarily on previously collected information rather than fieldwork conducted specifically for the preparation of this document. However, the wildlife ecologists have a solid understanding of the wildlife and habitats of the South Bay during all seasons. Reconnaissance-level wildlife surveys by foot and car were performed during summer and fall 2004 for the existing conditions report for the South Bay Salt Ponds Project. H.T. Harvey & Associates ecologists have made numerous visits to the Study Area since that time, and additional surveys were conducted in March 2007 specifically to assess wildlife habitat in portions of the Shoreline Study Area outside the SBSP Project Area.

4.3 Description of Wildlife Communities in the South Bay

4.3.1 Invertebrates

Invertebrate communities of the South Bay are important consumers, controlling phytoplankton biomass in the Bay, and are key prey for fish and birds. They are also important in nutrient and contaminant recycling and the accumulation of contaminants (Thompson and Shouse 2004). Invertebrate communities vary considerably among different habitats in the South Bay. This section includes a separate description of invertebrates in subtidal/intertidal habitats, tidal marshes, salt ponds, terrestrial habitats, and freshwater habitats, as well as a discussion of invasive invertebrates and mosquitoes.

Subtidal/Intertidal Invertebrate Communities. Intertidal mudflats contain three main groups of invertebrates: benthic infauna (less mobile invertebrates living in or on the mudflats), epifauna (more mobile species on the mud's surface), and pelagic fauna (highly mobile species living in the water column). Most research has focused on benthic infauna. Because of the instability caused by nearly constant erosion and deposition of sediments, as well as dramatic fluctuations in salinity, benthic infauna are dominated by species that can easily colonize mudflats, many of which are non-native species (Nichols 1979). Within the San Francisco Estuary, the South Bay contains by far the highest invertebrate biomass, likely due to greater stability of salinity and sediments, large detritus biomass, and the abundance of several introduced bivalve species (Nichols 1979; Nichols and Pamatmat 1988). The estimated biomass of invertebrates in the South Bay in winter (637 g/0.1m^2) and summer (609 g/0.1m^2) is nearly six times that for the Central Bay, San Pablo Bay, and Suisun Bay combined (115 g/0.1m^2 and 112 g/0.1m^2 in winter and summer, respectively) (Meiorin et al. 1991; Nichols and Pamatmat 1988). Studying infaunal productivity on mudflats in the South Bay, Nichols (1979) determined rates of annual productivity varying from 53 to 100 grams/meter^2/year. Although biomass was dominated by two or three common bivalves, the standing crop of invertebrates was abundant throughout the year. Migratory shorebirds were thought to be the primary consumers of invertebrate biomass on South Bay mudflats.

Much of the food for benthic invertebrates on mudflats of the South Bay comes from phytoplankton that settle to the bottom of the water column (Meiorin et al. 1991) and diatoms and blue-green algae growing on the surface of the sediment (Nichols and Pamatmat 1988). Both phytoplankton and microalgae blooms occur in the South Bay primarily in spring, in turn supporting large numbers of filter-feeders (Nichols and Pamatmat 1988). The South Bay tidal invertebrate community is dominated primarily by filter/suspension feeders such as shrimp, clams, and mussels that obtain food from phytoplankton and organic debris and bacteria, and deposit feeders, which include worms and some clams that obtain food primarily from organic debris on the surface of the mud.

Several studies of the infaunal invertebrate communities of South Bay mudflats have been conducted. Nichols and Pamatmat (1988) and Nichols and Thompson (Nichols and Thompson 1985a; Nichols and Thompson 1985b) determined that the numerically dominant species on mudflats in the vicinity of the Alviso salt ponds are the gem clam (*Gemma gemma*), the amphipod *Ampelisca abdita*, and the polychaete

worm *Streblospio benedicti*. Although less abundant, the Baltic clam (*Macoma balthica/petulam*), soft-shelled clam (*Mya arenaria*), and eastern mud snail (*Illyanassa obsoleta*) "often represent the bulk of benthic invertebrate biomass" (Nichols and Thompson 1985a). All of these dominant species except for the Baltic clam are introduced.

The benthic infaunal community has been studied in the South Bay at three stations on intertidal mudflats near the Palo Alto Water Quality Control Plant since 1974 (Thompson and Shouse 2004). The number of invertebrate species at each of three stations ranged from ten to 16 and included five bivalves, one cnidarian, seven crustaceans, two gastropods, and 14 polychaetes and oligochaetes. *Gemma*, *Streblospio* and *Ampelisca* dominated the community until the 1980s, but since 1998 *Gemma* has been the overwhelming dominant on the Palo Alto flats. Since trace element concentrations at the plant were reduced in the mid-1980s, this research has noted a substantial decline in metals accumulation in the Baltic clam and an increase in the species' reproductive activity (Hornberger et al. 2000).

Sampling nearby areas along lower San Francisquito Creek and the Palo Alto Water Quality Control Plant outfall channel, Cressey (1997) had somewhat different results. He found simple invertebrate communities in these areas, with the most abundant taxa consisting of four annelids (*Neanthes succinea*, *Eteoni lighti*, *Tubificidae* sp., and *Heteromastus filiformis*), three arthropods (*Nippoleucon hinumensis*, *Corophium alienense*, and *Grandidierella japonica*), and two mollusks (the Baltic clam and the Asian clam *Potamocurbula amurensis*); all except the Asian clam were found at all stations in both channels, in a variety of salinities from one to 27 ppt. The 1994-1996 Benthic Pilot Study of San Francisco Estuary Regional Monitoring Program (1997) found that in muddy estuarine sediments of the South Bay, the most abundant species were *Potamocurbula amurensis*, *Ampelisca abdita*, *Nippoleucon hinumensis*, *Corophium heteroceratum*, *C. alienense*, *Grandidierella japonica*, *Balanus improvisus*, *Tubificidae* sp., *Neanthes succinea*, and *Streblospio benedicti*.

More recently, the USGS sampled invertebrates in eight South Bay sloughs in 2004 (Takekawa et al. 2005). *Heteromastus*, *Streblospio*, and Tubeficoides were the dominant taxa in these sloughs. The clam *Gemma gemma* was numerous in Mt. Eden Creek and Alameda Creek. *Macoma balthica* was present in all sloughs sampled. Low insect diversity was observed; insects were recorded in only three sloughs, with four species in Mt. Eden Creek representing the highest diversity in any of the sloughs sampled.

Bivalve mollusks, which represent the majority of the invertebrate biomass of the San Francisco Estuary (Nichols 1979), are primarily filter feeders, taking in large quantities of phytoplankton. A variety of clams and mussels, many of which are introduced, occur in the South Bay. Of the native species, the Baltic clam is the only one that is still common in the South Bay. The Baltic clam is the largest-bodied infaunal invertebrate in the South Bay and thus contributes significantly to the biomass of the region. It is eaten by birds (Painter 1966) and bat rays (*Myliobatus californica*) (Thompson and Shouse 2004) and likely by a number of other fish species as well. In the mid-1800s, the eastern oyster (*Crassostrea virginica*) and Pacific oyster (*C. gigas*) were introduced into San Francisco Bay, replacing much of the fishery for the native oyster (*Ostrea lurida*). Until around 1910, extensive oyster beds were located in the South Bay south of Dumbarton Bridge, and off Eden Landing and Redwood City. However, the introduced oysters declined in the early 1900s due in part to reduced Bay water quality; the loss of

marshes may have also influenced the decline in oyster populations, as much of the oysters' food is detritus that is derived from tidal marshes (Harvey et al. 1977) . A native oyster bed was present in Salt Pond A-9 in Alviso until the 1970s (Laine, pers. comm.).

Thompson (1999), studying the spatial and temporal distribution of bivalves in the South Bay (primarily between the San Mateo and Dumbarton Bridges but with some stations scattered throughout the far South Bay, from 1991 to 1995), found that bivalves mostly disappeared from shallower areas in winter and spring; they declined in, but did not disappear from, deeper areas in winter. Recruitment varied among years, but was more likely to be limited in higher-elevation mudflats in some years than in deeper mudflats closer to channels, possibly due to predation by shorebirds and bat rays. Thompson and Shouse (2004) hypothesized that recruitment of bivalves onto South Bay mudflats where they are available to birds is dependent on the abundance of adult bivalves in deeper water and circulation patterns that transport larvae from either deeper water or from North Bay areas.

Tidal invertebrates in South Bay estuarine habitats must either be able to tolerate daily and seasonal changes in salinity (e.g., benthic invertebrates) or be mobile enough to follow preferred salinities. During particularly wet years, species intolerant of fresher water (e.g., *Mya arenaria*, *Corophium acherusicum*, *Ampelisca abdita*, and *Streblospio benedicti*) virtually disappear from portions of the upper San Pablo Bay and shallow areas of the Bay. During a two-year drought, these same species colonized Suisun Bay, which is usually too fresh for these species (Nichols and Thompson 1985a). Similarly, Hopkins (1987) noted that several intertidal invertebrate species disappeared during an unusually wet winter but had re-established the following year under normal conditions; two of his four intertidal study sites were near Palo Alto and Hayward. In contrast, limited observational data following unplanned breaches of Napa ponds 2a and 3, with releases of water having salinity of 50 and >60 ppt into South Slough, revealed no extensive losses of benthic invertebrates, suggesting that this elevated salinity did not have a significant impact on benthics.

The epifaunal invertebrate community in the South Bay is dominated by several species of shrimps and crabs. Two native caridean shrimps, the California bay shrimp (*Crangon franciscorum*) and blacktail bay shrimp (*C. nigricauda*), are common in tidal sloughs and in the Bay itself. The California bay shrimp supports the only commercial fishery remaining in the South Bay aside from the limited harvest of brine shrimp that occurs in salt ponds (as discussed below). Each year, two to four boats are involved in shrimping in the South Bay, catching approximately 75,000 lb valued between $154K and $312K per year (Hansen 2003), although shrimping activity and success have declined in recent decades (Laine, pers. comm.). Most shrimping activity occurs between the Dumbarton Bridge and Calaveras Point, with limited activity above Calaveras Point in Coyote Creek (Hansen 2003).

According to Hatfield (1985), adult California bay shrimp spawn in the ocean in March and April. The planktonic larvae are carried into the San Francisco Bay by tides, and by currents into the Suisun and South Bays. Juvenile bay shrimp arrive in the South Bay in May, and use shallow waters having lower salinities as nurseries. These juveniles migrate up sloughs to brackish water, seeking out waters with salinities of three to 19 ppt, preferring a range of ten to 15 ppt (Baxter et al. 1999). Thus, they use the Guadalupe, Alviso, and Coyote Slough systems, and likely other South Bay tributaries as well, for

feeding and growth through the summer. As they mature, the shrimp migrate to deeper, more saline Bay waters until they migrate out of the Bay to spawn in the ocean in winter (Baxter et al. 1999; Kinnetic Laboratories 1987). California bay shrimp are present in the South Bay year-round, but they are most abundant September-October and least abundant March-April (Hansen 2003). Bay shrimp are sensitive to changes in salinity and water quality, and may abandon sloughs in the far South Bay for deeper, more saline waters during periods of high freshwater runoff. Effluent from wastewater treatment plants may have altered the distribution of bay shrimp as well, as this species has declined in abundance in the far South Bay in recent decades (Laine, pers. comm.).

Crabs of South Bay tidal habitats include the yellow shore crab (*Hemigrapsus oregonensis*), lined shore crab (*Pachygrapsus crassipes*), Dungeness crab (*Cancer magister*), brown rock crab (*Cancer antennarius*), red rock crab (*Cancer productus*), and several introduced species, including the xanthid crab (*Rothropanopeus harrisii*), Chinese mitten crab (*Eriocheir sinensis*), and European green crab (*Carcinus maenas*) (Josselyn and San Francisco State Univ. 1983). Most of these species forage both in tidal sloughs and on mudflats and deeper waters of the South Bay. Although Dungeness crabs, and particularly larger individuals, occur much more commonly in the north and central Bay, this species was historically more common in the South Bay (i.e., into the 1970s) (Laine, pers. comm.). The *Cancer* crabs do not support a fishery within the South Bay, but use of South Bay marshes by juveniles of these species, and detrital export to the Central Bay from South Bay marshes, may help to support the economically important ocean fishery for these crabs. Crabs tagged as juveniles in the Bay have been caught by commercial fishermen in the ocean (Harvey et al. 1977). Furthermore, Dungeness crabs in the Bay mature nearly twice as fast as populations outside the Bay, presumably because of higher Bay water temperatures but possibly also due to the high productivity of the estuary (Life Science 2004). Early larval stages of the Dungeness crab are currently limited primarily to the Central Bay, but later planktonic larvae and juveniles may be found throughout the Bay (Life Science 2004).

The California Department of Fish and Game has conducted a fishery survey for shrimp and crabs within the San Francisco Bay since 1980, with monthly surveys in deeper subtidal areas and some beach seine sampling (CDFG data Life Science 2004). These surveys include data from three open-water stations (Stations 102, 101, and 140) located near the San Mateo and Dumbarton Bridges, and two beach seine stations (171 and 172) also located in the South Bay. Between 1980 and 2001, Dungeness crabs accounted for 52.6, 43.8, and 73.3% of crabs caught at Stations 101, 102, and 140. Chinese mitten crabs were 42.1, 12.5, and 18.8% of the total crab captures at these stations. Graceful rock crabs (*Cancer gracilis*) and brown rock crabs were, collectively, 18.8% of the total catch at Station 102 but <3% of the crab catch at the other two stations. California bay shrimp accounted for 79.5, 58.8, and 78.7% of shrimp captures at Stations 101, 102, and 140, while blacktail bay shrimp were 12.8, 34.2, and 14.0% of captures. Other shrimp species, including blackspotted bay shrimp (*Crangon nigromaculata*), oriental shrimp (*Palaemon macrodactylus*), stout coastal shrimp (*Heptacarpus brevirostris*), miniature spinyhead (*Mesocrangon munitella*), ridgetail prawn (*Exopalaemon carinicauda*), and visored shrimp (*Betasus longidactylus*), were all represented but were much less abundant in the South Bay.

Tidal Marsh Invertebrate Communities. The invertebrates of the vegetated portions of tidal salt and brackish marshes, which include benthic infauna, epifauna, and terrestrial species, have not received as

much study as those of intertidal habitats, in part because much of the invertebrate biomass within tidal marshes occurs within the intertidal and subtidal zones of sloughs and smaller marsh channels. However, tidal salt marsh invertebrates perform a variety of important ecological services, as discussed by Maffei (2000b).

Within tidal salt marshes in the South Bay, common invertebrates include the ribbed mussel (*Ischadium demissum*), the Baltic clam, the mud snail (*Illyanassa obsoleta*), and the yellow shore crab (*Hemigrapsus oregonensis*) (Niesen and Lyke 1981). The introduced ribbed mussel is common within the lower zone of tidal marshes (among Pacific cordgrass), and the Baltic clam may occur up into the cordgrass zone as well (Josselyn and San Francisco State Univ. 1983; Vassallo 1969). The native hornsnail *Cerithidea californica* formerly occurred in pickleweed marshes and on mudflats throughout much of the Bay, but it has been displaced from much of its former habitat and range by the introduced mud snail, and it is now restricted to high salt pannes in the South Bay (Race 1981). The mud snail is abundant in intertidal habitats and sloughs. The marsh snails *Assiminea californica* and *Ovatella myosotis* inhabit dense pickleweed marshes (Fowler 1977). Several amphipod species, including *Anisogammarus confervicolus*, *Orchestria traskiana*, *Hyale plumulosa*, and *Grandidierella japonica*, occur within the ground litter in pickleweed-dominated marshes (Josselyn and San Francisco State Univ. 1983). The amphipod *Traskorchestia traskiana* is abundant in at least some pickleweed marshes of the San Francisco Bay (Obrebski et al. 2000). This detritivore tolerates salinities up to 50 ppt (Koch 1989), and is one of the only invertebrates known to consume pickleweed (Page 1997).

Terrestrial invertebrate assemblages of salt marshes are dominated by a variety of insects and spiders. Diptera (true flies) are a major component of South Bay cordgrass/pickleweed marshes, while the orders Homoptera (plant hoppers and aphids) and Lepidoptera (butterflies and moths) are also well represented (Lane 1969). Reticulate water boatmen, brine flies, chironomid midges, and other species dominate open-water areas such as marsh ponds within the tidal marsh (Barnby et al. 1985; Maffei 2000b).

Detritus from macrophytic vegetation in the tidal marsh is an important component of the food web of the tidal marsh itself, as Teal (1962) demonstrated in Atlantic tidal salt marshes. Cameron (1972) determined that half of the detritus produced in San Pablo Bay marshes was exported out of the marsh, where it serves as an extremely important source of nutrients and carbon for the aquatic components of the Bay ecosystem (Harvey et al. 1977; Warwick and Price 1975).

Salt Pond Invertebrate Communities. Invertebrate communities in South Bay salt ponds have been extensively studied (Carpelan 1957; Anderson 1970; Swarth et al. 1982; Lonzarich and Smith 1997). Carpelan (1957), studied the floral and faunal communities in six Alviso salt ponds ranging in salinity from a mean of 27.5 ppt in the intake ponds to 94 ppt in the highest-salinity pond. Only one vascular plant species, wigeon grass, was present in this study; it only occurred one of the lower-salinity ponds for a brief period in mid-summer. Thus, the flora of the salt ponds is dominated by the macroscopic green algae *Rhizoclonium* and *Enteromorpha* in the lower-salinity ponds and by unicellular algae, particularly *Stichococcus bacilaris*, in higher-salinity ponds.

In salt ponds, invertebrate species richness decreases, and biomass increases (to a point) as salinity increases, primarily because of the increase in brine shrimp (Anderson 1970; Britton and Johnson 1987; Carpelan 1957; Lonzarich 1989; Swarth et al. 1982; Williams et al. 1990). In lower-salinity ponds, numerous nematodes occur in decaying organic matter and mud. The most prevalent worm in lower-salinity ponds is the polychaete *Polydora ligni*. This polychaete serves as prey for fish and the nemertinean *Tubulanus sexlineatus*, which is common in decomposing algae in the lowest-salinity ponds. Carpelan (1957) found few mollusks within the salt ponds. The introduced mud snail, which was abundant on the adjacent tidal mudflats, was found in scattered areas, although in its limited areas of distribution it was the dominant benthic species. Anderson (1970) reported that mud snails did not survive long in the Newark-area ponds he studied, and that although the ribbed mussel and native oyster were present in the adjacent slough, they did not become established in the intake ponds. A number of other non-arthropod species of varying abundance, including roundworms, rotifers, protozoans, and coelenterates, occur throughout the salt ponds (Anderson 1970; Carpelan 1957).

A survey of benthic invertebrates in Alviso salt ponds by Lonzarich (1989) found three mollusks (*Gemma gemma*, *Ilyanassa obsoleta*, and *Tryonia imitator*), two annelids (*Nereis succinea* and *Tubificoides* sp.), and six crustaceans (*Anisogammarus confervicolus*, *Crangon* sp., *Hemigrapsus oregonensis*, *Ostracoda* sp., *Palaemon macrodactylus*, and *Sphaeroma quoyana*) in ponds that seasonally reached salinities of 40 ppt, but not in higher-salinity ponds. Only the annelid *Polydora ligni* and the crustaceans *Artemia franciscana*, *Balanus* sp., *Copepoda* sp., and *Corophium* sp. tolerated salinities in the ponds that averaged 22-84 ppt.

Studying North Bay salt ponds, Takekawa et al. (2004) recorded 20 zooplankton taxa, with more taxa in lower-salinity ponds and highest abundance at mid-salinities. Copepods and brine shrimp accounted for 66.1 and 28.2% of all zooplankton sampled; copepods dominated low and mid-salinity ponds (23-48 ppt), while brine shrimp dominated higher-salinity ponds (170 ppt). Brine flies were also common in higher-salinity ponds. Total zooplankton abundance was highest in spring and early summer, with biomass several orders of magnitude higher in a pond having a salinity of 170 ppt than in lower-salinity ponds due to the abundance of brine shrimp. The diversity of macroinvertebrates was also higher in lower-salinity ponds (23 ppt), which contained 50-55 taxa (only three to four at high densities, including the polychaete *Heteromastus*, the bivalve *Gemma*, and the amphipods *Corophium* and *Ericthonius*). Mid-salinity ponds (48 ppt) contained 25 taxa dominated by the polychaetes *Polydora*, *Capitella*, and *Streblospio*, by *Corophium*, and by water boatmen, while a high-salinity pond (170 ppt) contained 12 taxa dominated by brine shrimp and brine flies.

Sampling of South Bay salt ponds between 2003 and 2005, Takekawa et al. (2005) recorded 58 taxonomic groups of macroinvertebrates. Crustaceans were the best represented group, with 17 taxa, followed by 12 annelid taxa; these taxa were predominantly in lower-salinity ponds (i.e., below 60 ppt). Five species of bivalves and nine insect families were also recorded, with overall taxa richness occurring in the ponds with the lowest salinity (27-44 ppt).

Arthropods are the dominant, and ecologically most important, group of invertebrates inhabiting salt ponds in the South Bay. The brine shrimp (*Artemia franciscana*) is the predominant animal in higher-

salinity ponds. Although it can occur in salinities near that of seawater (Persoone and Sorgeloos 1980), the brine shrimp's aquatic predators (e.g., insects such as water boatmen) are more abundant in less saline water (Wurtsbaugh 1992), allowing brine shrimp to reach high densities only in their optimal hypersaline environments (70 to 170 ppt) (Carpelan 1957). Herbst (2001) found water boatmen to be most abundant in lower-salinity ponds while brine shrimp were most abundant in moderate to high salinity salt ponds in the Mojave Desert. Brine shrimp are absent from crystallizer ponds with salinities exceeding 200 ppt (Larsson 2000). Historically, brine shrimp occurred in the San Francisco Bay area in salt pannes and ponds with hypersaline conditions. They still occur in these natural features within tidal salt marshes in the South Bay, in addition to salt ponds.

Carpelan (1957) estimated that brine shrimp in the Alviso salt ponds produced up to eight generations/year, with winter eggs having delayed hatching. Larsson (2000) reported that females produce an average of ten broods during their 50-75 day lifespan in the lab, although under natural conditions three to four broods may be more likely. Productivity of brine shrimp in the highest-salinity pond in Carpelan's study area was estimated at 56 lb/acre/year. Brine shrimp are so abundant in some ponds that they have supported a small commercial industry, primarily as food for aquarium fish. According to Thomas Laine (pers. comm.), these shrimping operations can regularly obtain 10,000-13,000 lb of shrimp per day, with two people once collecting 27,000 lb in a day in South Bay ponds, and a 42-day operation netting 500,000 lb of brine shrimp in South Bay salt ponds. Brine shrimp are still harvested in Newark salt ponds, where they fetch $0.55/lb (Laine, pers. comm.).

Two insect groups are also important components of the South Bay invertebrate fauna due to numerical abundance and importance to foraging birds. Adult reticulate water boatmen inhabit salt ponds year-round. Carpelan (1957) found that egg-laying occurs in spring, summer, and fall, with the main hatch in spring; many nymphs are observed in April and May. Water boatmen have been reported to occur in water ranging from brackish to 170 ppt (Carpelan 1957; Cox 1969; Jang 1977), and Carpelan (1957) found them in Alviso salt ponds with salinities from 23 to 153 ppt. However, they occur and reproduce in greatest abundance in ponds with salinities between 35 and 80 ppt (Maffei 2000c). A number of species of brine flies occur within the San Francisco Bay area; the most common species within the Shoreline Study Area are *Ephydra millbrae*, *E. cinerea*, and *Lipochaeta slossonae*, which occur in variable numbers in natural salt pannes and marsh ponds, and in artificial salt ponds and crystallizers (Carpelan 1957; Maffei 2000b). *E. millbrae* has been reported to occur in pools with salinity concentrations up to 42 ppt (Jones 1906), while *E. cinerea* and *Lipochaeta slossonae* occur in saline and hypersaline environments, with *Lipochaeta* found commonly in crystallizers (Maffei 2000a). Even as adults, water boatmen are primarily aquatic, although they can fly. In the South Bay, adult brine flies become common by early March and can be seen in dense swarms on the edges of high-salinity ponds from April through September (Swarth et al. 1982).

The biomass of brine shrimp in South Bay salt ponds may be four times that of water boatmen (Swarth et al. 1982), and brine shrimp have been found to be a numerically important component of the diet of the western sandpiper, Wilson's and red-necked phalaropes, and other waterbirds (Anderson 1970; Colwell and J.R. Jehl 1994; Hamilton 1975; Harvey et al. 1992; 1988; Jehl 1988). Despite the high biomass of brine shrimp in salt ponds, the nutritive value of brine shrimp to foraging shorebirds may be limited, as

Rubega and Inouye (1994) found that red-necked phalaropes could not survive foraging on brine shrimp alone. As a result, brine flies (both adults and larvae) and reticulate water boatmen are also very important to shorebirds that forage in mid- to high-salinity South Bay salt ponds. Amphipods, most notably *Corophium* spp., are numerous in South Bay salt ponds as well (Carpelan 1957), serving as additional prey items important to shorebirds and fish.

Freshwater Macroinvertebrate Communities. Stream macroinvertebrate communities are structured largely by physical factors, such as temperature, light, current velocity, and substrate composition, and chemical factors, such as oxygen levels, pH, nutrients, and chemical pollutants. These communities are comprised of a diverse array of species that can generally be grouped into functional assemblages based on their feeding mechanisms and the roles that they play in stream ecology. Within a given taxonomic group, different species often assume different ecological functions and feeding preferences.

Collectors and filterers include certain decapods (freshwater crayfish), or larvae of some tricopterans (caddisflies), plecopterans (stoneflies), ephemeropterans (mayflies), and others. Many of these species filter fine particulate organic matter directly from the water column; and members of this functional group typically dominate invertebrate communities in larger-order, lower-gradient streams because of the high concentrations of particulate detritus suspended within the water column within these river mouth habitats. Representative South Bay groups include larval common midges (*Chironomus* sp., Diptera:Chironomidae) which are abundant filterers of living phytoplankton from the water column, and leptocerid caddisflies (Trichoptera:Leptoceridae), which are indiscriminant detritus feeders that are common in ponds and slow-moving river mouths.

Grazers can include large invertebrates such as gastropods (freshwater snails), or larval insects such as other species of caddisflies and nematoceran true flies. These groups are more prevalent in open areas with ample light and substantial algal growth, such as mid-order riverine systems and open ponds. Common Bay Area groups include the northern snailshell caddisfly (*Helicopsyche borealis*, Trichoptera:Helicopsychidae), which actually constructs a larval case that looks like a snail's shell. Larval psycodid gnats such as the lance-winged moth fly (*Maruina lanceolata*, Diptera: Psychodidae) are frequently found in foothill streams around the South Bay, where they graze on algal or diatomaceaous films (Powell and Hogue 1979). In contrast, shaded, steeper, lower-order streams in higher elevation areas support more vegetation shredders, because most of the plant material in these areas of streams is large and relatively undecayed. Shredders include larval or naiad members of many caddisflies, mayflies, and diperans (true flies).

Predatory invertebrates, such as larva of species in the Order Odonata (dragonflies and damselflies), larval culicid flies (mosquitos), some larval stoneflies, and adults of certain hemipterans (true bugs) and coleopterans (beetles), occur throughout all stream types. Some predaceous insects are so large and powerful that their prey can include tadpoles or even small fish. Giant water striders (*Gerris reigis*, Hemiptera:Gerridae) are common on many types of surface aquatic habitats across the area from smaller high elevation streams to stock tanks, while toad bugs (*Gelastocoris oculatus*, Hemiptera:Gelastocoridae) hunt for prey along the shores of water bodies. Other impressively large and common aquatic hemipterans include the large water boatman (*Hesperocorixa laevigata*, Hemiptera:Corixidae) and

common water scorpion (*Ranatra brevicollis*, Hemiptera:Nepidae). Aquatic predaceous beetles such as dytiscids and gyrinids are predaceous both as larval and adult forms, and common species or genera in the area include giant green water beetles (*Dytiscus marginicollis*, Coleoptera:Dytiscidae), river beetles (*Agabus* sp., Coleoptera:Dytiscidae), and common whirligig beetles (*Gyrinus* sp., Coleoptera:Gyrinidae).

In the South Bay, studies of freshwater invertebrates have focused primarily on invertebrate assemblages in the middle and upper reaches of streams entering the Bay. In comparison, there are relatively few data on the downstream reaches of these streams, the reaches that are present within the Shoreline Study Area. A 1997 study of stream macroinvertebrates in the Santa Clara Valley identified 261 taxa at 44 sites along seven streams (Carter and Fend 2000). Taxon richness decreased from upstream to downstream sampling locations. Generally, higher-elevation sites supported higher taxon richness and a higher percentage composition of the Orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), while lower-elevation sites supported a higher percentage composition of taxa contained within the Chironomidae (midges) and Oligochaeta (worms). These results parallel perceived gradients in stream water quality, with mayflies, stoneflies, and caddisflies generally having low tolerance of stream pollutants and midges and oligochaete worms being much more tolerant of low water quality.

In the vernal pool habitats of the Warm Springs Unit of the SFBNWR, studies of invertebrates have focused primarily on the federally endangered vernal pool tadpole shrimp; this species is discussed in detail below under Section 4.3.1).

Upland Invertebrate Communities. As in much of the American West, there has been limited published data providing comprehensive species lists for the upland invertebrate communities of the South Bay. In fact, much like annual plants, insect populations can be extremely ephemeral from year to year, with a given species reaching large densities in some years and appearing completely absent from the fauna in others. The following provides a very general description of the species that would be most likely found in upland habitat, since a more detailed description would go far beyond the scope of this document. When considering ecosystem function, four pricipal groups bear discussion: soil fauna, responsible for consuming decayed organic matter (detrivores) or those that predate upon soil detrivores; phytophagous invertebrates, which consume tissue from living plants, zoophagous invertebrates, which predate or parasitize other invertebrates or larger animals; and pollinators, responsible for reproduction of many flowering plants. Upland habitat contains an immensely diverse array of terrestrial invertebrates including multiple species in the Hexapoda (insects), Diplopoda (millipedes), Chilopoda (centipedes), Arachnida (arachnoids, including spiders, mites, and ticks), Gastropoda (terrestrial snails and slugs), Malacostraca (terrestrial crustaceans), and Oligochaeta (worms).

Invertebrates that reside primarily in soil or under tree bark on fallen, dead logs comprise an important component of the terrestrial habitat of the South Bay and include a diverse array of species that specialize in feeding on decaying organic material, or that predate on other detrivores in the soil profile. Soil macrofauna carry out extremely important ecosystem functions by facilitating nutrient cycling through their feeding activities and soil pedturbation. Some represenative examples of soil macrofauna include colonial insects such as ants (Hymenoptera:Formicidae) and termites (Isoptera). The South Bay hosts colonies of invasive Argentine ants (*Iridomyrmex humilis*, Hymenoptera:Formicidae), as well as red

mound ants (*Formica* sp., Hymenoptera:Formicidae). Western subterranean termites (*Reticulitermes hesperus*, Isoptera:Rhinotermitidae) may be the most common termite within the South Bay, and is responsible for structural damage to buildings. Many beetles are also present in the soil, including dung beetles such as the European dung beetle (*Aphodius fimetarius*, Coleoptera:Scarabidae), which is common wherever livestock is kept; and carrion or burying beetles such as *Nicophorus* sp. (Coleoptera: Silphidae), which are important processors of mammalian carcasses. Although not well known as a group due to their tiny size, entognathous (internal mouth-part) insects (orders Protura, Diplura, and Collembola) are extremely numerous in all non-saturated soil samples, and are concomitantly some of the most important detrivores. Springtails (Collembola) are among the best-known entognathous insects, including lawn springtails (*Bourletiella arvalis*, Collembola), which can be found almost anywhere in California, and obese springtails (*Morulina multatuberculata*, Collembola), which prefer hilly, wooded areas. There are also large, common, non-hexapodous invertebrates such as earthworms, millipedes, centipedes and pillbugs.

Phytophagous invertebrates in the Study Area include numerous insect species in the Coleoptera (e.g., weevils, leaf beetles, bark beetles), Homoptera (hoppers, cicadas, aphids, whiteflies and scale insects), Hemiptera (e.g., seed bugs and leaf bugs), Thysanoptera (thrips), larval Lepidoptera (caterpillars), Orthoptera (grasshoppers, crickets, and katydids), Phasmida (walking sticks and leaf insects), Psocoptera (woodlice and booklice), and Neuroptera (lacewings), as well as arachnid mites (Acarina) and terrestrial gastropods (snails and slugs). This terrestrial group is important as a major ecosystem pathway for converting low-protein, high-cellulose plant tissue into high-protein, easily-digestible animal tissue. While these groups can be pests when dealing with gardens, lawns, or crops, they also control and structure plant populations. This group is very speciose, as physical and chemical plant defenses against invertebrate pests are often formidable and require specific adaptations. Many phytophagous insects are resticted to particular plant families, genera, or even species, and other groups are further resticted to certain plant parts, such as the thrips, which feed only within flower blossoms.

Zoophagous invertebrates include both those groups that feed on other invertebrates, as well as those adapted to be parasities of larger animals such as birds and mammals (e.g. ticks, lice, and fleas). Invertebrates that predate upon other invertebrates are important for structuring invertebrate communities and controlling numbers of insect pests. This group includes many species within the Diptera (e.g., asilid and tabanid flies), Neuroptera (e.g. snakeflies, antlions, and dobsonflies), Hymenoptera (parasitic and predatory wasps, ants, and bees), Strepsiptera (twisted wing parasites), Mantoidea (mantises), Hemiptera (assassin bugs and toe biters) and Coleoptera (e.g., ladybugs and tiger beetles). Another categorization within the zoophagous invertebrates includes those species that are parasites of birds and mammals, such as biting lice (Mallophaga), which specialize on bird hosts; sucking lice (Anoplura), which typically specialize on mammalian hosts; Siphonaptera (fleas); dipterans such as mosquitos (Diptera:Culicidae) and biting gnats (Diptera:Ceratopoginidae); and Acarina (ticks). These species are important vectors of mammalian and avian diseases.

Those invertebrates that serve as potential pollinators in the upland habitats of the South Bay include insects in the Orders Hymenoptera, Diptera, Lepidoptera and Coleoptera. Not all flower-visiting insects are competent pollinators, as they must sequentially visit flowers of the same species, and have

compatable behavior and morphology with the floral parts so that pollen picked up and deposited on receptive stigmatic surfaces. Bees (Apiodea) are hymeopterans specifically apdapted to collecting pollen and nectar from plants, and are often, although not always, competent pollinators of the plants that they visit. European honeybees (*Apis mellifera*, Hymenoptera:Apidae) are extremely important naturalized pollinators of many South Bay plants. Native bees include bumblebees (*Bombus* sp., Hymenoptera:Apidae), the short leafcutter bee (*Megachile brevis*, Hymenoptera:Megachilidae), loosely colonial minute sweat bees (*Halictus* and *Lasioglossum* sp., Hymenoptera:Halictidae), and common burrowing bees (*Andrena* sp., Hymenoptera:Andrenidae). Wasps (Vespidae, Specidae, Tiphidae) are other hymenopterans that may pollinate plants, but also predate upon or parasitize other insects for their larva. Several flies in the Syrphidae (flower flies) and Bombyliidae (bee flies) are also pollinators, although these are often generally considered less competent at pollen movement than bees. Lepidopteran adults are also often observed visiting flowers, although their morphology is such that they also tend to carry less pollen than bees. Coleopteran pollinators include beetles in the Meloidae (blister beetles) and Cerambycidae (longhorn beetles), including the special status species the Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*, Coleoptera:Cerambycidae). Flower-visiting beetles consume a large proportion of the pollen produced by the plants they visit, and only incidently move pollen while foraging.

Invasive Invertebrates of the South Bay. According to Cohen and Carlton (2003), the San Francisco Estuary is the most invaded aquatic ecosystem in North America. This study is the most recent and most inclusive compilation of information on aquatic invasive species in the San Francisco Estuary. Previous lists and/or descriptions of introduced aquatic species include works on fish fauna by Moyle (1976) and McGinnis (1984), freshwater mollusks by Hanna (1966) and Taylor (1981), marine mollusks by Nichols et al. (1986), and introduced marine and estuarine invertebrates by Carlton (Carlton 1975; Carlton 1979a; Carlton 1979b; Carlton et al. 1990). Collectively, these non-native species have significant impacts on the San Francisco Estuary through aggressive predation, highly efficient filter feeding, and competition, which, when magnified by the great abundance of some of these species, has the potential to change (or already has changed) the trophic structure and dynamics of the Bay ecosystem (Josselyn et al. 2004).

Cohen and Carlton (2003) note that at least 212 species, 69% of which are invertebrates, have been introduced to the Bay and Delta since 1850. The most important include a number of clams, many of which were introduced into the Bay via releases of ballast water (Cohen and Carlton 1995), such as the introduced Asian species of *Venerupis* and *Musculista,* and the Atlantic clam *Gemma.* With the exception of the Baltic clam, the numerically dominant mollusks of the South Bay are all non-native species (Nichols and Pamatmat 1988). Collectively, these introduced clam species are capable of filtering the entire volume of the South Bay daily, in addition to having dramatic impacts on the Bay's phytoplankton populations. Cohen and Carlton (2003) suggest that the phytoplankton populations of the northern reaches of the San Francisco Bay may be continuously and permanently controlled by introduced clams.

The Asian clam *Potamocorbula amurensis*, the most abundant clam in the San Francisco Bay, was introduced via ballast water around 1986 (Cohen 1998). Since then, this filter feeder has impacted phytoplankton populations in the North Bay (Alpine and Cloern 1992), preventing summer phytoplankton blooms since its introduction and altering the trophic structure of the North Bay. Although similar large-

scale impacts on the South Bay have not yet been detected, the species is present in the South Bay. This clam was found by a CDFG study to be the most important prey of scoters in Suisun Bay (Harvey et al. 1982). The gem clam (*Gemma gemma*) occurs throughout the South Bay, in both deep subtidal and high intertidal habitats. It occurs in lower-salinity salt ponds as well. This clam is eaten by a variety of shorebirds (Recher 1966) and waterfowl (Painter 1966), and thus benefits some native wildlife species. The Atlantic ribbed marsh mussel (*Arcuatula demissa*) was introduced in the late 1800s, and is now common throughout much of the Bay. Although it is apparently "a major food source" for the clapper rail, rails have been known to drown after getting their beaks or toes caught in the open valves of the mussel (Takekawa 1993). The soft-shell clam (*Mya arenaria*) was introduced for commercial purposes, and maintained an important fishery in the Bay in the late 1800s and early 1900s (Skinner 1962). Although it is still present in the Bay, most individuals are small (Thompson and Shouse 2004). It is an important prey item for bat rays, flounder, and in the Suisun Bay, canvasbacks (Harvey et al. 1982). Thompson (1999) found that it disappeared rapidly from areas where it recruits, suggesting that it is preyed upon heavily by these fish, and possibly by birds and other invertebrates.

A carnivorous opisthobranch, *Philine auriformis*, invaded the South Bay in 1982, and has been noted in abundance in bottom trawls by the Marine Sciences Institute (Thompson and Shouse 2004). This species, which has been found most frequently in deeper water, preys on bivalves. The polychaete worm *Streblospio benedicti* was first detected in the Bay in 1932. This species readily colonizes the Bay in both deep and shallow intertidal habitats, and is consistently one of the dominant species on South Bay mudflats.

The dominant crustaceans of the South Bay are all introduced as well. The tube-dwelling amphipod *Ampelisca abdita* was first detected in the Bay in the 1950s. Since then, it has increased in abundance, and can achieve very dense beds at a variety of depths. This species was a dominant species on Palo Alto mudflats until the 1990s, when abundance declined (though it has remained common) (Thompson and Shouse 2004). The other dominant crustaceans in the South Bay include several burrowing amphipods, including *Grandidierella japonica* and several non-native *Corophium* species. Both of these genera tolerate poor water quality, and readily colonize available habitat throughout the South Bay. These crustaceans are important prey species for shorebirds on intertidal mudflats.

The European green crab (*Carcinus maenas*) became established in the San Francisco Bay in 1989-1990. This opportunistic omnivore eats a variety of plant and animal matter, including bivalves and shore crabs, and has the potential to impact native species considerably (Josselyn et al. 2004). After its invasion of Bodega Bay in 1993, a 90-95% decline in the abundance of native bivalves and grapsid shore crabs was observed (Grosholz et al. 2000).

Two non-native species could physically impact South Bay marshes, levees, streambanks, and other structures. The Australian-New Zealand boring isopod (*Sphaeroma quoyanum*) burrows into mud banks and levees throughout the Bay, potentially weakening these features and making them prone to erosion (Talley et al. 2001). Another burrowing species that may cause the same problem is the Chinese mitten crab (*Eriocheir sinensis*), which has been known to accelerate bank erosions in Germany. First detected in the Bay in 1992, the mitten crab has undergone rapid population increases throughout the Bay and its

tributaries. This catadramous species migrates upstream (in virtually all of the Bay's tributaries) year-round, peaking in spring. Downstream migration to saltwater (approximately 25 ppt) breeding areas occurs primarily August-January, with a peak in September-October (Veldhuizen and Stanish 1999). The Chinese mitten crab is common in the South Bay. Halat (1996) has reported that the burrows of this crab reach densities of 30 burrows/m^2 along San Francisquito Creek. Halat did not report any bank erosion even at this density of mitten crab borrows but suggested that if bank erosion does occur it is likely to occur along steep clay banks in tidally influenced alluvial controlled reaches of the Bay. Thompson and Shouse (2004) noted abundant Chinese mitten crab burrows in a salt marsh bank in Palo Alto, possibly due to its proximity to San Francisquito Creek, and speculated that the erosion of the salt marsh bank observed since the mitten crab's invasion in the early 1990s may have been caused by the crab's burrowing. Surveys by the Marine Science Institute recorded burrow densities as high as 6.2/m^2 in December 1995 and 8.9/m^2 in March 2000 along Alviso Slough. These densities are three to 4.5 times greater than the next highest density for the South Bay.

Mosquitoes. There is an extensive body of literature on mosquitoes associated with tidal and seasonal wetlands of the South Bay region, as summarized by Bohart and Washino (1978), Durso (1996), and Maffei (2000d; 2000e; 2000f; 2000g; 2000h). More than 20 species occur in the San Francisco Bay area, but five of these, the summer salt marsh mosquito (*Aedes dorsalis*), winter salt marsh mosquito (*Aedes squamiger*), Washino's mosquito (*Aedes washinoi*), western encephalitis mosquito (*Culex tarsalis*), and winter marsh mosquito (*Culiseta inornata*), are routinely controlled by the mosquito and vector control agencies within each of the counties of South San Francisco Bay. Within the Shoreline Study Area, the Alameda County Mosquito Abatement District and the Santa Clara Vector Control District are responsible for managing the populations of mosquitoes for their respective communities.

The Goals Project's Baylands Ecosystem Species and Community Profiles (Maffei 2000d; 2000e; 2000f; 2000g; 2000h) included a detailed discussion of the ecology of mosquitoes in the South Bay, including preferred habitats, salinity tolerances, reproductive rates, flight characteristics, adult hosts and vector/nuisance potential. Adult females feed on blood; the hosts vary depending on the species, but include mammals, birds, reptiles, and amphibians. Adult males feed on plant juices, while larvae generally feed on particulate matter, unicellular algae, and other microorganisms. Larvae serve as prey for a variety of aquatic organisms, shorebirds, and waterfowl, while birds such as the swallow and other insects feed on adult mosquitoes. Larval survivorship is typically low, with most losses attributable to predation. The rate of larval development is often a function of water temperature and food availability.

The summer salt marsh mosquito is widespread throughout most of the United States and southern Canada, and is found in Europe and Asia as well (Carpenter and LaCasse 1955; Darsie and Ward 1981). In California, it inhabits coastal salt marshes and brackish marshes of the Sacramento/San Joaquin River Delta (Bohart and Washino 1978). In the San Francisco Bay area, this species occurs primarily in temporarily flooded tidal marsh pannes, heavily vegetated ditches, and brackish seasonal wetlands, while adults occur in open habitats such as grasslands, salt marsh, and woodland edges (Maffei 2000d). The summer salt marsh mosquito lays its eggs on mud at the edges of tidal pools or brackish seasonal wetlands, with larvae often occupying the same pools occupied by the tidal pool brine fly (*Ephydra millbrae*) and reticulate water boatman (Maffei 2000d). Eggs may hatch in the spring, but they can

remain viable for years, and subsequent hatching can occur when the larval habitat is reflooded. Although survivorship may be highest in water having a salinity near seawater (Washino and Jensen 1990), larvae have successfully completed development at the Great Salt Lake in water with salinities as high as 120 ppt (Rees and Nielsen 1947). Up to 12 broods and eight generations were found to occur during a single breeding season in Marin County (Telford 1958). Adults are highly mobile, aggressive, day-biting mosquitoes that may be able to disperse more than 30 miles (Rees and Nielsen 1947).

The winter salt marsh mosquito occurs along the Pacific Coast from Sonoma County south to Baja California, including much of the immediate area around Southern and Northern protions of San Francisco Bay (Maffei 2000h). Tidal and diked pickleweed marshes with salt marsh pools diluted by rains provide the preferred habitat of this species. This species has not been found in freshwater marshes, instead occurring in brackish and salt marshes having salt concentrations from 1.2 to 35 ppt, with optimal conditions for larval development at salinities of five to 15 ppt. Egg laying occurs in spring on plants and on mud close to the edges of marsh pools. The eggs lie dormant until fall rains inundate them, although hatching as early as late September has been noted due to water diversion into a marsh. Some eggs do not hatch until later re-floodings. Most adults emerge from salt marsh pools in late February and March and disperse widely into surrounding areas, sometimes dispersing as far as 15 miles or more from larval areas. Feeding occurs from March through June, with biting occurring during daytime and early dusk.

Washino's mosquito occurs from Oregon south to Santa Barbara, California, including the entire San Francisco Bay area (Maffei 2000e). In the Bay area, shallow pools and fresh to slightly brackish sites in uplands near salt marshes or in riparian areas, often dominated by willow, cottonwood, or blackberry, provide this species' preferred habitat. Females deposit eggs in mud along the receding water line of larval habitat. The eggs hatch when these pools are reflooded the following winter. Adults emerge from the larval depressions in late winter and early spring, and are present into June. Females are day-biting mosquitoes, and may travel up to 1.5 miles from their larval habitat along artificial canals (Maffei 2000e).

The western encephalitis mosquito is widespread in a variety of habitats and locations in western North America, with larvae occurring in most freshwater habitats (Maffei 2000f). Typical larval habitat includes poorly drained fields and pastures, rice fields, marshes, ponds, and seeps, although most artificial waterbodies in urban areas provide potential habitat for this species as well. The species has been found in salt marsh pools with salt concentrations up to ten ppt (Telford 1958). Adults may be present year-round but enter facultative diapause in winter. Females lay eggs in groups directly into the water. Adult females usually feed at night. This species seems to be able to disperse readily with wind, and dispersal distances of 20-25 miles are suspected for some Sacramento Valley populations (Bailey et al. 1965). The western encephalitis mosquito is the main vector of western equine encephalitis and St. Louis encephalitis in most of the western United States (Maffei 2000f), and is a vector of avian malaria.

The winter marsh mosquito occurs in a wide range of habitats throughout much of western North America. Larval habitat includes a variety of pools, ponds, marshes, and other water bodies, in salinities ranging from eight to 26 ppt (Maffei 2000g; Telford 1958). Adults are present from fall through spring, entering facultative diapause in summer. Females lay groups of eggs directly on the water. San Francisco Bay populations tend to remain within two miles of their larval source, although they may

disperse up to 14 miles (Clarke 1943). Larvae of the summer salt marsh mosquito, winter salt marsh mosquito, and winter marsh mosquito are often found in the same locations (Maffei 2000h). Mosquito species occurring in the major habitats in the Shoreline Study Area are listed in Table 4 below.

Table 4 – Mosquito Species Found in Marsh Habitats in the Shoreline Study Area.

Habitat	Mosquito Species
Open salt pond with vigorous wave action	none
Fully tidal salt marsh: Higher ground with pools or borrow channels that do not flush	*Aedes squamiger* (winter), *Aedes melanimon* (fall), *Aedes dorsalis* (summer), *Aedes taeniorhynchus* (summer), *Culiseta inornata* (winter)
Muted tidal salt marsh: Pools and channels that do not flush vigorously	*Aedes squamiger* (winter), *Aedes melanimon* (fall), *Aedes dorsalis* (summer), *Aedes taeniorhynchus* (summer), *Culiseta inornata* (winter)
Seasonal wetland: Brackish to nearly freshwater pools with vegetated margins	*Aedes squamiger* (winter), *Aedes melanimon* (fall), *Aedes dorsalis* (summer), *Aedes taeniorhynchus* (summer), *Aedes washinoi* (winter fresh water), *Culex tarsalis* (spring, summer), *Culex erythrothorax* (summer in tules), *Culex pipiens* (foul fresh water), *Culiseta incidens* (spring, fall fresh water), *Culiseta inornata* (winter)
Vernal pools, upland freshwater marsh	*Aedes washinoi* (winter), *Culex tarsalis* (spring, summer), *Culex erythrothorax* (summer in tules), *Culex pipiens* (foul fresh water), *Culiseta incidens* (spring, fall fresh water), *Culiseta inornata* (winter)

Marshes that lack vigorous tidal flow can provide suitable mosquito breeding habitat. Salt marshes at the southern end of the San Fransisco Bay produce a single seasonal brood of the winter salt marsh mosquito and multiple broods of the summer salt marsh mosquito each season. Because both of these mosquito species can fly considerable distances and are aggressive biters, control of mosquitos at the source (i.e., in salt marshes) is necessary to reduce the inconvenience to humans in the South Bay.

Detailed records are maintained by the local mosquito and vector control districts concerning major mosquito breeding areas, population densities, and control techniques and materials. In Santa Clara County, areas with known or potential mosquito problems include Coyote Reach 1A, New Chicago Marsh, Sunnyvale Baylands Park, the Moffett Field Flood Control Basin, Mountain View Demonstration Marsh, the Palo Alto Flood Basin (Palo Alto Baylands Park), the Zanker Landfill Marsh, Dow-Corning Marsh, Alviso Marshes, ITT Marsh (near the Palo Alto Water Quality Control Plant), the Palo Alto Municipal Airport, and the Palo Alto Municipal Golf Course (Strickman 2005). In the Alameda County portion of the Study Area, south of the San Mateo Bridge, sites that can produce large numbers of mosquitoes if not treated include the Perry Duck Club, Alameda Creek Marshes, Union City Marshes, Coyote Hills Marshes, Mayhew's Landing, and the upper ends of major sloughs (Mowry, Newark, Plummer, Albrae, and Mud Sloughs). Fully tidal marshes such as Hook Island (Palo Alto), Triangle Marsh (Coyote Creek), and Greco Island, do not produce significant numbers of mosquitoes.

Mosquito control techniques employed by these agencies emphasize minimization and disruption of suitable habitat, and control of larvae through chemical and biological means, as opposed to spraying of adults. Control techniques most often include source reduction, source prevention, larviciding, use of

mosquito fish (*Gambusia affinis*) as larval predators, and monitoring of mosquito populations and vector-borne diseases (Alameda County Mosquito Abatement District 1999). Larvicides employed by the San Mateo County Mosquito Abatement District include Golden Bear 11 11 (a short-lived petroleum distillate that is applied to the surface of the water and causes mosquito larvae to drown), methoprene (a juvenile growth hormone that specifically targets mosquito larvae and prevents their maturation), *Bacillus thuringensis israelis* (a bacteria that is toxic to mosquito larvae), and *Bacillus sphaericus* spores and toxin (for *Culex* species) (http://www.smcmad.org/preventative_approach.htm).

In salt marshes, attempts to control mosquito populations by ditching have resulted in marsh degradation. Ditching is not necessary to reduce mosquito populations in tidal marshes. Rather, functional tidal marshes do not provide high-quality habitat for the most troublesome mosquito species in the Bay area, and maintenance and restoration of natural tidal flushing in these marshes is effective at limiting mosquito populations while sustaining the natural hydrology of the marsh (San Francisco Bay Joint Venture 2004).

Mosquitos serve as vectors for several diseases that pose health concerns for humans and domestic animals. The western encephalitis mosquito is a vector of avian malaria and the main vector of western equine encephalitis and St. Louis encephalitis in the western United States (Maffei 2000f). Anopheles mosquitos carry the organism that causes malaria. The West Nile virus is a mosquito-borne disease that has been found in parts of Asia, Eastern Europe, Africa and the Middle East. First detected in the U.S. in 1999 in New York City, West Nile virus has since spread through most of the U.S. West Nile Virus is typically spread from an infected mosquito, usually in the genus *Culex*, to a bird that then disperses or migrates, spreading the virus after being bitten by other mosquitos. Most people and domestic animals that become infected with the virus have few or no symptoms, but in rare cases they can become seriously ill. In 2006, West Nile virus was detected in 54 of 58 California counties, with 276 human infections from 30 counties in California (http://westnile.ca.gov/latest_activity.htm). In 2006, 58 infections of horses from 23 counties in California were reported, along with 1446 dead birds that tested positive for the virus.

4.3.2 Fishes

Fishes play very important ecological roles in the South Bay system. Information on South Bay fish communities is somewhat limited, likely due to the lack of a commercial fin-fishing industry in this part of the Bay. However, a dataset from the CDFG and several other studies provide information on fishes of the South Bay's tidal habitats, while several studies have identified the fish present in South Bay salt ponds (Anderson 1970; Carpelan 1957; Lonzarich 1989; Takekawa et al. 2005) and freshwater streams (summarized in Buchan et al. 2002). Information on key species is also available in the Goals Project's Baylands Ecosystem Species and Community Profiles (Goals Project 2000).

Fish Communities of Tidal Habitats. More than 100 fish species have been recorded in the tidal waters of the South Bay (Laine, pers. comm.). The California Department of Fish and Game has conducted a fish survey within the San Francisco Bay since 1980, with monthly surveys in deeper subtidal areas and some beach seine sampling in shallow water habitats (CDFG data in Life Science 2004). These surveys

include data from three open-water stations (Stations 102, 101, and 140) located near the San Mateo and Dumbarton Bridges, and two beach seine stations (171 and 172) that are also located in the South Bay. Three sampling methods were used in the open-water stations: the otter trawl (which was towed on the bottom for five minutes against the current, then retrieved), midwater trawl (which was towed with the current for 12 minutes then retrieved obliquely), and plankton net (which was towed on the bottom for five minutes then retrieved obliquely).

A total of 65 fish species was captured at Stations 102, 101, and 140 during CDFG's surveys between 1980 and 2002, with 51 species captured by the otter trawl, 48 species by the midwater trawl, and 27 by the plankton net. Table 5 summarizes the most abundant fish species captured during these surveys. Numerically, the dominant fish were the northern anchovy (*Engraulis mordax*), shiner surfperch (*Cymatogaster aggregata*), longfin smelt (*Spirinchus thaleichthys*), white croaker (*Genyonemus lineatus*), Pacific staghorn sculpin, bay goby (*Lepidogobius lepidus*), plainfin midshipman (*Porichthys notatus*), English sole (*Parophrys vetulus*), cheekspot goby (*Ilypnus gilberti*), and Pacific herring (*Clupea pallasi*). The dominant fish captured at the beach seine stations were topsmelt (37.3%), arrow goby (*Clevelandia ios*, 22.6%), yellowfin goby (16.9%), jacksmelt (*Atherinopsis californiensis*, 16.2%), and Pacific staghorn sculpin (3.3%), with 22 other species representing <2% of the catch at Station 171, and topsmelt (54.4%), jacksmelt (23.4%), Pacific herring (9.7%), Pacific staghorn sculpin (3.0%), and northern anchovy (2.0%), with 28 other species representing <2% of the catch at Station 172.

Kinnetics (1987) collected fish from two locations in Coyote Creek and one location in Guadalupe Slough between 1982 and 1985. The dominant species collected from these sloughs included the staghorn sculpin, northern anchovy, starry flounder (*Platichthys stellatus*), shiner perch, yellowfin goby, threadfin shad (*Dorosma petenense*), and longfin smelt. Fish sampling in the nearby open waters of the Bay revealed species composition similar to that in the sloughs, with white croaker and striped bass (*Morone saxatilis*) also occurring as dominants. Sampling fish in lower San Francisquito Creek and the Palo Alto Water Quality Control Plant outfall channel, Cressey (1997) recorded the northern anchovy, topsmelt, yellowfin goby, staghorn sculpin, and threespine stickleback (*Gasterosteus aculeatus*).

Surveys of South Bay tidal sloughs by the USGS (Takekawa et al. 2005) from March 2004 to June 2005 recorded a total of 16 fish species in Alviso Slough, Coyote Creek, and Stevens Creek. Northern anchovies and topsmelt were by far the most abundant species caught; the American shad (*Alosa sapidissima*), threadfin shad, longjaw mudsucker, longfin smelt, common carp (*Cyprinus carpio*), starry flounder, rainwater killifish, bat ray, leopard shark (*Triakis semifasciata*), Sacramento sucker (*Catostomus occidentalis occidentalis*), striped bass, staghorn sculpin, shiner surfperch, and yellowfin goby were also recorded.

Many of the fish recorded in the South Bay, including the bat ray, leopard shark, northern anchovy, gobies, and many others, occur in tidal channels within marshes, in sloughs, and/or on mudflats at high tide when they are inundated. Thus, these tidal channels and mudflats are productive foraging habitats for estuarine fish in this system (Harvey 1988).

The spatial and temporal distribution of different estuarine fish in the South Bay, vary widely among species, as does the degree to which different specied use the Bay for breeding and foraging. The South Bay is particularly important to the leopard shark. Pupping (live birth) in the San Francisco Bay occurs almost exclusively in the South Bay (CDFG Bay Trawl data cited in McGowan (2000a)). This species appears to be most abundant in the areas on either side of the Dumbarton Bridge, where it forages in shallow mud and sand flats (Compagno 1984). Leopard sharks occur in the Bay year-round, although individuals may move in and out of the Bay (McGowan 2000b). The Bay is also important for northern anchovies, which spawn in the South Bay, including areas south of the Dumbarton Bridge (McGowan 1986). Spawning occurs in marsh channels; larvae forage over shallow flats after hatching (McGowan 2000b). Adult anchovies generally leave the Bay for the open ocean in fall, but some late-spawned juveniles remain in the Bay throughout the winter. Jacksmelt likely spawn in the South Bay as well. Here, spawning occurs from October to early August (Wang 1986), when adults move inshore from marine habitats and lay eggs on aquatic vegetation and other substrates. Apparently preferring more saline waters, the jacksmelt is most common in the Central and South Bays during years of high freshwater flows from the Delta (CDFG 1987 in Saiki [2000b]).

Table 5 – Summary of the most abundant fish species captured during California Department of Fish and Game South Bay fishery surveys, 1980-2002. Data are from Stations 101, 102, and 140 between the San Mateo and Dumbarton Bridges.

Species	Station 101			Station 102			Station 140		
	Otter Trawl	Midwater Trawl	Plankton Net	Otter Trawl	Midwater Trawl	Plankton Net	Otter Trawl	Midwater Trawl	Plankton Net
Northern Anchovy[1]	34.8	93.5	85.5	24.6	92.8	82.2	7.7	87.7	36.7
Shiner Perch	19.2			17.1			34.7	2.3	
Longfin Smelt	13.9								
White Croaker	9.8			3.5			4.4	3.2	
Pacific Staghorn Sculpin	4.5						7.0		
Bay Goby	4.3			19.1			8.3		
Plainfin Midshipman	3.1						7.9		
English Sole				12.0			7.4		
Cheekspot Goby				5.7					
Speckled Sanddab				4.0			2.1		
Pacific Herring			5.7	3.5		10.3			2.3
California Tonguefish							3.9		
White Seaperch							3.0		
Brown Smoothhound							2.4		
Topsmelt					2.2				
Jacksmelt					2.0				
Walleye Surfperch								2.1	

Arrow/Cheekspot Goby			2.8						21.1
Yellowfin Goby			2.3						
Goby Type II			2.2			2.0			3.8
Unidentified Fish									34.1
Total Species Richness	42	36	22	46	42	24	48	42	27
Other Species (Percent)	10.4	6.5	1.5	10.5	3.0	5.5	11.2	4.7	2.0

[1] Only species that make up at least 2.0% of the catch for a given sampling method at a given station are included. Data are the percentage of the total number of fish caught that were composed of each species.

Adult topsmelt enter shallow sloughs and mudflats to spawn in late spring and summer, which has been observed in the South Bay near the Dumbarton Bridge (Wang 1986). Eggs are laid on submerged vegetation. Locally this species is most abundant in the South Bay; where mudflats and sloughs are used for spawning and feeding, and as nursery areas for juveniles (Saiki 2000c). The Pacific staghorn sculpin is most abundant in central and north San Francisco Bay, but in some years it occurs commonly in the South Bay as well (CDFG 1987 in Tasto (2000b)). This sculpin spawns from November to March in shallow subtidal to intertidal water, and the young gradually shift their foraging areas from shallow intertidal habitats to deeper subtidal habitats as they mature (Tasto 2000b). The arrow goby occurs on shallow intertidal flats and in salt-marsh channels throughout much of the South Bay, where it is often commensal with burrowing invertebrates (Hieb 2000a). This species breeds primarily in spring and early summer, with peak larval occurrence from April through July. The bay goby occurs in somewhat deeper-water habitats than the arrow goby, and is also a common breeding species in the South Bay (Hieb 2000b). The longjaw mudsucker resides on mudflats and in tidal channels and sloughs. Marshes with complex channels provide the highest-quality habitat, although this species also breeds in lower-salinity salt ponds (Hieb 2000c). The longjaw mudsucker spawns from November through June in the South Bay, constructing burrows for breeding.

Other species forage in the South Bay but are not known to breed here. Pacific Herring are present in the North Bay from November through March, when spawning occurs; larvae and juveniles occur more widely, during which time they occur in the South Bay (though abundance decreases southward). Most individuals depart the Bay by August (Tasto 2000a). Longfin smelt spawn in fresh water in the upper end of Suisun Bay and in the Delta, occurring in the South Bay year-round as pre-spawning adults and yearling juveniles (Wernette 2000). Striped bass were introduced into the San Francisco Estuary in 1879, and are now the most important sport fish in the San Francisco Estuary, bringing in approximately $45 million per year into the local economies of the Estuary (Sommer 2000). Adults congregate in the San Pablo and Suisun Bays in fall and move into the Delta to spawn primarily in the Sacramento/San Joaquin Rivers in May and June. Striped bass in the South Bay are likely subadult fish foraging widely in the Bay, as this species is not known to breed in the South Bay. The California halibut (*Paralichthys californicus*) forages to some extent in the South Bay, but is not known to breed anywhere inside San Francisco Bay (Saiki 2000a). Juvenile starry flounders (*Platichthys stellatus*) occur fairly commonly in

South Bay sloughs, tidal marsh channels, and mudflats, although this species is not known to breed in the Bay (Kline 2000).

Adult steelhead (*Oncorhynchus mykiss*; Central California coast DPS) migrate through the Shoreline Study area into freshwater streams within the South Bay typically from December through April. Outmigration of smolts mainly occurs from February through June (Roessler et al. 2001, SCVWD unpublished data). Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley Fall-Run ESU, also migrate through the Study area during adult upstream migration from August through December, and during the downstream migration of juveniles typically from February through June (Roessler et al. 2001, SCVWD unpublished data). Relatively few data are available regarding use of South Bay marshes by salmonids, due to the difficulty of sampling small fish in this habitat. Steelhead were not captured by the CDFG during its South Bay surveys, and Chinook salmon were captured only in very low numbers. These species are discussed in detail in the Special-Status Wildlife Species section below (Section 3.7).

The diets of South Bay fish vary widely (Goals Project 2000; Harvey et al. 1977). Herring, anchovies, perch, and a variety of other fish and shrimp species provide prey for striped bass. The American shad feeds on copepods, larval fish, and *Corophium*. Northern anchovies are filter feeders that capture zooplankton and phytoplankton. Gobies prey on small fish and crustaceans. Jacksmelt eat a variety of copepods, insects, and polychaetes. Longfin smelt feed on zooplankton, shrimp, and copepods. Chinook salmon (*Oncorhynchus tshawytscha*) prey on insects, shrimp, amphipods, and isopods. The Pacific sardine (*Sardinops sagax*) is a filter and particulate feeder. The bat ray feeds on benthic mollusks, polychaete worms, and crustaceans. Leopard sharks eat a variety of crabs, shrimp, and small fish.

The history of the fisheries in the San Francisco Bay area, based on commercial catch data, was well described by Skinner (1962), but information specific to the South Bay in that text is very limited. According to Thomas Laine (pers. comm.), saltwater fish have declined in abundance in the far South Bay, with an apparent decline being particularly noticeable in the Alviso area since the 1970s. Although no commercial fishery for fin-fishes has existed in the Alviso area, this area was important for recreational fishing, particularly for sturgeon and striped bass, when the boat ramp at the Alviso marina was operational, and fishing derbies for sturgeon in the 1970s attracted as many as 700 entrants (Laine, pers. comm.). Large sturgeon and striped bass are still caught in the South Bay, but public boating access is limited to boat launches at the SFBNWR headquarters entrance in Newark and in the Redwood City area (except for the few boats currently moored along Alviso Slough).

Salt Pond Fish Communities. Fish community composition and abundance within the salt ponds of the South Bay are primarily a function of salinity, with more diverse communities and greater abundance in lower-salinity ponds, and generally no fish surviving salinities greater than 100 ppt. Carpelan (1957) found that in the Alviso salt ponds he studied, the primary fish species were topsmelt and threespine stickleback. Stickleback, primarily a freshwater species, occurred in low-salinity ponds, where they were often noted in clear water above macrophytic green algae. Topsmelt were the most abundant fish species, occurring in ponds with salinities up to 55 ppt. These fish feed in the salt ponds primarily on copepods. The longjaw mudsucker and the Pacific staghorn sculpin also occurred in the lower salinity Alviso ponds, but in lower abundance.

Lonzarich and Smith (1997) more recently studied fish assemblages in Alviso ponds A9 through A12, finding topsmelt, threespine stickleback, and longjaw mudsucker to be common in low- to mid-salinity ponds (35-90 ppt). Adult topsmelt occurred in ponds with salinities up to 90 ppt, and juvenile topsmelt occurred in ponds up to 75 ppt. Rainwater killifish (*Luciana parva*) and yellowfin gobies were also resident in most ponds studied. Nine additional fish species recorded in salt ponds by Lonzarich and Smith (1997), including staghorn sculpin, leopard shark (*Triakas semifasciata*), and northern anchovy, were apparently seasonal transients from adjacent Bay waters.

Surveys by USGS (Takekawa et al. 2005) recorded 14 fish species in Alviso salt ponds between March 2004 and June 2005; these results are similar to those of Lonzarich and Smith (1997), with longjaw mudsucker, rainwater killifish, topsmelt, and yellowfin goby being the most abundant fish, although very few sticklebacks were caught by USGS. Other species recorded in the Alviso salt ponds by USGS included northern anchovy, bay pipefish, staghorn sculpin, chameleon goby (*Tridentiger trigonocephalus*), leopard shark, shiner surfperch, striped bass, starry flounder, and bat ray.

Freshwater Stream Fish Communities. Fishes in the freshwater streams entering the Bay in the Shoreline Study Area consist of a moderately diverse assemblage of native species augmented by a number of non-natives. Coyote Creek has been the best studied of the creeks entering the Study Area in terms of its fish communities; such studies were summarized in Appendix C of Buchan et al. (2002). Native species recorded along lower Coyote Creek between 1858 and 2000, and thought to be extant as of 2000, include the splittail (*Pogonichthys macrolepidotus*), Pacific lamprey (*Lampetra tridentata*), steelhead/rainbow trout, California roach (*Lavinia symmetricus*), hitch (*Lavinia exilicauda*), Sacramento blackfish (*Orthodon microlepidotus*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker, threespine stickleback, prickly sculpin, riffle sculpin (*Cottus gulosus*), and staghorn sculpin (Buchan et al. 2002, Buchan and Randall 2003). Other natives, such as the thicktail chub (*Gila crassicauda*), Sacramento perch (*Archoplites interruptus*), coho salmon (*Oncorhynchus kisutch*), speckled dace (*Rhinichthys osculus*) were recorded historically in lower Coyote Creek but may have been extirpated.

Anadromous fish, such as the Central California Coast steelhead and Chinook salmon use the reaches of freshwater streams in the Study Area primarily during movements between upstream spawning areas and estuarine/oceanic habitats. Coho salmon (*Oncorhynchus kisutch*) formerly spawned in the Coyote Creek watershed, but was apparently extirpated by the 1970s.

A variety of non-native fish introduced either unintentionally or intentionally for angling or mosquito control, occurs in South Bay freshwater streams. These include the mosquitofish (*Gambusia affinis*), channel catfish (*Ictalurus punctatus*), brown bullhead (*Ictalurus nebulosus*), yellow bullhead (*Ameiurus natakis*), black bullhead (*Ameiurus melas*), white crappie (Pomoxis annularis), black crappie (*Pomoxis nigromaculatus*), red shiner (*Notropis lutrensis*), inland silverside (*Menidia beryllina*), carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), fathead minnow (*Pimephales promelas*), redear sunfish (*Lepomis microlophus*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), golden shiner (*Notemigonus crysoleucas*), and others (Buchan et al. 2002, Buchan and Randall 2003). Many of these non-natives are widespread in streams throughout central

California, and are fairly tolerant of marginal water quality and a variety of stream conditions. The number of non-native fish species recorded along lower Coyote Creek increased from zero during the period 1858-1940 to 21 during the period 1987-2000 (Buchan et al. 2002).

4.3.3 Reptiles and Amphibians

Relatively few species of reptiles and amphibians occur in the Shoreline Study Area, and consequently, there has been little study of these taxa within the Study Area. The western fence lizard (*Sceloporus occidentialis*), a ubiquitous lizard in California, occurs in a variety of habitats in the Study Area. Other reptile species that occur within the Study Area include garter snakes (*Thamnophis couchi*, *T. elegans*, and *T. sirtalis*), gopher snakes (*Pituophis melanoleucus*), and southern alligator lizards (*Elgaria multicaranata*), all of which occur along edges of well-vegetated levees, in riparian habitats, and in grassland and ruderal habitats.

A small, isolated population of western pond turtles (*Clemmys marmorata*) occurs in brackish habitats near the Sunnyvale WPCP and Moffett Field, and this species is also present in small numbers along the lower reaches of Coyote Creek and the Guadalupe River (see Special-Status Wildlife Species in Section 3.7). Small numbers of a several species of non-native turtles, most likely pets that have been released, are present in South Bay streams as well.

Due to the paucity of freshwater habitats within the immediate Study Area, amphibian use of the Study Area is even more limited. Where fresh water occurs along the inland margins of the Study Area, the Pacific treefrog (*Hyla regilla*), western toad (*Bufo boreas*), and non-native bullfrog (*Rana catesbeiana*) are present. California slender salamanders (*Batrachoseps attenuatus*) and arboreal salamanders (*Aneides lugubris*) occur in moist riparian areas along the margins of the Study Area, but are much more abundant in higher-elevation, more wooded, less urbanized sites outside the Study Area. California tiger salamanders (*Ambystoma californiense*) occur in vernal pool habitats in the Warm Springs area, primarily on SFBNWR lands.

4.3.4 Mammals

Relatively few species of mammals occur in the Shoreline Study Area owing to the intense disturbance and habitat conversion that has occurred within the area. Within the Study Area, most research attention on mammals has focused on the ecology of special-status salt marsh associated species (i.e., the salt marsh harvest mouse and salt marsh wandering shrew, along with other small mammals using salt marshes), the use of South Bay waters and tidal habitats by the Pacific harbor seal, and the presence and impacts of non-native mammals. Upland habitats within the Study Area are primarily ruderal, although some non-native grassland habitat and the riparian corridor of Coyote Creek do support a variety of small mammal species.

Salt marsh harvest mice and salt marsh wandering shrews occur in the Study Area primarily in pickleweed-dominated salt marshes. Harbor seals, the only marine mammals that regularly occur in the

South Bay, forage in Bay waters and sloughs and breed and loaf on the edges of tidal marshes and mudflats. Because these three species are discussed in detail in the Special-Status Wildlife Species section (Section 3.7), they are not discussed further in this section.

Trapping studies for the salt marsh harvest mouse in the South Bay have revealed much about the status of other small mammals in marsh habitats of the region. House mice (*Mus musculus*) and California voles are common in diked and tidal salt marshes, particularly in the pickleweed-dominated high marsh and the peripheral halophyte zone, where the western harvest mouse (*Reithrodontomys megalotis*) also occurs in the high marsh. Deer mice (*Peromyscus maniculatus*), shrews, and both black rats (*Rattus rattus*) and Norway rats (*Rattus norvegicus*) are also recorded in these marshes during salt marsh harvest mouse trapping studies. Table 6 below lists the results of a small sample of such studies to indicate the relative abundance (relative to trapping effort and among species) of these species in South Bay marshes (Environmental Science Associates 1991; H. T. Harvey & Associates 1988; 1989; 1990; 1991; Harvey and Stanley Associates 1985; 1986; Muench 1985; Shellhammer et al. 1988; Wondolleck et al. 1972).

Aside from the introduced house mouse, which occurs commonly in a variety of habitats in the South Bay, the most abundant mammal trapped during the studies listed in Table 6 was the California vole. This species is a common inhabitat of grasslands, ruderal habitats, and wetlands around the South Bay, and is a keystone species in grasslands due to its importance as a prey species to mammals and raptors (Pearson 1985) and the significant effect this species may have on vegetation during populations peaks (Lidicker 1989; Lidicker 2000). Studies of populations in upland areas have demonstrated dramatic fluctuations in abundance, and when it is particularly abundant, the California vole may have adverse effects on other small mammals. For example, western harvest mice are impacted strongly, presumably via competitive interactions, during vole outbreaks, and it is possible that high densities of voles may have the same negative impacts on salt marsh harvest mice, as has been suggested by Geissel et al. (1988).

Several species of bats, such as the Mexican free-tailed bat (*Tadarida brasiliensis*), forage over the salt ponds, marshes, and grasslands of the South Bay. Native mammals such as the California vole, western harvest mouse, deer mouse, Botta's pocket gopher (*Thomomys bottae*), California ground squirrel, black-tailed jack rabbit, Audubon's cottontail, brush rabbit, striped skunk (*Mephitis mephitis*), and long-tailed weasel (*Mustela frenata*) occur on salt pond levees, at the margins of marshes, and in upland ruderal and grassland habitats around the periphery of the Study Area.

Several non-native mammal species occur in the South Bay, including the red fox (*Vulpes vulpes regalis*), Norway rat, black rat, feral cat (*Felis felis*), and Virginia opossum (*Didelphis virginiana*). These species have the potential to impact populations of California clapper rails and other native species in the South Bay considerably. The red fox was first reported in the South San Francisco Bay area in 1986 (Foerster and Takekawa 1991), and it has since increased and expanded to become established throughout the Bay area. It dens in a variety of habitats, including salt pond levees (Foerster and Takekawa 1991).

Table 6 – Relative abundance of small mammals captured during selected salt marsh harvest mouse trapping studies in the South Bay.

Site and Habitat	Year(s)	Trap Nights	Species*							Reference
			Salt Marsh Harvest Mouse	Western Harvest Mouse	House Mouse	Deer Mouse	California Vole	Shrew spp.	Black / Norway Rat	
1990 Bay Road, East Palo Alto (tidal salt marsh)	1990-91	1000	20		3	1	3		3	Environmental Science Associates 1991
Dumbarton Marsh (tidal salt marsh)	1990-91	1000	18		8	1	16	1		Environmental Science Associates 1991
Palo Alto Baylands (salt marsh)	1972	2058	196		74		39	3		Wondolleck et al. 1972
Western Alameda and Northeastern Santa Clara Counties (diked marsh)	1983-86	12,800	140	45	717	54	478	10	3	Shellhammer et al. 1988
Western Alameda County (tidal salt marsh)	1983-86	1200	13	7	72		129	2		Shellhammer et al. 1988
Lower Calabazas Creek at Hwy. 237, Alviso (fresh/brackish tidal marsh)	1988	1000		3	46					H. T. Harvey & Associates 1988
Coyote Creek Flood Control Project (ruderal/alkali habitat)	1990	1000	7	4 (harvest mouse sp.)	21	2	1			H. T. Harvey & Associates 1990c
Mayhews Landing (mixed grassland, diked marsh, fresh/brackish marsh)	1988-89	3120	36		101		7			H. T. Harvey & Associates 1989
Warm Spring International Industrial Park (diked pickleweed marsh)	1985	900	1		36					Harvey and Stanley Associates 1985
Warm Springs II/Fremont Airport (diked pickleweed/grassland)	1985	2400	27		≤ 154		1			Harvey and Stanley Associates 1986
Triangle Marsh (tidal salt marsh) and New Chicago Marsh (diked salt marsh)	1985	776	1	1	161		6	1		Muench 1985
Triangle Marsh (tidal salt marsh)	1990	500	10		8	3	18			H. T. Harvey & Associates 1991c

Site and Habitat	Year(s)	Trap Nights	Species*							Reference
			Salt Marsh Harvest Mouse	Western Harvest Mouse	House Mouse	Deer Mouse	California Vole	Shrew spp.	Black / Norway Rat	
Calaveras Point Marsh (tidal salt marsh)	1990	400	22				1			H. T. Harvey & Associates 1991c
Warm Springs Marsh (tidal brackish marsh)	1990	500			35	3	57			H. T. Harvey & Associates 1991c
Coyote Creek Flood Control Project (ruderal/alkali habitat)	2001	800		3	22		4			H. T. Harvey & Associates 2001
Stevens Creek Marsh (tidal salt marsh)	2005	400	2	1	40		5			H. T. Harvey & Associates 2005
Calaveras Point Marsh (tidal salt marsh)	2006	2000	15		4		6			H. T. Harvey & Associates 2007
Triangle Marsh (tidal salt marsh)	2006	2000	28		37		53			H. T. Harvey & Associates 2007
Warm Springs Marsh (tidal brackish marsh)	2006	2000	10		18		29			H. T. Harvey & Associates 2007

* In these studies, species other than salt marsh harvest mice were not uniquely marked for identification, and hence the numbers listed for species other than the salt marsh harvest mouse include an unknown number of recaptures. However, the house mouse and California vole were still found to be the most abundance species in many marshes.

Clapper rail predation by both red foxes and feral cats has been directly documented in the South Bay by the tracking of radio-marked rails that were depredated in 1991 and 1992 (Albertson 1995). In addition, the remains of clapper rails were found at a fox den in a tidal marsh on the SFBNWR (Harding et al. 1998), and at the entrance to a den in the outboard levee along salt pond A9 (Steve Rottenborn, pers. obs.). Norway rats are thought to be one of the main predators of California clapper rail eggs (Foerster et al. 1990; Harvey 1988), and raccoons have also been known to prey on California clapper rail eggs (Foerster et al. 1990). In addition to impacts to clapper rails, red fox predation on nests of the federally threatened western snowy plover has been recorded, and fox predation has resulted in the abandonment of important colonies of Caspian terns (at Mowry and Bair Island) and herons (at Bair Island) in the South Bay in 1991 (Strong 2004a).

The feral cat is fairly common in upland habitats around the South Bay (Foerster and Takekawa 1991; Takekawa 1993), whereas the Norway rat and roof rat occur in most habitat types in the Study Area. Both rats are known nest predators of California clapper rails, and up to one-third of clapper rail eggs in the South Bay may be depredated by Norway rats (BDOC Unpublished; Josselyn et al. 2004). Rats have depredated California Gull nests in the South Bay as well (Jones 1986).

In 1991, the San Francisco Bay NWR implemented a predator management plan directed at the removal of red foxes, raccoons (*Procyon lotor*), striped skunks, and feral cats to protect the federally listed California clapper rail and western snowy plover (Harding et al. 1998). From spring 1991 to fall 1996, the average number of individuals removed from NWR lands per year included 90 red foxes, 27 feral cats, 26 striped skunks, and two raccoons. In addition, 38 non-native opossums and 25 native gray foxes (*Urocyon cinereoargenteus*) were captured and released. The number of red foxes trapped was consistent from 1991 to 1996, but trapping rates declined because more traps were used in successive years. Successful trapping required 46 traps/fox in 1991-1992 and 83 traps/fox in 1995-1996, suggesting that the trapping program was successful in reducing fox populations. More than half of the cats and skunks trapped were in the Warm Springs/Fremont area. In 2003, the CDFG implemented a predator-control program at the Eden Landing Ecological Reserve to reduce predation on listed species (John Krause, pers. comm.).

4.3.5 Birds

The birds of the South Bay have been studied more than any other wildlife group. This focused attention results from the high diversity of birds in the region, the presence of several San Francisco Bay-area endemics and state and federally listed species, the plasticity demonstrated by a number of species in adapting to the anthropogenic changes (including salt pond development and urbanization) that have occurred in the South Bay, and the intensity of interest in the birdlife of the region by professional and amateur ornithologists. The birds of the Bay and associated salt ponds and marshes represent the most significant contribution of the South Bay to the avifauna of the Pacific Flyway, and the following discussion focuses primarily on birds associated with these areas. In addition, riparian habitats in the Study Area, though limited in extent, provide important foraging habitat for migrants and wintering birds and valuable breeding habitat for a few riparian-associated species.

Overview of Baylands Bird Communities. The San Francisco Bay area is extremely important to breeding birds and, particularly, to migratory waterbirds in the Pacific Flyway. The Bay provides important foraging and roosting habitat for more than one million waterbirds each year, supporting large proportions of the populations of some shorebird and duck species (Accurso 1992; Harrington and Perry 1995; Page et al. 1999; Stenzel et al. 1989; Stenzel and Page 1988; Takekawa et al. 2001). With its extensive mudflats, remnant salt marsh, and salt ponds, the South Bay in particular supports very high diversity and abundance of waterbirds (Harvey et al. 1992; Takekawa et al. 2000; Warnock 2004b). More than 250 bird species occur in the greater South Bay area with some regularity, and many of these are common inhabitants of the Shoreline Study Area and its immediate vicinity. More than 75 species of waterbirds use the salt ponds, tidal marshes, mudflats, subtidal habitats, and surrounding managed marshes, water treatment plants, and managed ponds regularly, with more than 50 species more occurring rarely and/or in low numbers. Species richness in the South Bay system is generally highest in fall and lowest in summer and winter, while waterbird abundance is highest in spring and winter (Strong 2003; Takekawa et al. 2001; Takekawa et al. 2004). In Bay-wide surveys, Bollman et al. (1970) found waterbird abundance to be lowest in summer, increasing rapidly in early September and peaking in December.

The high waterbird diversity in the South Bay is a function of the diversity of wetland and aquatic habitats in the region, while high bird abundance is a function of the high productivity of the South Bay estuary and, secondarily, of alternative habitats such as salt ponds. Despite the extensive loss and degradation of the South Bay's tidal marsh, and the invasion of the South Bay benthic invertebrate community by non-native species, this system is still extremely productive. The remnant tidal marshes not only provide habitat for marsh obligates such as the California clapper rail, they also play important roles as sources of nutrients and carbon for the aquatic system, resulting in high abundance of invertebrates on the mudflats and shallow subtidal areas (Warwick and Price 1975), and ultimately high fish populations. These invertebrates and fish in turn serve as prey to the myriad shorebirds, waterfowl, herons, egrets, gulls, terns, grebes, and other waterbirds that use the South Bay.

Salt ponds and other alternative habitats (such as artificial ponds and lakes, water treatment plant settling and oxidation ponds, muted and managed marshes, and managed ponds) also provide important habitat for waterbirds in the South Bay (Hanson and Kopec 1994; Harvey et al. 1992; Stralberg et al. 2003; Takekawa et al. 2000; Takekawa et al. 2001; Warnock 2004b). Though salt ponds are more or less closed systems, providing little input of carbon or nutrients to the estuary itself, the concentration of superabundant invertebrate prey in salt ponds, provision of alternate foraging habitat during high tide, provision of roosting sites, and concentration of fish in lower-salinity ponds results in suitable foraging conditions for a variety of waterbirds. For some species, such as the Wilson's phalarope, red-necked phalarope, black-necked stilt, American avocet, western snowy plover, Bonaparte's gull, American white pelican, and breeding gulls and terns, these ponds provide higher-quality nesting and/or foraging habitat than the existing tidal marshes or intertidal habitats. A number of other species use salt ponds primarily when their preferred intertidal habitats are inundated, or when high densities may cause some birds to forage in less optimal areas (Warnock and Takekawa 1995). For such species, the question of whether salt ponds and other alternate habitats are required for foraging, or whether they are required primarily for high-tide roost sites, varies among species, and possibly among seasons (i.e., being more important for

foraging when densities are high). Alternate habitats such as salt ponds and levees are required for high-tide roosting sites, refugia from strong winds, and foraging sites during prolonged winter storms, when winds, rain, and high water may limit foraging efficiency and limit the availability of intertidal foraging areas (Davidson and Evans 1986; Evans 1976; Pienkowski 1981).

Although birds may be very abundant in salt ponds during high tide, most bird activity is concentrated in small areas within the larger salt pond complexes. For example, Stralberg et al. (2003) reported that 90% of the small shorebirds and dabbling ducks in their South Bay study area were recorded in six of 22 ponds under study, while 90% of the larger shorebirds were recorded in ten of 22 ponds. This concentration is a result of the dispersion of suitable foraging habitat and prey availability, which may be concentrated in relatively few ponds having suitable water depths and salinities. It has been reported that salt ponds close to the edge of the Bay have greater bird use than those farther from the Bay, and that many shorebirds use mudflats and salt ponds in close proximity to one another (Warnock and Takekawa 1996), thus reducing commuting distances between low-tide intertidal foraging habitat and high-tide refugia within the ponds for birds that use both habitats. Studies of color-marked or radio-tagged shorebirds in the South Bay indicate that many individuals have high site fidelity and small home ranges, often using the same roosting and foraging sites consistently (Kelly and Cogswell 1979; Warnock and Takekawa 1996). Wintering western sandpipers in the South Bay were found to have a mean home range size of 22 km^2, and the mean distance between feeding and roosting areas was 2.2 ± 0.1 km, although some birds moved around quite a bit, particularly within pond complexes. Warnock and Takekawa (1996) found less movement from one side of the Bay to the other. While the ponds supporting the greatest use do tend to be closer to the Bay (Takekawa et al. 2005), and many birds may repeatedly use the same small areas, waterbirds in some areas are known to repeatedly travel longer distances (e.g., thousands of shorebirds regularly commuting more than four miles between intertidal foraging areas and high-tide roosting areas near the NWR headquarters in Newark; (Morris 2004)). The sudden appearance of large numbers of shorebirds when salt ponds were drained during ISP implementation (Krause, pers. comm.; H. T. Harvey & Associates Unpublished), or of large numbers of piscivores at prey fish "blooms" (Steve Rottenborn, pers. obs.), is also indicative of these birds' potential for significant local movement to exploit favorable foraging conditions.

A few studies have compared the use of salt ponds with the use of other available habitats (e.g., tidal marsh, mudflats, and subtidal areas) in the South Bay. Within salt ponds and nearby mudflats near Coyote Hills, Swarth et al. (1982) found higher bird species richness in low-salinity ponds than in higher-salinity ponds or mudflats, although relatively few species used the salt ponds at low tide. In contrast, Takekawa et al. (2001) found species richness and diversity in the North Bay to be higher in natural baylands (i.e., tidal marsh and mudflats) than in salt ponds during all seasons, while overall bird density was higher in salt ponds than in baylands in winter and spring (and overall was twice as high in salt ponds than in baylands). During Bay-wide surveys, Bollman et al. (1970) found that salt ponds supported densities of waterbirds (57-73 birds/acre) two to three times higher than mudflats (29-30 birds/acre) and open water (15-18 birds/acre). At any given time, the proportion of a salt pond or mudflat in use by foraging birds may be relatively small, as birds often concentrate in areas providing the most suitable conditions, complicating the comparison of densities among these habitat types. Studies of shorebird use

of different South Bay habitats during high tide, coordinated by SFBBO, are summarized under Shorebirds, below.

Stralberg et al. (2003), comparing use of salt ponds with a limited sampling of tidal marshes (though not including tidal mudflats in the comparison), found that salt ponds had significantly higher species richness than tidal marshes, with a mean of 47 species/pond. However, salt ponds supported high densities of relatively few species, with only occasional use by many of the species contributing to the high species richness in the ponds; in contrast, tidal marsh was used at lower densities by many species. Warnock et al. (2002) confirmed this finding, reporting that ten species (out of 75 recorded) composed >85% of all birds recorded in 22 salt ponds in the South Bay. Thus, tidal marsh provides habitat for more species more consistently; salt pond use by most species is more limited or irregular, but may be very important (to large numbers of individuals of at least some species) at times. Within salt ponds, species richness decreases with salinity, though many species use a wide range of salinities. Of the 50 most common species in salt ponds, the core salinity range for 34 included low-salinity (20-60 ppt) ponds, with 18 found only in this range; mid-salinity (60-120 ppt) ponds were within the core salinity range for 31 species. No species were restricted only to high-salinity ponds (Stralberg et al. 2003).

Stralberg et al. (2003) found waterbird species richness and diversity in tidal marshes negatively associated with the proportion of salt ponds in the surrounding landscape and positively associated with the proportion of surrounding mudflat and marsh. Within marshes, waterbird diversity was higher in marshes with more large channels, and the densities of ducks, larids, and shorebirds increased with increasing amounts of open water within the marsh; waders and other piscivores increased with larger channels in marsh.

The use of individual salt ponds, and foraging locations within those salt ponds, by foraging waterbirds is determined primarily by prey availability, which is mainly a function of salinity and water depth. Warnock et al. (2002) reported bird diversity in South Bay salt ponds to be highest at mid-salinity ponds (±126 ppt), while bird density on salt ponds peaks at higher salinities (±140 ppt). Due to variations in bill and leg length, foraging behavior (i.e., swimming, wading, or diving), and prey preferences, different waterbird species are able to, or prefer to, forage in water of different depths (Isola et al. 2000). Thus, ponds with more topographic heterogeneity, such as islands and uneven bottoms, are important in providing habitat for a greater diversity of foraging guilds by providing a range of foraging depths (Anderson 1970; Takekawa et al. 2004; Velasquez 1993; Warnock 2004b).

The most recent and comprehensive dataset on bird use of the South Bay salt ponds themselves has been compiled by USGS, which has been conducting monthly bird surveys at 53 ponds in the South Bay Salt Ponds complexes (USGS, unpubl. preliminary data). Surveys have been conducted since January 2002 in some of the Alviso Complex ponds (and at all Alviso ponds since January 2003). In addition, the Cargill-managed ponds in the Mowry, Newark, and Coyote Hills pond complexes have been surveyed by SFBBO (using the same methods used by USGS) since 2005. Because management of the salt ponds included in this study may have differed from prior management in anticipation of the purchase of these ponds (and/or their mineral rights) from Cargill (Takekawa, pers. comm.) and because these surveys overlap the implementation of ISP management in some ponds, these data cannot be clearly related to pre-ISP or to

ISP conditions, making it difficult to ascribe mechanisms to the patterns observed. Nevertheless, this dataset is useful in characterizing the general temporal and spatial distributions of birds in the Study Area salt ponds at the present time.

From October 2002 to June 2005, the surveys by USGS had recorded 75 species of waterbirds in the Alviso Complex. Excluding Ponds A19-A23 (since these ponds were not surveyed as many times as the remaining ponds), the number of species/pond ranged from a low of 30 species in the mostly dry Pond A6 to 59 in Pond A9. Ponds A1, A5, A7, A10, and AB2 supported 50-56 species each, while ponds with the lowest species richness included A6, A12, A13, A15, and A17. Although it is likely not possible to determine the mechanisms responsible for these patterns, since ISP conditions were implemented during the study period in some ponds, those ponds having high species richness tended to be large ponds with high topographic variability that included both shallow and deep water, thus providing foraging habitat for a number of foraging guilds. Low-diversity ponds tended to be deep-water ponds with little topographic heterogeneity or ponds that contained little water during the year. Ponds supporting high waterbird abundance during the period October 2002 to June 2005 in the Alviso Complex were Ponds A5 (due largely to high western sandpiper abundance, and high abundance of other species), A6 (due to the large California gull colony in this pond), and A9 (due to high abundance of many species, particularly ducks); Ponds A12, A13, A15, A16, A17, and AB1 supported the lowest bird abundance.

Continued surveys by USGS from July 2005 to August 2006 recorded more than 1.75 million observations of waterbirds representing 67 species in the Alviso Complex salt ponds (Takekawa et al. 2006). These ponds supported higher abundance of certain groups than the Ravenswood and Eden Landing complexes surveyed simultaneously, hosting 96% of the gulls, 84% of dabbling ducks, 83% of diving ducks, 74% of piscivores, and 71% of herons recorded among the three pond complexes. The complex consisting of A1, A2W, A2E, AB1, AB2, A3N, and A3W supported 55% of the diving ducks in the Alviso complex. Ponds A5, A6, and A8 collectively supported 80% of the small shorebirds and 42% of the medium shorebirds in the Alviso complex. The high-salinity ponds, such as pond A13, supported the highest numbers of phalaropes and eared grebes.

The majority of the information on birds of the salt ponds within the Study Area is based on data collected prior to ISP implementation since the ISP has been only recently implemented in some salt ponds (and the effects of this implementation on wildlife use have not yet been fully identified) and has not yet been implemented in other ponds. Ongoing studies by USGS, SFBBO, and others will help to refine the response of wildlife to implementation of the ISP. Already, monitoring data indicates an overall reduction in numbers of salt pond-specialist birds (e.g., eared grebes and phalaropes) as fewer ponds are managed for high-salinity conditions, an increase (at least locally, at the pond or pond complex level) in abundance of small shorebirds in ponds managed for shallow depths, and an increase in abundance of dabbling ducks in ponds that are converted from high-salinity to low-salinity ponds.

Birds in the South Bay overlap considerably in habitat preference and resource use, but general groups of species can be distinguished based on their physical adaptations, habitat associations, foraging behavior, dietary requirements and prey, the ways in which they use salt ponds as habitats (e.g., for nesting, foraging, or roosting), and their temporal occurrence in the Study Area. For the purposes of describing

the existing conditions of the bird community in the South Bay, six general groups of species have been identified: shorebirds; waterfowl (ducks and geese); large waders (herons, egrets, and ibis) and other piscivores (fish-eating grebes, cormorants, and pelicans); larids (gulls and terns); other waterbirds (eared grebes, coots, and rails); and landbirds (including raptors and passerines). Each of these groups is discussed in detail below.

Shorebirds. Perhaps no other group of birds using the South San Francisco Bay has been better studied than shorebirds, which include plovers, sandpipers, stilts, avocets, and phalaropes, and perhaps no other group relies more heavily on the South Bay. Comprehensive shorebird surveys of the Pacific Coast of the U.S., summarized by Page et al. (1999), have documented that the San Francisco Bay supports 41-97% (mean 67%) of estimated totals for key species for the entire West Coast in fall, 38-90% (mean 55.7%) in winter, and 24-86% (mean 52.3%) in spring. No other site on the West Coast of the U.S. supports a mean greater than 8% in any season. For 11 shorebird species, the San Francisco Bay supports >50% of the individuals recorded in all U.S. Pacific Coast wetlands in at least one season. The percentage of the total West Coast population of individual shorebird species that occurs in San Francisco Bay in fall, winter, and spring, respectively, include numbers as high as 62%, 59%, and 56% for black-bellied plovers (*Pluvialis squatarola*); 59%, 68%, and 54% for western sandpipers; 67%, 39%, and 73% for least sandpipers; 78%, 90%, and 58% for black-necked stilts; 97%, 88%, and 86% for American avocets; and 69%, 59%, and 57% for willets (*Catoptrophorus semipalmatus*). The San Francisco Bay supports an average of more than 40% of the West Coast populations over these three seasons for semipalmated plover (*Charadrius semipalmatus*), red knot (*Calidris canutus*), dowitchers (*Limnodromus* spp.), long-billed curlews (*Numenius americanus*), and marbled godwits (*Limosa fedoa*) as well. The San Francisco Bay likely supports more than one million shorebirds in spring and hundreds of thousands in the fall and winter (Stenzel et al. 1989). As a result of these numbers, the San Francisco/San Pablo Bay area has been designated as a site of hemispheric importance by the Western Hemisphere Shorebird Reserve Network (Harrington and Perry 1995), and the Don Edwards San Francisco Bay NWR has been designated a Globally Important Bird Area by the American Bird Conservancy (2004).

The South Bay is the most important part of the larger San Francisco Bay from the perspective of use by breeding, migrant, and wintering shorebirds. Of 838,000 shorebirds counted during a Bay-wide survey 16-18 April 1988, 70% were recorded south of the San Mateo Bridge, with the highest concentration at low tide occurring on the broad intertidal flats on the east side of the Bay between the San Mateo and Dumbarton bridges (Stenzel and Page 1988). Mudflats and salt ponds on the east side of the Bay between these two bridges supported approximately 305,000 shorebirds during this survey, compared to 62,000 on the west side of the Bay between the bridges and 224,000 south of the Dumbarton Bridge. Of nearly 379,000 shorebirds counted during another Bay-wide survey 9-12 September 1988, 75% were recorded south of the San Mateo Bridge; within this area, 128,000 shorebirds were south of the Dumbarton Bridge, compared to 25,000 on the west shore and 77,000 on the east shore between the Dumbarton and San Mateo Bridges (Stenzel et al. 1989). The wintering shorebird population in the South Bay was estimated by Harvey et al. (1988) to exceed 200,000.

Most of the shorebirds that use the South Bay do so only for foraging and roosting but do not breed here. Only four shorebird species breed within the baylands habitats of the South Bay, while 20 species

regularly use the South Bay for foraging and roosting as nonbreeders, and 19 additional shorebird species occur only as rare visitors to the area. Most individuals of most shorebird species in the South Bay forage primarily on intertidal mudflats when these flats are available at low tide. These individuals then seek high-tide refugia in salt ponds, on levees, in other alternative habitats in the area (e.g., water treatment plants, managed ponds, and muted or managed marshes), and to a limited extent in tidal marsh; here, most individuals of the larger shorebird species simply roost until the tide recedes again, while some individuals of the smaller shorebird species forage in their high-tide habitats. A few shorebird species remain in these alternative habitats throughout the tidal cycle, using salt ponds, water treatment plants, and managed ponds and marshes for foraging regardless of tide height.

Shorebird abundance in the South Bay is highest in spring and winter. For most species, the spring migration is rapid and compressed to a relatively brief period from early April to mid-May (Recher 1966; Stenzel and Page 1989), resulting in large numbers of individuals using the South Bay simultaneously. In contrast, the fall migration is more protracted for most species, as different sexes and age classes migrate in fall at different times. Shorebird abundance is lowest during summer, when only breeding individuals of four species and low numbers of non-breeders of other species are present. However, the summer period for shorebirds is very short in the South Bay – late spring migrants may move through the area as late as late May or early June, and the first fall migrants (usually Wilson's phalaropes) begin to arrive in mid-June, with the first southbound arrivals of a number of other species appearing by late June and early July. Fall migration then continues through October.

Breeding. Prior to conversion of tidal marshes to salt ponds in the San Francisco Bay area in the mid 1800s, only one shorebird species, the killdeer likely bred in the South Bay. This species breeds on open ground in a variety of habitats, and open sand, gravel, or soil suitable for breeding was likely present historically. However, the creation of salt ponds in the South Bay has enhanced breeding habitat for several species. The western snowy plover, which nests on salt flats and islands within salt ponds, likely did not breed in the South Bay prior to late 1800s; although salinas were present in the tidal salt marsh, they were not extensive and may not have been large enough to support breeding by this species (Goals Project 1999). This species was first recorded breeding in salt ponds in 1918 (Harvey et al. 1992), and today, snowy plovers nest on levees, islands, and salt flats throughout the South Bay salt ponds, occurring in highest concentrations in the Eden Landing area. This species is discussed in greater detail below in the Special-Status Wildlife Species section (Section 3.7).

The American avocet and black-necked stilt also did not breed in the San Francisco Bay area prior to the creation of salt ponds. These species were first recorded breeding in Bay-area salt ponds in 1926 and 1927, respectively (Gill 1977; Harvey et al. 1992). Since then, their populations have increased considerably, with avocet population estimates of 1800 pairs in 1971 (Gill 1977) and 540 pairs in 1981 (Rigney and Rigney 1981), and stilt population estimates of 400-500 pairs in 1971 (Gill 1977) and 600-650 pairs in 1981 (Rigney and Rigney 1981). More recently, a breeding-season survey of the South Bay by Rintoul and others (2003) counted 1184 black-necked stilts and 2765 American avocets, with the number of breeding pairs estimated at 135-590 for stilts and 440-1380 for avocets. No other coastal site along the Pacific Coast supports such high abundance of these two species (Rintoul et al. 2003).

Both stilts and avocets nest at scattered locations throughout the Shoreline Study Area, although Rintoul et al. (2003) noted particularly large concentrations of both species in New Chicago Marsh in Alviso, with another concentration of avocets in the Warm Springs area along the upper edges of the salt ponds and marshes (Figure 2). Rintoul et al. (2003) noted an increase in the importance of the Eden Landing area for nesting stilts and avocets since 1981 (Rigney and Rigney 1981). It is not clear whether their surveys covered the San Jose/Santa Clara WPCP, where on 10 May 1997, more than 30 stilt nests were found scattered over the sludge ponds during an informal survey (Steve Rottenborn, pers. obs.).

Rintoul et al. (2003) found 21% of 137 black-necked stilt nests in marshes and 69% around salt ponds; of 409 American avocet nests, 3% were in marshes and 93% were around salt ponds. Stilts used salt ponds and marshes in proportion to availability, while avocets favored salt ponds. Within marshes, stilts tended to use more heavily vegetated areas than avocets. Both species used similar habitats for brooding young (mostly salt ponds, with lesser numbers in marshes). Less than 20% of nests found were on levees; most were on islands, as reported by others (Gill 1973; Harvey et al. 1988; Rigney and Rigney 1981; Robinson et al. 1997; Robinson et al. 1999; Swarth et al. 1982). Both species commonly nest among nesting Forster's terns on islands.

Feeding. As noted previously, the South Bay is the single most important area on the west coast, south of Alaska, for use by migrant and wintering shorebirds. Surveys have documented more than 590,000 shorebirds present simultaneously 16-18 April 1988 (Stenzel and Page 1988) and 230,000 present 9-12 September 1988 (Stenzel et al. 1989) in the South Bay. Because these were only snap-shot surveys, and thus capture only a fraction of the shorebirds that use the South Bay as migratory stopover or staging areas, the actual number of birds that use the South Bay for foraging during migration is much higher. The San Francisco Bay is the northernmost location used by large numbers of shorebirds in winter on the West Coast (Warnock 2004a), and wintering shorebird numbers in the South Bay were estimated by Harvey et al. (1988) to exceed 200,000.

Shorebirds tend to forage in habitats, at times, under conditions, and on prey that provide high foraging efficiency while balancing predation risk and other adverse factors (Goss-Custard 1970; Goss-Custard 1979; Goss-Custard et al. 1977; Van de Kam et al. 2004). Shorebirds tend to concentrate foraging activity where suitable prey is most dense (Skagen and Oman 1996) and/or where such prey is most available (i.e., where the birds can reach and obtain food), although they may alter their behavior (e.g., foraging duration or foraging locations) based on competition from other shorebirds or energetic needs. For example, western sandpipers in the South Bay make more use of salt ponds during spring than during other seasons (Warnock and Takekawa 1996), possibly because high spring shorebird densities force some birds to spread out from preferred intertidal mudflats and forage more heavily in less optimal habitats. In winter, shorebirds may spend more time foraging and less time roosting due to decreased daylength, more rapid energy loss due to cool temperatures, and adverse effects of low temperature on food availability and foraging efficiency (Goss-Custard et al. 1977; Heppleston 1971; Kelly and Cogswell 1979; Van de Kam et al. 2004).

Most shorebird species in the South Bay are mudflat specialists, foraging primarily on intertidal mudflats when these flats are available at low tide (Anderson 1970; Kelly and Cogswell 1979; Recher 1966;

Stralberg et al. 2003; Swarth et al. 1982; Warnock et al. 2002; Warnock et al. 1995). These birds move to mudflats as they uncover on an ebbing tide, often concentrating at the edge of the receding tideline. Near the waterline, worms, crustaceans, and bivalves occur close to the surface, whereas these prey species recede deeper into the mud as the water level drops. Near the waterline, microhabitat use often varies among species based on bill and leg length; Semipalmated and black-bellied plovers feed on recently exposed mud, small sandpipers such as western and least sandpipers forage on recently uncovered mud and shallow water, mid-sized birds such as dunlin, red knots, long-billed dowitchers, and short-billed dowitchers forage in slightly deeper water, and larger shorebirds such as willets, long-billed curlews, and marbled godwits probe in deeper water.

Some authors have reported that the greatest concentrations of shorebirds occur at the receding tideline (Recher and Recher 1969; Stenzel and Page 1988; Storer 1951). Gerstenberg (1979) reported that shorebirds forage along the tideline until it reaches its ebb, then spread out over the tidal flats (especially when bird abundance is high), although he also noted that shorebirds may concentrate along the waterline on both the receding and incoming tide. All of these scenarios have been observed in the South Bay, where shorebirds may be observed foraging along the receding and incoming waterline, and often spread out over the flats as well (Steve Rottenborn, pers. obs.). It is likely that shorebirds use more of the tidal flats when densities are higher, as competition for space and food resources requires the birds to spread out over the flats more.

After the mudflat specialists have finished foraging on the mudflats, they may roost temporarily on the upper mudflats before leaving as the tide rises, or fly directly to alternate sites to roost or, to varying degrees, forage during high tide. Although sites such as water treatment plants, managed ponds (e.g., the Coyote Creek Reach 1A pond), managed/muted tidal marshes, and wet fields are used (heavily at times) by mudflat specialists during high tide, most shorebirds move to the salt ponds. Surveys of South Bay high-tide roosting and foraging sites, coordinated by SFBBO between October 1992 and May 1993, documented 51% of shorebirds using salt ponds at high tide, with 10% on levees around and within salt ponds and other habitats, 10% in tidal marsh, 12% in diked marsh, and up to 4% in inactive salt ponds, uplands, freshwater ponds (including sewage treatment ponds), tidal islands, and salt pannes (Hanson and Kopec 1994).

The use of salt ponds for foraging by mudflat specialists varies considerably among species, and for some species, it varies among individuals, seasons, and possibly age classes. Of the mudflat specialist species, most of the individuals observed in salt ponds at high tide are roosting rather than foraging. For example, over all surveys and all shorebird species recorded during SFBBO's 1992-1993 study, roosting composed 68% of activity at these high-tide areas, while foraging composed 26% of shorebird activity (Hanson and Kopec 1994). The percentage of birds in a given location that were foraging at high tide varied considerably among surveys; for example, <1% of more than 24,400 shorebirds in Pond R1 on 22 March 1993 were foraging, whereas 70% of the 6200+ birds (of similar species composition) in the same pond on 3 May 1993 were foraging at high tide. At times, nearly all birds in a given location were observed foraging at high tide, with foraging activity being particularly high in spring.

Long-billed curlews, marbled godwits, and black-bellied plovers roost in salt ponds but do not use them heavily for foraging (Warnock et al. 2002). Black-bellied plovers, willets, and dowitchers make somewhat greater use of salt ponds for foraging, but still do not forage in salt ponds to a great extent. Most western sandpipers and dunlin use salt ponds primarily for roosting, but forage on moist mud and in shallow water to a greater extent. A greater proportion of least sandpipers seems to use salt ponds for foraging than is observed in other mudflat specialists (Steve Rottenborn, pers. obs.).

Telemetry studies by Warnock and Takekawa (1995; 1996) determined that western sandpipers made greater use of salt pond levees and shallows for foraging during spring, when densities in the South Bay were higher, than during winter. These results suggest that birds depositing fat prior to spring migration may need to spend more time foraging (and thus forage in salt ponds during high tide), and that at higher densities (such as occur during spring migration), more birds are relegated to less preferred habitats, such as salt ponds. Some individuals of other mudflat specialists, particularly least sandpipers, dunlin, and semipalmated plovers, may also take advantage of suitable foraging conditions within salt ponds and remain in these ponds throughout the tidal cycle; even within salt ponds, these birds forage primarily at low tide, with most individuals roosting at high tide (Hanson and Kopec 1994; Warnock et al. 2002).

The mild microclimate of the South Bay may help to explain its high bird use during winter (Warnock and Takekawa 1996). Nevertheless, alternate foraging sites may be particularly important for mudflat specialists during the wet season. High winter tides, combined with sustained strong winds and/or flooding, may reduce the extent to which intertidal mudflats are uncovered, temporarily limiting the availability of these preferred foraging habitats (Storer 1951). Flooding may also wash silt onto mudflats, reducing prey availability or foraging efficiency (Gerstenberg 1979; Warnock and Takekawa 1996). Studies have demonstrated that dunlin in coastal areas may move inland to forage after heavy rains (Warnock et al. 1995).

Several species of shorebirds make little or no use of intertidal mudflats, instead preferring the "alternate" habitats for foraging regardless of tide height (Harvey et al. 1988; Stenzel and Page 1988; Storer 1951; Swarth et al. 1982; Warnock et al. 2002). American avocets forage in shallow pools and wet mud on mudflats, and occasionally in deeper water near the tideline (Hamilton 1975; Storer 1951; Warnock et al. 2002), and snowy plovers may use mudflats for foraging as well, but these species are most abundant in the South Bay in salt ponds. Black-necked stilts and Wilson's and red-necked phalaropes also occur in the South Bay primarily in salt ponds, rarely foraging in tidal habitats. Greater yellowlegs and lesser yellowlegs (*Tringa flavipes*) forage in a variety of nontidal habitats in the South Bay, including salt ponds, and occur less frequently on tidal mudflats. While these seven pond specialists may occur by the hundreds or thousands in alternate habitats other than salt ponds, the salt ponds support the vast majority of the South Bay's populations of these species.

Within the salt ponds, water depth and salinity influence the distribution of foraging shorebirds. The abundant invertebrates of the mid- and high-salinity ponds (60-200 ppt), namely brine shrimp, brine flies, and reticulate water boatmen, are important food sources for shorebirds (Larsson 2000; Maffei 2000b; Stralberg et al. 2003; Warnock et al. 2002), but their availability to shorebirds is limited by water depth. Most shorebirds forage in water less than ten to 15 centimeters deep, with depths below four centimeters

being preferred by smaller species such as the western sandpiper, least sandpiper, and dunlin (Isola et al. 2000; Safran et al. 1997). Thus, only the moist soils along the edges of salt ponds, and moist soil or very shallow water within the ponds, provide suitable foraging habitat for these wading species.

The extent of shorebird foraging habitat present within the salt ponds varies considerably among ponds and seasons, but at any given time a relatively small proportion of the salt pond complexes provides suitable conditions (e.g., moist soil or shallow water <ten centimeters deep) for foraging by most shorebirds. Deeper ponds without shallowly sloping sides provide foraging habitat only in a very narrow zone along their immediate periphery. For example, a 12 in-wide strip of moist-soil and shallow-water foraging habitat around the edge of pond A2W (which represent the ponds that lack shallowly sloping sides and are usually flooded) would represent only ±0.1% of the area of this pond.

Calculating the area of suitable foraging habitat for shorebirds over an entire pond complex and across multiple seasons is problematic. Water depth in seasonal ponds may vary considerably among years, seasons, and even months or weeks depending on precipitation levels and temperature. Even in ponds where water levels are managed more actively, the lack of data on microtopography of the pond bottoms and the vagaries of management make it difficult to predict the extent of areas providing water <ten centimeters deep, and floating mats of algae in late summer and fall may provide foraging habitat for birds in ponds >ten centimeters deep. Furthermore, extensive dry flats with thick salt crusts provide only marginal foraging habitat for shorebirds, as prey densities may be low away from the moist-soil and ponded areas. Rough estimates suggest that at any one time, less than 15% of the total salt pond area provides foraging habitat for most shorebirds under ISP management during winter and early spring (when ponds contain the most water), and less than 25% of the salt pond area provides suitable foraging habitat during late summer and fall (when ponds are driest).

In contrast, phalaropes, and American avocets to a lesser extent, can forage while swimming. Thus, these birds are able to use the entire surface area of a pond, taking advantage of prey near the surface of the water. Phalaropes can draw invertebrates from deeper water upward in the water column by spinning on the water's surface. However, much of the invertebrate biomass of the mid- and high-salinity salt ponds may still occur at depths greater than those that can be used by these shorebirds (Laine, pers. comm.). Although brine shrimp account for most of the biomass of the invertebrates within these high-salinity ponds, the nutritive value of brine shrimp to foraging shorebirds may be limited, as Rubega and Inouye (1994) found that red-necked phalaropes could not survive foraging on brine shrimp alone. Brine flies (both adults and larvae), and water boatmen to a lesser extent, are thus very important to shorebirds that forage in South Bay salt ponds (Anderson 1970).

Most vegetated tidal marsh receives little use by foraging shorebirds because of the height and/or density of marsh vegetation. However, more open areas within the marsh are used for foraging by some species. Willets forage in the vegetated portions of tidal marshes (Gerstenberg 1979; Kelly and Cogswell 1979; Long and Ralph 2001), particularly when these areas are flooded during very high tides but occasionally even during low tide (Kelly and Cogswell 1979). Long-billed curlews, marbled godwits, least sandpipers, and other species occasionally forage in vegetated tidal marsh areas as well, usually in more sparsely vegetated areas but occasionally in dense (but short) pickleweed. Large numbers forage on intertidal flats

along the larger sloughs within marshes when the flats are exposed, but most shorebirds avoid areas with dense, tall vegetation, and therefore do not forage in most of the marsh plain. These birds will forage, sometimes abundantly, in shallow marsh ponds and pannes within the high marsh, and in areas where bare mud and shallow water is interspersed with short pickleweed vegetation. Stralberg et al. (2003) reported that the proportion of small shorebirds foraging (rather than roosting) was higher in tidal marsh than in salt ponds. Thousands of individuals of a variety of species use New Chicago Marsh, a managed marsh (i.e., not considered a tidal marsh) in Alviso, for foraging at both low and high tide, as this marsh provides extensive shallow-water marsh pond/panne habitat interspersed with low pickleweed. However, most such areas that formerly occurred within South Bay tidal marshes have been destroyed by fill and diking, and at this time, high marsh habitat within fully tidal marshes is of limited importance for foraging shorebirds in the South Bay.

Birds are often classified by their foraging methods and habitats, which are largely a reflection of their physical adaptations for foraging and their preferred prey, into foraging groups or guilds. As indicated in the USGS unpublished preliminary bird data from Alviso salt ponds, shorebirds in the South Bay are generally grouped into three foraging guilds – shallow probers, deep probers, and sweepers.

Shallow probers are species that pick prey off the surface of the water or sediment (generally after locating the prey visually), or that probe at shallow depths within mud or moist sand to locate prey tactilely. The more common shallow probers in the South Bay include the killdeer, black-bellied plover, semipalmated plover, snowy plover, red knot, dunlin, least sandpiper, and western sandpiper. This guild represents the majority of the migrant and wintering shorebirds in the South Bay, with hundreds of thousands of western sandpipers, tens of thousands of least sandpipers and dunlin, thousands of black-bellied plovers and semipalmated plovers, and hundreds of snowy plovers and red knots using the South Bay at times (Harvey et al. 1992; Stenzel et al. 1989; Stenzel and Page 1988). Warnock and Bishop (1998) have identified the San Francisco Bay as a major staging area for the western sandpiper because individuals are present for longer periods of time and presumably put on more fat than in the stopover areas that are used, but are less important, elsewhere along the central California coast. The western sandpiper is by far the most abundant shorebird species present in the South Bay.

Deep probers include species generally having larger bodies and longer legs and bills than the shallow probers. These species, which probe more deeply into moist sediment and burrows for prey and do less picking of items from the surface (except for yellowlegs), include short-billed dowitchers (*Limnodromus griseus*), long-billed dowitchers, long-billed curlews, marbled godwits, whimbrels (*Numenius phaeopus*), and willets. Though not nearly as abundant in the South Bay as the shallow probers, this guild is still represented by tens of thousands of dowitchers, 10,000+ willets and marbled godwits, and hundreds of long-billed curlews, whimbrels, and greater and lesser yellowlegs during migration and winter (Harvey et al. 1992; Stenzel et al. 1989; Stenzel and Page 1988). The salt pond surveys by USGS identified the highest abundance of both shallow and deep probers (the vast majority of which were likely roosting, rather than foraging, in these ponds) in Alviso Ponds A5 and A7 (Takekawa et al. 2005).

Sweepers include the American avocet, black-necked stilt, Wilson's phalarope, and red-necked phalarope. All of these species forage by picking visually identified prey from the soil surface or water column, but

avocets also forage by sweeping their bills from side to side through water and mud, tactilely detecting prey. Phalaropes may create a vortex by spinning in the water and drawing prey to the surface. In the South Bay, breeding populations of American avocets and black-necked stilts are augmented in winter, when up to 24,500 avocets and 11,500 stilts are present (Harvey et al. 1988). High counts of phalaropes in the South Bay include counts of 37,462 Wilson's phalaropes on 6 August 1984 and 19,000 red-necked phalaropes on 18 August 1981 (Harvey et al. 1992), with combined phalarope counts of as many as 70,000 individuals (Harvey et al. 1988). Both species are much less common in spring than in late summer and fall in the South Bay. Due to the presence of the South Bay salt ponds, the San Francisco Bay is one of five major staging areas for adult Wilson's phalaropes prior to their non-stop migration to South America (Colwell and J.R. Jehl 1994). The salt pond surveys by USGS identified the highest abundance of sweepers in Alviso Ponds A1, A5, A7, A8, A9, A14, A16, and AB2 (Takekawa et al. 2005).

Shorebirds in the South Bay eat a wide variety of invertebrates, and occasionally small fish. Brine shrimp, brine flies, and reticulate water boatmen probably compose the bulk of the prey taken in salt ponds, although *Corophium* spp., annelids, polychaetes, and other invertebrates are known to be taken in salt ponds as well (Anderson 1970). *Corophium* spp., polychaetes, bivalves, and snails likely compose the bulk of the prey taken on mudflats (Harvey et al. 1992; Recher 1966; Swarth et al. 1982). Shorebirds are very flexible and opportunistic in their diets, with considerable dietary overlap among species and foraging guilds (Skagen and Oman 1996). They often take prey in accordance with availability, concentrating where prey is most dense (Goss-Custard 1970; Goss-Custard 1977; Goss-Custard 1979). Thus, the hydrologic regimes and ecosystem processes that maintain abundant invertebrate populations are more important than the specific invertebrate taxa available. As a result, shorebirds are still abundant in the South Bay, and still show a preference for foraging on intertidal mudflats, despite the widespread and pervasive invasions of the South Bay benthic invertebrate community by nonnative species.

Roosting. Shorebirds generally roost, resting and preening, when they are not foraging. Many mudflat specialists roost on the upper flats after initially foraging on the receding tide, then fly to alternate habitats to roost as the mudflats flood. In the South Bay, the most commonly used high-tide roosts for both pond specialists and mudflat specialists are shallows and bare sediment within salt ponds, levees surrounding and (especially) between salt ponds, and islands and artificial structures such as boardwalks within these ponds (Warnock et al. 2002). Surveys coordinated by SFBBO in 1992 and 1993 (Hanson and Kopec 1994) found that 28% of all birds were in shallow water of salt ponds at high tide (most roosting), with an additional 23% on islands within salt ponds and another 10% on levees around a variety of habitats, including salt ponds. Islands within salt ponds were found to be used primarily for roosting, whereas shallow water within salt ponds was used by similar numbers for foraging and roosting. Levees were used for roosting more in spring than in winter, and infrequently in fall.

Although some shorebirds forage at high tide within salt ponds, most birds, including both pond specialists and mudflat specialists, roost during high tide (Hanson and Kopec 1994; Warnock et al. 2002). Major high tide shorebird roosts in the South Bay, based on the unpublished preliminary USGS bird survey data and SFBBO's 1992-1993 study (Hanson and Kopec 1994), are indicated on Figure 3, which also depicts the sites of major western sandpiper roosts in the South Bay identified by Warnock and Takekawa (1995).

Shallowly flooded marsh ponds, marsh pannes, managed marshes, managed ponds, and water treatment plant drying ponds are also used for roosting, and American avocets, willets, long-billed curlews, marbled godwits, dunlin, and dowitchers roost to some extent in tidal marshes with short vegetation (PRBO Conservation Science 2004; Storer 1951). Diked and tidal marshes along the Foster City/Redwood Shores shoreline provide roosting sites for large numbers of birds at times, particularly larger species such as willets, marbled godwits, and black-bellied plovers (Hanson and Kopec 1994).

Due to their proximity to foraging habitat, protection from predators, and protection from wind and wave action, some high-tide roosts are used consistently, and studies of color-marked or radio-tagged shorebirds in the South Bay indicate that many individuals use the same roosting sites consistently (Kelly and Cogswell 1979; Warnock and Takekawa 1995). Other shorebird roosts, however, may be more ephemeral or inconsistently used (Colwell et al. 2003). For foraging shorebirds, site fidelity is tied to consistently suitable conditions at certain locations (e.g., certain ponds that consistently provide shallow foraging habitat for shorebirds) rather than the locations themselves. While the same is likely true of shorebird roost sites, fidelity to a roost site is less easily explained given the abundant, widespread nature of ostensibly suitable roosting habitat on salt pond levees throughout the South Bay.

Waterfowl. Historical accounts of waterfowl numbers in the San Francisco Bay area attest to the abundance of ducks and, to a lesser extent, geese using the Bay area during migration and winter; for example, more than 300,000 ducks were sold in San Francisco markets during the 1911-1912 waterfowl season (Skinner 1962). The South Bay undoubtedly supported large wintering waterfowl populations, as reported by Skinner (1962) for the Alvarado area and the Santa Clara Valley, and the town of Drawbridge near Alviso "became a resort solely for duck hunters arriving from San Francisco by regular trains in the 1880s" (Harvey et al. 1992). The loss of 90% of the Bay's wetlands, along with hunting pressures, contamination, and other factors led to a decline in waterfowl populations, although this decline is not well documented for the South Bay. Currently, the South Bay supports fairly large migrant and wintering populations of ducks, with several breeding species as well.

More than 32 species of waterfowl use the baylands and immediately adjacent habitats of the South Bay. Of these, eight species breed regularly (with populations augmented considerably during the nonbreeding season), nine additional species occur regularly during migration and winter, and at least 15 more occur irregularly and/or in very low numbers in the baylands as nonbreeders. Harvey et al. (1988) reported that wintering waterfowl in the South Bay (south of the San Mateo Bridge) in 1981 exceeded 75,000 individuals, with more ducks on salt ponds than in the Bay, especially from January through April. Surveys in 1987-1990 revealed approximately 57,000 dabbling ducks (ducks that feed without submerging their entire bodies) and 220,000 diving ducks (Goals Project 1999) in the Bay area. The South Bay salt ponds were found to support up to 76,000 wintering waterfowl, representing more than one-quarter of the Bay's waterfowl population, including 89% of the Bay's northern shovelers, 67% of the ruddy ducks, half of the buffleheads, and 17% of the canvasbacks wintering in the Bay (Accurso 1992; Takekawa et al. 2000).

Breeding. Though not nearly as important to nesting waterfowl in the Bay Area as the Suisun Bay (Goals Project 1999; Harvey et al. 1992), the baylands habitats of the South Bay support eight regularly nesting waterfowl species: the mallard, gadwall, and Canada goose (breeding populations of which are introduced) are fairly common breeders, while the cinnamon teal, northern pintail (*Anas acuta*), ruddy duck, lesser scaup, and northern shoveler breed in smaller numbers. Several other species, including the green-winged teal (*Anas crecca*), blue-winged teal (*Anas discors*), canvasback (*Aythya valisineria*), and redhead (*Aythya americana*), have been recorded breeding only a few times in the Study Area (Santa Clara County Bird Data Unpublished).

Few data exist on breeding population estimates for these waterfowl species in the South Bay. The most comprehensive survey and population estimate for this area was by Gill (1977). During the 1971 breeding season, he found 21 nests or broods of the northern pintail, 19 of the gadwall, eight of the mallard, five of the ruddy duck, four of the cinnamon teal, and one of the northern shoveler in the South Bay. Based on his observations, Gill estimated breeding populations of these species at 50-100 pairs of pintails, 100-150 pairs each of gadwalls and mallards, 50-100 pairs of ruddy ducks, 75-100 pairs of cinnamon teal, and one to five pairs of shovelers in the South Bay. Based on breeding bird atlas work and other observations by birders, current populations of these species likely exceed Gill's 1971 estimates. For example, 650 gadwalls (including 25 broods of young) on 24 July 1993 at the Sunnyvale WPCP (Steve Rottenborn, pers. obs.) attest to much higher breeding abundance than was estimated by Gill. In addition, the lesser scaup has become a regular breeder (albeit in low numbers, likely ten to 20 pairs or more) in the South Bay since Gill's studies (Santa Clara County Bird Data Unpublished).

None of the 41 nesting attempts observed by Gill in salt marsh was successful, leading him to postulate that breeding populations in the South Bay were limited by the availability of freshwater habitats. The nesting microhabitats of these waterfowl within the South Bay are poorly known since nests are usually well hidden, and most breeding is detected by the observation of adults with broods of precocial young. Nesting by most of these species likely occurs in dense herbaceous vegetation in the upper tidal marsh, managed wetlands, upland transition areas, ruderal vegetation on levees, and upland areas surrounding ponds, sloughs, and ditches, such as weedy lots and fields. In contrast, the ruddy duck builds its nests in emergent vegetation in freshwater marshes and the marshy borders of freshwater ponds and ditches.

Important breeding areas for waterfowl in the South Bay combine freshwater or brackish seasonal wetlands with extensive grassy or ruderal vegetation for nesting and fresh, brackish, or low-salinity ponds and marshes for brooding of young. Such areas occur in the Study Area in the Palo Alto Flood Control Basin and vicinity, the Moffett Field/Crittenden Marsh area, the Sunnyvale and San Jose-Santa Clara WPCPs, the Sunnyvale Baylands, and the Coyote Creek Reach 1A waterbird pond.

Foraging and Roosting. The South Bay is an important foraging area for migrant and wintering waterfowl. All of the breeding species are present in much greater abundance during the nonbreeding season than during summer, and they are joined by other species that occur in the South Bay solely as nonbreeders. Duck abundance in the South Bay increases in August and September as migrants, particularly northern shovelers, arrive in salt ponds and marshes. Numbers of other dabbling ducks and

several species of diving ducks increase through the fall and into winter, and remain high into March (Santa Clara County Bird Data Unpublished; Takekawa et al. 2005).

Dabbling ducks forage in a variety of habitats in the South Bay, including mudflats, shallow subtidal habitats, tidal sloughs and marsh channels, marsh ponds, managed and muted tidal marsh, seasonal wetlands, managed ponds, and water treatment plants. In these areas, dabbling ducks feed on a variety of aquatic plants and invertebrates. Because these species do not typically dive for food, dabbling ducks usually forage in water less than 30 centimeters deep (Page 2001). Within salt ponds, salinity is also important for these birds. The plants on which many dabbling ducks feed cannot tolerate high salinities, and thus dabbling duck abundance tends to be highest on lower salinity ponds (20-63 ppt) ponds, with few in ponds >154 ppt (Accurso 1992).

The most abundant dabbling ducks wintering in the South Bay are the northern shoveler, American wigeon (*Anas americana*), northern pintail, mallard, and gadwall (Takekawa et al. 2005). Shovelers are both abundant and flexible in habitat use in the South Bay, although they do not use tidal habitats frequently (Swarth et al. 1982). The northern shoveler was the third most abundant species recorded at the Coyote Creek Reach 1A waterbird pond during monitoring from 1992 to 2003, composing 81% of the waterfowl recorded there (Strong 2003), and counts of 4750 (19 Dec 1999) at the San Jose-Santa Clara WPCP and 5500 (20 December 1996) at the Sunnyvale WPCP have been recorded (Santa Clara County Bird Data Unpublished). Swarth et al. (1982) found shovelers to be much more abundant on salt ponds than in tidal habitats, with 16,500 shovelers counted on two salt ponds during a census in early November. In contrast, these observers found American wigeon, canvasback, scaup, and surf scoters to be much more abundant on the Bay than in salt ponds. Ruddy ducks and northern pintails were common in both habitats.

Diving ducks are the most abundant wintering waterfowl in the South Bay. Common species include the lesser scaup, greater scaup (*Aythya marila*), ruddy duck, canvasback, bufflehead (*Bucephala albeola*), surf scoter, common goldeneye (*Bucephala clangula*), and red-breasted merganser (*Mergus serrator*). These species may "tip up" for food in shallow water, but more frequently dive completely underwater to obtain food. Bivalves, including large numbers of Baltic clams, are a favored food item for diving ducks such as scaup, canvasbacks, and surf scoters, and canvasbacks often congregate over bivalve beds (Miles 2000b; Takekawa and Marn 2000; White et al. 1988). Ruddy ducks forage on aquatic vegetation (such as wigeon grass), which grows primarily in lower-salinity ponds, and invertebrates, including mollusks and water boatmen (Anderson 1970; Miles 2000a). Brine fly larvae/puparie are important to lesser scaup foraging on South Bay salt ponds (Anderson 1970).

Diving ducks are common in the open waters of the Bay, where large flocks of lesser and greater scaup, canvasbacks, and other species often congregate to roost. Although diving ducks may forage in water up to ten meters deep (Miles 2000b), these birds forage primarily in water only a few meters deep (John Takekawa, pers. comm.), and therefore much of the Bay is not available to (or does not provide high-quality foraging conditions for) these birds for foraging, and foraging flocks of diving ducks tend to congregate over shoals and over intertidal flats when they are inundated at high tide. Diving ducks are

also common on salt ponds, in larger sloughs, and on some artificial lakes, such as Shoreline Lake in Mountain View.

Surveys conducted between October 1987 and March 1988 found that scaup composed 41%, scoters 21%, northern shovelers 11%, ruddy ducks 9% and canvasbacks 6% of all waterfowl on the open waters of the Bay (Takekawa et al. 1988). A large percentage (up to 25% or more) of the Bay's wintering populations of scaup and surf scoters occur in the South Bay, but most forage on the Bay itself, whereas buffleheads and ruddy ducks forage more extensively in salt ponds (Takekawa et al. 1988). Conducting winter censuses (November 2000 – February 2001) of the Bay south of the Bay Bridge, Ford et al. (2002) estimated more than 168,000 scoters, 164,000 scaup, and 53,000 ducks of other species on the open waters of the Bay. Although the center of abundance moved around somewhat among surveys, the greatest concentrations of scoters were north of the San Mateo Bridge, while several centers of abundance for scaup included areas between the Dumbarton and San Mateo Bridges and south of the Dumbarton Bridge.

Although total numbers of waterfowl are higher on the Bay than in salt ponds in the South Bay, lower-salinity salt ponds (20-63 ppt) of moderate size (50-175 ha) support the highest densities of waterfowl in the Study Area (Siegel and Bachand 2002). Ponds A9 and A10 in Alviso, and the Sunnyvale WPCP ponds, have been identified as being particularly important to northern pintail populations in the South Bay (Casazza and Miller 2000). Results of the salt pond surveys by USGS (Takekawa et al. 2005) indicate that in the Alviso Complex, Ponds A1, A2E, A2W, A5, A7, A9, and AB2 support high numbers of dabbling ducks, with the higher salinity Ponds A12, A13, and A19-A23 supporting few dabblers. Ponds A1, A2W, A9, and A10 support large numbers of diving ducks, primarily ruddy ducks and scaup, with fewer buffleheads and canvasbacks.

On decommissioned salt ponds in the North Bay, Takekawa et al. (2004) found that diving benthivores, primarily diving ducks, dominated the bird community on the salt ponds. Diving duck densities were four times higher in salt ponds than in the natural baylands in winter and spring, as contrasted with dabbling ducks, which were consistently higher in baylands habitats than in salt ponds. In South Bay salt ponds, dabbling ducks tend to dominate the salt pond bird communities, with northern shovelers accounting for 41-46% of all birds in ponds at low tide (Warnock et al. 2002). Ruddy ducks are the next most abundant duck wintering on South Bay salt ponds (primarily on low-salinity ponds), with up to 19,000 recorded on these ponds (Accurso 1992). In contrast to shorebirds, the vast majority of which use salt ponds primarily at high tide, duck numbers on South Bay salt ponds are similar at high and low tides (Warnock et al. 2002).

Stralberg et al. (2003) found that dabbling duck species richness in the South Bay tended to be higher in marshes than in salt ponds, and that dabbling ducks were more abundant in marshes at low tide, while diving ducks were more abundant at high tide. Dabbling ducks reached peak densities in salt ponds in fall and early winter, while diving ducks peaked in early spring. Dabbling duck densities tended to be higher in salt ponds with more natural upland, less tidal marsh, and less development surrounding the pond, while diving ducks tended to be higher in ponds closer to the Bay. Ninety percent of the dabbling ducks

recorded during this study were recorded in just six of 22 ponds, while 90% of the diving ducks were recorded in nine ponds, indicating that the majority of ponds support few ducks.

Diving ducks, and many dabbling ducks, often roost while swimming in the open waters of the Bay, on sloughs, and in salt ponds. Dabbling ducks, and diving ducks to a lesser extent, also roost on the edges of mudflats and marshes, on islands and levees within ponds, and on mud and shallow water within the bottoms of salt ponds.

Large waders and other piscivores. This category includes a diverse group of approximately 20 species of piscivorous (i.e., fish-eating) waterbirds that occur in the South Bay, including pied-billed grebes (*Podilymbus podiceps*), western grebes (*Aechmophorus occidentalis*), Clark's grebes (*Aechmophorus clarkii*), loons (which are uncommon to rare visitors), double-crested cormorants, American white pelicans, brown pelicans (*Pelecanus occidentalis*), and large waders (i.e., herons, egrets, and ibis). Several other species, including gulls, terns, mergansers, and belted kingfishers (*Ceryle alcyon*) also forage for fish in the Study Area but are treated in other categories.

While a number of piscivores breed in the South Bay, numbers of most of these species are highest during the nonbreeding season. Western and Clark's grebes do not nest in the baylands of the South Bay but may occur in the area, particularly on salt ponds and in the open Bay, year-round (being most abundant in winter). Brown pelicans typically occur in San Francisco Bay as post-breeding dispersants during summer and fall (Ainley 2000a). American white pelicans are most abundant from June through December.

Breeding. Several piscivorous species in this category nest in the South Bay. Pied-billed grebes nest in freshwater wetlands, building floating nests of vegetation, in scattered areas surrounding the salt ponds and tidal wetlands in the Study Area. Double-crested cormorants nest on electrical transmission towers at several locations in the Study Area, and on the levee between Ponds A9 and A10 in Alviso (see Figure 5); this species and the white-faced ibis (*Plegadis chihi*) are discussed in greater detail in the Special-Status Wildlife Species section below (Section 3.7).

Herons and egrets nest in the Study Area as well (Figure 4). A sizeable colony of waders was detected at Mallard Slough in Alviso in the mid 1970s (Harvey et al. 1992). This colony steadily increased in size, peaking at over 800 nests, through the 1990s. Ten nesting pairs of great egrets were discovered in 1977, increasing to 30 pairs in 1990, when an estimated 266 pairs of snowy egrets and 115 pairs of black-crowned night-herons were present. Up to nine pairs of cattle egrets (*Bubulcus ibis*) and one or more pairs of little blue herons (*Egretta caerulea*) and white-faced ibis also nested in the Mallard Slough colony in the early 1990s. However, this colony was abandoned for unknown reasons in 1999. That year, a small colony of great egrets, containing up to 30 adults and eight nests, became established nearby along lower Coyote Creek near the Reach 1A waterbird pond. Twelve great egret nests were found here in 2000, and seven pairs of great blue herons nested at this location in 2001 (Santa Clara County Bird Data Unpublished). However, this colony has since been abandoned.

Since 1998, small heron rookies have appeared on islands in inland reservoirs in the South Bay (e.g., Lake Cunningham, Almaden Lake, and Vasona Reservoir), and several other small colonies have appeared in the immediate Study Area. Currently, heron rookeries in the vicinity of the Alviso Complex include a colony of snowy egrets and black-crowned night-herons at the Palo Alto Baylands duck pond; small numbers of great blue herons nesting on transmission towers in Ponds A2W, A2E, A3N, and A19 (and on a duck blind in Pond A2E); great egrets, snowy egrets, and black-crowned night-herons nesting in California bulrush at the west end of the Coyote Creek Lagoon near Newby Island (first noted in 2000); and great egrets, snowy egrets, black-crowned night-herons, and little blue herons in Guadalupe Slough between ponds A4 and A5 (Santa Clara County Bird Data Unpublished; Strong 2004a). Green herons (*Butorides virescens*) nest at low densities in scattered locations throughout the South Bay, including mixed-species heronries but also as isolated pairs or in small monospecific groups on duck blinds, along sloughs, and in trees and brush.

Foraging and Roosting. The piscivorous birds of the South Bay forage in a variety of habitats and locations where prey fish are available. The low-salinity salt ponds that support fish, tidal sloughs and channels, edges of intertidal mudflats, nontidal ponds and channels, and artificial lakes such as Shoreline Lake provide the highest-quality foraging areas, and large frenzies of feeding activity may be observed at these locations, presumably when conditions result in large fish concentrations. Brown pelicans usually plunge-dive for fish and therefore require water several feet deep, but American white pelicans and cormorants swim while feeding and can thus feed in shallower water. Although double-crested cormorants, western and Clark's grebes, and brown pelicans forage to varying degrees within the open waters of the Bay, American white pelicans apparently do not, instead preferring nontidal waterbodies (Cogswell 2000; Harvey et al. 1988). Large wading birds are constrained by water depth, and are usually seen foraging from the edges of a body of water or wading within the shallows. Pied-billed grebes and most of the herons and egrets often forage along freshwater streams and in smaller ponds in the South Bay, and great blue herons and great egrets occasionally forage for small mammals in upland fields and ruderal areas.

The larger piscivores move around the South Bay in search of suitable foraging conditions, allowing them to exploit particularly large concentrations of fish. Cormorants and pelicans exhibit movements between foraging areas at inland reservoirs and the South Bay, although most foraging likely occurs within the baylands habitats (Steve Rottenborn, pers. obs.). Piscivore density tends to be lower in salt ponds at low tide than at high tide, as some birds move to intertidal flats to forage (e.g., herons and egrets) or roost (e.g., pelicans) at low tide (Stralberg et al. 2003).

Within salt ponds, the fish commonly taken by piscivores include the mudsucker, topsmelt, sculpin, and stickleback (Cogswell 2000; Harvey et al. 1988). These fish are usually found in water having salt concentrations up to 70-80 ppt, and most cannot tolerate salinity >40 ppt (Carpelan 1957; Lonzarich 1989). As a result, most piscivore use of salt ponds is concentrated in ponds with lower salinities (Anderson 1970; Swarth et al. 1982).

Swarth et al. (1982) reported that loons and western and Clark's grebes were much more abundant on the Bay than in the salt ponds west of the Coyote Hills (Swarth et al. 1982), noting that piscivorous species

were more common in the Alviso ponds than in the Coyote Hills ponds. Approximately 94% of the pelicans and double-crested cormorants recorded by Swarth et al. (1982) were in low-salinity ponds, though most of the cormorants used these ponds only for roosting (primarily on wooden pilings and platforms within the ponds). Although cormorants may take advantage of local concentrations of fish within salt ponds, most apparently feed in the Bay (Ainley 2000b; Anderson 1970). Herons and egrets forage primarily in sloughs and marshes, with only some birds moving to salt ponds at high tide (Anderson 1970; Swarth et al. 1982). However, where temporary concentrations of fish were present (generally in low-salinity ponds in fall), these waders occurred in large concentrations. Takekawa et al. (2001) reported that piscivores were more abundant in natural baylands than in salt ponds in the North Bay during all seasons, while Stralberg et al. (2003) determined that the species richness of large waders tended to be higher in the tidal salt marsh than in salt ponds, although piscivore abundance was higher in salt ponds.

Aerial surveys of the South Bay salt ponds have recorded counts of up to 3147 (on 6 August 1984) American white pelicans using these ponds (Harvey et al. 1992). These surveys only found white pelicans using ponds with salinities between 25 and 90 ppt, with the highest densities in ponds with low salinities (25-30 ppt). Harvey et al. (1992) suggested that the conversion of tidal marsh to salt ponds has benefited white pelicans, and that populations of nonbreeders in the Bay have increased as a result of the provision of sheltered foraging areas that concentrate fish and undisturbed levees for roosting.

Surveys of the South Bay salt ponds by USGS (Takekawa et al. 2005) indicate that species richness of piscivores is more or less constant throughout the year, though abundance is highest in late summer and fall due to the presence of high numbers of herons, egrets, and American white pelicans foraging in salt ponds at this time. Within the Alviso Pond Complex, piscivore abundance is highest in Ponds A1, A2W, A3W, A5, A7, A9, A10, and AB2 and very low in Pond B6 (which contains little water) and the high-salinity ponds A19-A23.

grebes and loons roost entirely on the water, and other swimming piscivores (e.g., pelicans and cormorants) may form floating roosts as well. However, most roosting by pelicans and cormorants occurs on salt pond levees (particularly interior levees between ponds), islands, and artificial structures such as boardwalks. Cormorants often roost in flocks on transmission towers as well. Herons and egrets roost on salt pond levees and in dense marsh vegetation along tidal sloughs.

Larids. Although larids (i.e., birds in the family Laridae, such as gulls, terns, and skimmers) have always used the South Bay for foraging during winter and migration, the use of this area has undoubtedly increased as a result of salt pond creation and, for gulls, the provision of food at landfills, and several species have begun nesting in the South Bay over the last century as a result. Currently, larid populations in the Bay are highest in winter due to the presence of tens of thousands of (if not 100,000+) wintering gulls. However, terns are generally more abundant in the South Bay during the breeding season. Information on special-status larids in the South Bay, including the California gull, California least tern, and black skimmer, can be found in the Special-Status Wildlife Species section below (Section 3.7).

Breeding. In the early 1900s, the Caspian tern was the only larid known to nest in the San Francisco Bay area, with a colony of more than 100 pairs nests present as early as 1916 in marshes near the east end of the Dumbarton Bridge (Grinnell and Miller 1944; Grinnell and Wythe 1927). This colony was reported to occur on a dike between salt ponds as of 1952 (Sibley 1952). As this colony grew to a size of 200 pairs, it split into two colonies in the Newark/Eden Landing area, and a third colony became established on salt pond levees near Mowry Slough in the late 1960s. By 1981, a colony of 1000 pairs was present on Bair Island as well, with approximately 2350 nesting birds present in the South Bay (Rigney and Rigney 1981). However, predation and disturbance by red foxes caused the abandonment of both the Mowry and Bair Island colonies in 1990 and 1991. Subsequently, Caspian terns nested in small numbers at Bair Island in 1993 and 1994 (Harding et al. 1998). Since 1990, breeding within the Study Area has also occurred in Pond A7 (breeding 1997-2006, peaking at 195 individuals in 2001 but with only 30 in 2006) and Ponds A9/A10 (70 individuals present in 1992 only). All nesting in the South Bay currently occurs on isolated portions of levees and islands with little or no vegetation within salt ponds. Although South Bay populations have declined precipitously since the early 1980s, the establishment of a large colony on Brooks Island in the North Bay has allowed Bay-area populations to remain fairly constant, with approximately 2300 individuals breeding in the Bay area in 2003 (Strong 2004a).

Forster's terns were not reported to be nesting in the San Francisco Bay area as of 1944 (Grinnell and Miller 1944), but a colony containing approximately 100 nests was discovered near the east end of the San Mateo Bridge in 1948 (Sibley 1952). Another colony was detected near the east end of the Dumbarton Bridge in 1952, and since then, Forster's tern colonies have appeared at scattered locations throughout the South Bay, with populations peaking at 4386 birds in 1992. However, local populations of Forster's terns have declined significantly since 1984, and a 2003 estimate of the Bay-wide population stands at 2450 individuals (Strong 2004a). In 2003, the 1958 Forster's terns thought to be nesting in the South Bay represented 80% of the total San Francisco Bay population, and represented nearly 25% of the Pacific Coast population and 10% of the North American population estimated in 2001 (McNicholl et al. 2001; Strong et al. 2004a).

Since 1990, Forster's tern colonies have been recorded in the Study Area at the following locations (Figure 4): Charleston Slough and the Palo Alto Flood Control Basin; Alviso Ponds A1, A5, A6, A7, A8, A9/A10, A16, A17, A18, and AB2. These colonies are located on small islands having little or no vegetation (and no tall vegetation) within salt ponds, tidal flats (at Charleston Slough), and managed marsh (Palo Alto Flood Control Basin), with small numbers on duck blinds. In 2006, the largest colonies within the Study Area were at Pond A7 (170 nests) and Pond A16 (132 nests; Strong 2006).

Predation by red foxes, and by avian predators such as California gulls and common ravens (*Corvus corax*), may be impacting tern populations to some extent. In addition, encroachment on Forster's tern nesting sites by an ever-increasing California gull breeding population in the South Bay has taken its toll on nesting terns; for example, islands in Alviso Pond AB2 that were formerly used by nesting Forster's terns have been largely, or entirely, taken over by nesting gulls (Strong 2004a). Because nesting on islands is so important to Forster's terns and black skimmers (and secondarily to the other breeding larids in the South Bay) to deter mammalian predation, population sizes may be limited by available breeding sites.

Least terns, black skimmers, and California gulls are also recent additions to the breeding avifauna of the South Bay; these species are discussed in detail in the Special-Status Wildlife Species section below (Section 3.7). Western gulls (*Larus occidentalis*) nest in very low numbers in the Study Area, with one to three pairs nesting in Pond A6 and on the levee between Mowry Ponds M4 and M5, both within large California gull colonies (Strong 2004a, Strong 2006). The western gull breeds much more commonly near the mouth of the Bay and along the coast.

Foraging and Roosting. Terns and skimmers in the South Bay, which include not only the aforementioned species, but also post-breeding elegant terns (*Sterna elegans*) and occasionally common terns (*Sterna hirundo*), feed primarily on small fish. Foraging occurs commonly within the open waters of the Bay and in low-salinity salt ponds, as well as tidal sloughs and freshwater and brackish channels and ponds. Caspian and Forster's terns often forage at inland ponds and lakes as well, even during the breeding season. Terns may roost on intertidal mudflats at low tide, whereas at high tide and at night they roost primarily on isolated levees, islands, and exposed mud surrounded by water within shallow ponds.

During the nonbreeding season, nesting populations of western and California gulls within the South Bay are augmented not only by nonbreeders of those species (likely including 10,000+ more California gulls and hundreds to 1000+ western gulls), but also by large numbers of herring (tens of thousands), Thayer's (*L. thayeri*; thousands), ring-billed (*L. delawarensis*; thousands to 10,000+), mew (*L. canus*; thousands), glaucous-winged (*L. glaucescens*; hundreds to 1000+), and Bonaparte's (thousands) gulls. With the exception of the Bonaparte's gull, which forages primarily on invertebrates in salt ponds and sewage treatment plants, these gulls are opportunistic foragers. They eat a wide variety of animal matter, including invertebrates, fish, small mammals and birds, and carrion, as well as processed food in landfills. Many gulls forage or roost on intertidal mudflats at low tide (Warnock et al. 2002).

The Newby Island landfill north of Coyote Creek near Alviso in the Study Area and the Tri-Cities Recycling and Disposal Facility located in Fremont immediately adjacent to the Study Area provide food for tens of thousands of wintering gulls, and are likely primarily responsible for the large wintering (and possibly breeding) populations of gulls in the South Bay. Gull abundance is much higher in the vicinity of these landfills than elsewhere in the Study Area, and particularly large concentrations of roosting birds occur in the Alviso and Fremont salt ponds. For example, the location of Ponds A22 and A23 between these two large landfills makes them a particularly attractive roosting location for gulls in winter. California gulls forage extensively at landfills in the South Bay, but they (and mew gulls to some extent) also forage in large numbers on brine flies and other invertebrates within mid- and high-salinity salt ponds, like the Bonaparte's gull (Steve Rottenborn, pers. obs.). Up to 10,000 Bonaparte's gulls forage in the South Bay, primarily on brine shrimp and brine flies in salt ponds having salinities of 90-200 ppt (Harvey et al. 1992). The recent surveys of South Bay salt ponds by USGS (Takekawa et al. 2005) found Bonaparte's gull abundance highest on Alviso Pond A8.

Most of the gulls in the greater South Bay area roost on the Bay or salt ponds/levees at night and large numbers roost in these areas during the day as well. Thousands of gulls disperse inland from the Bay area

during the day to forage at inland landfills, on agricultural fields and seasonal wetlands, on athletic fields, and in urban areas, particularly in winter.

Carpelan (1957) indicated that Forster's terns are the main predator on topsmelt in South Bay salt ponds, and Anderson (1970) also suggested that the topsmelt was likely the main prey item of Forster's terns in the South Bay. A study of the diet of breeding Forster's terns in the South Bay in 1972 (Anonymous Unpublished) found that their diet consisted primarily of fish; many were caught in the Bay, but a large percentage was caught in lower-salinity salt ponds as well. Fish most frequently taken at these ponds included small (<six centimeters) Pacific herring (which were often fed to chicks), topsmelt, and anchovies. Observations of adults with prey at four Forster's tern colonies in the South Bay indicated that threespine stickleback outnumbered all other fish combined by an order of magnitude, with several thousand sticklebacks observed as prey. The next five most abundant fish brought to colonies were northern anchovy (90 individuals), topsmelt (82), staghorn sculpin (64), shiner surfperch (50) and dwarf surfperch (*Micometrus minimus*, 45). Ten other fish species, all represented by 27 individuals or fewer, were also used as prey, as well as four individuals of two genera of bay shrimp.

Gill (1976) recorded 21 species of fish found at the Mowry colony of Caspian terns during the 1971 breeding season. The eight species representing greater than 2% of the total number of fish recorded were jacksmelt (33%), shiner perch (16%), staghorn sculpin (16%), longjaw mudsucker (9%), Oriental goby (5%), northern anchovy (6%), rainbow trout (4%), and topsmelt (3%). While the vast majority of fish recorded at this colony were estuarine species, seven species were primarily freshwater fish. The observation of Caspian terns with tagged trout that had been released at Del Valle Reservoir, 25 miles away from the Mowry tern colony, exemplifies this terns' propensity for foraging widely during the breeding season.

Other Waterbirds (eared grebes, coots, and rails). The eared grebe and South Bay members of the family Rallidae, which includes the American coot (*Fulica americana*), common moorhen (*Gallinula chloropus*), and several species of rails, are combined into a separate group for the purposes of this existing conditions report.

The eared grebe is a small diving bird that breeds only occasionally and in small numbers in the South Bay, occurring much more abundantly as a nonbreeding forager from October to April. Eared grebes nest in California on freshwater wetlands in the Central Valley and Great Basin regions fairly commonly, but in the South Bay, breeding has occurred only in a flooded, diked pickleweed marsh in the Moffett Field/Crittenden Marsh area, where nesting occurred in 1983, 1986, 1993, and 1995 (Cogswell 2000; Santa Clara County Bird Data Unpublished).

Nonbreeding eared grebes in the South Bay are closely tied to deeper, higher-salinity salt ponds, where they feed on brine shrimp, brine flies, and reticulate water boatmen (Anderson 1970). Censuses of eared grebes on South Bay salt ponds have exceeded 40,000 individuals (Harvey et al. 1992), and Cogswell (2000) suggested that the total Bay Area wintering/migrant population could be as high as 50,000 to 100,000 birds. The recent surveys of South Bay salt ponds by USGS (Takekawa et al. 2005) found eared grebe abundance highest on Alviso Ponds A8 and A11-A17.

American coots and, in much lower abundance, common moorhens breed in freshwater wetlands, channels, and ponds in and around emergent vegetation in a number of locations throughout the South Bay. These birds are omnivorous, eating a wide variety of plant and animal (particularly invertebrate) material. Coot populations are augmented substantially during winter, when this species occurs by the hundreds or low thousands on lower-salinity salt ponds (Anderson 1970), sewage treatment plant ponds, and other open-water locations.

The status of the California clapper rail and California black rail in the South Bay is described in detail in the Special-Status Wildlife Species section below (Section 3.7). Two other rails occur regularly in the South Bay. Both the sora (*Porzana carolina*) and Virginia rail (*Rallus limicola*) may breed in very small numbers in freshwater wetlands around the South Bay, although they occur much more commonly as nonbreeders from August to May. During the nonbreeding season, these secretive species occur in a wide variety of tidal and nontidal salt, brackish, and freshwater marsh habitats, being most abundant in freshwater and brackish areas. Here, these species forage primarily on invertebrates. Significant depredation of these rails by egrets and herons has been observed during exceptionally high tides in winter, particularly in areas where high tide refugia (such as upland transitional zones in the high marsh or along tidal channels) are lacking.

Terrestrial/Riparian Birds. Although riparian habitats in the Study Area have been highly degraded by vegetation removal, stream channelization, and encroachment by agriculture and urbanization, the riparian habitats within the Study Area still support high abundance and diversity of terrestrial birds. In particular, the remnant mature riparian woodland along lower Coyote Creek, augmented by the habitat restoration efforts of the Santa Clara Valley Water District, provides important breeding and foraging habitat for birds. These bird communities are dominated by insectivorous passerines during summer; representative breeding species include permanent residents such as the song sparrow, saltmarsh common yellowthroat, bushtit, chestnut-backed chickadee (*Poecile rufescens*), downy woodpecker (*Picoides pubescens*), and Anna's hummingbird and summer residents such as the California yellow warbler (*Dendroica petechia brewsteri*), Pacific-slope flycatcher (*Empidonax difficilis*), and black-chinned hummingbird (*Archilochus alexandri*). Breeding raptors include the red-tailed hawk (*Buteo jamaicensis*), red-shouldered hawk (*Buteo lineatus*), Cooper's hawk (*Accipiter cooperii*), and American kestrel (*Falco sparverius*). During spring and fall migration, large numbers of insectivores such as the Swainson's thrush, orange-crowned warbler, Wilson's warbler (*Wilsonia pusilla*), and warbling vireo (*Vireo gilvus*), forage in the riparian trees and shrubs. Seed-eating birds that frequent more open habitats during migration and winter include the white-crowned sparrow, golden-crowned sparrow, Lincoln's sparrow (*Melospiza lincolnii*), and fox sparrow (*Passerella iliaca*), in addition to resident American goldfinch (*Carduelis tristis*) and house finch. The Coyote Creek Field Station of the SFBBO (formerly Coyote Creek Riparian Station) monitors numbers of birds along lower Coyote Creek.

The lower Guadalupe River has fairly well-developed woody riparian habitat in some areas, and supports extensive emergent and ruderal vegetation that provides cover and food for high densities of a few species such as sparrows, red-winged blackbirds, and saltmarsh common yellowthroats. Riparian bird communities are more poorly developed (i.e., supporting fewer taxa and generally lower densities) along

other streams within the Study Area due primarily to degradation (or absence) of woody riparian habitat and encroachment of urbanization. For example, the portions of Calabazas, San Tomas Aquinas, Stevens, Matadero, and many other creeks in the Study Area are highly channelized, narrow corridors that support little woody riparian vegetation. Birds present in these areas are generally common stream-associated birds such as the mallard, green heron, and killdeer or common, widespread terrestrial bird, with few riparian-associated passerines.

Only a few passerines breed at all commonly in tidal salt, brackish, and freshwater marsh in the South Bay. Within most tidal salt marsh, the only nesting passerines are the Alameda song sparrow and marsh wren (in the lower marsh dominated by cordgrass and gumplant) and the savannah sparrow, which nests in pickleweed and peripheral halophytes in the upper portions of tidal and diked saltmarsh, along vegetated levees, and in adjacent upland transitional zones. South Bay population estimates for these species in 1971 by Gill (1977) included 1000-1200 pairs of marsh wrens (in cordgrass, but more abundantly in freshwater marshes, especially at Alviso and Guadalupe Sloughs, Coyote Creek and Mud Slough, and the Palo Alto Flood Control Basin), 800-1000 pairs of savannah sparrows, and 1800 pairs of Alameda song sparrows. The saltmarsh common yellowthroat may also nest in South Bay salt marshes in small numbers (Ray 1919; Steve Rottenborn, pers. obs.), although it nests primarily in brackish and freshwater marsh; this species, and the Alameda song sparrow, are discussed in detail in the Special-Status Wildlife Species section below (Section 3.7). Northern harriers, and formerly (or rarely) the short-eared owl (*Asio flammeus*), also nest within tidal salt marshes in broad vegetated marsh plains; these species are also discussed in the Special-Status Wildlife Species section (Section 3.7).

In addition, the red-winged blackbird nests in freshwater marsh in the Study Area, and scattered small trees and shrubs along salt pond levees and upland edges provide nesting sites for white-tailed kites, loggerhead shrikes, California towhees, and other species in limited numbers. Barn and cliff swallows breeding on artificial structures within and adjacent to the baylands forage commonly for flying insects over marshes and salt ponds in the South Bay.

Transmission towers within the marshes and salt ponds in the South Bay provide nesting sites for red-tailed hawks, common ravens, and peregrine falcons. Both species may prey on small mammals, rails, waterfowl, and shorebirds in the South Bay, and common ravens are particularly notorious predators of eggs and young of a variety of birds. Populations of ravens and American crows have increased markedly in recent decades throughout the Bay area, feeding heavily at the landfills around the South Bay but also preying on other wildlife species. Few data are available on the impact of ravens and crows on breeding populations of other species, but it is likely that ravens nesting on towers within tidal marshes and salt ponds have at least some impact on populations of California clapper rails, snowy plovers, and other breeding bird species.

During the nonbreeding season, additional landbirds occur in the baylands, including large numbers of sparrows of several species and several raptors. Short-eared owls occur regularly in small numbers in the more extensive marshes in winter, foraging on small mammals and birds, and merlins (*Falco columbarius*), peregrine falcons (*Falco peregrinus*), and other raptors forage for waterfowl and shorebirds throughout the South Bay.

Other upland habitats include grasslands and developed settings. Non-native grasslands in the South Bay support limited and declining populations of burrowing owl. A variety of birds use annual grasslands as foraging habitat, including savannah sparrows, horned larks (*Eremophila alpestris actia*), American pipits, western meadowlarks (*Sturnella neglecta*), lesser goldfinches, barn swallows, and various raptors. Western meadowlarks and mourning doves may nest in this habitat as well. Birds in developed areas face not only regular human disturbance, but also unique foraging and nesting opportunites. Those that are well adapted to such habitats commonly breed here. These species include the house finch, mourning dove, barn swallow, cliff swallow, and black phoebe and non-native European starling, rock pigeon (*Columba livia*), and house sparrow (*Passer domesticus*).

4.3.6 Notable Wildlife Resources in the Shoreline Study Area

Based on recent monitoring conducted by the USGS, SFBBO, and others, the most prominent wildlife resources and patterns of wildlife distribution in the Shoreline Study Area are as follows:

- Mixed heronries are located along Guadalupe Slough and at the west end of the Coyote Creek Lagoon near Newby Island, and small numbers of great blue herons nest on transmission towers in or adjacent to several salt ponds in this complex.
- Breeding concentrations of black-necked stilts and American avocets occur in New Chicago Marsh, in the vicinity of Pond A22, in Pond A8, and in the Palo Alto Flood Control Basin, with additional concentrations of avocets at the Warm Springs Marsh and Reach 1A waterbird pond, and stilts in the San Jose-Santa Clara WPCP.
- Moderate numbers of western snowy plovers breed in Pond A22 and Pond A8. In the past, western snowy plovers have bred in Pond A6, although they have not nested in this pond years, likely due to the gull colony there. Western snowy plovers have also recently nested in a small impoundment north of the Alviso marina.
- Large numbers of shorebirds forage on the intertidal mudflats ringing the South Bay south of the Dumbarton Bridge during low tide.
- Large numbers of shorebirds roost, and forage to varying degrees, in Ponds AB2, A5, and A7, with high numbers also present in Ponds A3N, A6, A9, A14, and A8, in New Chicago Marsh, in Crittenden Marsh, and at the San Jose-Santa Clara Water Pollution Control Plant at times.
- Several California gull colonies, including the state's second largest colony in Pond A6, are present in the Alviso pond complex.
- Double-crested cormorants nest on transmission towers in Pond A2W, in the AB1/AB2/A3N area, and in Pond A18, and on the levee between Ponds A9 and A10.
- Red-tailed hawks and common ravens nest on transmission towers in several ponds, and in 2007 two pairs of peregrine falcons nested in old raven nests on towers in the Alviso Complex.
- Forster's terns nest on small islands in a number of locations (primarily in salt ponds), and black skimmers nest in the Palo Alto Flood Control Basin and in Ponds A1, AB1, AB2, A8, and A16. Caspian terns nest, or have recently nested, in Pond A7, and on the levee between Ponds A5 and A7.

- The main post-breeding staging area for California least terns is within the Alviso pond complex, primarily in the ponds north of Moffett Field but with birds regularly using a number of other ponds in this pond complex for foraging and roosting. California least terns also forage over the Bay off the Alviso salt ponds.
- California clapper rails occur in a number of locations, although high-quality habitat is limited. The highest numbers are likely in the more extensive tidal salt marshes along Coyote Creek and near Palo Alto, although this species is also present in brackish marshes in the Warm Springs area, along Guadalupe Slough and Alviso Slough, and in smaller marsh remnants along sloughs and the Bay edge.
- Ponds A1, A2E, A2W, A5, A7, A9, and AB2 support high numbers of dabbling ducks, whereas Ponds A1, A2W, A9, and A10 support large numbers of diving ducks.
- Tens of thousands of gulls roost in the Alviso ponds and levees, with many foraging at landfills near Milpitas and in Fremont.
- Within the Alviso pond complex, piscivorous bird abundance is highest in Ponds A1, A2W, A3W, A5, A7, A9, A10, and AB2.
- Ponds A19, A20, and A21 have been restored to tidal action under the ISP. These ponds initially provide intertidal foraging habitat for shorebirds and other waterbirds at low tide, and tidal foraging habitat for waterfowl at high tide. As sediment accumulates (and the gypsum layer is buried and/or deteriorates), tidal marsh vegetation will become established, providing breeding and foraging habitat for the California clapper rail and other marsh species.
- Steelhead occur in San Francisquito Creek, Stevens Creek, the Guadalupe River, and Coyote Creek.
- Chinook salmon occur in the Guadalupe River and Coyote Creek.
- Salt marsh harvest mouse habitat in the Alviso pond complex is limited. Most of the marshes are brackish marshes, areas that are little used by salt marsh-dependent species such as the salt marsh harvest mouse and salt marsh wandering shrew, and the salt marsh that does exist has little to no high marsh or escape cover.
- A small population of western pond turtles (*Emys marmorata*) is present along the northern edge of Moffett Field and the Sunnyvale WPCP, with a few individuals present along the lower Guadalupe River and Coyote Creek as well.
- The Warm Springs portion of the SFBNWR supports vernal pool tadpole shrimp (*Lepidurus packardi*) and California tiger salamanders.
- Burrowing owls occur in grassland habitats fringing the South Bay, with higher concentrations at Shoreline Park, Moffett Field, and the San Jose WPCP buffer lands.
- The riparian corridor of Coyote Creek supports a variety of migrant and resident landbirds.

4.4 Special-Status Wildlife Species

Special-status animal species that occur in the Study Area and adjacent habitats are described below. The legal status and likelihood of occurrence of these species are given in Table 7. Expanded descriptions are included for species for which potentially suitable habitat occurs in the Study Area, or for which the resource agencies have expressed particular concern.

A number of special-status species occur in the Study Area as visitors, migrants, or foragers, but are not known or expected to breed in the immediate area. Expanded species accounts are not provided for these species. Animals that occasionally occur within the Study Area and breed in upland habitats in the greater South Bay Area, but occur only in the Study Area as uncommon to rare foragers, include the bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), Vaux's swift (*Chaetura vauxi*), bank swallow (*Riparia riparia*), yellow-breasted chat (*Icteria virens*), and pallid bat (*Antrozous pallidus*). Species that occur in the Study Area regularly as foragers, but have special status only at nesting sites elsewhere in California, include the common loon (*Gavia immer*), American white pelican, sharp-shinned hawk (*Accipiter striatus*), osprey (*Pandion haliaetus*), Barrow's goldeneye (*Bucephala islandica*), long-billed curlew, and elegant tern.

Expanded species accounts are provided below for key special-status wildlife species. More information on most of these species can be found in the Goals Project Baylands Ecosystem Species and Community Profiles (Goals Project 2000).

Table 7 – Special-status animal species, their status, and potential occurrence in the Shoreline Study Area.

Name	Status*	Habitat	Potential For Occurrence On Site
Federal or State Threatened or Endangered Species			
Bald Eagle (*Haliaeetus leucocephalus*)	FPD, SE, SP	Occurs mainly along seacoasts, rivers and lakes; nests in tall trees or in cliffs. Feeds mostly on fish.	Occasional visitor, primarily during winter, to the Study Area. May occasionally forage, but does not nest, in the Study Area.
American Peregrine Falcon (*Falco peregrinus anatum*)	SE, SP	Forages in many habitats; nests on cliffs and similar human-made structures.	Regular forager (on other birds) in the Study Area, primarily during migration and winter. Nested in 2006 and 2007 (two nests) in old raven nests on transmission towers in the Alviso pond complex.
California Clapper Rail (*Rallus longirostris obsoletus*)	FE, SE, SP	Salt and brackish marsh habitat usually dominated by pickleweed and cordgrass.	Resident in many tidal marshes in the Study Area.
California Least Tern (*Sterna antillarum browni*)	FE, SE, SP	Nests along the coast on bare or sparsely vegetated flat substrates.	The South Bay is an important post-breeding staging area for least terns, although this species does not currently breed within the Study Area. Recent breeding by small numbers has occurred at Hayward Regional Shoreline and Eden Landing Pond E8A. Forages and roosts in a number of South Bay ponds, especially Alviso ponds in the vicinity of Moffett Field.
California Brown Pelican (*Pelecanus occidentalis californicus*)	FE, SE, SP	Occurs in nearshore marine habitats and coastal bays. Nests on islands in Mexico and southern Calfiornia.	Regular during nonbreeding season (summer and fall) in Study Area. Roosts on levees in the interiors of pond complexes, forages in salt ponds and Bay.
Salt Marsh Harvest Mouse (*Reithrodontomys raviventris raviventris*)	FE, SE, SP	Salt marsh habitat dominated by pickleweed.	Occurs in pickleweed marshes within the Study Area. Also occurs in brackish marshes.
Steelhead – California Central Coast ESU (*Oncorhynchus mykiss*)	FT	Cool streams with suitable spawning habitat and conditions allowing migration, as well as marine habitats.	Known to be present in several South Bay creeks (including Coyote, Stevens, and San Francisquito Creeks, and the Guadalupe River) and associated marshes and small channels in the Study Area, especially as habitat for smolts as they transition to life in a marine environment. Suitable spawning habitat is not present in the Study Area, but this species moves through the area to spawn upstream.
California Black Rail (*Laterallus jamaicensis coturniculus*)	ST, SP	Breeds in fresh, brackish, and tidal salt marsh.	Non-breeding individuals winter in small numbers in tidal marsh within the Study Area, but the species is not currently known to breed in the South Bay.
Western Snowy Plover (*Charadrius alexandrinus nivosus*)	FT, CSSC	Nests on sandy beaches and salt panne habitats.	Breeds and forages at several sites within the Study Area, primarily Ponds A8 and A23. Additional birds occur in the Study Area during winter.
Bank Swallow (*Riparia riparia*)	ST	Colonial nester on vertical banks or cliffs with fine-textured soils near water.	Observed in the study ara as rare transient. No suitable breeding habitat in the Study Area.

Name	Status*	Habitat	Potential For Occurrence On Site
California Tiger Salamander *(Ambystoma californiense)*	FT, CSSC	Vernal or temporary pools in annual grasslands, or open stages of woodlands.	A population is present on SFBNWR lands in the Fremont/Warm Springs area within the Study Area.
Vernal Pool Tadpole Shrimp (*Lepidurus packardi*)	FE	Freshwater vernal pools in grasslands.	Present in small numbers in vernal pools on SFBNWR lands in the Fremont/Warm Springs area.
California Species of Special Concern			
Central Valley Fall- and Late Fall-run Chinook Salmon (*Oncorhynchus tshawytscha*)	CSSC (Late Fall-run only)	Cool rivers and large streams that reach the ocean and that have shallow, partly shaded pools, riffles, and runs.	Centrail Valley Fall-Run Chinook salmon are known to be present in several South Bay creeks (including Coyote Creek, Alameda Creek, and the Guadalupe River) and associated marshes and small channels in the Study Area, especially as habitat for smolts as they transition to life in a marine environment. Suitable spawning habitat is not present in the Study Area, but this species moves through the area to spawn upstream.
Western Pond Turtle *(Clemmys marmorata)*	CSSC	Permanent or nearly permanent fresh or brackish water in a variety of habitats.	Uncommon along the inshore side of pond A3W; a few are occasionally recorded along lower Coyote Creek and the Guadalupe River. May occur rarely in freshwater and brackish creeks and sloughs elsewhere in the Study Area.
Common Loon (*Gavia immer*)	CSSC (nesting)	Nests in freshwater marshes, winters in coastal marine habitats.	Occasional winter visitor; does not breed in the Study Area.
American White Pelican (*Pelecanus erythrorhnchos*)	CSSC (nesting)	Forages in freshwater lakes and rivers, nests on islands in lakes.	Common non-breeder, foraging primarily on salt ponds in the Study Area. Regular visitor from late summer to spring. Not known to breed in the Study Area.
Double-crested Cormorant (*Phalacrocorax auritus*)	CSSC (nesting)	Colonial nester on coastal cliffs, offshore islands, electrical transmission towers, and along interior lake margins. Feeds on fish.	Breeds on electrical transmission towers and on levees within the Study Area, and forages in ponds and other open water habitats in the Study Area.
White-faced Ibis (*Plegadis chihi*)	CSSC (nesting)	Forages in freshwater marshes, and to a lesser extent, brackish areas.	Occasional visitor in fall and winter. Has bred in heron rookery on Mallard Slough, but no current nesting known.
Barrow's Goldeneye (*Bucephala islandica*)	CSSC (nesting)	Nests in freshwater marshes, winters in coastal marine habitats.	Occasional winter visitor; does not breed in the Study Area.
Northern Harrier (*Circus cyaneus*)	CSSC (nesting)	Nests and forages in marshes, grasslands, and ruderal habitats.	Breeds in small numbers in marsh habitats in the Study Area, forages in a variety of habitats.
Sharp-shinned Hawk (*Accipiter striatus*)	CSSC (nesting)	Nests in woodlands, forages in many habitats in winter and migration.	Observed on site as a migrant and winter resident. No breeding habitat in Study Area.
Cooper's Hawk (*Accipiter cooperii*)	CSSC (nesting)	Nests in woodlands, forages in many habitats in winter and migration.	Breeds in limited numbers in upland habitats fringing the South Bay; forages throughout the Study Area.

Name	Status*	Habitat	Potential For Occurrence On Site
Osprey (*Pandion haliaetus*)	CSSC (nesting)	Nests in tall trees or cliffs on freshwater lakes and rivers and along seacoast; feeds on fish.	Occasional forager, primarily during the nonbreeding season. No breeding records in the Study Area.
Golden Eagle (*Aquila chrysaetos*)	CSSC	Breeds on cliffs or in large trees or electrical towers, forages in open areas.	Occasional forager, primarily during the nonbreeding season. No nesting records within the Study Area.
Merlin (*Falco columbarius*)	CSSC	Uses many habitats in winter and migration.	Regular in low numbers during migration and winter. Does not nest in California.
Long-billed Curlew (*Numenius americanus*)	CSSC (nesting)	Nests on prairies and short-grass fields; forages on mudflats, marshes, pastures, and agricultural fields.	Forages on mudflats, marshes, and grasslands and roosts on levees, diked marshes, and ponds within the Study Area as a migrant and winter resident. Does not nest in the Study Area.
California Gull (*Larus californicus*)	CSSC (nesting)	Nests on lakes inland and, around S. F. Bay, in salt ponds.	Common resident, breeding on several salt ponds in the Study Area. The colony in Pond A6 is the second largest colony in California. Forages throughout Study Area.
Black Skimmer (*Rynchops niger)*	CSSC (nesting)	Nests on abandoned levees and islands in salt ponds and marshes.	A few pairs breed and forage in the Study Area, on islands in salt ponds.
Short-eared Owl (*Asio flammeus*)	CSSC (nesting)	Nests on ground in tall emergent vegetation or grasses, forages over a variety of open habitats.	Uncommon. Has bred in small numbers within the Study Area, although current breeding status unknown. Most numerous in area in migration and winter.
Western Burrowing Owl (*Athene cunicularia hypugea*)	CSSC	Flat grasslands and ruderal habitats.	Breeds at several upland sites within the Study Area.
Vaux's Swift (*Chaetura vauxi*)	CSSC (nesting)	Nests in snags in coastal coniferous forests or, occasionally, in chimneys; forages aerially.	Forages over Study Area. No nesting habitat within area.
Loggerhead Shrike (*Lanius ludovicianus*)	CSSC (nesting)	Nests in dense shrubs and trees, forages in grasslands, marshes, and ruderal habitats.	Resident in low numbers within the Study Area.
California Horned Lark (*Eremophila alpestris actia*)	CSSC	Short-grass prairie, annual grasslands, coastal plains, and open fields.	Present in low numbers in the Study Area, nesting on salt pond levees, salt flats, and ruderal habitats.
California Yellow Warbler (*Dendroica petechia brewsteri*)	CSSC (nesting)	Breeds in riparian woodlands, particularly those dominated by willows and cottonwoods.	Nests in riparian corridor of Coyote Creek.
Saltmarsh Common Yellowthroat (*Geothlypis trichas sinuosa*)	CSSC	Breeds primarily in fresh and brackish marshes in tall grass, tules, willows; uses salt marshes more in winter.	Common resident, breeding in freshwater and brackish marshes (and possibly to a limited extent in salt marshes), and foraging in all marsh types during the nonbreeding season.
Yellow-breasted Chat (*Icteria virens*)	CSSC	Riparian brush and woodlands.	Rare nonbreeding visitor to riparian habitats during migration.

Name	Status*	Habitat	Potential For Occurrence On Site
Alameda Song Sparrow (*Melospiza melodia pusillula*)	CSSC	Breeds in salt marsh, primarily in marsh gumplant and cordgrass along channels.	Uncommon resident, breeding and foraging in tidal salt marsh.
Tricolored Blackbird (*Agelaius tricolor*)	CSSC (nesting)	Breeds near fresh water in dense emergent vegetation.	Has bred in the Study Area at the San Jose-Santa Clara Water Pollution Control Plant, but occurs in the Study Area primarily as a nonbreeding forager.
Salt Marsh Wandering Shrew (*Sorex vagrans halicoetes*)	CSSC	Medium high marsh with abundant driftwood and pickleweed.	May occur in salt marshes throughout the Study Area, although numbers have declined, and current status is unknown.
State Protected Species or CNPS Species			
White-tailed Kite (*Elanus caeruleus*)	SP (nesting)	Nests in tall shrubs and trees, forages in grasslands, marshes, and ruderal habitats.	Common resident; breeds within the Study Area where suitable nesting habitat occurs.

FE = Federally-listed Endangered
FT = Federally-listed Threatened
FPD = Federally Proposed for Delisting
SE = State-listed Endangered
ST = State-listed Threatened
CSSC = California Species of Special Concern
SP = State Fully Protected Species

4.4.1 Federal or State Threatened or Endangered Species

Vernal Pool Tadpole Shrimp (*Lepidurus packardi*). Federal Listing Status: Endangered; State Listing Status: None. The vernal pool tadpole shrimp is a small crustacean that occurs in ephemeral pools in California. The known range of the species is limited to the Central Valley, and a limited area in, and adjacent to, the Warm Springs Seasonal Wetland Unit of the SFBNWR. Due to the continuing loss of habitat, the vernal pool tadpole shrimp was listed by the USFWS as Endangered in 1994. Critical habitat was designated for the species in 2006 (USFWS 2006a); the Study Area includes two Critical Habitat Units, 14A and 14B, within the Warm Springs Seasonal Wetland Unit of the SFBNWR.

Vernal pool tadpole shrimp spend the majority of their lives as dormant cysts, which may remain viable for up to ten years. When these cysts are inundated in vernal pools, some hatch into shrimp, which live only as long as the pool retains water. Ahl (1991) found that egg cysts hatch within 11 to 26 days (mean = 17 days) after pools refill with water. In contrast to most fairy shrimp, juvenile vernal pool tadpole shrimp develop slowly and require a minimum hydroperiod of about seven to eight weeks to reach reproductive maturity in the field (Gallagher 1996, Helm 1998). Juveniles look like the adults but are merely smaller in overall size and are not reproductively mature. There is only one generation per year. Adults have hard carapaces, and may attain a length of one inch or more.

This shrimp is generally found in sparsely vegetated, grass-bottomed swales on old alluvial soils that are underlaid by hardpan, or in mud-bottomed pools containing highly turbid water. The pools are usually deep (≥ six inches) and typically retain water longer than shallower vernal pools. Unlike fairy shrimp, which actively swim in the water column, tadpole shrimp move about primarily by crawling, but will swim for brief periods. Vernal pool tadpole shrimp are not expected to occur in the Shoreline Study Area outside the area of known distribution in the mixed vernal pool/grassland habitat north/northwest of Pond A22 in the Warm Springs Seasonal Wetland Unit of the SFBNWR.

California Tiger Salamander (*Ambystoma californiense*). Federal Listing Status: Threatened; State Listing Status: Species of Special Concern. The California tiger salamander breeds in temporary (lasting at least 12 weeks) or small permanent ponds in grassland habitats during the winter rainy season. During dry summer months, they aestivate in small mammal burrows in grasslands adjacent to breeding ponds. Adults often emerge from the burrows at night during the first moderate to heavy winter rains and migrate to breeding ponds where they lay their eggs.

The eggs are attached singly or in small clumps to vegetation under water, or directly on the bottom of the pool if emergent vegetation is lacking. The eggs hatch approximately one week after they are deposited. The larvae prey upon invertebrates and other amphibian larvae for between three and six months, during which time they metamorphose into juveniles. Juveniles typically leave the pools in mass during a one to two week period, usually as the ponds dry. The juveniles then search for available burrows. Juveniles feed and grow in these burrows until the following winter. California tiger salamanders take several years to reach maturity and do not necessarily breed every year, even if sufficient habitat is available.

The range of the California tiger salamander is restricted to the Central Valley and the South Coast Range of California from Butte County south to Santa Barbara County. Tiger salamanders have disappeared from a significant portion of their range due to habitat loss from agriculture and urbanization and the introduction of non-native aquatic predators. The California tiger salamander was listed as Threatened under the FESA by the USFWS in July 2004. The USFWS designated Critical Habitat for the California tiger salamander in August 2005 (USFWS 2005). No portion of the Study Area is within Critical Habitat for this species.

California tiger salamanders occur in the mixed vernal pool/grassland habitat north/northwest of Pond A22 in the Warm Springs Seasonal Wetland Unit of the SFBNWR, the only location in the South Bay that they occur adjacent to tidally influenced marsh habitat.

Steelhead (*Oncorhynchus mykiss*), Central California Coast ESU. Federal Listing Status: Threatened; State Listing Status: None. The steelhead is an anadromous form of rainbow trout that migrates upstream from the ocean to spawn. Steelhead in the South Bay usually migrate upstream to spawning areas from late December through early April, with the greatest activity in January through March, when flows are sufficient to allow them to reach suitable habitat in far upstream areas. Spawning occurs between December and June. Steelhead eggs remain in gravel depressions, known as redds, for 1.5 to four months before hatching. After hatching, young-of-the-year steelhead tend to use riffles with cover, while older juveniles use deeper water (such as pools) as rearing habitat, remaining in fresh water for one to four years before migrating to the ocean. This downstream migration of juveniles generally occurs between February and June. After migration, steelhead typically grow rapidly for two to three years before returning to freshwater streams to spawn. Unlike other anadromous salmonids, steelhead do not necessarily die after spawning. Adults may survive and return to the ocean after spawning, coming back to spawn for one or more additional seasons; however, it is unknown if this phenomenon occurs in the South Bay streams.

Steelhead usually spawn in gravel substrates in clear, cool, perennial sections of relatively undisturbed streams. Preferred streams typically support dense canopy cover that provides shade, woody debris, and organic matter, and are usually free of rooted or aquatic vegetation. Steelhead usually cannot survive long in pools or streams with water temperatures above 70 °F, but they can use warmer habitats if food is available, such as at fast water riffles where fish can feed on drifting insects. Steelhead in some coastal estuaries in central California apparently make extensive use of estuarine habitats for foraging (Bush, pers. comm.), although the extent of the use of estuarine habitats by steelhead in many areas, including the South San Francisco Bay area, is virtually unknown.

Steelhead populations in many areas have declined due to degradation of spawning habitat, introduction of barriers to upstream migration, over-harvesting by recreational fisheries, and reduction in winter flows due to damming and spring flows due to water diversion. Steelhead and other salmonids have been categorized into subpopulations, or Distinct Population Segments (DPSs). In 1997, the National Marine Fisheries Service (NMFS) listed the Central California Coast DPS as a threatened species under FESA; threatened status was reaffirmed in 2006. The Central Coast DPS includes all runs from the Russian

River in Sonoma County south to Aptos Creek in Santa Cruz County, including all steelhead spawning in streams flowing into San Francisco Bay streams. In 2005, NMFS designated critical habitat for this and other DPSs as occupied reaches of all rivers and estuaries within the range of each listed DPS. A recovery plan is being developed but has not yet been approved for this DPS.

Steelhead are known to occur in several stream systems in the South San Francisco Bay Area (Figure 5), and this species could potentially spawn in virtually any reach of a stream offering suitable spawning habitat and lacking downstream barriers to dispersal. Information on the fine-scale distribution of steelhead in South San Francisco Bay streams is limited, but steelhead are currently known to run in the Coyote Creek, Guadalupe River, Stevens Creek, and San Francisquito Creek watersheds (Foxgrover et al. 2004, Leidy et al. 2005). Few steelhead are present in any of these South Bay streams (Leidy et al. 2005). Within the Study Area, no suitable steelhead spawning habitat exists. Steelhead may use tidal channels in marshes as well, as such channels (particularly in brackish marshes) may provide habitat for juveniles during the process of smoltification (i.e., physiological adaptation to the saltwater environment). The use of larger sloughs within the Study Area by juvenile salmonids may be limited by the relatively high density of predators, including harbor seals and striped bass (Jerry Smith, pers. comm.).

Chinook Salmon (*Oncorhynchus tshawytscha*), Central Valley Fall- and Late Fall- Run ESU. Federal Listing Status: None; State Listing Status: Species of Special Concern (Late Fall-Run only). Like the steelhead, the Chinook salmon is an anadromous salmonid. Adults of the Central Valley Fall-Run ESU migrate from the ocean to spawning streams in fall and begin spawning in beds of coarse river gravels between September and December. Adults die after spawning. After the eggs hatch, juvenile salmon typically migrate downstream to the Bay or ocean within a few months. Young fish remain in the ocean for several years before returning to freshwater streams and rivers to spawn. Chinook salmon generally spawn in cool waters providing incubation temperatures no warmer than 55 ^{o}F.

Much more is known regarding the use of estuarine habitats by Chinook salmon than steelhead, and in at least some areas, juvenile Chinook make heavy use of estuarine habitats. Juvenile Chinook salmon may spend a significant amount of time, up to 189 days (Simenstad et al. 1982), foraging in estuarine habitats, showing significant growth in some estuaries (MacDonald et al. 1987), as they adapt physiologically to higher-salinity environments (Maragni 2000). In at least some areas, tidal marshes are important habitats for Chinook salmon. Fry forage throughout shallower tidal sloughs and channels, even foraging within the marsh during flood tides, while larger smolts forage in larger primary and secondary channels and subtidal habitats (Maragni 2000).

Fall-run Chinook salmon populations have suffered the effects of over-fishing by commercial fisheries, degradation of spawning habitat, added barriers to upstream migration, and reductions in winter flows due to damming. Approximately 40-50% of the spawning and rearing habitats in Central Valley streams have been lost or degraded. Hatchery-raised fish considerably enhance present populations. Because long-term population trends have been generally stable, NMFS determined that the Central Valley fall- and late fall-run evolutionarily significant unit (ESU) was not a priority for listing as threatened or endangered.

Chinook salmon did not historically spawn in streams flowing into South San Francisco Bay. Since the mid-1980s, however, small numbers of fall-run Chinook salmon have been found in several such streams, including Coyote Creek, Los Gatos Creek, and the Guadalupe River (Leidy et al. 2003). Genetic analysis indicates that fish from Guadalupe River and Coyote Creek are closely related to Central Valley Fall-run Chinook salmon (Garcia-Rossi and Hedgecock 2002).

These fall-run Chinook salmon typically arrive in South San Francisco Bay streams in October or later, although on rare occasions, adult Chinook salmon have been detected in these streams in summer, and spawning has been observed on Los Gatos Creek as early as September (Salsbery, pers. comm.). Seasonal stream flow and temperature conditions in these streams may not be suitable for successful spawning by Sacramento River winter-run Chinook salmon, which typically spawn in late spring and summer, or by Central Valley spring-run Chinook salmon, which typically spawn in late summer and early fall. Therefore, any adult Chinook salmon found in the South San Francisco Bay in the summer are presumed to be Fall-run fish with ancestry to the Central Valley. The use of tidal channels and sloughs within the Study Area by Chinook salmon is unknown. Predation pressure may limit the use of larger sloughs as more than transit habitat, as noted above for steelhead, but it is possible that Chinook salmon use tidal marshes in the South Bay as extensively as has been reported in other areas.

California Brown Pelican (*Pelecanus occidentalis californicus*). Federal Status: Endangered; State Status: Endangered. Brown pelicans are large seabirds found in coastal and nearshore marine habitats along the Atlantic, Gulf and Pacific coasts of North America. In the middle of the 20th century, brown pelican populations were severely reduced. The primary cause of this decline was eggshell thinning related to ingestion of the pesticide DDT, which entered the marine food chain through agricultural runoff and industrial discharge (Anderson and Gress 1983). The brown pelican was listed by the USFWS as Endangered in 1970 and by the state of California in 1971, and the state considers it a fully protected species. A recovery plan for the species was completed in 1983 (U.S. Fish and Wildlife Service 1983); critical habitat has not been designated for the brown pelican. DDT was banned in the United States in 1972, and brown pelican populations began recovering. In 1985, the brown pelican was delisted in the southeastern U.S. as recovered, but west coast populations did not recover as quickly (Shields 2002). However, west coast numbers have increased substantially in the past two decades, and the U.S. Fish and Wildlife Service is considering a proposal to delist the California brown pelican (USFWS 2006b).

The California brown pelican nests in Mexico, on the California Channel Islands, and at the Salton Sea in early spring, approximately January to May (Anderson and Gress 1983; Shields 2002). Much of the postbreeding dispersal occurs northward (as far north as Canada), and by June, many post-breeding birds are present in central California. Local abundance in central California usually peaks from August to October (Briggs et al. 1987; Jaques 1994). Although a small number of non-breeding birds may be found locally year-round, most pelicans return to their southern breeding grounds by January. California brown pelicans feed on northern anchovies and other small fishes, which they capture by plunge-diving. Brown pelicans require secure night-roosts, free of terrestrial predators (Jaques 1994).

Several hundred brown pelicans typically occur in San Francisco Bay during summer and fall, but numbers are variable (Ainley 2000a). Post-breeding dispersants typically begin to arrive in the South Bay

in June and July, with most individuals departing by late fall. However, a few may also be found in the South Bay in winter and spring as well (Santa Clara County Bird Data Unpublished). California brown pelicans occur regularly in some South Bay salt ponds, and often roost on salt pond levees. Recent surveys by USGS included 225 individuals in the Alviso Complex in September 2004, although more typical counts number less than 100 at Alviso Ponds (Takekawa et al. 2005). Several ponds in the Alviso Complex are used for roosting by brown pelicans, with the greatest use in the vicinity of Alviso Slough and Guadalupe Slough (Takekawa et al. 2005), although local concentrations may occur in any of the lower-salinity ponds (which provide fish) throughout the Alviso Complex. Although information on daily activity patterns, habitat use, and key foraging areas of brown pelicans in the South Bay is limited, this species uses salt ponds both for foraging (which takes place in the less saline ponds supporting fish) and for roosting (on levees between ponds).

American Peregrine Falcon (*Falco peregrinus anatum*). Federal Listing Status: Delisted; State Listing Status: Endangered, Fully Protected. The peregrine falcon occurs throughout much of the world, and is known as one of the fastest flying birds of prey. Peregrine falcons prey almost entirely on birds, which they kill while in flight. These falcons nest on ledges and caves on steep cliffs, as well as human-made structures like buildings and power towers. In California, they are known to nest along the entire coastline, the northern Coast, and the Cascade Ranges and Sierra Nevada. During winter and migration, this species can be found throughout the state. Peregrine falcons are most likely to be encountered in coastal or inland marsh habitats where large numbers of waterfowl and shorebirds concentrate, as occurs at the Study Area.

A severe decline in populations of the widespread North American subspecies *Falco peregrinus anatum* began in the late 1940s. This decline was attributed the accumulation of DDE, a metabolite of the organochlorine pesticide DDT, in aquatic food chains (Thelander and M. 1994). When concentrated in the bodies of predatory birds such as the peregrine falcon, Bald Eagle, brown pelican, and Osprey, this contaminant led to reproductive effects, such as the thinning of eggshells. The American peregrine falcon was listed as Endangered by the USFWS in 1970 and by the State of California in 1971. Recovery efforts included the banning of DDT in North America and captive breeding programs. The USFWS removed the American peregrine falcon from the Endangered Species List in 1999, though the State of California still lists the species as endangered, and as a fully protected species.

Peregrine falcons are uncommon in the Study Area, but nonbreeders are present in small numbers in fall and winter. These birds often use electrical transmission towers as perches, hunting waterbirds over salt ponds, marshes, and the open bay. Prior to 2006, this species was not known to breed in the Study Area. However, in 2006 a pair nested in an old raven nest on a transmission tower in the Alviso pond complex, and two nests approximately 1.3 kilometers apart were occupied in 2007.

California Clapper Rail (*Rallus longirostris obsoletus*). Federal Listing Status: Endangered; State Listing Status: Endangered. The California clapper rail is a secretive marsh bird currently endemic to the marshes of San Francisco Bay. It formerly bred at several other locations, including Humboldt Bay, Elkhorn Slough (Monterey County), and Morro Bay, but is now extirpated from all sites outside of San Francisco Bay. California clapper rails nest in salt and brackish marshes along the edge of the bay, and

are most abundant in extensive salt marshes and brackish marshes dominated by cordgrass, pickleweed, and marsh gumplant, and containing complex networks of tidal channels (Harvey 1980). Shrubby areas adjacent to or within tidal marshes are important for predator avoidance at high tides.

California clapper rails breed from February through August in the vegetation along tidal sloughs. Breeding generally occurs in two pulses, one in April/May, and a second in June/July. Clapper rails lay up to 14 eggs, which are incubated by both parents for just under a month. The young are precocial, but are dependent on their parents for food for five to six weeks (Eddleman and Conway 1998). California clapper rails are non-migratory, although juveniles disperse around the Bay during late summer and autumn. Adults are territorial, and maintain territories throughout the year. Most California clapper rails studied via radio-telemetry had home ranges of about 115 meters in radius (Keldsen 1997). They forage on crabs, clams, and other invertebrates, which they find in exposed mud along tidal channels (usually secondary channels) or in vegetation at the edges of such channels (Shuford 1993).

Since the mid-1800s, about 90% of San Francisco Bay's marshlands have been eliminated through filling, diking, or conversion to salt evaporation ponds (Goals Project 1999). As a result, the California clapper rail lost most of its former habitat, and the population declined severely. The subspecies was listed by the USFWS as Endangered in 1970, and by the State of California as Endangered in 1971, and the state considers it a fully protected species. The USFWS approved a joint recovery plan of the salt marsh harvest mouse and the California clapper rail in 1984 (U.S. Fish and Wildlife Service 1984), and an updated Tidal Marsh Species Recovery Plan is currently under development. Critical habitat has not been proposed for the California clapper rail.

In the 1970s, the Bay-wide population estimate for California clapper rails was 4000-6000 birds, with 55% in the South Bay, 38% in Napa marshes, and the remaining 8% in other North Bay and outer coast marshes (Gill 1979). Based on surveys of most suitable marshes in the San Francisco Bay area in the late 1970s and early 1980s, Harvey (1988) estimated a population of 1500 individuals. The difference between the estimates of Gill (1979) and Harvey (1988) may have reflected a population decline, but was also likely a result of more accurate surveys by Harvey. Nevertheless, density estimates in three South Bay marshes were found to decline from 1.47, 0.89, and 0.69 rails/hectare in 1980 (Harvey 1988) to 0.64, 0.26, and 0 rails/ha, respectively in 1989 (Foerster et al. 1990), indicating an actual, considerable population decline. Populations of rails in five South Bay marshes declined by as much as 85%, apparently as a result of depredation by the non-native red fox (Albertson 1995). By the mid 1980s, approximately 1200-1500 California clapper rails remained, with greater than 80% occurring in the South Bay. By 1988, populations were estimated at 700 rails, and by 1991 the bay-wide total was estimated at 300-500 individuals (Alberston and Evens. 2000).

Clapper rail predation by both red foxes and feral cats has been directly documented in the South Bay by the tracking of radio-marked rails that were depredated in 1991 and 1992 (Albertson 1995). In addition, the remains of clapper rails were found at a fox den in a tidal marsh on the SFBNWR (Harding et al. 1998), and at the entrance to a den in the outboard levee along salt pond A9 (Steve Rottenborn, pers. obs.). Norway rats are thought to be one of the main predators of California clapper rail eggs (Foerster et

al. 1990; Harvey 1988), and raccoons have also been known to prey on California clapper rail eggs (Foerster et al. 1990).

A predator management plan implemented by the SFBNWR since 1991 has met with some success in reducing the effects of mammalian predators on clapper rails, resulting in an increase in rail populations (Harding et al. 1998). Between 1991 and 1996, clapper rail population size within a given marsh showed a significant negative relationship with the number of red foxes removed the prior year, and rail population growth rates were significantly related to red fox trapping success the prior year. The most recent population estimate for California clapper rails was approximately 1040 to 1264 birds in 2000 (Alberston and Evens. 2000). Although management of mammalian predators has helped boost clapper rail populations, avian depredation by raptors, common ravens, and possibly gulls still poses a threat, and may be increasing (Alberston, pers. comm.). In 2003, the CDFG implemented a predator-control program at the Eden Landing Ecological Reserve to reduce predation on listed species (John Krause, pers. comm.).

Other ongoing threats to clapper rails include loss of habitat to sea-level rise (Keldsen 1997), human disturbance, and accumulation of mercury and other contaminants. Few data are available regarding the effects of human disturbance on California clapper rails. Clapper rails are typically shy and reclusive, and avoid areas of high human use. Construction-related disturbance has been found to result in abandonment of territories, but in one instance, use of a jack-hammer within 50 feet of a territory did not result in abandonment of that territory (Wetlands Research Associates 1994).

California clapper rail eggs collected from several sites around the San Francisco Bay in 1975, 1986, and 1987 were found to have elevated levels of PCBs, selenium, and mercury (Lonzarich et al. 1992). Analysis of unhatched eggs from the Central Bay by Schwarzbach and Adelsbach (2003) detected mean mercury concentrations of 0.81 ppm on a fresh wet weight basis, concentrations that were considered embryotoxic. The levels and effects of mercury concentrations in South Bay birds are the subjects of ongoing study.

Breeding-season surveys of South San Francisco Bay marshes for California clapper rails through the early 1990s, summarized by Foin et al. (1997), indicated that the most substantial populations of clapper rails in the South Bay were, predictably, in the largest sections of tidal salt marsh: at Mowry Marsh and Dumbarton Marsh (in the east Bay between the Dumbarton Bridge and Mowry Slough), at the Faber/Laumeister Tracts and other marshes in the Palo Alto/East Palo Alto area, and at Greco Island in Redwood City. Mean counts from these areas include 68 birds at Mowry Marsh, 57 at Faber-Laumeister, and 44 at Dumbarton (Foin et al. 1997). Nest searches by San Francisco Bay NWR personnel detected 40 nests in the Faber/Laumeister Tracts, 33 on Greco Island, and 13 in North Mowry Marsh in 1992 (Keldsen 1997). Clapper rails occurred in many other marshes as well, including Ideal Marsh (adjacent to Cargill pond N5), Calaveras Marsh (adjacent to Cargill Ponds M2 and M3), and Triangle Marsh in Alviso. Clapper rails have been found to occasionally use salt pond dredge locks as high-tide refugia (Wetlands Research Associates 1994b). Although site-specific surveys have not been conducted in all suitable habitat for clapper rails in the South Bay, this species is likely to occur in tidal salt marsh habitats in a number of additional areas as well (Figure 5).

Although California clapper rails are typically found in tidal salt marshes, they have also been documented in brackish marshes in the South Bay. Breeding-season surveys conducted in marshes bordering Coyote Creek in 1989 documented breeding California clapper rails in a wide variety of plant associations. Surveys conducted during the 1990 breeding season (H. T. Harvey & Associates 1990d) and winter season (H. T. Harvey & Associates 1990c) found a number of California clapper rails occupying salt/brackish transitional marshes and several brackish, alkali bulrush-dominated marshes, including Warm Springs Marsh (immediately east of Pond A19) and the marshes along upper Coyote Slough even farther east. In addition, California clapper rails were found in nearly pure stands of alkali bulrush along Guadalupe Slough in 1990 and 1991 (H. T. Harvey & Associates 1990c; H. T. Harvey & Associates 1990d; H. T. Harvey & Associates 1991c). Although it has been suggested that habitat quality may be lower in brackish marshes than in salt marshes (Shuford 1993), further studies comparing reproductive success in different marsh types are necessary to determine the value of brackish marshes to California clapper rails.

On rare occasions, California clapper rails have been recorded even farther upstream, in brackish/freshwater transition marshes, particularly during the nonbreeding season. In the Alviso/Sunnyvale area, such individuals have been recorded along upper Alviso Slough near the Gold Street bridge (14 February 1997; Scott B. Terrill, pers. obs.), in nontidal freshwater ponds between Calabazas and San Tomas Aquino Creeks north of Highway 237 in Sunnyvale (16 August 1998; Steve Rottenborn, pers. obs.), and along Artesian Slough near the Environmental Education Center in January 1999 and January-February 2001 (Santa Clara County Bird Data Unpublished).

No Bay-wide breeding-season surveys have been conducted for clapper rails since the 1990s. However, the USFWS, in conjunction with other agencies, conducts annual winter high-tide surveys using an airboat. These surveys attempt to cover all South Bay marshes at least once every two years (although areas with dense cordgrass cannot be surveyed with this method except on the highest tides). Recent winter surveys indicate that clapper rail populations in the Mowry/Dumbarton Slough area appear to be fluctuating, but populations in other areas seem to be more stable, see Table 8 (Alberston, pers. comm.). This may be the result of higher avian predation rates in the Mowry/Dumbarton area, but this hypothesis has not been studied.

Table 8 – High and low winter counts of clapper rails from major tidal salt marshes in the South Bay, 1994-2000 and 2002 (USFWS unpubl. data).

Location	High Count (Year)	Low Count (Year)
Dumbarton	104 (1994)	28 (2000)
Mowry	126 (1997)	4 (2000)
Hooks Island	46 (1997)	16 (2000, 2002)
Palo Alto Harbor	16 (1997)	5 (2002)
Faber	60 (1997)	29 (1995)
Laumeister	48 (1997)	24 (1995)
Greco Island	96 (2002)	87 (2000)

Both winter and breeding season surveys suggest that there is substantial annual variability in local distribution and abundance of clapper rails in the South Bay. For example, at one of the sites where rails were found in brackish marshes in Guadalupe Slough (discussed above), no rails were found during protocol-level surveys the year before (H. T. Harvey & Associates 1990c; H. T. Harvey & Associates 1990d; H. T. Harvey & Associates 1991c). Table 8 shows the high variability in winter counts, and suggests that populations may be particularly high in certain years, such as 1997, presumably following high breeding success.

California Black Rail (*Laterallus janaicensis coturniculus*). Federal Listing Status: None; State Listing Status: Threatened. The California black rail is a small rail that inhabits tidal salt, brackish, and freshwater marshes. This small bird is very secretive, and is most often seen during high tides when it is forced into high marshes. Little information is available regarding the biology of California black rails. They are most abundant in tidal marshes with some freshwater input (Evens et al. 1991). They nest primarily in pickleweed-dominated marshes with patches or borders of *Scirpus*, often near the mouths of creeks. They build nests in tall grasses or marsh vegetation during spring, and lay about six eggs. Nests are usually constructed of pickleweed, and are placed directly on the ground or slightly above ground in vegetation. Black rails feed on terrestrial insects, aquatic invertebrates, and possibly seeds (Trulio and Evens 2000).

The California black rail reportedly bred in the Alviso area in the early 1900s (Wheelock 1916), but currently it is not known to breed in the South Bay. In the San Francisco Bay area, this small rail currently breeds primarily in marshes in the north San Francisco Bay Area (i.e., San Pablo Bay and Suisun Bay). After breeding, some black rails disperse into the South Bay, accounting for most records of the species in this area. Here, the abundance of the black rail during the nonbreeding season is unknown due to its very small size and highly secretive nature. Most observations of black rails in the South Bay consist of only a few birds observed seeking high-tide refugial cover at the edges of the salt marsh in a few areas during spring tides from November to February. Nearly every winter, small numbers (up to ten or more in a day, but usually four or fewer) are seen during such spring tides at the Palo Alto Baylands, and occasionally individuals are observed in the East Palo Alto marshes as well. This species is likely present in small numbers at other scattered locations as well (e.g., there are unconfirmed reports from the Alviso marina during high winter tides), but the inaccessibility of most suitable areas to look for black rails during spring tides, and the species' silence in the South Bay during winter, makes it virtually impossible to survey the species in the Study Area during this season.

Late-season (April) calling black rails have been reported at the Palo Alto Baylands (26-27 April 1993; Santa Clara County Bird Data) and near the east end of the Dumbarton Bridge. There is also a 30 August 1995 record from the vicinity of the Sunnyvale Water Pollution Control Plan (presumably along Guadalupe Slough) (Santa Clara County Bird Data Unpublished). However, there are no records of black rails breeding in the South Bay since at least the 1920s (Trulio and Evens 2000).

The absence (or scarcity) of breeding black rails in the South Bay is presumably a result of habitat loss. Tidal marsh habitat has been lost, but perhaps more important to winter survival is loss of high-tide

refugia habitat. Upland transition habitat, both on natural levees within marshes and on landward edges of marshes, has been lost as a result of fill for development, and reductions in marsh size and resultant reductions in natural levees along higher-order channels. Predation by egrets, herons, gulls, and harriers has been observed in these marshes during winter high tides, as black rails are forced into the open by rising water. The importance of this predation on a population level, especially in light of impacts to high tide refugia, is unknown, but it may be a significant factor in the extirpation of breeding populations of the species from the South Bay.

Western Snowy Plover (*Charadrius alexandrinus nivosus*). Federal Listing Status: Threatened; State Listing Status: Species of Special Concern. The snowy plover is a small shorebird that occurs on almost every continent. In North America, there are two races of snowy plover: the western snowy plover (*C. a. nivosus*) occurs west of the Mississippi River, primarily in the Great Basin and along the Pacific coast, and the Cuban snowy plover (*C. a. tenuirostris*) occurs in the southeastern United States (Page et al. 1995). On the Pacific coast, snowy plovers nest on sandy beaches and salt panne habitat from Washington to Baja Mexico. Because they nest during the summer, primarily on beaches in a temperate climate, western snowy plovers are susceptible to nest disturbance and other negative interactions with humans. Much of their nesting habitat, particularly in southern California, has been lost to development and high human use. In addition, introduced predators, especially the non-native red fox, have had dramatic effects on snowy plover nesting success (Neuman et al. 2004). In response to severe population declines, the USFWS listed the Pacific coast population of the western snowy plover as Threatened in 1993. Critical habitat was designated for this population in 1999, and a draft recovery plan was released in 2001 (U.S. Fish and Wildlife Service 2001). None of the breeding sites within San Francisco Bay are considered critical habitat. The State of California lists the western snowy plover as a species of special concern.

In the South San Francisco Bay, snowy plovers nest on low, barren to sparsely vegetated salt pond levees and islands, at pond edges, and on salt panne areas of dry ponds (Page et al. 2000), and preferentially use light-colored substrates such as salt flats (Feeney and Maffei 1991; Marriott 2003). Nesting areas are located near water, where prey (usually brine flies and other insects) are abundant. In some areas, snowy plovers nest within dry salt ponds; in other areas where ponds typically hold water through the summer (e.g., the Newark salt ponds), nests are located primarily on levees. Often, nests are located near disruptive objects such as rocks or surface irregularities, and may be constructed in depressions created by footprints and vehicles (Marriott 2003; Page et al. 1995). Nests consist of a depression scratched into the substrate sometimes lined with shell fragments, pebbles, or similar local materials (Page et al. 2000; Page et al. 1995). Eggs are oval and buff-colored with small, brown- and black-colored spots and scrawls.

According to Page et al. (1995), pairing begins as early as mid February; egg-laying commences in early March, and may continue with multiple broods into early August. The incubation period ranges from 26 to 32 days. Three eggs are typically laid two to five days apart. Replacement clutches are initiated approximately six to eight days after the destruction of a completed clutch. Young birds are precocial, leaving the nest within hours of hatching. Chicks are usually cared for exclusively by the male parent, until they fledge at 28-33 days. Chicks feed themselves, but require the protection of an adult for brooding and evasion of predators. The breeding season of the western snowy plover in California, from

nest initiation to fledging of chicks, is considered to be 1 March to 31 September. Although snowy plovers can nest as early as 1 March, damp nesting substrate in salt ponds, from flooding or normal spring rains, may delay nesting in this habitat until the substrate dries.

Some snowy plovers remain in their coastal breeding areas year-round, while others are migratory. Some individuals that nest in the San Francisco Bay Area probably migrate south as far as Mexico (U.S. Fish and Wildlife Service 2001). There is overlap between the San Francisco Bay population and the adjacent coastal nesting population. Birds banded at Monterey Bay and in Oregon have been seen in the San Francisco Bay salt ponds (Feeney and Maffei 1991). Snowy plovers typically live three to four years (Page et al. 1995).

Snowy plovers in the South Bay forage primarily on small flies, especially brine flies (*Ephydra cinerea* and *Lipochaeta slossonae*; (Feeney and Maffei 1991). They also feed on other small invertebrates, including beetles and small marine invertebrates. Snowy plovers forage visually, and often run after prey which they capture in their bills. In the South Bay, western snowy plovers are likely to forage anywhere where prey is available. Brine flies are usually found in greatest densities at the shallow margins of shallow salt ponds or puddles, but snowy plovers also forage in open salt flats, and occasionally, on mudflats adjacent to salt ponds.

It is not known whether this species nested inside San Francisco Bay before conversion of salt marsh to salt evaporation ponds. Breeding habitat may have been present in natural salinas prior to the creation of salt ponds, but such features would have provided limited breeding habitat for snowy plovers, at best. Salt ponds have provided suitable nesting and foraging habitat since the beginning of the 20th century, and as of 1990, about 10% of the California population of snowy plovers bred within San Francisco Bay salt ponds, mostly in the southern part of the Bay (Page et al. 2000; Page et al. 1991). Surveys conducted by PRBO, SFBBO, and others since the 1970s have shown that the breeding population in the South Bay may be declining. Window surveys in the South Bay, which cover most available breeding habitat in a one-week period, detected 351 breeding birds in 1978, 270 in 1984, and 216 in 1989 (Page et al. 2000). In 2004, the results of breeding-season monitoring of the Eden Landing, Alviso, and Ravenswood pond complexes resulted in a maximum of only 113 snowy plovers (Strong et al. 2004b); this total was down to 99 birds in 2006 (Robinson et al. 2006). Numbers of snowy plovers in the South Bay may be considerably higher in winter, when the local population is augmented by wintering birds that likely breed in the Great Basin. In contrast, recent surveys by USGS (Takekawa et al. 2005) found lower abundance in winter in the Alviso pond complex.

Figure 6 depicts the areas where snowy plovers have been recorded breeding in the South Bay since 1989 (although no recent data are available from the Newark and Redwood City salt ponds). During both the winter and breeding seasons, the greatest concentration of snowy plovers in the San Francisco Bay area has consistently occurred in the Eden Landing/Hayward area, with a lower but moderate level of use at Ravenswood and Alviso ponds.

Within the Study Area, substantial breeding populations occur in the Warm Springs salt ponds (Ponds A22 and A23) in the Alviso complex. At Warm Springs, Ponds A22 and A23 are used, with > ten adults

found during the 2003 nesting season, a high count of 32 plovers at A22 in 2004 (Strong et al. 2004b), and 13 plovers at A22 in 2006 (Robinson et al. 2006). Low densities of snowy plovers have been recorded during the breeding season, sometimes with nests or chicks, at some other Alviso salt ponds, primarily at A6 and A8 (Ryan and Parkin 1998b; Strong et al. 2004b); the species also nested in the late 1990s in Alviso Pond A3N and in a small impoundment immediately east of Pond A12 (Santa Clara County Bird Data Unpublished). In 2006 and 2007, Pond A8 in Alviso has been used extensively by snowy plovers, after several years with very little plover activity in Alviso. In 2006, up to 36 snowy plovers were seen in A8, and 11 nests were found here (Robinson et al. 2006). In addition, the presence of snowy plover chicks and adults at an impoundment east of the Alviso Marina indicated that snowy plovers nested here, although no nest was found (Robinson et al. 2006).

Habitat conditions (including water depth and predator density) change over time at each of these nesting areas, so the numbers cited above are not necessarily representative of the current distribution of snowy plovers in the South Bay. The snowy plover is opportunistic, capable of moving around among potential breeding areas and breeding where conditions are suitable. The abundance and distribution of snowy plovers in the South Bay shifts annually, and is also dynamic within a given nesting season. Early in each breeding season, many ponds may not be suitable for nesting due to late rains creating muddy substrates, and nesting may be concentrated at a few ponds with suitable conditions. Later in the season, as more ponds dry out and become available for nesting, snowy plovers may be more dispersed among many nesting locations, and nest in lower densities.

Primary threats to the western snowy plover are mammalian and avian predators, and human disturbance (Page et al. 1995). Non-native predators, such as red fox, have had major effects on populations in California; in the South Bay, two snowy plover nests were known to have been depredated by red foxes in 1993 and 1994 in the Coyote Hills and Dumbarton areas (Harding et al. 1998), and such events have probably occurred much more frequently than is known. Efforts to curtail nest depredation by mammalian predators have greatly enhanced nesting success by snowy plovers in some areas (Neuman et al. 2004). In the South Bay, no strong increase in nest success was noted between 1991 and 1996, after a predator management plan was implemented, except at a few nests where exclosures were used; such nests had generally high success rates (Harding et al. 1998). Overall nest success in the South Bay has been fairly high in some recent years, with 80% nest success in 2001 (N=78 nests) and most of 2004 (N=54 nests as of July) (Wilson 2004). However, fledging success is unknown, and may be far less due to predation by avian predators.

Avian predators, particularly California Gulls and corvids (crows and ravens), are increasingly becoming an issue for snowy plover reproductive success (Wilson 2004). California gulls at Mono Lake are known to prey on snowy plover eggs and chicks (Page et al. 1983), and given the abundance of California gulls in the South Bay during the breeding season, even low levels of predation may be important to nesting plovers. American Crows (*Corvus brachyrhynchos*) and common ravens are adept at finding snowy plover nests and preying on eggs. Corvid numbers may be increasing throughout California, at least partially in response to increased availability of food from anthropogenic sources, such as garbage dumps. Other avian predators, including Loggerhead Shrikes, American Kestrels, and Northern Harriers have been documented taking snowy plover chicks, and in some areas, have dramatically reduced fledging

success (Neuman, pers. comm.). Human disturbance can also be a serious factor limiting nesting and fledging success. Human disturbance (including disturbance from domestic dogs) can lead to nest abandonment or direct trampling of eggs or chicks (Page et al. 1995). In addition, because young chicks are dependent on adults for protection, human disturbance resulting in the separation of chicks from adults can lead to the death of the chicks.

California Least Tern (*Sterna antillarum browni*). Federal Listing Status: Endangered; State Listing Status: Endangered. Least terns are small fish-eating birds that nest primarily on beaches. The California least tern nests during summer from Baja California north to San Francisco Bay. Least terns are migratory, and spend winter months in coastal areas of Mexico and Central America. Most breeding colonies are located in southern California. The California least tern is listed as endangered on the state and federal levels, and the state considers it a fully protected species.

Currently, the breeding colony at Alameda is one of the most important breeding colonies in the state. In 2003, this colony had 301 breeding pairs (Hurt 2004). This total is up considerably from prior decades: 128 pairs were found in 1993, and only 70 pairs nested in 1982 (Collins 1994). Least terns nesting at Alameda typically arrive at the colony in late April, and fledge chicks from late June to early August. They forage for small fish in shallow coastal waters near the colony, mainly around Alameda Point (Hurt 2004). Adults and juveniles typically start dispersing south from the Alameda colony in early July.

Least terns also nested in 2000 and 2001 at Albany (near Alameda), with up to 12 pairs in 2000. At Pittsburg, on Suisun Bay, 13 pairs nested in 2001 and eight pairs nested in 2003. Historically, small numbers of birds have nested at the Oakland International Airport (last reported in 1995), Bay Farm Island (last reported 1975), Bair Island (last reported 1984), Port Chicago (last reported in 1988), the Bay Bridge Sand Spit (one-time attempt in 1985), and tern Island (one-time attempt in 1990) (Takekawa et al. 2005).

In addition, South Bay salt ponds have been used historically for sporadic and limited nesting attempts. These include attempts on levees at Ponds E10/E11 at Eden Landing (last reported 1985), Ponds N5/N7 (last reported 1983) and N1A in the Newark salt ponds, and Pond R3 in the Ravenswood Compex (Hurt 2004; Wetlands Research Associates 1994). In the South Bay, recent breeding has occurred only at Hayward Regional Shoreline, where eight pairs nested in 2005 and 15 pairs in 2006 (Strong 2006), and at Pond E8A in Eden Landing, where at least five pairs nested in 2007.

Currently, least terns use the Shoreline Study Area only as a post-breeding staging area from about late June through late August, prior to their southward migration. Here, both adult and juvenile least terns roost on salt pond levees (both outboard levees and interior levees between ponds) and boardwalks, and forage both in the salt ponds and over the open waters of the Bay. At the Alameda colony, least terns forage primarily on silversides (e.g., topsmelt), northern anchovies, Pacific herring, and surfperches (Elliott et al. 2004). Although data are unavailable regarding diet during the post-fledging period in the South Bay, diet is likely similar. Least terns have often been observed foraging in South Bay salt ponds, but they also forage heavily in adjacent open Bay waters. For example, 50 of 58 least terns observed foraging in the SBSP project area on 14 July 2004 were doing so over the Bay, with only eight

individuals actively foraging in salt ponds (Steve Rottenborn, pers. obs.). However, the relative importance of salt ponds versus Bay waters for foraging by least terns in the South Bay is largely unknown.

In recent years, the main post-breeding (late summer/fall) staging area for least terns in the South Bay has been in the complex of salt ponds immediately north of Moffett Field (Ponds AB1, A2E, and AB2; Figure 5), located in the Study Area. For example, 276 least terns were seen in these three ponds on 27 July 2004 (Steve Rottenborn, pers. obs.). This site is used predictably for roosting and foraging by both adult and juvenile least terns in July and August each year, with typical counts of 20-100 birds. Least terns have also been recorded at a number of other ponds in the Study Area, including A1, A2E, A3N, A3W, A4, A5, A7, A9, A10, A11, and A14 (Hurt 2004).

Salt Marsh Harvest Mouse (*Reithrodontomys raviventris raviventris*). Federal Listing Status: Endangered; State Listing Status: Endangered. The salt marsh harvest mouse is a small mouse endemic to salt marshes of San Francisco Bay. The USFWS listed the salt marsh harvest mouse as an Endangered Species under the authority of the Federal Endangered Species Act on 13 October 1970, based on population declines and loss of habitat. The State of California listed the salt marsh harvest mouse as an Endangered Species on 27 June 1971, and considers it a fully protected species. The USFWS approved a joint recovery plan for the salt marsh harvest mouse and the California clapper rail on 16 November 1984 (U.S. Fish and Wildlife Service 1984). Critical habitat has not been established for either the California clapper rail or salt marsh harvest mouse.

The salt marsh harvest mouse's current distribution includes salt marshes in San Francisco, San Pablo, and Suisun Bays. The species no longer occurs on the Peninsula north of Coyote Point (Shellhammer 2000a). *Reithrodontomys raviventris* is separated into two subspecies, *R. r. raviventris* of the South Bay and *R. r. halicoetes* of the North Bay. *R. r. raviventris* is restricted along both sides of San Francisco Bay to an area from San Mateo County on the west side and Alameda County on the east side, south to Santa Clara County; this subspecies was one of the pivotal species upon which the decision to initially establish a National Wildlife Refuge in the South San Francisco Bay was based (H.R. Bill 17047, (1970), and Senate Bill 2291, (1969)).

These mice are dependent on dense vegetative cover, usually in the form of pickleweed and other salt dependent or salt tolerant vegetation in both tidal and diked salt marshes (Fisler 1965; Shellhammer 1982; Shellhammer 2000a; Shellhammer et al. 1988; Shellhammer et al. 1982). Pickleweed provides more horizontal branches (and therefore more cover) than other halophytic species. Closely tied to the cover of dense pickleweed, salt marsh harvest mice were thought to make little use of pure alkali bulrush or pacific cordgrass stands (Shellhammer 1977; Wondolleck et al. 1976). More recent trapping (H. T. Harvey & Associates 2007) detected salt marsh harvest mice in brackish marshes dominated by alkali bulrush. The extent of their distribution in, and use of, this habitat is not yet known. Grasslands adjacent to pickleweed marshes are generally used only in the spring when new growth affords suitable cover and possibly forage (Johnson and Shellhammer 1988). Salt marsh harvest mice may also use adjacent grasslands on a daily basis to avoid high tide events, but only a small percentage of the edge of the South Bay has grassland or even much in the way of escape cover adjacent to it, hence the salt marsh harvest mice have almost

nowhere to go to escape from high tides. Refugial vegetation, especially peripheral halophytes, is necessary in tidal marshes and in diked marshes that flood seasonally. On the highest spring tides in winter, the lack of high-tide refugia exposes salt marsh harvest mice to intense predation, and numerous small mammals (many of which are likely salt marsh harvest mice) have been observed being depredated by gulls, herons, egrets, and raptors on such high tides in the South Bay. Marshes without appropriate cover, and narrow marshes without refugial zones into which the mice can escape during flooding or high tides, generally lack salt marsh harvest mice. Figure 7 depicts areas currently providing pickleweed habitat that is known to support, or could potentially be supporting, salt marsh harvest mice within the Study Area and adjacent areas, as well as locations where this species has and has not been detected during survey efforts, and locations providing suitable escape cover; relatively few areas provide high-quality habitat.

Salt marsh harvest mice build loose nests of dry grasses (Shellhammer 1982). Average litter size ranges from 3.7 to 4.2 mice/litter and most animals are thought to have only one litter/year (Fisler 1965). However, recent evidence shows more frequent reproduction (Geissel et al. 1988), with Grizzly Island Wildlife Area populations reproducing as often as three times per year (Krause, pers. comm.). Reproduction occurs from March through November (Fisler 1965). There are few data on foraging by harvest mice, but they probably subsist on leaves and stems of plant species, primarily pickleweed, found in tidal and diked salt marshes. Fisler (1965) reported a high seasonal variation in stomach contents. In winter, fresh green grasses were preferred, while in the rest of the year, pickleweed and other halophytes such as salt grass were the main food sources. The salt marsh harvest mouse is capable of drinking pure seawater, but it generally prefers brackish water (Fisler 1965).

Historically, the marshes in San Francisco Bay were a complex mosaic of vegetation zones, generally consisting of low marsh adjacent to mudflats dominated by cordgrass, high marsh plains dominated by pickleweed, and broad transitions of peripheral halophytes (salt-tolerant plants that cannot tolerate as much inundation by the tides) into upland habitats, with narrower transitional zones on natural levees along larger channels within the marshes. Most of the tidal marshes around the Bay and especially in the South Bay were eliminated, and those remaining have lost the upper portion of their pickleweed zones as well as the higher zone of peripheral halophytes (Shellhammer 1982; Shellhammer and Duke 2004). For example, detailed mapping by H. T. Harvey & Associates for the South Bay Salt Pond Restoration project reveals that pickleweed dominated habitat and peripheral halophyte habitat comprise only 275 acres and 113 acres, respectively, within the 8000-acre Alviso Complex; much of the peripheral halophyte acreage in the Alviso Complex, however, is adjacent to little used brackish vegetation. Most of the tidal salt marshes in the South Bay are small, isolated strip-like marshes along backshores against levees or other hardened structures that promote predation, inhibit further high marsh development, and are threatened by sea level rise (Shellhammer 1989). Similarly, most of the marshes do not have higher order tidal channels within them and hence lack a pattern of natural levees supporting shrubs such as gum plant, and other peripheral halophytes, within them that might act as escape cover for mice within the marshes. Shellhammer and Duke (2004) note that most of the marshes of the South Bay are de facto corridors, likely not wide enough to support viable populations, but wide enough to function as dispersal corridors. Recent mapping is also documenting the fragmentation of the habitat (Figure 7). Cover-dependent salt marsh harvest mice are unlikely to move long distances over bare areas, and thus, isolation of suitable

habitat may lead to genetic isolation of populations. While they are known to swim well, especially in comparison with western harvest mice, they have not been documented to move more than four to five meters across water or more than five meters over bare ground (Bias 1994; Geissel et al. 1988). Based on this information, Shellhammer and Duke (2004) have hypothesized that barren areas of land more than five meters wide, reaches of water more than four meters wide, and brackish or freshwater marsh more than 250 meters wide act as barriers to movement of the southern subspecies of the salt marsh harvest mouse, and hence barriers to gene flow. The more recent (2006) discovery of salt marsh harvest mice in brackish marshes tempers the description of barriers somewhat, but there are still broad areas without vegetation. Areas of bare ground, water, or fresh/brackish marsh less than or equal to these distances may act as filters, reducing the movement of animals (and hence the rate of gene flow) between populations or between portions of a semi-fragmented population. The isolation of populations has contributed to the decline of the species (Shellhammer and Duke 2004) and could lead to local extinctions due to demographic processes or genetic "death." Based on their assessment of potential barriers in the South Bay, Shellhammer and Duke (2004) estimated that there were potentially 25 separate populations of salt marsh harvest mice in the South Bay as of 2002 (not including mice that might be present in very small patches of pickleweed). Figure 7 indicates the locations of major barriers and filters to dispersal of salt marsh harvest mice among the tidal salt marsh remnants in the South Bay.

Habitat degradation has also occurred as a result of the conversion of existing tidal salt marsh to brackish or even freshwater marsh over the past four decades. Within the Alviso Complex, the combination of treated effluent discharge, sedimentation that has reduced the tidal prism, and freshwater flows from rivers and streams (especially in high-rainfall years) has created conditions too fresh for pickleweed to compete and survive (H. T. Harvey & Associates 1994; 2002; 2006; Shellhammer 1982; Shellhammer et al. 1988; Shellhammer et al. 1982). The habitat value of brackish marsh needs reexamination after recent results in the Suisun Marsh and more recently in Alvios. Trapping in salt marsh harvest mouse preserves in the range of the northern subspecies in the Suisun Bay by Barthman-Thompson of CDFG has shown that salt marsh harvest mice do use other species of bulrush and cattail (*Typha* spp.) in the area. Preliminary results from a number of mouse trapping projects (most of which were done in the Suisun Bay) suggest that monocultures of peppergrass, which dominate large areas of brackish marsh in the South Bay, are not used by the mice.

As a result of habitat loss, degradation, and fragmentation, salt marsh harvest mouse populations are small. A database for all salt marsh studies carried out in the South San Francisco Bay, including the entire Study Area, was compiled by H. Shellhammer at H. T. Harvey & Associates (Shellhammer and Duke 2004). Trapping records from permits issued by the USFWS and the CDFG were reviewed and compiled. The database, which includes 198 trapping projects (estimated 95% of all such projects and studies) representing 134,204 trap nights (TN) completed through 2003, shows that 37% of all trapping projects (73 of 198, or 49,481 TN of a total of 134,204 TN) captured 0 salt marsh harvest mice. The average capture efficiency (CE, or total effort in TN divided by the number of mice captured) of all trapping projects was 0.013. In terms of unit effort, it took an average of 79 TN to capture one salt marsh harvest mouse. The approximately 64% of the projects in which at least one mouse was captured (153 of 198) had a capture efficiency equal to or less than 0.019, or it took 77 TN to capture a single mouse.

There were few projects in which numerous salt marsh harvest mice were captured; there were only eight projects with a CE ≥ 0.06.

The Alviso ponds have had 11 projects in the New Chicago Marsh area (mostly from the 1970s and 1980s), and 11 or more in Triangle Marsh and its western extension (north of Alviso), but again most of them date from the 1970s and 1980s. There are nine or more, widely spaced projects in the middle of the Alviso Complex: two were done along Guadalupe Slough, six on or near the northwestern edge of Moffet Field, and one in the southeastern corner of the Sunnyvale Baylands Park. The highest density of trapping projects in the area of the Alviso Complex is just west of the complex, where 13 projects have been carried out between Charleston Slough and San Francisquito Creek. Most of the harvest mouse trapping projects were carried out in the late 1980s and 1990s. A relatively small number of projects have been carried out in these ponds compared to other parts of the South Bay because they were protected from development for most of the last few decades.

Despite the species' small populations, the salt marsh harvest mouse is known to rapidly colonize restored areas. This species quickly moves into areas of appropriate habitat from nearby inhabited areas as has been shown in numerous trapping projects' reports, including many in the South Bay (H. T. Harvey & Associates 1984a; 1985a; 1985b; 1985c; 1987; 1996; 1997a).

4.4.2 Other Special-Status Species

Western Pond Turtle (*Clemmys marmorata*). Federal Listing Status: None; State Listing Status: Species of Special Concern. The western pond turtle is an aquatic turtle found west of the Sierra Nevada from the Columbia River south to northern Baja California, Mexico. This turtle requires some slack or slow water, although it will occur where enough food resources occur in faster moving water; it usually leaves the aquatic site to reproduce, to aestivate, and to over-winter. Typical habitat includes freshwater ponds and backwaters in slow-moving rivers with abundant aerial and aquatic basking sites. Nesting usually occurs in upland areas from March to July, in hard-packed clay soil. Hatchlings disperse from the nest with winter rains. Threats to the western pond turtle include impacts to nesting habitat from agricultural and grazing activities, human development of habitat, and increased predation pressure from native and non-native predators as a result of human-induced landscape changes. Many of the current records for the species are from the greater San Francisco Bay area, including the Santa Clara Valley (Jennings and Hayes 1994).

Western pond turtles are absent from most of the Shoreline Study Area, due to a lack of suitable freshwater habitat. A small population occurs in brackish habitats near Moffett Field and the Sunnyvale WPCP, in the vicinity of Pond A3W (Alderete and McGowan 2003; Figure 5). Here, up to five turtles were found on 31 May 2002, in the Northern Channel on the south side of A3W (Alderete and McGowan 2003). This population is clearly isolated from other pond turtle populations in the South Bay. A review of western pond turtle records in Santa Clara County in 1999 (H. T. Harvey & Associates 1999b) included a single record along lower Stevens Creek near Moffett Field from 1987, but the next closest records to Moffett Field were more than seven miles away at Lagunita at Stanford, along San Francisquito

Creek in Palo Alto, and in a pond along San Tomas Aquino Creek in Santa Clara. Pond turtles are occasionally seen along lower Coyote Creek and the Guadalupe River; these are likely individuals that have dispersed downstream from populations in the upper watersheds of these streams.

Double-crested Cormorant (*Phalacrocorax auritus*). Federal Listing Status: None; State Listing Status: Species of Special Concern (Rookery Site). Double-crested cormorants are large fish-eating waterbirds resident along the entire coast of California and on inland lakes and estuaries. Breeding occurs at undisturbed sites, typically in trees or on man-made structures beside water. Double-crested cormorants are considered Species of Special Concern by the CDFG only at rookery sites. Double-crested cormorants nest during spring and summer (and occasionally into early fall), and are resident in the South Bay year-round. Numbers are augmented considerably in fall and winter, when non-breeding birds from other locations visit San Francisco Bay (Ainley 2000b).

Double-crested cormorants have increased as breeders in the San Francisco Bay area in recent decades. First breeding records for Alameda County, the bayside of San Mateo County, and Santa Clara County were established only as recently as 1984, 1989, and 1992, respectively. As of 1991, there were approximately 2800 double-crested cormorants nesting around San Francisco Bay, primarily on North Bay bridges(Ainley 2000b). Relatively few, however, breed in the Study Area. Here, this species has recently nested on electrical transmission towers at several sites, including towers in ponds A18, AB1, AB2, and A2W ((Strong 2004a); Figure 5). Santa Clara County Bird Data indicate that cormorants were first recorded nesting in the Alviso Complex on electrical towers in Pond A2W in 1992. Nesting by as many as ten pairs/year at this location has continued through 2004, and new colonies appeared on towers in Ponds AB1/AB2 in 1993 (with up to eight nests in subsequent years) and Pond A18 in 1994 (with a high of 27 nests in 1997). In 2006, 34 nests were counted at Pond A2W (Strong 2006). Double-crested cormorants use salt pond levees in the South Bay primarily for roosting, but a colony established in 1998 on the levee between Ponds A9 and A10 has contained up to 70+ nests in years since. In 2006, 29 nests were counted on this levee (Strong 2006).

These birds probably forage primarily in the open Bay, but cormorants also forage for fish in salt ponds. Counts from USGS censuses in South Bay salt ponds from 2002 through 2004 peaked in October and November, with high counts of 1963 at the Alviso Ponds in October 2003 (Takekawa et al. 2005). Numbers during surveys by USGS were lowest from January through March, with high counts typically under 100 birds at the Alviso Ponds. Large foraging flocks occasionally form around high fish concentrations, as indicated by counts of 1550 in Pond A9 on 9 October 2000 and 1200 on Shoreline Lake in Mountain View on 16 November 1996 (Santa Clara County Bird Data Unpublished).

White-faced Ibis (*Plegadis chihi*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting colony). The white-faced ibis is a medium-sized wading bird that is an uncommon breeder in California; it is considered a Species of Special Concern only at nesting colonies. White-faced ibises have nested at only a few locations in California, including the Salton Sea, Honey Lake, isolated locations in the Central Valley, and at Mallard Slough, in the South Bay. Currently, most ibises in California now nest at Kern NWR, in the Central Valley. Nests are built of vegetation, in dense stands of tule, cattail, or similar marsh vegetation.

The only nesting by the white-faced ibis in the South Bay occurred at Mallard Slough (also known as Artesian Slough), between Ponds A16 and A18 (Figure 5). Here, six adults were observed in and around a large mixed-species heronry in 1985, and adults were seen carrying nesting material in 1991 and 1992 (Santa Clara County Bird Data Unpublished). However, successful breeding was not documented, and there has been no subsequent evidence of breeding by this species in the South Bay since that time. White-faced ibises occur irregularly throughout the San Francisco Bay Area during the nonbreeding season.

Northern Harrier (*Circus cyaneus*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting). The Northern harrier is a raptor commonly found in open grasslands, agricultural areas, and marshes. Nests are built on the ground in areas where long grasses or marsh plants provide cover and protection. Harriers hunt for a variety of prey, including rodents, birds, frogs, reptiles, and insects by flying low and slowly in a traversing manner. The Northern harrier is considered a Species of Special Concern in California only at nesting sites.

This species is a common forager over San Francisco Bay marshes and extensive areas of ruderal habitat immediately surrounding the Bay, particularly during the non-breeding season (winter) when migrant and wintering birds augment the local resident population. Northern harriers breed in low numbers within the South Bay, nesting in the larger expanses of tidal marsh that remain, such as Triangle Marsh in Alviso, the Warm Springs marshes, and the Palo Alto/East Palo Alto marshes. This species also nests in extensive tracts of tall ruderal vegetation, moist fields, and nontidal or muted tidal marsh, such as occurs on Moffett Field and in the Palo Alto Flood Control Basin. The minimum patch size needed to support a pair of nesting harriers in the South Bay is unknown, and the narrow strips of marsh along some of the sloughs between salt ponds in the Study Area are likely too narrow to provide suitable nesting habitat for this species. However, nest-building along Guadalupe Slough near the Sunnyvale WPCP in 1993 and a successful nesting along Mountain View Slough, between Ponds A1 and A2W in Mountain View, in 2000 indicates that some of these narrower marshes do provide suitable nesting habitat (Santa Clara County Breeding Bird Atlas Committee Unpublished). Northern harriers may be important predators of nesting shorebirds and terns in the South Bay, with individuals or pairs keying in on certain areas having concentrations of nesting waterbirds. This species has been known to take both adult and young snowy plovers in the Eden Landing Complex (Krause, pers. comm.).

White-tailed Kite (*Elanus leucurus*). Federal Listing Status: None; State Listing Status: Fully Protected Species. This raptor species prefers habitats with low ground cover and variable tree growth. Kite nests are usually built near the tops small trees or large shrubs near open habitats, such as partially cleared or cultivated fields, grassy foothills, and marsh. Kites prey primarily on small rodents (especially the California vole), but also feed on birds, insects, reptiles, and amphibians.

This species occurs in the South Bay commonly throughout the year, primarily in the upland fringes of the Shoreline Study Area. Breeding occurs primarily in spring and early summer, although breeding activity as early as February, with young in the nest as late as October, has been noted in the South Bay (Santa Clara County Bird Data Unpublished). This species breeds in a number of locations around the

Study Area where nest sites (e.g., trees and shrubs) occur adjacent to open fields, ruderal habitats (e.g., active and closed landfills), and marshes. The riparian corridor of Coyote Creek is likely to support several breeding pairs each breeding season.

Merlin (*Falco columbarius*). Federal Listing Status: None; State Listing Status: Species of Special Concern (wintering). The merlin is a medium-sized falcon that breeds in North America primarily in Canada. Merlins do not breed in California, but have been listed as a Species of Special Concern due to concerns over the species' wintering populations here. Non-breeding merlins occur in the San Francisco Bay area from September through April.

Like most falcon species, the merlin feeds primarily on small birds. Merlins are widespread, but in low abundance, throughout the entire Bay area during migration and winter, where they forage aerially. Shorebirds (e.g., sandpipers) provide abundant prey, thus merlins can often be found foraging over salt ponds and mudflats. They also forage on a variety of other bird species, and can be found in virtually all habitats in the Shoreline Study Area.

California Gull (*Larus californicus*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting colony). The California gull breeds colonially throughout the western United States, often in colonies of several thousand birds. They typically start attending colonies in early April, and lay eggs in early May (Winkler 1996). Incubation takes about 27 days, and chicks hatch in the late May to early June. Chicks remain near the nest until fledging about six weeks after hatching. Typical nesting habitat is barren or sparsely vegetated borders of saline lakes. Abundant nesting populations from the Great Basin (e.g., Great Salt Lake) disperse to coastal California after breeding, greatly augmenting the wintering population in the Bay area.

Historically, California gulls bred primarily on saline inland lakes, and this species was declared a Species of Special Concern at nesting colonies by CDFG due to concern over impacts to inland breeding colonies. In 1980, a small group colonized abandoned levees on Pond A6 in Alviso. This colony steadily increased in size over the next two decades, and by 2000 this colony had grown to over 10,000 nesting individuals, making it the second largest colony in California (Shuford and Ryan 2000). Adult California gulls attend the Pond A6 colony year-round, but numbers increase during spring. Egg laying occurs between mid-April and mid-May, and most young are fledged by mid-August (Shuford and Ryan 2000). Adult California gulls breeding in the South Bay forage on natural prey, such as brine flies and their larvae, and brine shrimp, supplemented by food obtained from human sources, including the Newby Island Landfill near Milpitas and the Tri-Cities Landfill in Fremont. It is likely that the availability of food at these landfills has been at least partly responsible for the increase in South Bay breeding populations, both by providing food during the breeding season and by aiding in the survival of younger birds during the nonbreeding season.

California gulls also prey on the eggs and young of other birds, such as snowy plovers, Forster's terns, American avocets, and black-necked stilts, and they likely take small mammals such as salt marsh harvest mice as well. A study by Ackerman et al. (2006) documented that 15% of American avocet nests monitored with cameras in the South Bay were depredated by California gulls; 61% of American avocet

chicks and 23% of black-necked stilt chicks fitted with radio transmitters in this study were determined to be depredated by California gulls. California gulls at Mono Lake are known to prey on snowy plover eggs and chicks (Page et al. 1983), and given the abundance of California gulls in the South Bay during the breeding season, even low levels of predation may be important to nesting waterbirds. Salt marsh harvest mice are particularly vulnerable during extreme high tide events, when most of the pickleweed marsh plains of the South Bay are completely inundated. At these times, salt marsh harvest mice are forced to swim, and gulls (including California gulls) readily forage over the flooded marshes, presumably including salt marsh harvest mice among their prey.

California gulls also nest in smaller numbers at several other sites within the Study Area. As of 2004, they were nesting in at least five colonies in the South Bay. Figure 2 depicts the locations where this species has nested in the South Bay since 1994. In 2006, the largest colonies other than at Pond A6 were at Coyotes Hills ponds 2A/3A (3721 nests) and on the levee between ponds M1 and M2 (2492 nests; Strong 2006). Numbers of California gulls in the South Bay increase during winter, when the local population is augmented considerably by birds moving from interior populations.

Table 9 – Numbers of California gulls at colonies in ponds in the Shoreline Study Area, from 1982 to 2006. All numbers are either total number of adults counted on the colony, or twice the number of nests counted on the colony. Data from Strong (Strong 2004b, Strong 2006).

Year	A1	AB2	A6	A9/10
1982	0	0	412	434
1983	0	0	1342	0
1984	0	0	2000	150
1985	0	0	3000	374
1986	0	0	3000	97
1987	0	0	4000	100
1988	0	0	4600	180
1989	0	0	5310	434
1990	2	0	7600	122
1991	0	0	5250	0
1992	0	0	5500	200
1993	200	82	6912	234
1994	350	556	9000	300
1995	74	300	7236	4
1996	0	282	6558	1410
1997	164	1000	6256	1722
1998	0	400	6562	1628
1999	145	248	9380	2117
2000	0	254	11482	1986
2001	278	624	11216	3056
2002	510	712	11302	3590

Year	A1	AB2	A6	A9/10
2003	862	384	13644	1010
2004*	445	531	8600	1047
2006	190	187	9726	117

* Numbers are based on a single aerial survey, and are likely underestimates.

Black Skimmer (*Rynchops niger*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting colony). The black skimmer is a unique species, with a lower mandible longer than the upper mandible. This extended lower mandible allows these birds to fly over the surface of the water, skimming for small fish. Black skimmers nest primarily on the coasts of the Southeast United States, the Gulf of California, and the Pacific Coast of Baja, California, north to San Diego, and in California, the black skimmer is a Species of Special Concern only at nesting sites.

Black skimmers were first detected nesting in California in 1972, and since that time, this species' populations have increased considerably (e.g., to approximately 1200 pairs in 1995 (Collins and Garrett 1996). Until the mid-1990s, the black skimmer was considered a very rare nonbreeding visitor to the San Francisco Bay area. However, the species was documented nesting in San Francisco Bay in 1994, when one pair nested in Pond AB2 in Santa Clara County, and one pair nested at Hayward Regional Shoreline in Alameda County (Layne et al. 1996). Since 1994, this species has occurred in the South Bay every year and has nested at several additional sites in the Study Area, including ponds A1, A2W, AB1, A8, and A16 ([Strong 2004b]; Figure 5). In these areas, black skimmers have usually nested among Forster's terns, on small dredge-spoil islands (including both bare islands and islands vegetated, sometimes heavily, with pickleweed) in salt ponds. Exact nesting locations vary from year to year.

Skimmer populations in the South Bay have slowly but steadily increased (e.g., to a high count of 27 in Pond A8 on 28 September 2003; [Santa Clara County Bird Data Unpublished]). Because nesting success in the South Bay has apparently been low, judging by the low number of chicks surviving to fledging age, this population increase has likely been primarily the result of immigration from the increasing southern California population. Within the Shoreline Study Area, the species is most abundant in the vicinity of the Alviso Complex and most post-breeding flocks have been recorded in this area (e.g., on Pond A8 and in Charleston Slough).

Burrowing Owl (*Athene cunicularia*). Federal Listing Status: None; State Listing Status: Species of Special Concern. The burrowing owl is a small, terrestrial owl of open country. Burrowing owls occupy grasslands and sparsely vegetated shrubland ecosystems. In California, burrowing owls are found in close association with California ground squirrels. Ground squirrels provide nesting and refuge burrows, and maintain areas of short vegetation height, providing foraging habitat and allowing for visual detection of avian predators by burrowing owls. Burrowing owls are semi-colonial nesters, and group size is one of the most significant factors contributing to site constancy by breeding burrowing owls. The nesting season, as recognized by the California Department of Fish and Game, runs from 1 February through 31 August.

Burrowing owl populations in the South San Francisco Bay have been decreasing rapidly and significantly in recent decades. As of 1990, the South Bay burrowing owl population was thought to have declined at least 50% since 1981 (Barclay et al. 1998). A statewide census, the largest and most comprehensive undertaken to that date or since, suggested that the rate of disappearance of South Bay burrowing owls was greater than the rate found for owls in the Central Valley, and that the rate of decline for both regions was accelerating (DeSante et al. 1993; DeSante et al. 1997). A new statewide census was conducted in 2006. Surveyors on this census counted 595 burrowing owls statewide, of which 56 were in Santa Mateo and Santa Clara County.

Despite recent declines, burrowing owls still breed in a number of locations offering suitable burrows and open foraging habitat around the upland perimeter of the South Bay. Such sites include Byxbee Park in Palo Alto, Shoreline Park and Moffett Field in Mountain View, the Sunnyvale Baylands Park, the San Jose/Santa Clara WPCP buffer lands, and the SFBNWR lands in Fremont, and a few other scattered locations in the Shoreline Study Area (Figure 8). Burrowing owls are occasionally observed in shoreline, rocky, and upland habitats that rim the South Bay, and they are believed to nest at least infrequently in salt pond levees (Trulio 2000).

Short-eared Owl (*Asio flammeus*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting). Short-eared owls occur in open habitats such as grasslands, wet meadows, and marshes. They require tall herbaceous vegetation for nesting or daytime refuge. Short-eared owls once bred much more widely in California, including the San Francisco Bay Area. However, the species now occurs primarily as a migrant and winter visitor, and is a rare and local breeder in the South Bay. The most recent nesting record in the South Bay was of three pairs producing four fledglings at Bair Island in 1994 (Yee et al. 1994). Other breeding-season records in the South Bay include a pair at the Palo Alto Baylands in 1966 (Chase and Chandik 1966) and two nests in the Palo Alto Flood Control Basin in 1972 (Gill 1977). The species is apparently much more abundant in the North Bay, with over 100 fledglings banded at Grizzly Island (Solano County) in 1987 (Campbell et al. 1987). Potential breeding habitat does occur in the Study Area, but the status of this species as a breeder in the Study Area is unknown. If short-eared owls currently breed in the South Bay, they are likely to nest only in the larger tracts of suitable habitat.

During winter, the species is more widespread, though in low numbers, with many records from bayside locations virtually throughout the Study Area. Locations of more regular observations in winter include Byxbee Park and the Palo Alto Flood Control Basin. Short-eared owls are considered Species of Special Concern only at nesting sites.

Cooper's Hawk (*Accipiter cooperii*). Federal Listing Status: None; State Listing Status: Species of Special Concern. The Cooper's hawk is a medium-sized raptor that preys upon smaller birds (e.g., jays, doves, and quail) and occasionally takes small mammals and reptiles. The Cooper's hawk prefers landscapes where wooded areas occur in patches and groves which facilitates the ambush hunting tactics employed by this species. Breeding pairs in California are often found in stands of live oak woodland or riparian areas, although this species has adapted well to suburban habitats and tolerates human activity. Cooper's hawks typically nest between March and August. During winter, local Cooper's hawks may

migrate south, while the local population may increase with immigration of migrants that breed farther north.

Within the Study Area, Cooper's hawks have been found nesting in surburban areas fringing the South Bay. They may nest in a variety of trees in this area, and may also nest in the riparian corridor of Coyote Creek.

Loggerhead Shrike (*Lanius ludovicianus*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting). These predatory songbirds are year-round residents in grassland and scrub habitats in California. Shrikes generally build their nests in shrubs and trees in fairly open areas, and nest in spring and early summer. They hunt in open areas, usually from a low perch, such as a fence post or overhead wire. They forage primarily on large insects, lizards, and small mammals, but some individuals also prey on snowy plover chicks and other young shorebirds. Loggerhead shrike numbers have declined dramatically in eastern North America, but populations in California may be more stable. Loggerhead shrikes are considered Species of Special Concern only at nesting sites.

The species nests in low numbers throughout the Shoreline Study Area. Loggerhead shrikes are found in a number of locations around the Study Area where nest sites (e.g., trees and shrubs) occur adjacent to open fields, ruderal habitats (e.g., active and closed landfills), and marshes. Shrikes forage in ruderal habitats, on salt pond levees, and in marshes in the Study Area.

California Horned Lark (*Eremophila alpestris actia*). Federal Listing Status: None; State Listing Status: Species of Special Concern. Horned larks are songbirds that occur over much of North America in bare ground habitats with short grass, scattered bushes, or no vegetation. In winter, they often form large flocks that sometimes contain several subspecies. The California horned lark is a widespread breeder along the coast and in the Central Valley of California. They breed from March through July, with peak activity in May. Horned larks build grass-lined nests directly on the ground, in dry, open habitats with sparse vegetation.

Horned larks occur primarily as migrants and winter visitors in the Shoreline Study Area, when they may be found in small numbers foraging along salt pond levees, in salt pannes within dried-out salt ponds, and in short grassland and ruderal habitats (e.g., active and closed landfills) around the South Bay. A few pairs likely breed in these locations as well, as evidenced by scattered breeding-season records in and around the Alviso Pond Complex (Steve Rottenborn, pers. obs.; Santa Clara County Bird Data Unpublished).

Saltmarsh Common Yellowthroat (*Geothlypis trichas sinuosa*). Federal Listing Status: None; State Listing Status: Species of Special Concern. The saltmarsh common yellowthroat is a small songbird that inhabits emergent vegetation, primarily in fresh and brackish marshes, and associated upland areas in the San Francisco Bay Area. This subspecies (one of approximately 12 subspecies of common yellowthroat recognized in North America) breeds from mid-March through early August, and pairs frequently raise two clutches/year. Because this subspecies cannot be reliably distinguished in the field from other races that occur in the South Bay as migrants, determination of the presence of saltmarsh

common yellowthroats can be achieved only by observation of presence during the summer months when other subspecies are not expected to be present. Although little is known regarding the movements of this taxon, the wintering areas have been described as coastal salt marshes from the San Francisco Bay region to San Diego County (Terrill 2000).

Despite their common name, saltmarsh common yellowthroats breed primarily in fresh and brackish marshes, and in freshwater riparian habitats. In the South Bay, this species is a fairly common breeder in such habitats virtually wherever they occur, although very small patches of marsh often lack this species. Particularly large populations occur in brackish and freshwater marshes in the Alviso Complex (e.g., along the middle and upper reaches of the major sloughs and in the Warm Springs/Alviso marshes). The saltmarsh common yellowthroat likely breeds to some extent in salt marshes providing taller herbaceous vegetation (Ray 1919), as evidenced by the species' presence during the breeding season in such marshes (Santa Clara County Bird Data Unpublished; Santa Clara County Breeding Bird Atlas Committee Unpublished). Saltmarsh common yellowthroats also breed in the riparian corridor of Coyote Creek within the Study Area.

California Yellow Warbler (*Dendroica petechia brewsteri*); Federal Status: None; State Status: Species of Special Concern. The yellow warbler is a small songbird that breeds in well-developed riparian vegetation, and feed on insects. The yellow warbler is a migratory species that is common during migration, but migratory birds in California are mostly of one of the northern subspecies. Yellow warblers that remain to breed in northern and central California are of the race *D. p. brewsteri*. Due to a loss of riparian habitat in California over the last century, this subspecies is listed as a California Species of Special Concern. Most California yellow warblers migrate to Mexico and South America in the fall and return to California to breed from May through August. Yellow warblers are rare breeders in the Study Area, likely nesting only in the riparian corridor along lower Coyote Creek.

Alameda Song Sparrow (*Melospiza melodia pusillula*). Federal Listing Status: None; State Listing Status: Species of Special Concern. The Alameda song sparrow is one of three subspecies of song sparrow breeding only in salt marsh habitats in the San Francisco Bay area. Locally it is most abundant in the taller vegetation found along tidal sloughs, including salt marsh cordgrass and marsh gumplant. Populations of the Alameda song sparrow have declined due to the loss of salt marshes around the Bay, although within suitable habitat it is still fairly common. The location of the interface between populations of the Alameda song sparrow and those of the race breeding in freshwater riparian habitats (*M. m. gouldii*) along most creeks is not known due to difficulties in distinguishing individuals of these two races in the field.

In salt marshes, *pusillula* are most abundant in tall marsh vegetation, particularly in the marsh gumplant/California cord grass association immediately adjacent to tidal sloughs. *Pusillula* are also found in peppergrass in the upper, drier portions of salt marshes and occasionally in brackish marshes dominated by bulrushes (Marshall and Dedrick 1994). Except during very high tides, they make more limited use of the broad expanses of short pickleweed favored by savannah sparrows. Along several streams in the South Bay, song sparrows seem to be distributed continuously from the upper reaches down to tidal salt marsh. This distribution indicates that *gouldii* and *pusillula* come into contact along

these streams, probably at the interface of brackish and freshwater habitats, as Grinnell (1901) found at San Francisquito Creek.

Song sparrows nest as early as March, but peak nesting activity probably occurs in May and June. Salt marsh-breeding song sparrows in the Bay area (including *pusillula*) are known to breed about two weeks earlier than *gouldii* (Johnston 1954; Johnston 1956). This early breeding by *pusillula* is apparently an adaptation to breeding in a tidal environment, as high tides in late spring and early summer may destroy large numbers of nests.

Optimum habitat for this subspecies is tidal salt marsh, although it occurs in tidal brackish marsh, seasonal wetlands, salt pond complexes and other adjacent habitats. Alameda song sparrows occur commonly in suitable habitat throughout the South Bay, including the Shoreline Study Area, being particularly abundant in more extensive marshes but also occurring fairly commonly in narrower marshes along tidal sloughs as long as taller herbaceous vegetation for nesting is present.

Tricolored Blackbird (*Agelaius tricolor*). Federal listing status: None; State Listing Status: Species of Special Concern (nesting colony). Tricolored blackbirds are found almost exclusively in the Central Valley and central and southern coastal areas of California. This species was originally listed as a Species of Special Concern (at its nesting colonies) in California due to concerns over the loss of wetland habitats in the state. However, in 1992, surveys by the California Department of Fish and Game determined that the population of this species was much larger than previously believed (Beedy and Hamilton 1997), lessening concern for the species.

The tricolored blackbird is highly colonial in its nesting habits and forms dense breeding colonies, which in some Central Valley areas may consist of up to tens of thousands of pairs. This species typically nests in tall, dense, stands of cattails or tules, but also nests in blackberry, wild rose bushes and tall herbs. Nesting colonies are usually located near standing or flowing fresh water. Tricolored blackbirds form large, often multi-species, flocks during the non-breeding period and range more widely than during the reproductive season.

Appropriate breeding habitat for this species in the Shoreline Study Area is limited, and most breeding sites in the South Bay area are well inland from areas of tidal influence. This species nested in 1992 in ruderal habitat in the San Jose-Santa Clara Water Pollution Control Plant (Santa Clara County Breeding Bird Atlas Committee Unpublished), but no other breeding records are known from the immediate Study Area. Freshwater marshes providing fairly extensive stands of tules and cattails are present along upper Artesian, Alviso, and Guadalupe Sloughs, in the Warm Springs marshes, and along the Moffett Channel. However, the tricolored blackbird typically nests only in nontidal freshwater marshes, and it is therefore unlikely to use such tidal marshes for nesting.

Salt Marsh Wandering Shrew (*Sorex vagrans halicoetes*). Federal Listing Status: None; State Listing Status: Species of Special Concern. Formerly more widely distributed in the Bay area, this small insectivorous mammal is now confined to salt marshes of the South Bay (Findley 1955). Salt marsh wandering shrews occur most often in medium-high wet tidal marsh (six to eight feet above sea

level), with abundant driftwood and other debris for cover (Shellhammer 2000b). They have also been recorded occasionally in diked marsh. This species is typically found in fairly tall pickleweed, in which these shrews build nests. They breed and give birth during spring, although very little is known regarding the natural history of the species.

This subspecies was formerly recorded from marshes of San Pablo and San Francisco Bays in Alameda, Contra Costa, San Francisco, San Mateo, and Santa Clara Counties, but captures in recent decades have been very infrequent anywhere in these areas. Shrews are occasionally captured during salt marsh harvest mouse trapping studies (see Table 6 above), but the difficulty in identifying them to species has precluded a better understanding of the current distribution of this species in the South Bay. As of 1986, there were only four locations, including Bair Island, the Alameda Creek mouth, Dumbarton Point, and Mowry Slough, where this species had been positively identified between 1980 and 1985, although the species was considered likely present in a number of other marshes in the South Bay (Western Ecological Services Company (WESCO) 1986).

This species is likely present, albeit probably in low numbers, in extensive tidal salt marshes within the Shoreline Study Area. Much of the previous discussion of the habitat requirements of the salt marsh harvest mouse, such as extensive salt marsh with high-tide refugia, and of the effects of habitat fragmentation and barriers to dispersal, applies to the salt marsh wandering shrew as well.

Pacific Harbor Seal (*Phoca vitulina richardsi*). Federal Listing Status: None; State Listing Status: None. Pacific harbor seals are currently the only marine mammals that are permanent residents of San Francisco Bay. Although they are not listed by the state as a Species of Special Concern, harbor seals are protected under the federal Marine Mammal Protection Act, and are sensitive to human disturbance. NOAA Fisheries (the agency that oversees the protection of marine mammals) recommends a 100-yard disturbance-free buffer around harbor seals. Disturbance can lead to separation of pups from nursing mothers, can add physiological stress to adults, and can lead to long-term abandonment of historical haul-out sites (Lidicker and Ainley 2000).

Pacific harbor seals occur along the Pacific coast of North America from Alaska south to Baja California. In San Francisco Bay, they haul out at a number of sites to rest and pup (give birth). Most pupping occurs during spring, with a peak in April (Fancher and Alcorn 1982). Females nurse pups for about 28 days, during which time they are susceptible to being separated as a result of human disturbance. Haul-out sites are typically mudflats far from areas used regularly by humans, and near deeper water, where seals forage. Harbor seals forage in nearshore marine habitats on variety of fishes and invertebrates. Kopec and Harvey (1995) studied diet at several haul-out sites in 1991-1992, and found that in the South Bay, major diet items included yellowfin goby (*Acanthogobius flavimanus*), staghorn sculpin (*Leptocottus armatus*), and white croaker (*Genyonemus lineatus*).

More than ten sites around the Bay may be used by seals at any given time (Lidicker and Ainley 2000), and any undisturbed intertidal habitat accessible to the open Bay could potentially be used by harbor seals. Primary haul-out sites in San Francisco Bay are Mowry Slough (243 seals in 1999), Castro Rocks near the Richmond-San Rafael Bridge (107 seals in 1999), and Yerba Buena Island (72 seals in 1999;

(Lidicker and Ainley 2000). Mowry Slough, the most important site in the South Bay, produced 78 pups in 1999, 90 in 2000, 102 in 2001 and 144 in both 2002 and 2003 (Green et al. 2004); surveys in April 2004 found 283 seals, including 59 pups, at Mowry Slough and 34 seals, including nine pups, near the mouth of Coyote Creek at Calaveras Point (Bell Unpublished). At both these sites, mudflats and adjacent pickleweed marsh at various locations may be used at any particular time. Use of haul-out sites varies over time, and other South Bay sites, including Guadalupe Slough near the northeastern end of Pond A3N, the mouth of the Alameda Flood Control Channel, Newark Slough, Bair Island, and Greco Island are currently used or have been important haul-outs historically (Bell Unpublished; Fancher and Alcorn 1982; Kopec and Harvey 1995) (Figure 5).

4.4.3 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act requires federal fishery management plans (FMPs) to describe the habitat essential to the fish being managed and describe threats to that habitat from both fishing and non-fishing activities. In addition, in order to protect this Essential Fish Habitat (EFH), federal agencies are required to consult with NOAA Fisheries on activities that may adversely affect EFH.

The Shoreline Study Area includes EFH from three FMPs, the Coastal Pelagic, West Coast Groundfish, and Pacific Coast Salmon FMPs. Fish species covered under these plans that occur in the South Bay are listed in Table 10.

Table 10 - Fisheries Management Plan (FMP) species in the South Bay

Common Name	Scientific Name	Occurrence
Coastal Pelagic FMP		
Northern anchovy	*Engraulis mordax*	Abundant from South to Central Bay; adults and juveniles present in South and South-Central Bay, adults, juveniles, larvae, and eggs present in Central Bay
Pacific sardine	*Sardinops sagax*	Present in South and South-central Bay and rare in Central Bay; adults and juveniles present
Jack mackerel	*Trachurus symmetricus*	Present in Central Bay; eggs and larvae
Pacific Groundfish FMP (Estuarine Composite EFH)		
Leopard shark	*Trikakis semifasciata*	Present from South Bay to Central Bay; adults and juveniles present
Soupfin shark	*Galeorhinus galeus*	Present in South-central and Central Bay and rare in South Bay; adults and juveniles present in Central Bay and rare in South Bay, less known about life stages in South-central Bay
Spiny dogfish	*Squalus acanthias*	Present from South Bay to Central Bay; adults and juveniles in South and Central Bay, less known about life stages in South-central Bay
Big skate	*Raja binoculata*	Present from South Bay to Central Bay; adults and juveniles present in Central Bay, less known about other life stages present in South and South-central Bay

Common Name	Scientific Name	Occurrence
California skate	*Raja inornata*	Present in South Bay (probably rare)
Lingcod	*Ophiodon elongatus*	Present from South to Central Bay but rare in South-central Bay; adults and juveniles present in Central Bay, less known about life stages present in South Bay
Kelp greenling	*Hexagrammos decagrammus*	Present in Central Bay; juveniles and adults
Pacific whiting (hake)	*Merluccius productus*	Present in Central Bay; eggs and larvae
Brown rockfish	*Sebastes auriculatus*	Present from South to Central Bay; juveniles present in South and South-Central Bay, adults and juveniles present in Central Bay
Curlfin sole	*Pleuronichthys decurrens*	Present in Central Bay; juveniles
English sole	*Parophrys vetulus*	Abundant from South to Central Bay; adults and juveniles present
Pacific sanddab	*Cintharichthys sordidus*	Present from South to Central Bay; adults, juvenile, larvae, and eggs present in Central Bay, less known about life stages in South Bay
Sand sole	*Psettichthys melanostictus*	Present in South and Central Bay but rare in South-central Bay; adults, juveniles, and larvae present
Starry flounder	*Platichthys stellatus*	Present from South to South-central Bay and abundant in Central Bay; adults and juveniles present in South Bay and adults juveniles, larvae, and eggs present in Central Bay
Cabezon	*Scorpaenichthys marmoratus*	Rare to few from South to Central Bay; juveniles present in South and South-Central Bay, adults and juveniles present in Central Bay
Bocaccio	*Sebastes paucispinis*	Rare in Central Bay, less known about presence and life stages elsewhere in Bay
Calico rockfish	*Sebastes dalli*	Rare in South Bay, life stages unknown
Rex sole	*Glyptocephalus zachirus*	Rare in South Bay, life stages unknown
Pacific Coast Salmon FMP (Estuarine Composite EFH)		
Chinook salmon Central Valley fall- and late fall-run ESU	*Oncorhynchus tshawytscha*	Spawns in several South Bay streams, including Coyote Creek and the Guadalupe River

The Magnuson-Stevens Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." For the Pacific Coast Salmon FMP, the EFH includes freshwater and marine habitats, including habitats for estuarine and ocean rearing and juvenile and adult migration. The important features of EFH include "1) adequate water quality; 2) adequate temperature; 3) adequate prey species and forage base (food); and 4) adequate depth, cover, marine vegetation, and algae in estuarine and near-shore habitats." For the Coastal Pelagic Species FMP, the EFH includes "all marine and estuarine waters from the shoreline along the coasts of California, Oregon and Washington offshore to the limits of the Exclusive Economic Zone (EEZ) and above the thermocline where sea surface temperatures range between ten and 26 degrees C." For the West Coast Groundfish FMP, seven "composite" EFH categories are defined. The estuarine composite includes:

"…those waters substrates and associated biological communities within bays and estuaries of the coasts of Washington, Oregon, and California, seaward from the high tide line (MHHW) or extent of upriver saltwater intrusion. These areas are delineated from the USFWS National Wetland Inventory (NWI) and supplemented from NOAA's Coastal Assessment Framework for the water portion of the Estuarine Drainage Areas for two small estuaries (Klamath River and Rogue River), the Columbia River, and San Francisco Bay. NWI defines estuaries as areas with water greater than 0.5 ppt ocean-derived salt."

Thus, all marine areas within the Study Area below MHHW with salinity of 0.5 ppt or greater are considered EFH.

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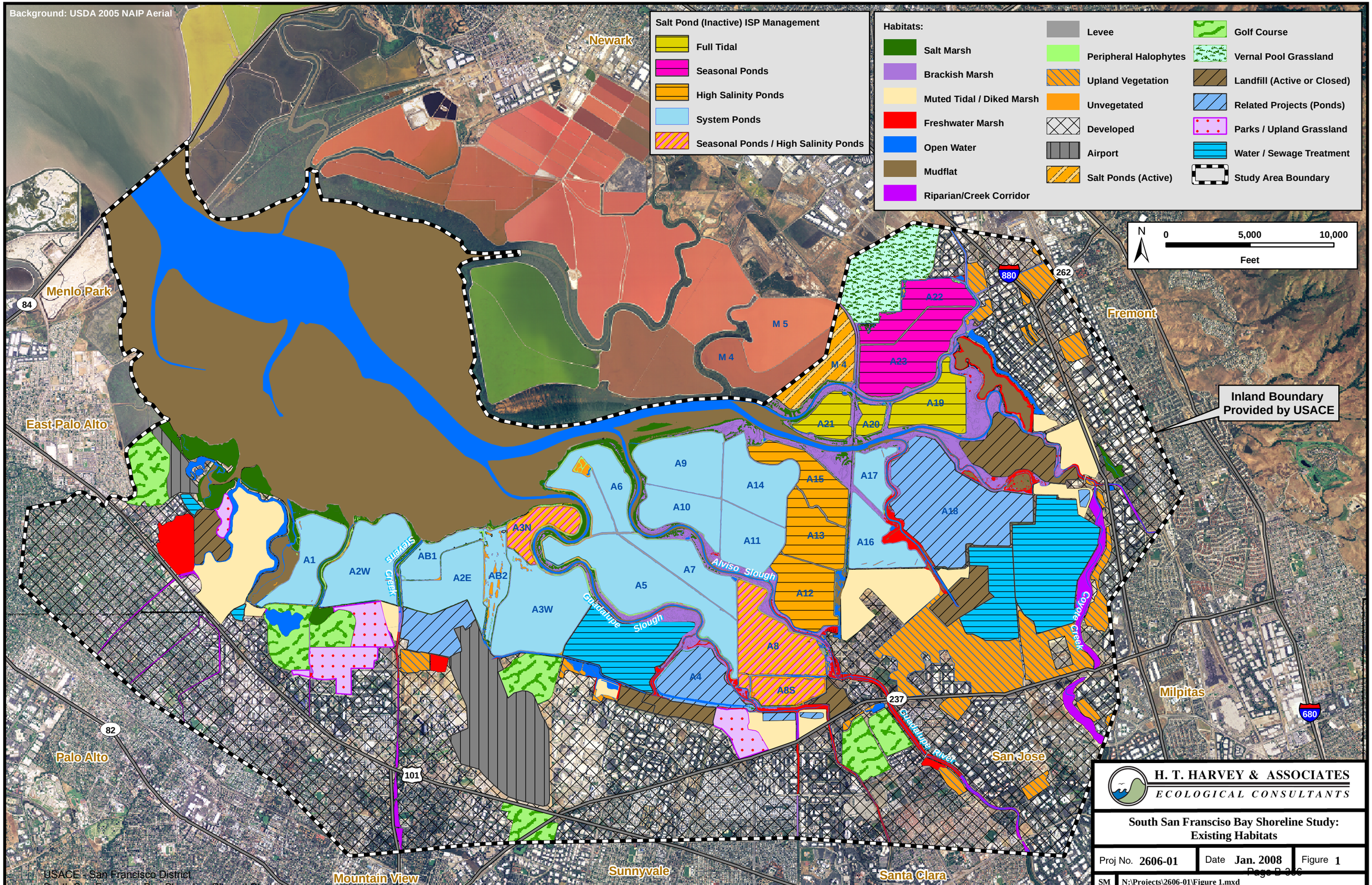
Acknowledgements:
City of San Jose for providing base satellite imagery


Background: USDA 2005 NAIP Aerial
Salt Pond (Inactive) ISP Management
Full Tidal
Seasonal Ponds
High Salinity Ponds
System Ponds
Seasonal Ponds / High Salinity Ponds
Habitats:
Salt Marsh
Brackish Marsh
Muted Tidal / Diked Marsh
Freshwater Marsh
Open Water
Mudflat
Riparian/Creek Corridor
Levee
Peripheral Halophytes
Upland Vegetation
Unvegetated
Developed
Airport
Salt Ponds (Active)
Golf Course
Vernal Pool Grassland
Landfill (Active or Closed)
Related Projects (Ponds)
Parks / Upland Grassland
Water / Sewage Treatment
Study Area Boundary
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Menlo Park
East Palo Alto
Palo Alto
Mountain View
Sunnyvale
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San Jose
Milpitas
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Stevens Creek
Alviso Slough
Guadalupe Slough
Guadalupe River
Coyote Creek
H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
South San Fransciso Bay Shoreline Study:
Existing Habitats
Proj No. 2606-01
Date Jan. 2008
Figure 1
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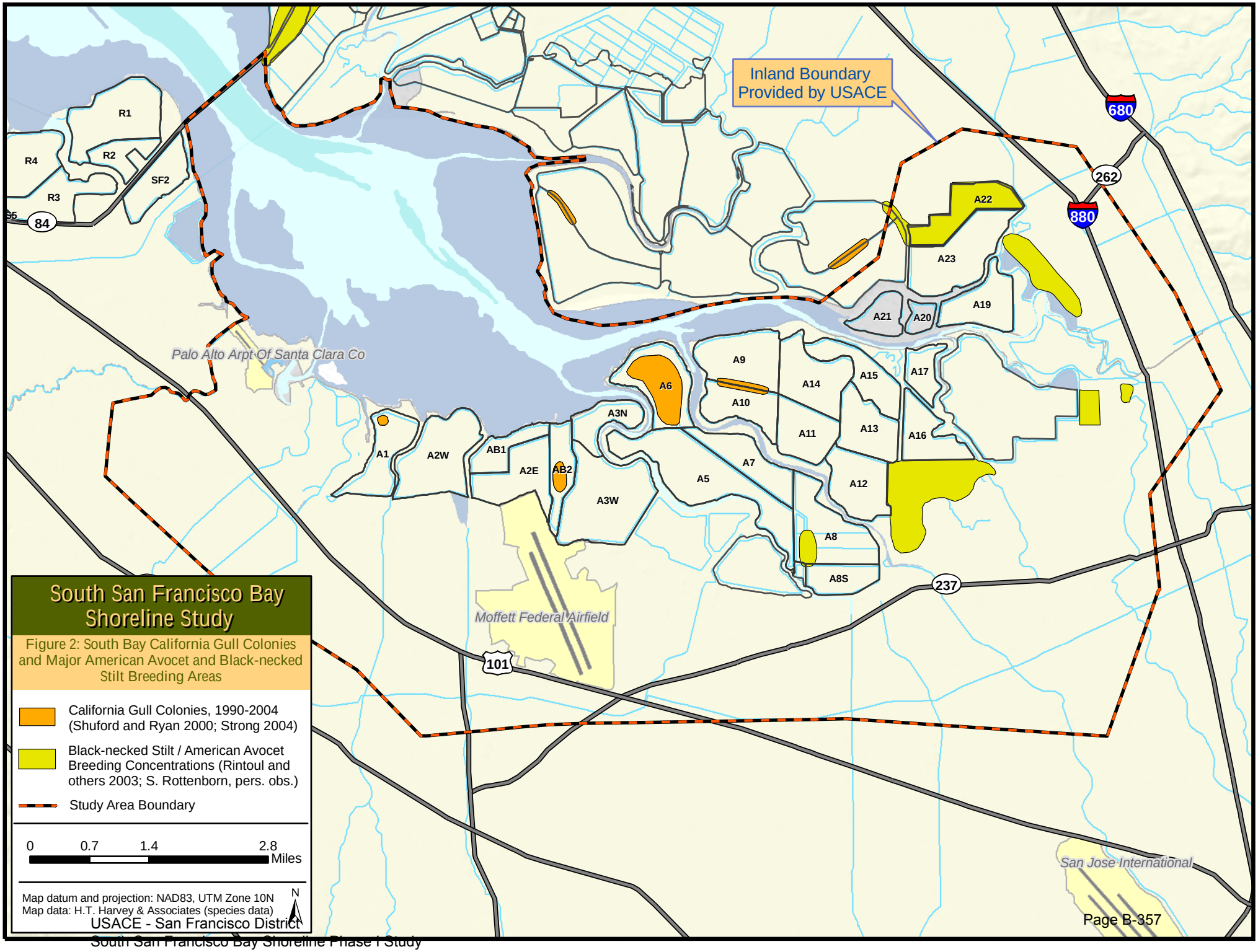
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237
Moffett Federal Airfield
101
San Jose International
South San Francisco Bay Shoreline Study
Figure 2: South Bay California Gull Colonies and Major American Avocet and Black-necked Stilt Breeding Areas
California Gull Colonies, 1990-2004 (Shuford and Ryan 2000; Strong 2004)
Black-necked Stilt / American Avocet Breeding Concentrations (Rintoul and others 2003; S. Rottenborn, pers. obs.)
Study Area Boundary
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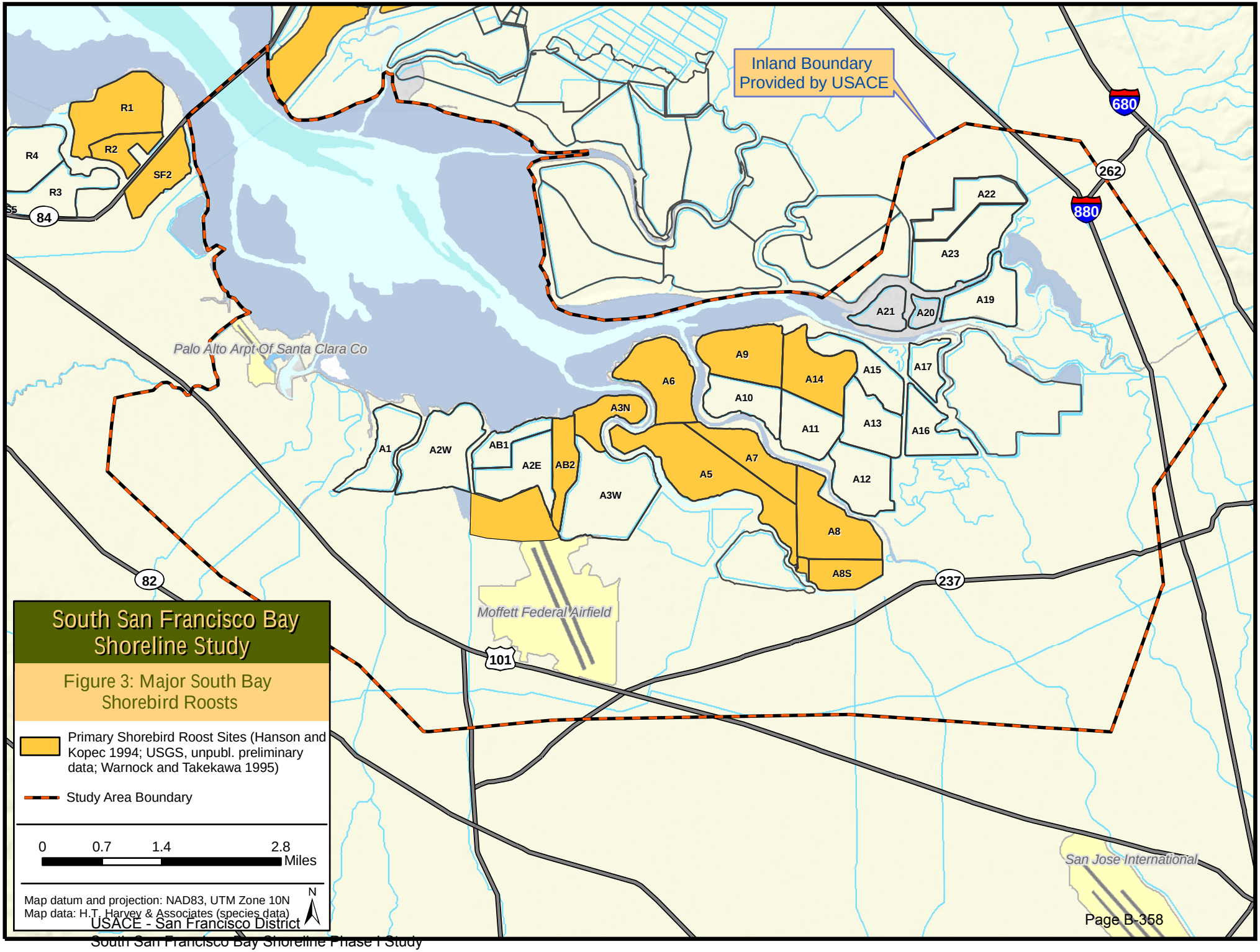
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Moffett Federal Airfield
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San Jose International
South San Francisco Bay Shoreline Study
Figure 3: Major South Bay Shorebird Roosts
Primary Shorebird Roost Sites (Hanson and Kopec 1994; USGS, unpubl. preliminary data; Warnock and Takekawa 1995)
Study Area Boundary
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Miles
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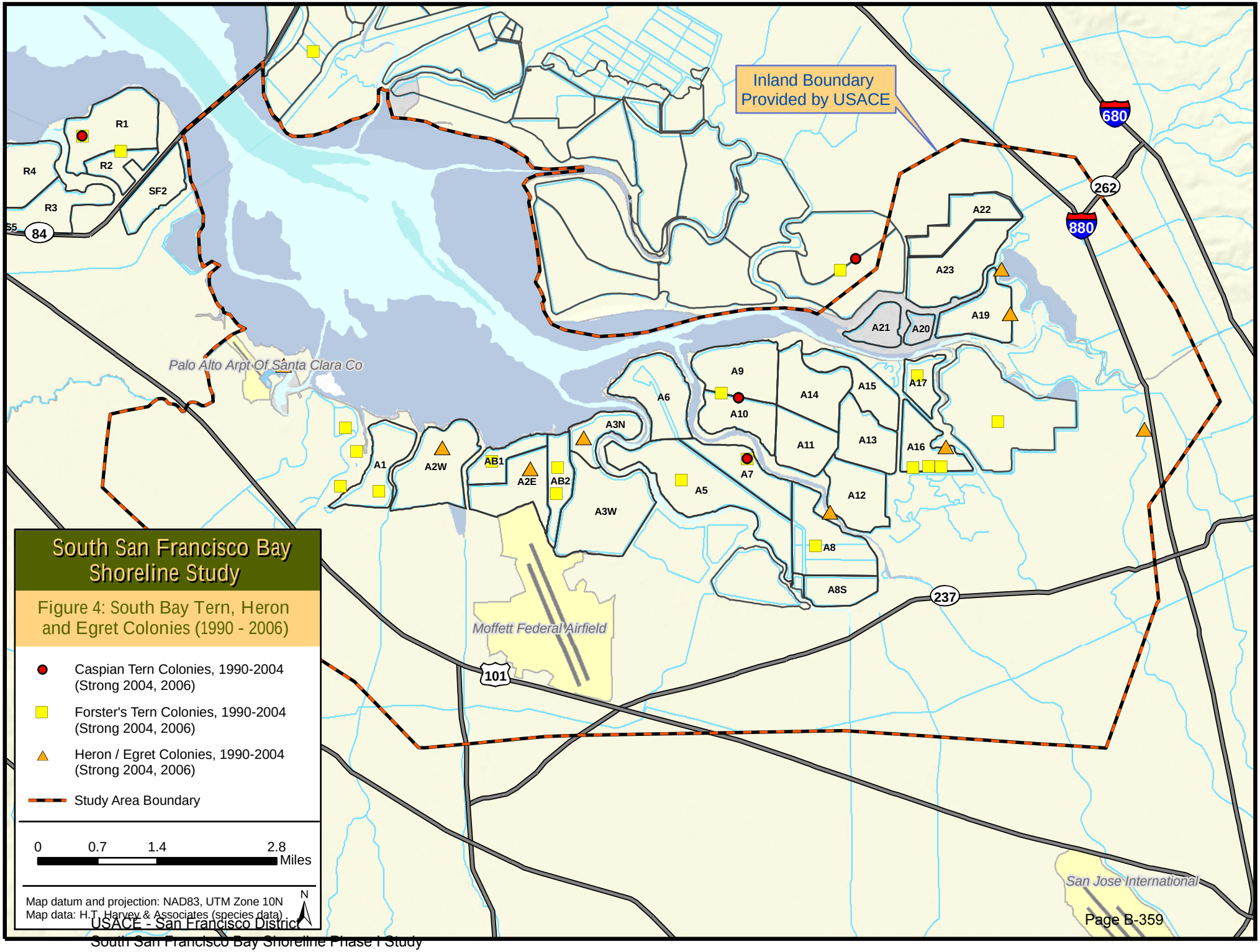
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)


Inland Boundary
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San Jose International
South San Francisco Bay Shoreline Study
Figure 4: South Bay Tern, Heron and Egret Colonies (1990 - 2006)
Caspian Tern Colonies, 1990-2004 (Strong 2004, 2006)
Forster's Tern Colonies, 1990-2004 (Strong 2004, 2006)
Heron / Egret Colonies, 1990-2004 (Strong 2004, 2006)
Study Area Boundary
0 0.7 1.4 2.8 Miles
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)
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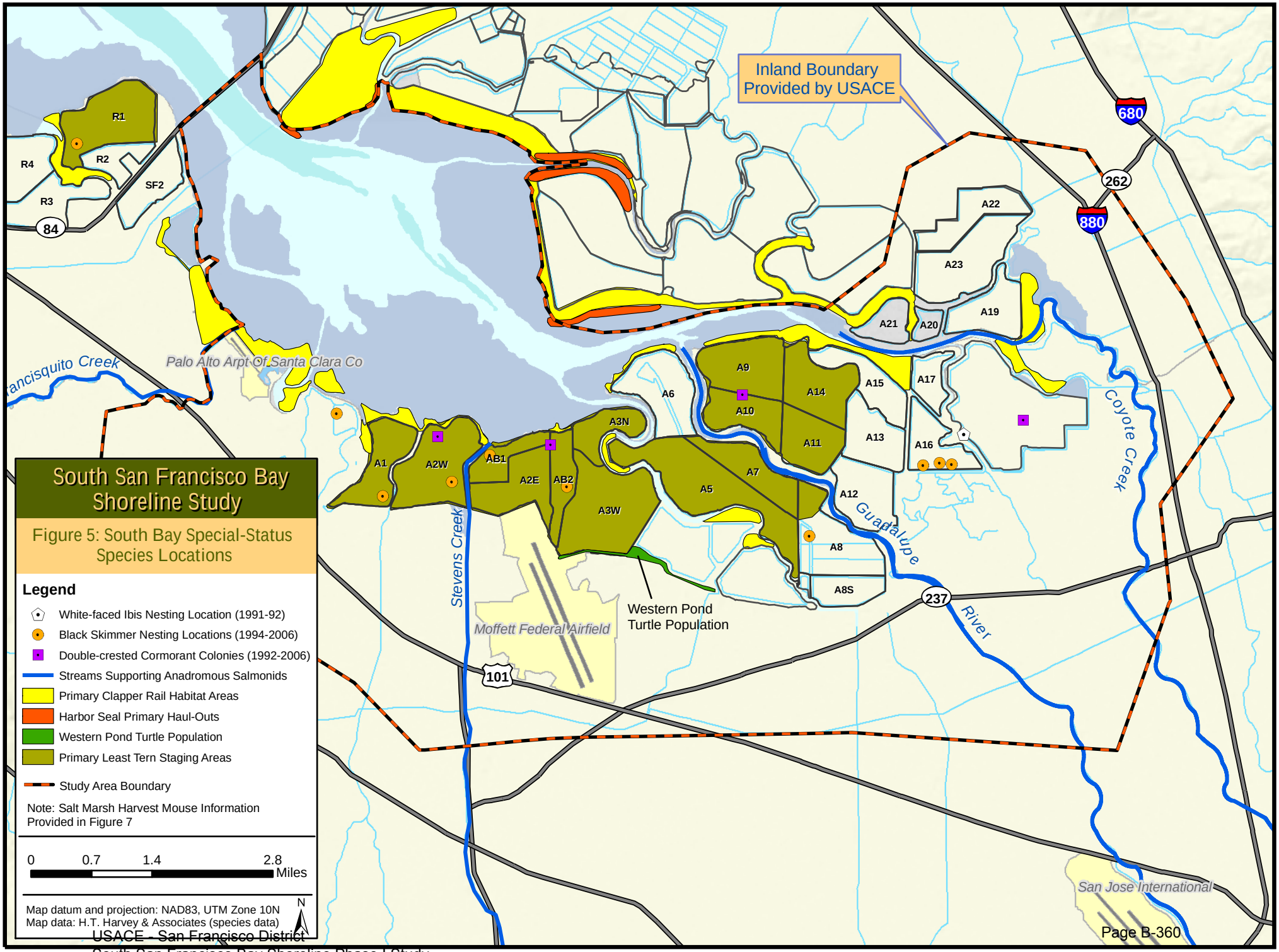
Inland Boundary
Provided by USACE
South San Francisco Bay Shoreline Study
Figure 5: South Bay Special-Status Species Locations
Legend
White-faced Ibis Nesting Location (1991-92)
Black Skimmer Nesting Locations (1994-2006)
Double-crested Cormorant Colonies (1992-2006)
Streams Supporting Anadromous Salmonids
Primary Clapper Rail Habitat Areas
Harbor Seal Primary Haul-Outs
Western Pond Turtle Population
Primary Least Tern Staging Areas
Study Area Boundary
Note: Salt Marsh Harvest Mouse Information Provided in Figure 7
0 0.7 1.4 2.8 Miles
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)
N
Western Pond Turtle Population
Palo Alto Arpt Of Santa Clara Co
Moffett Federal Airfield
San Jose International
Stevens Creek
Coyote Creek
Guadalupe River
R1
R2
R3
R4
SF2
A1
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A2E
AB1
AB2
A3N
A3W
A5
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A7
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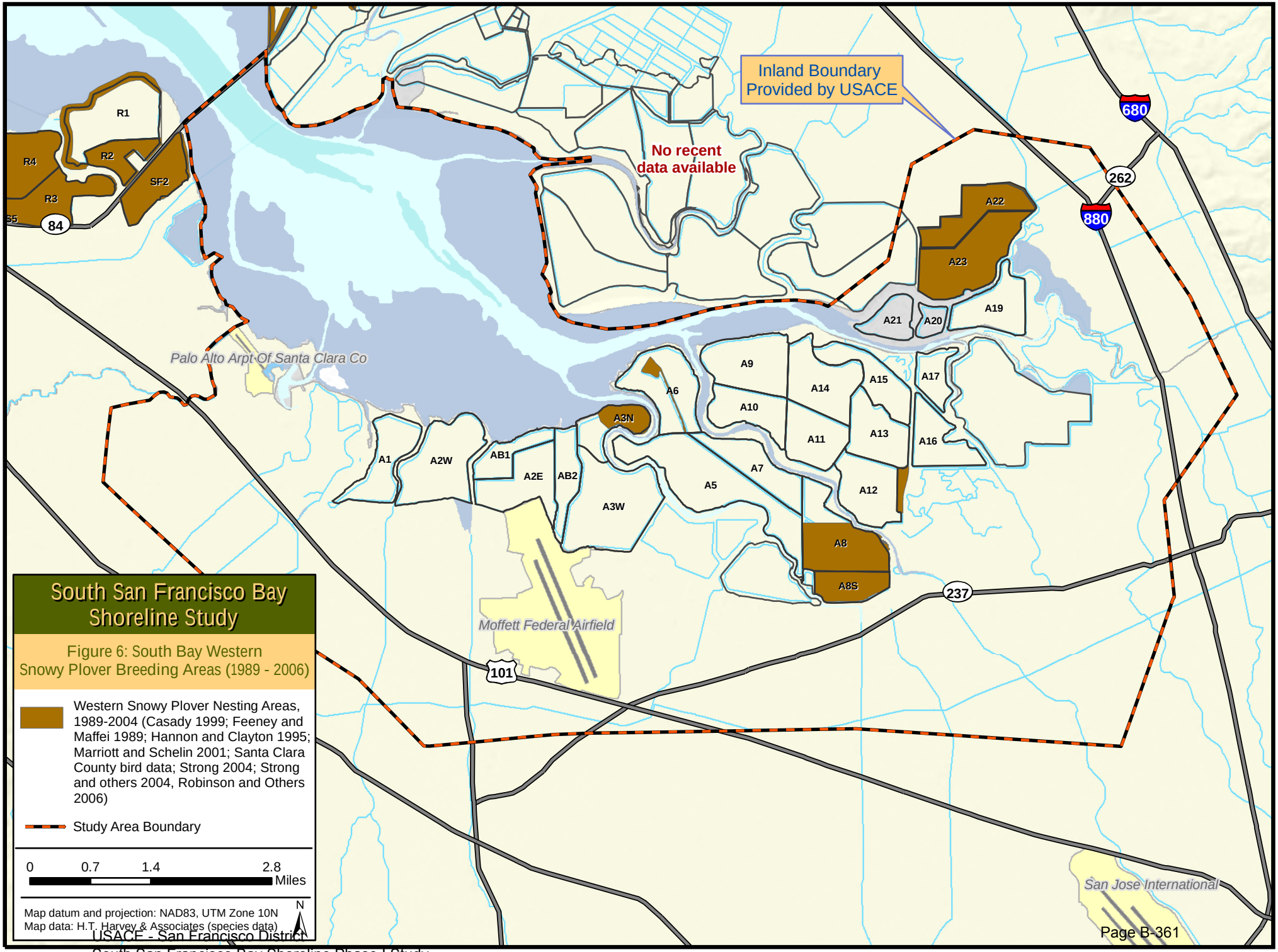
84
101
237
262
680
880


Inland Boundary
Provided by USACE
No recent
data available
R1
R2
R3
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SF2
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880
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Palo Alto Arpt Of Santa Clara Co
A9
A14
A15
A17
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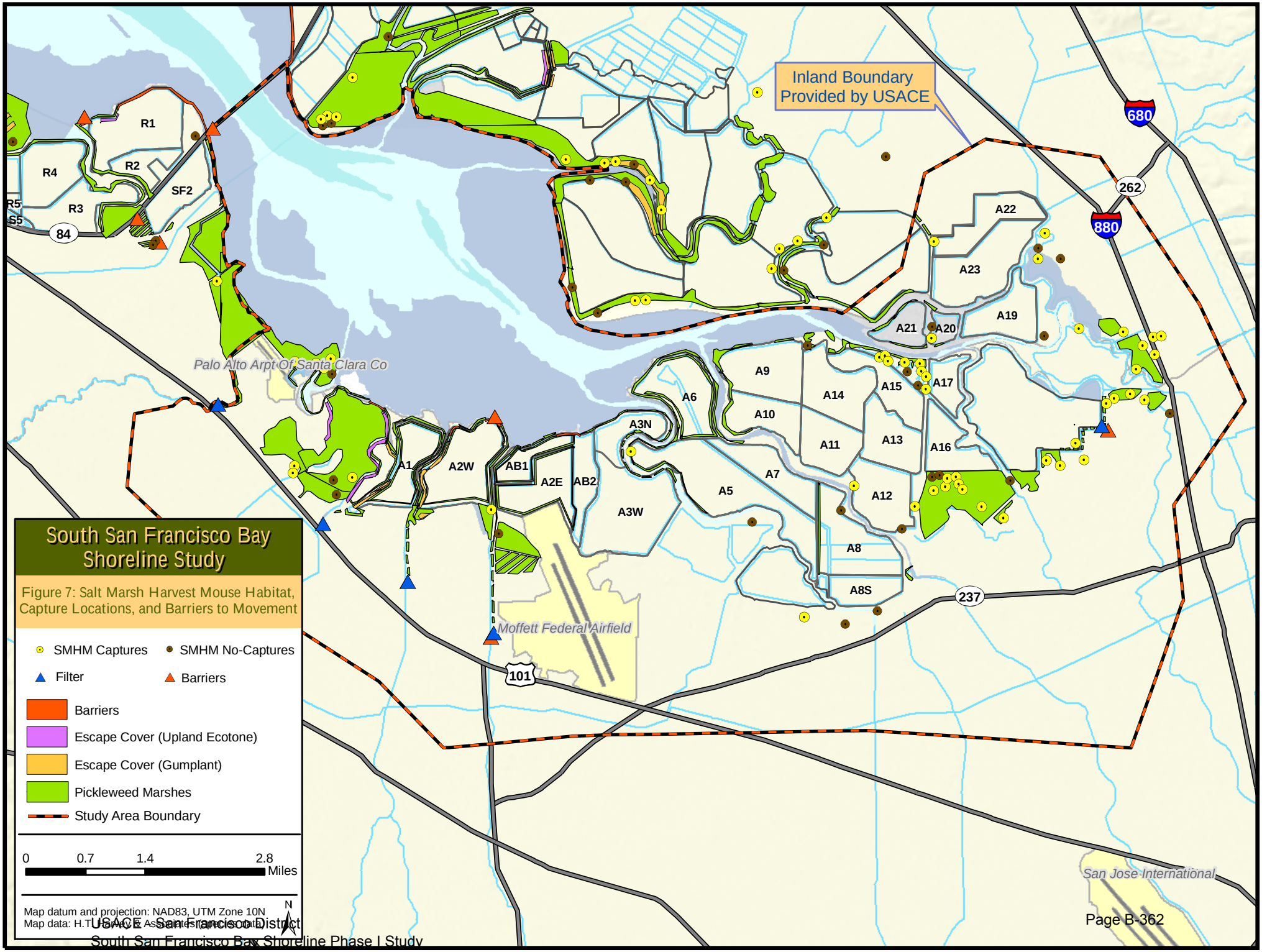
A10
A3N
A11
A13
A16
A1
A2W
AB1
A2E
AB2
A7
A5
A12
A3W
A8
A8S
237
Moffett Federal Airfield
101
San Jose International
South San Francisco Bay
Shoreline Study
Figure 6: South Bay Western
Snowy Plover Breeding Areas (1989 - 2006)
Western Snowy Plover Nesting Areas, 1989-2004 (Casady 1999; Feeney and Maffei 1989; Hannon and Clayton 1995; Marriott and Schelin 2001; Santa Clara County bird data; Strong 2004; Strong and others 2004, Robinson and Others 2006)
Study Area Boundary
0
0.7
1.4
2.8
Miles
N
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)


Inland Boundary
Provided by USACE
R1
R2
R3
R4
R5
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84
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A2W
AB1
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A17
A19
A20
A21
A22
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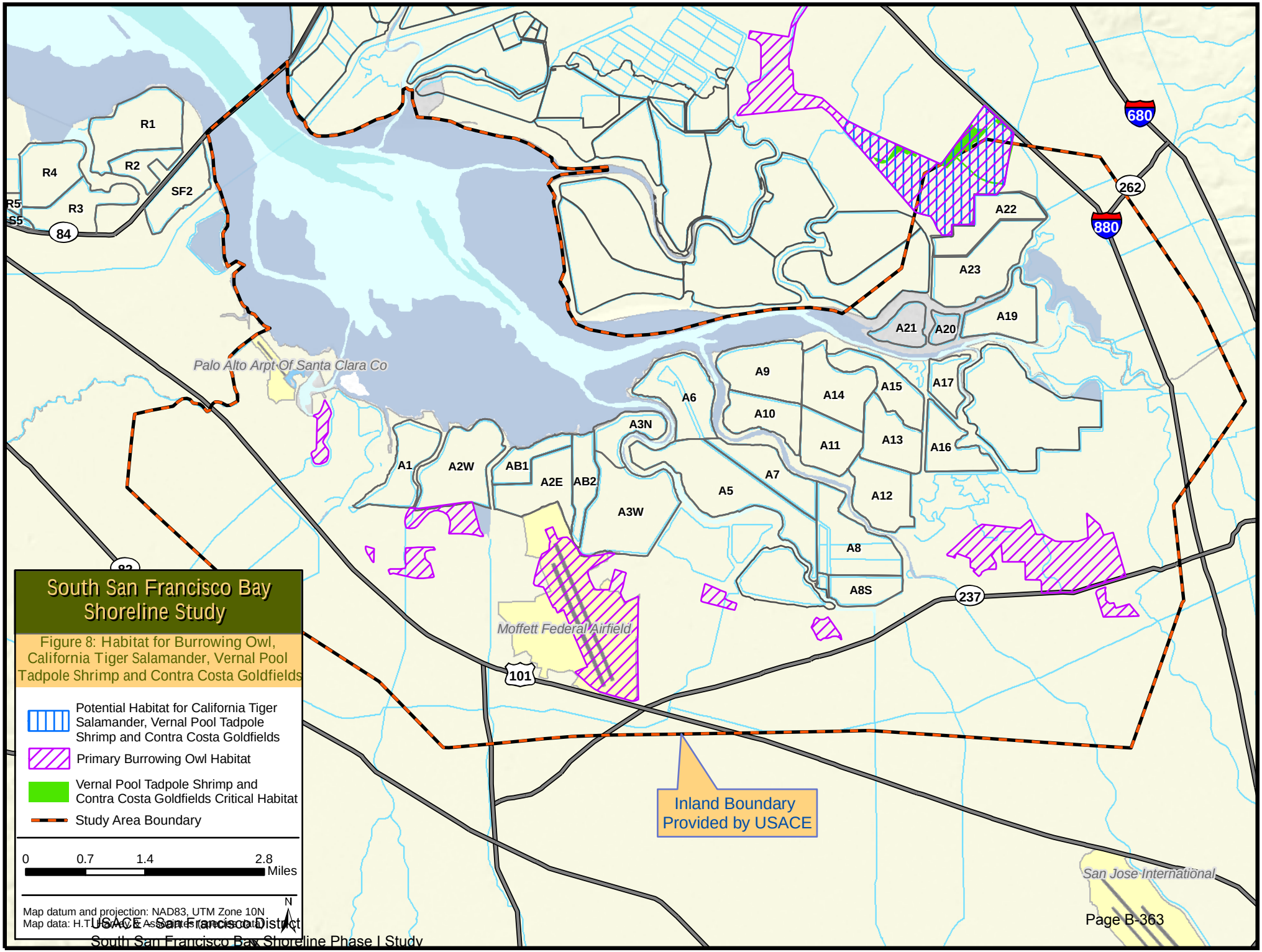
Palo Alto Arpt Of Santa Clara Co
Moffett Federal Airfield
San Jose International
South San Francisco Bay Shoreline Study
Figure 7: Salt Marsh Harvest Mouse Habitat, Capture Locations, and Barriers to Movement
SMHM Captures
SMHM No-Captures
Filter
Barriers
Barriers
Escape Cover (Upland Ecotone)
Escape Cover (Gumplant)
Pickleweed Marshes
Study Area Boundary
0
0.7
1.4
2.8
Miles
N
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (various dates)


South San Francisco Bay Shoreline Study
Figure 8: Habitat for Burrowing Owl, California Tiger Salamander, Vernal Pool Tadpole Shrimp and Contra Costa Goldfields
Potential Habitat for California Tiger Salamander, Vernal Pool Tadpole Shrimp and Contra Costa Goldfields
Primary Burrowing Owl Habitat
Vernal Pool Tadpole Shrimp and Contra Costa Goldfields Critical Habitat
Study Area Boundary
0 0.7 1.4 2.8 Miles
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)
N
Inland Boundary Provided by USACE
Palo Alto Arpt Of Santa Clara Co
Moffett Federal Airfield
San Jose International
R1
R2
R3
R4
R5
S5
SF2
A1
A2W
AB1
A2E
AB2
A3N
A3W
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Appendix A.

Special-Status Species Regulations Overview

Overview. Federal and state endangered species legislation gives special status to several plant and animal species known to occur in the vicinity of the Study Area. In addition, state resource agencies and professional organizations, whose lists are recognized by agencies when reviewing environmental documents, have identified as sensitive some species occurring in the vicinity of the Study Area. Such species are referred to collectively as "species of special status" and include plants and animals that are listed, proposed for listing, and candidates for listing as threatened or endangered under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA); animals listed as "fully protected" under the California Fish and Game Code; animals designated as "Species of Special Concern" by the CDFG; and plants listed as rare or endangered by the California Native Plant Society (CNPS) in the *Inventory of Rare and Endangered Plants of California* (2001).

ESA provisions protect federally listed threatened and endangered species and their habitats from unlawful take. Under the ESA, to "take" is "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any of the specifically enumerated conduct." The U.S. Fish & Wildlife Service's (USFWS) regulations define harm as "an act which actually kills or injures wildlife." Such an act "may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering" (50 CFR § 17.3). Activities that may result in "take" of individuals are regulated by the USFWS. The USFWS produced an updated list of candidate species May 11, 2005 (50 CFR Part 17). Candidate species are not afforded any legal protection under ESA; however, candidate species typically receive special attention from federal and state agencies during the environmental review process.

Provisions of CESA protect state-listed threatened and endangered species. CDFG regulates activities that may result in "take" of individuals (*i.e.*, "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill"). Habitat degradation or modification is not expressly included in the definition of "take" under the California Fish and Game Code. Additionally, the California Fish and Game Code contains lists of vertebrate species designated as "fully protected" (California Fish & Game Code §§ 3511 [birds], 4700 [mammals], 5050 [reptiles and amphibians], 5515 [fish]). Such species may not be taken or possessed.

In addition to federal and state-listed species, the CDFG also has produced a list of Species of Special Concern to serve as a watch list. Species on this list are of limited distribution or the extent of their habitats has been reduced substantially, such that threat to their populations may be imminent. Species of Special Concern may receive special attention during environmental review, but they do not have statutory protection. USFWS also uses the label "Species of Special Concern" as an informal term that refers to those species that might be in need of concentrated conservation actions. Species of Special Concern receive no legal protection as a result of their designation as Species of Special Concern, and the use of the term does not necessarily mean that the species will eventually be proposed for listing as a threatened or endangered species. However, most, if not all, of these species are currently protected by state and federal laws.

Vascular plants listed as rare or endangered by the CNPS, but which might not have designated status under state endangered species legislation, are defined as follows:

- List 1A Plants considered by the CNPS to be extinct in California.
- List 1B Plants rare, threatened, or endangered in California and elsewhere.
- List 2 Plants rare, threatened, or endangered in California, but more numerous elsewhere.
- List 3 Plants about which more information is needed – a review list.

Appendix B7

USFWS Coordination Act Report under the Fish and Wildlife Coordination Act

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Bay Delta Fish and Wildlife Office
650 Capitol Mall 8th floor 8-300
Sacramento, California 95814

In Reply Refer to:
08-FBDT00-
2015-CPA-0001

JUL 21 2015

Thomas Kendall
Chief of Planning
U.S. Army Corps of Engineers
San Francisco District
1455 Market Street
San Francisco, California 94103-1398

Dear Sir:

Please find enclosed our final Fish and Wildlife Coordination Act report for the U.S. Army Corps of Engineers' South San Francisco Bay Shoreline Phase I Study. This report has been revised based on comments on our June 25, 2015, draft report.

If you have questions on this final report, please contact Steven Schoenberg of my staff at (916) 414-6564, or at Steven_Schoenberg@fws.gov.

Sincerely,

Kim Webb
Acting Field Supervisor

Enclosure

cc:
Joseph Terry, Sacramento Fish and Wildlife Office, Sacramento, California
Anne Morkill, Refuge Manager, San Francisco Bay NWR, Fremont, California
William DeJager, San Francisco Corps of Engineers, San Francisco, California
Brenda Buxton, California Coastal Conservancy, Oakland, California
Tami Schane, California Department of Fish and Wildlife, Yountville, California
Rechelle Blank, Santa Clara Valley Water District, San Jose, California

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

FINAL FISH AND WILDLIFE COORDINATION ACT REPORT FOR THE

SOUTH SAN FRANCISCO BAY SHORELINE PHASE I STUDY

PREPARED BY:

Steven Schoenberg, Senior Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Habitat Conservation Division
Bay Delta Fish and Wildlife Office
Sacramento, California

PREPARED FOR:

U.S. Army Corps of Engineers
San Francisco District
San Francisco, California

July 2015

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SUMMARY

The South San Francisco Bay Shoreline Phase I Study addresses the risk of tidal flooding and ecological restoration of former industrial salt ponds in an area of south San Francisco Bay between Alviso Slough and Coyote Creek. This project includes building an engineered levee 15.2 feet high along the Alviso North levee alignment to the west and the Water Pollution Control Plant South levee alignment to the east, a 30:1 ecotone on the bay side of those levees adjacent to Ponds A12/13 and A18, and a tidal flood gate at Artesian Slough, and conducting tidal restoration actions in Ponds A9-A18. The proposed levees are needed to allow the adjacent tidal restoration actions to proceed and to protect the community of Alviso and the San Jose Water Pollution Control Plant from flood damage and sea level rise. The tidal habitat restored would benefit a diversity of aquatic and terrestrial species, including the listed salt marsh harvest mouse and California clapper rail, and other native species. The tidal restoration would be phased beginning with Ponds A12 and A18. Monitoring and adaptive management would be used following the initial restoration phase to best ensure that alternative habitat needs are balanced without major effects on species groups, and to guide the fate and design of future phases. The U.S. Fish and Wildlife Service supports the selection of the locally-preferred alternative (alternative 3) and recommends implementation of the project as proposed.

INTRODUCTION

This document constitutes the U.S. Fish and Wildlife Service's (Service) detailed report on the U.S. Army Corps of Engineers' (Corps) South San Francisco Bay Shoreline Phase I Study (project). The project is a combined flood control and habitat restoration effort encompassing ~7,450 acres (ac) at the south end of the bay between Alviso Slough and Coyote Creek, just north of urban development in San Jose, including the San Jose/Santa Clara Water Pollution Control Plant (WPCP), a facility that serves 1.4 million residents in the region. About 2,900 ac are former salt ponds currently owned by the Service and City of San Jose. The area has experienced significant subsidence due to groundwater overdrafting which exacerbates the flood risk in urban areas and affects habitat values and restoration potential. Because of this subsidence, the flood control elements involving levee construction must precede opening up the ponds to tidal action for the purpose of restoration.

It is estimated that 85% of the historic tidal marshes in San Francisco Bay have been lost due to development, much associated with the salt industry. Industrial salt ponds provide significant habitat values to some wildlife species, but not the same types nor all of the values of fully tidal marsh and mudflat. These retired salt ponds require perpetual management of non-engineered levees to retain these functions and provide only a modest level of flood protection to adjacent urban lands. Tidal habitats provide for much greater values to a diversity of vegetation and forage for birds, fishes, and invertebrates, including listed species, with reduced management costs. Restoring large contiguous blocks of tidal habitat in San Francisco Bay has become a primary goal of major initiatives to improve conditions for fish and wildlife resources (Goals Project 1999; USFWS and CDFW 2007). In 2003, about 15,100 ac of former salt ponds around the bay were acquired by the Service and California Department of Fish and Wildlife, and tidal restoration (among other actions such as enhancement of managed ponds) has been initiated in select ponds in 2008-2014 under Phase I of the South Bay Salt Pond Restoration Project (SBSPRP), including in the vicinity of the proposed project. Over the long term, the SBSPRP has a bay-wide goal to shift the habitat distribution from predominantly managed ponds to at least 50% tidal marsh by 2030 and to 90% tidal marsh over the longer term if wildlife needs can be balanced. While adjacent to and sharing the same goals and approach as the SBSPRP, the proposed project is a separate but related and complementary project to the SBSPRP effort.

There are a number of significant uncertainties which should be considered for tidal restorations in the South Bay generally that apply to the proposed project. The non-tidal ponds are heavily used by some wildlife species adapted to the water depth and salinity, conditions which will change with tidal restoration. When exposed to tidal action, these ponds will transition first to tidal mudflat and open water and then to mostly vegetated tidal marsh over the long term. Responses of wildlife populations to the conversion of non-tidal to tidal habitat cannot be easily predicted because they can depend on a variety of factors such as breeding grounds elsewhere (for migratory species), and the capacity of the remaining ponds to support populations. Tidal channels and adjacent fringe marsh will be expected to erode relatively soon after initial breaching due to the large increase in tidal prism, and perhaps rebuild over the long term as sediment accretes and the tidal prism is reduced. Salient processes in marsh evolution like sediment accretion and channel scour can only be coarsely estimated from models, and model predictions may differ from actual processes observed in the field. Other uncertain factors

include the ability to manage non-native vegetation in restored tidal marsh, and the effect of mercury present in sediments in the Alviso area which may be mobilized by restoration actions. Because of these unknowns, only the initial phase in tidal pond restoration is affirmed for certain (Ponds A12 and A18). Thereafter, monitoring and adaptive management will be applied to inform resource managers and guide decisions on the fate of the remaining ponds in the project area.

The non-Federal sponsors, the California Coastal Conservancy and the Santa Clara Valley Water District, have identified a preferred alternative which the Corps intends to recommend for Congressional authorization. The purpose of this report is to provide the Service's analysis of the project alternatives, our recommendation regarding implementation of the preferred alternative, our evaluation of the effects of the preferred alternative on resource values, and our recommendations, if any, for project refinement or related aspects. In letters of December 26, 2012, and October 21, 2014, we expressed support for a new levee alignment along the Alviso railroad spur to the west, and to the south of Pond A18 near the WPCP to the east (also called the WPCP South alignment). In our letter dated March 31, 2015, we withdrew this recommendation, and instead recommended the Alviso Slough North and WPCP South alignment, the same levee alignment described in the preferred alternative. A draft version of this report was provided for comment to the Corps and key stakeholders on June 25, 2015.

Information considered in this final report includes: (1) the Shoreline Phase I Study Draft Interim Feasibility Report and Environmental Impact Statement Report, prepared December 2014 (Corps 2014); (2) observations and information gathered during a site visit on May 7, 2015; (3) a memorandum on modeling of accretion and habitat conditions for preliminary alternatives for the project (ESA PWA 2012); (4) documents on the SBSPRP available on the internet (http://www.southbayrestoration.org/); (5) documents on the results of contracted habitat assessments (NHI 2012, 2014); (6) comments on the draft version of this report; and (7) other information in our files including, but not limited to, formal and informal communications.

PHYSICAL SETTING

The project study area is located at the south end of San Francisco Bay between Alviso Slough and Coyote Creek (Figure 1). It includes New Chicago Marsh (NCM), a diked saltwater wetland, the San Jose/Santa Clara Water Pollution Control Plant (WPCP), Zanker landfill, and various former industrial solar salt ponds (Ponds A9-A15, A18). The WPCP includes active and retired sewage ponds. Most of the salt ponds and NCM are owned and managed by the Service for wildlife, with the exception of Pond A18 which is owned by the City of San Jose. There are various types of ponds (muted tidal/diked, batch, circulation) and other habitats discussed in more detail below (see Resource Categories and Mitigation Goals). Artesian Slough carries freshwater in the form of treated effluent from the WPCP to Coyote Creek, and is parallel to another unnamed tidal ditch which receives local runoff. Overall, the project area is about 7,450 ac of which 1,704 ac are some form of upland, 1,317 ac are a type of wetland, and 4,429 ac are a type of open water. There are another ~5,000 ac of other ponds in the Alviso pond complex that are adjacent to but not within the project area. These are in various states of restoration, enhancement, or are planned for such in the future under the SBSPRP. Much of the project area has experienced subsidence owing to groundwater withdrawal; we estimate the current ground

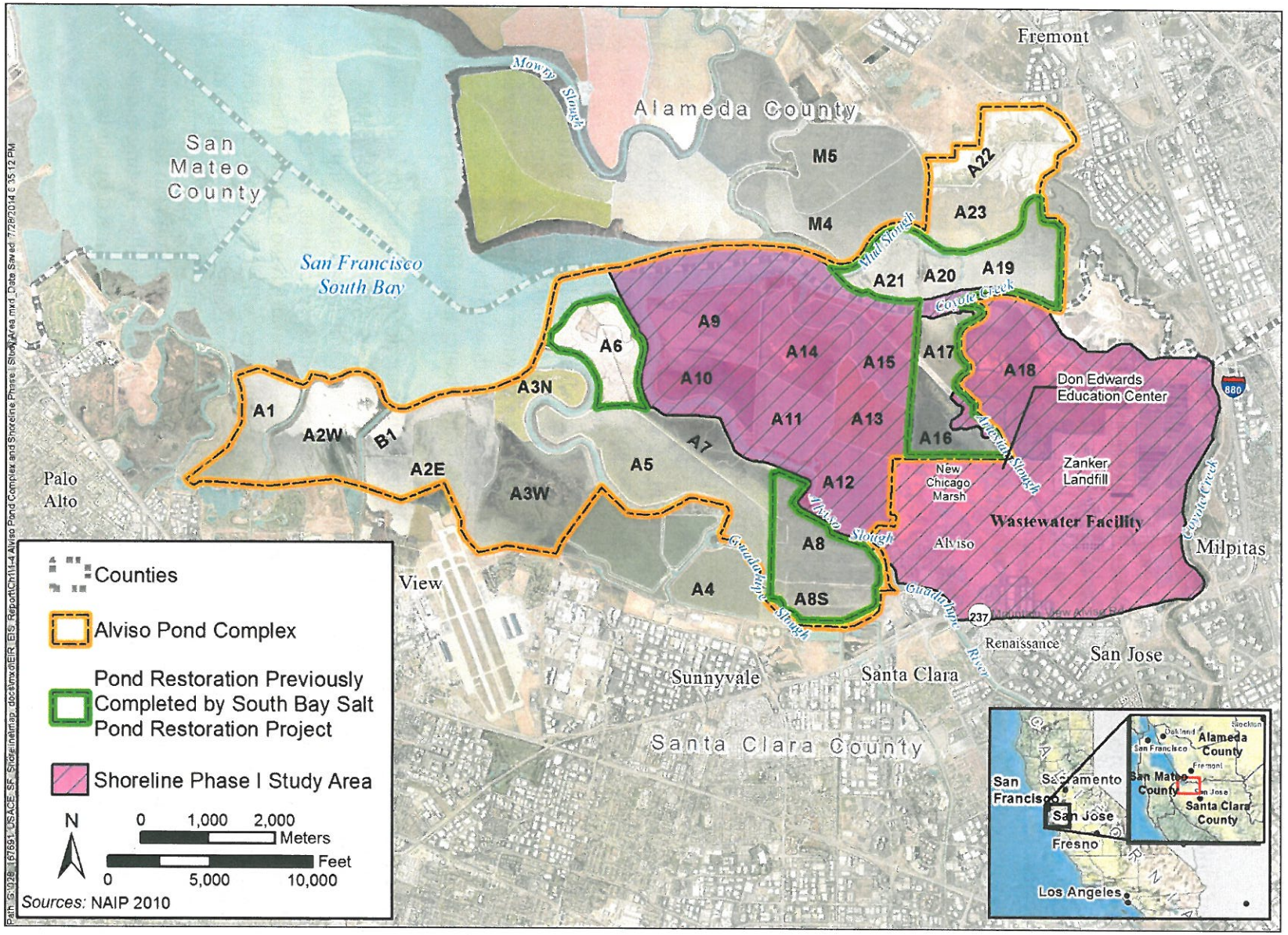

Figure 1. Area map for the SBSPRP Phase 1 actions and the South San Francisco Bay Shoreline Phase I Study project (Corps 2014).

elevations for ponds in the study area to vary from about 2.4 to 5.3 feet below mean tide level depending on the pond.

BIOLOGICAL RESOURCES

Studies of biological resources in the project area have been recently summarized (Harvey 2007) and various other studies have been carried out or commissioned by the Service (e.g., Amato and Vallopi 2015), the SBSPRP (http://www.southbayrestoration.org/), the San Francisco Estuary Project (e.g., Goals Project 1999), and other interests (e.g., Siegel and Bachand 2002; SFBO et al. 2008). Despite major historical losses of tidal wetlands, the project area still has significant habitat today that supports an array of fish and wildlife species, including rare, endemic, and/or listed species. San Francisco Bay as a whole, of which the study area is part, is of regional importance to migratory waterfowl and commercial fish species.

Fish: San Francisco Bay supports about 100 fish species and has been studied specifically to some extent for both tidal waters and pond habitats in the vicinity of the project area (Hobbs 2012). Hobbs (2012) observed a winter assemblage of species that tolerate a range of salinity such as longfin smelt, American shad, and Pacific herring. The summer assemblage included highly salinity and temperature tolerant species like Pacific staghorn sculpin and three-spine stickleback, both of which are also found in low-salinity ponds. The most abundant fish overall were Pacific staghorn sculpin, English sole, and northern anchovy. Harvey (2007) noted the most abundant fish in trawls of nearby open bay waters were northern anchovy, shiner surfperch, longfin smelt, white croaker, Pacific staghorn sculpin, bay goby, plainfin midshipman, English sole, and others. The dominant fish at beach seine stations were topsmelt, arrow and yellowfin goby, and jacksmelt. Results of slough channel sampling varied with the study, but were similar, with anchovy, staghorn sculpin, topsmelt, American and threadfin shad, longjaw mudsucker, longfin smelt, and others (Harvey 2007). Many of these same fish and others such as bat ray and leopard shark are also found in tidal sloughs and mudflats when inundated. The primary fish species in the lower salinity ponds are topsmelt, threespine stickleback, longjaw mudsucker, rainwater killifish, and yellowfin goby. Freshwater and freshwater tolerant species are present in Artesian Slough, such as Sacramento sucker, American shad, threespine stickleback, and common carp. No fish are present in ponds with a salinity greater than 100 parts per thousand.

Birds: The South Bay is recognized as contributing significant habitat support for a diverse and abundant bird community of resident and migratory birds, including several special status species. Shorebirds are the most abundant with an estimated 1 million resident and migrant shorebirds bay wide (SFBO et al. 2008). Most species are mudflat specialists, foraging at low tide in the project area generally in the vicinity of Coyote Creek and Alviso Slough. These include western and least sandpipers, dunlin, red knot, dowitchers, willet, long-billed curlew, and marbled godwit. These species could also use shallow waters of managed ponds at high tide. Other species tend to be pond specialists, such as phalaropes, black-necked stilt, American avocet, the threatened western snowy plover, pelicans, gulls (large populations in the project area), and terns. For these pond specialists, the ponds provide higher-quality nesting and/or foraging habitat than tidal habitats. Ponds and their levees are sometimes used by birds as refugia from wind and storm events.

Diving ducks are the most abundant wintering waterfowl, and include scaups, ruddy duck, canvasback, bufflehead, surf scoter, common goldeneye, and red-breasted merganser. The most abundant dabbling duck is the northern shoveler, followed by American wigeon, northern pintail, mallard, and gadwall. Use of South Bay ponds by dabbling ducks has increased from 2004-2011 (Pitkin and Wood 2011).

There are a number of species of large waders and other fish-eating birds present in the area including grebes, herons, cormorants, and egrets. The relatively uncommon white-faced ibis is known from Artesian Slough in the project area. Some other important birds in the project area include eared grebe, American coot, the State-listed as threatened California black rail, and the federally-listed as endangered California clapper rail (also called Ridgway's rail). There are various insectivorous passerine birds in the project area although the only nesting species are the marsh wren, Alameda song sparrow, and savannah sparrow.

Mammals: In the project area, there are mostly common species of mammals typical of the urban-wildland interface such as raccoon, opossums, rats, mice, and skunk. Other small mammals include the federally-listed endangered salt marsh harvest mouse and salt marsh wandering shrew (a California species of special concern), as well as more common species of bat, squirrel, rabbit, and fox. The Pacific harbor seal is the only marine mammal present in the area. Several non-native mammals are present such as Norway rat, red fox, and feral cat, all of which are subject to refuge control and removal under an ongoing predator management plan.

Vegetation: Vegetation in the project area has been recently mapped including tidal and non-tidal (muted tidal/diked) salt marsh, brackish marsh, and freshwater marsh. There are 322 ac of tidal salt marsh in the project study area, mostly along the bayward portions of Coyote Creek and Alviso Slough, with some additional tidal salt marsh just outside the project area in recently-restored Pond A17. Brackish marsh (432 ac) is found slightly farther upstream along the creek and slough, as well as in Triangle Marsh (just west of Pond A17) and along some of Artesian Slough. Freshwater marsh (93 ac) is restricted to the upper portions of Artesian Slough. Upland vegetation, mostly non-native grassland, is present in minor amounts on the various levees bordering the ponds, with much more present outside the project footprint in and around Zanker Landfill. The majority of the project area bayward of the proposed levees is unvegetated and consists of pond interior areas of open water or mudflat, a small area of pond islands, and barren portions of the levee subject to wavewash. Based on our May 7, 2015 site visit, shallower portions of Pond A18 do exhibit sparse vegetation, even though it is mapped as open water.

Several nonnative plant species are present in the project area but have not been quantified. The most significant of these which deserve management attention are smooth cordgrass (*Spartina alterniflora*) in tidal areas and perennial pepperweed (*Lepidium latifolium*) in many wetlands as well as in upland areas.

Listed Species: The following is basic information on special status species; for detailed information on these species, project effects, project-proposed avoidance and minimization measures, and terms and conditions, see the Service's Biological Opinions to the Corps and Service Refuge dated April 27, 2015 (USFWS 2015a-b).

Several special status fish species in the study area include chinook salmon, steelhead trout, green sturgeon, and longfin smelt. All are anadromous, spawning seasonally in freshwater. Salmon and steelhead spawn in Coyote Creek, the Guadalupe River, and other area streams, and are seasonally present in the project area during migration and rearing periods. Green sturgeon would be expected to forage in estuaries and bays including the South Bay and sloughs in the project area, but there are very little data on this species in the project area. Longfin smelt is much more abundant, and has been seasonally documented as part of the winter fish assemblage in the tidal sloughs in the project area.

Federally-listed bird species in the project area include the endangered California clapper rail and threatened western snowy plover. According to our Biological Opinions for this project, the rail has been occasionally detected along Alviso, Coyote, and Guadalupe Sloughs in the project area and most often near the mouth of Alviso Slough and around Triangle Marsh near Coyote Slough. According to Corps (2014), the plover breeds in and near the study area including ponds A13, A16-17, and A23, with additional birds present in the project area during winter. Nests have also been detected in the last 5 years in NCM and Pond A9 (personal communication, Strong 2015) The native habitat of the plover is tidal beach sand, although it is known to use salt ponds and levees. California clapper rails are generally associated with saltwater marshes dominated by pickleweed and Pacific cordgrass where they nest. They also forage along the edges of tidal channels.

The endangered salt marsh harvest mouse is the only federally-listed mammal species in the project area. It is typically associated with dense cover areas of tidal marsh, usually pickleweed but sometimes alkali bullrush in brackish marshes. In the South Bay, it has been captured in NCM, fringe marshes along various tidal creeks, Triangle Marsh, and the margin lands between Pond A18 and the WPCP (Figure 7 *in* Harvey 2007). NCM appears to have one of the largest blocks of pickleweed habitat outside of Triangle Marsh, as well as multiple captures of salt marsh harvest mice.

COVER-TYPES, RESOURCE CATEGORIES, AND MITIGATION GOALS

The Service's Mitigation Policy (Policy) (FR 46:15 January 23, 1981) provides general guidance in making recommendations to conserve fish and wildlife resources. Under the Policy, resources are assigned to one of four Resource Categories, with a mitigation goal consistent with the values provided to fish and wildlife and the rarity of that habitat (cover-type). A mitigation goal is assigned ranging from "no loss of existing habitat value" (Resource Category 1) for the most valuable kinds of habitat to "minimize loss of habitat value" (Resource Category 4) for the less valuable and most common kinds of habitat. Application of the Policy involves designating cover-types which may be affected and assigning evaluation species based on the sensitivity of those species to the project action, their role in the ecosystem, or association with Service-wide resource management issues such as anadromous fish and migratory birds. We then state the Resource Category, the rationale for that selection, and the corresponding mitigation goal.

For this project area, we have designated seven basic cover-types within the project area and adjacent areas affected by the project. If a cover-type is considered unaffected both directly and indirectly by the project, it is not discussed here. Due to differences in water depth and/or

salinity, there may be several more specific habitats within these cover-types, which are noted below.

Subtidal slough/channels: These are represented by the unvegetated, consistently open waters of Alviso Slough, Artesian Slough and Coyote Creek. These are used as habitat by numerous resident and migratory fishes during all tide levels and by an array of birds which forage at the interface between the fringe marsh and the channel, including the endangered California clapper rail. Such channels carry sediment and organic matter between marshes, upland watersheds, and bay waters that are important for sustaining the productivity of the bay and marsh as well as maintaining the marsh elevation in the face of rising sea level. Pond breaching would create a larger tidal prism which may cause channel enlargement at the expense of fringe marsh, and would eventually create more channels within the restored ponds. Appropriate evaluation species would be the longfin smelt and Pacific staghorn sculpin. Slough/channel habitat has been reduced in extent and quality during the historic loss of tidal wetlands and extensive shoreline development to the edge of many channels in the Bay area. Due to the vital importance of the slough/channel network, it is designated Resource Category 2, with a mitigation goal of no net loss of in-kind habitat value.

Open bay waters: Open waters are represented by unvegetated, permanently inundated areas of south San Francisco Bay below mean lower low water. These waters would not be directly affected by project actions, but would indirectly benefit from the transport of organic matter and food organisms from tidal marsh restored by the project. This cover-type is important for saltwater fish species and diving ducks like canvasback and scaups. An appropriate evaluation species would be one of the numerically abundant resident fish, such as topsmelt. Bay waters have been indirectly affected by tidal marsh loss and urban pollutants and contaminants, but direct losses from fill have been limited and it remains regionally abundant. For this reason, we designate it Resource Category 3, with a mitigation goal of no net loss of habitat value while minimizing loss of in-kind habitat value.

Non-tidal pond waters: Non-tidal ponds constitute most of the project area which would be directly affected by the project. The ponds vary in depth, circulation, and chemistry. There are about 2,000 ac of somewhat lower salinity "circulation ponds" maintained by circulating bay water through a series of ponds linked by water control structures. These ponds support some species of saltwater resident fish in addition to benthic and pelagic invertebrate forage organisms. They are used by dabbling and diving ducks, and other bird groups, depending on depth for forage and shelter. About 800 ac of the project area are called "batch" ponds because there is less circulation and a higher maintained salinity. These ponds do not have fish but have abundant brine shrimp and brine flies that provide forage for other birds like eared grebes, phalaropes, and shorebirds. At least some of these ponds, and potentially all of them, would be converted to tidal marsh with the project. As evaluation species, we would select a resident shorebird such as the American avocet for the batch ponds, and a duck such as the northern shoveler for the circulation ponds. Non-tidal pond waters are moderately abundant, providing significant habitat to these evaluation species, and replacing some of the functions of higher marsh salt pannes in the historical landscape. Due to this abundance and medium-to-high value to the evaluation species, we designate it Resource Category 3, with a mitigation goal of no net loss of habitat value while minimizing loss of in-kind habitat value.

Microtidal/diked pond waters: This type of pond is represented by NCM (340 ac) in the project area. It receives water through a control structure through the levee bordering Pond A16, and water levels vary minimally. This cover-type has some of the same features as fully tidal marsh in terms of vegetation and chemistry, but with lower plant and fish diversity. The lack of tidal connection means that bird foraging on this cover-type may occur throughout the tidal cycle, but also that it does not contribute organic material to bay open waters, nor provide value for migratory fish. In the study area, this cover-type provides important habitat support for the listed salt marsh harvest mouse, western snowy plover, and California clapper rail, as well as for Forster's tern, black-necked stilt, American avocet and other small shorebirds. With the proposed project, a small portion of this pond would be directly affected by levee construction, and levee overtopping and associated flood effects would no longer occur. A shorebird like the black-necked stilt would be an appropriate evaluation species. Due to the modest diversity and ecological function, but high use by some bird species, and medium-to-high value to the evaluation species, we designate it Resource Category 3, with a mitigation goal of no net loss of habitat value while minimizing loss of in-kind habitat value.

Tidal emergent marsh: In the project area, tidal emergent marsh presently occurs mainly as a fringe marsh of varying width along Alviso Slough, Artesian Slough and Coyote Creek. Tidal restoration elements of the project would affect the quantity of this cover-type because the increased tidal prism would cause erosion of this fringe marsh. Over a longer period of up to several decades or more, the breached pond interiors would accrete sediment to the point at which vegetation would colonize the surface. Species composition varies with salinity and elevation, contributing to a high diversity of plants and wildlife which use this cover-type. Dominant vegetation species in the project area are cordgrass, pickleweed, and saltgrass, along with other salt tolerant species. This cover-type provides significant, high value habitat to an array of mammals like the salt marsh harvest mouse, birds such as the marsh wren and clapper rail, and many fishes. Additionally, tidal emergent marsh produces organic matter that supports invertebrate and small fish forage organisms, that in turn are used by fish-eating birds and larger predatory fish. It is also a nursery ground for juvenile estuarine fish and invertebrates. An appropriate evaluation species would be a tidal marsh specialist like the marsh wren or black rail. The value of tidal marsh increases disproportionately with unit size, making it important to plan restoration projects with large contiguous units. Regionally, most of the tidal marsh has been lost due to conversion to industrial salt production and other coastal development. Due to this regional scarcity and very high values to the evaluation species, we designate tidal emergent marsh as Resource Category 2, with a goal of no net loss of in-kind habitat value.

Mudflat: Mudflats are substantially unvegetated tidal areas between mean low and mean lower low water that are regularly exposed during low tide. Mudflats are present along the margins of lower Coyote Creek and Alviso Slough, and more exists just outside the project area in ponds which were recently breached (Ponds A7, A19-21). With the project, much more mudflat would form as an interim habitat in breached ponds exposed to tidal action as sediment accretes. Over the longer term (after 30-50 years), sediments would accrete to the point that vegetation would colonize the surface and these interim mudflats would decline. Mudflat areas typically have a productive benthic community which provides forage for the shorebirds which specialize on them, as well as for gulls, terns, larger wading birds like herons and egrets, and ducks (see *Birds*, above). At higher tide stages, fish enter the mudflats and forage. Shorebird species which

specialize on recently exposed mud such as the western and least sandpiper would be appropriate evaluation species. While some mudflat has been lost due to fill and urban development, it has not been affected to the same extent as tidal emergent marsh. Due to the moderate amount of mudflat, and its high importance to the evaluation species, we designate mudflat as Resource Category 2, with a goal of no net loss of in-kind habitat value.

Upland: Upland in the project area occurs mostly as non-native annual grassland habitat on levee slopes, some of which would be temporarily disturbed by new levee construction. It supports common small mammals and passerine birds, many of which are non-native. A native species like the California vole would be an appropriate evaluation species. A modest area of upland adjacent to tidal emergent marsh has some value as a refugium for mammals like the salt marsh harvest mouse during tidal flood events. Considering its moderate abundance and value, we designate upland as Resource Category 4, with a mitigation goal to minimize loss of habitat value.

ALTERNATIVES

The Corps developed project alternatives using different combinations of flood risk management options for the Alviso segment levee alignment, levee height, and construction of transitional habitat on the outboard side of the levee adjacent to Ponds A12 and A18. The levee alignment also affects the extent of restoration. For all of the action alternatives, *common elements* would be: in-pond preparations in advance of tidal restoration, tidal restoration of Ponds A9-15 and A18, tide gates at Artesian Slough and a railroad crossing, a south alignment of the WPCP levee (no alignment options), replacing the siphon between Pond A16 and NCM, providing an alternative mechanism for brackish water transfer to a nontidal marsh area just south of Pond A18 and east of Artesian Slough, creating a small berm breach to restore freshwater flow between Artesian Slough and a parallel unnamed ditch and adjacent marsh to the west, staging areas, and recreational trails. Levees would be constructed of engineered earth fill and have 3:1 (horizontal:vertical) slopes. The components of the advance preparation for tidal restoration include: draining ponds and removing vegetation; internal fill features such as ditch blocks; internal dike lowering and internal breaches; and stabilizing pond dikes inboard of ponds to be breached. After this preparation, external channel work such as pilot channels would be completed, followed by the breaching and/or lowering of the outboard levees. Additionally, the sequence of restoration involves early tidal restoration of Ponds A12 and A18, with possible tidal restoration of the rest of the ponds to follow if warranted after 4-10 years of monitoring (Figure 2). The Corps would initially conduct actions on Ponds A12 and A18. For the purpose of this report, we assume that the monitoring, funding, and other considerations will lead to a decision by the Corps to proceed with future tidal restoration of the remaining Ponds A9-11 and A13-15.

Levee alignment options: The alternatives discussed below involve three options for the Alviso segment of the project (i.e., west of Artesian Slough) (Figure 3). The Alviso North alignment follows the western and northern outer levees of NCM along the margins of Ponds A12, A13, and A16. This alignment would exclude NCM from tidal restoration in the future, protect it from flooding, and preserve its current state as a diked marsh. The Alviso South alignment follows

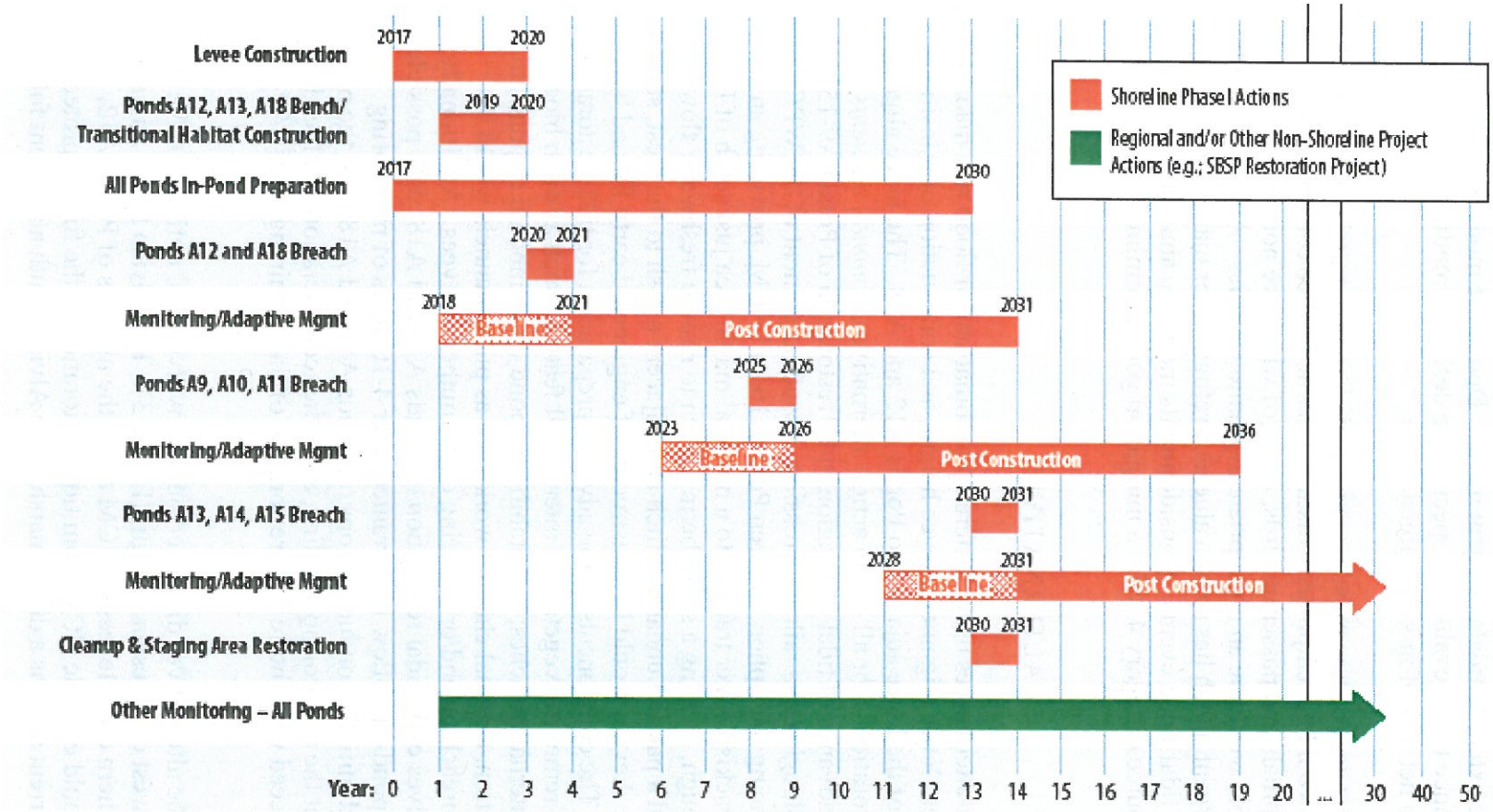

Figure 2. Construction Schedule for the South Bay Shoreline Phase 1 Study (personal communication, HDR 2015).

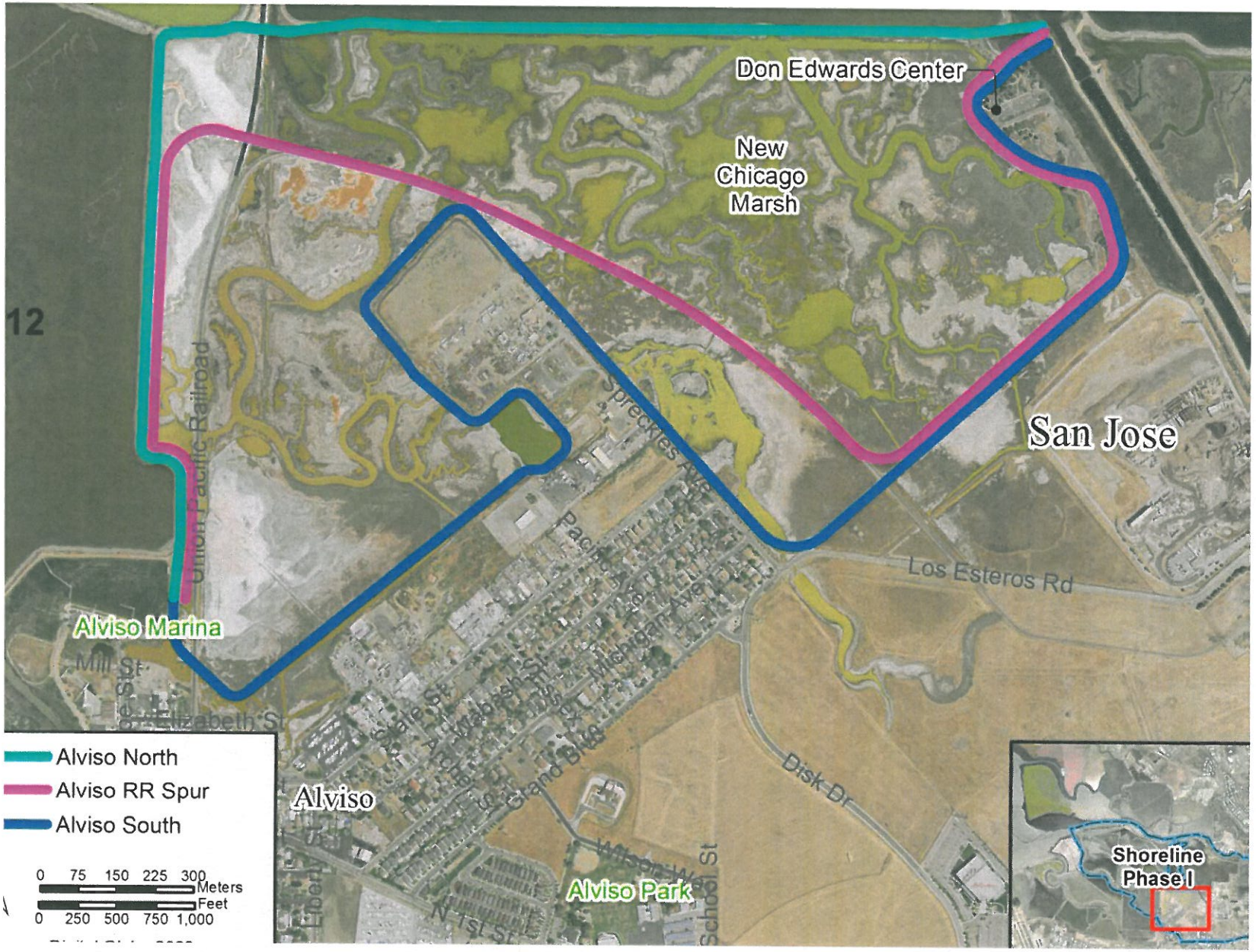

Figure 3. Alviso segment levee alignment options (Corps 2014).

the outer, generally south border between NCM and the town of Alviso, and would affect about 20 ac of diked marsh and 15 ac of developed land. This alignment would not protect any of NCM from flooding and it could be restored to tidal marsh. The Alviso Railroad Spur alignment follows some of the border of Pond A12, and then goes along an existing railroad spur levee through NCM. With this alignment, the roughly one third of the NCM area south of the new levee would be protected from flooding and would remain diked marsh. The area north of the new levee could be restored to tidal marsh.

Levee height options: The alternatives discussed below involve two options for levee height in addition to the no-project alternative. Recent history shows significant past flooding in Alviso about three times in the last 40 or so years due to overtopping of the slough levees. With the completion of flood control projects on Guadalupe River and lower Coyote Creek, the remaining risk is tidal flooding from the bay overtopping non-engineered levees. Under the no-project alternative, the risk of overtopping of the current, non-engineered levee is estimated at 1 in 3 years for the year 2017, which will rise to 1 in 2 years by the year 2067 due to sea level rise. For the 13.5-foot-high option, the chance of overtopping by the 1-percent event is reduced to 0.1-11.8% per year by year 2067, depending on the sea level rise scenario. The 15.2-foot-high option is two feet above the 1% event for year 2067, would meet FEMA accreditation, and would not be overtopped by the 1% event. The 15.2-foot levee height option is locally preferred and is the Corps proposed project height.

Transitional habitat options: There are two transitional habitat options, a 50-foot-wide flat bench with a steep slope into the pond bottom, and a broad, 30:1 sideslope "ecotone", about 350-feet wide (Figure 4). This transitional habitat would be built on the bayward side of the levee work bordering ponds intended for tidal restoration (Ponds A12, A13, and A18). No bench or ecotone would be constructed adjacent to Pond A16 because it would remain a managed pond. The bench or ecotone would be constructed of non-engineered fill. The 50-foot bench would be grassland, but the edge of the steep slope could have narrow bands of marsh. For the ecotone, the first 15 feet where it meets the levee would be maintained to low grass at most in accordance with Corps policy (Engineering Technical Letter 1110-2-571). The rest of the ecotone would be unmanaged (no mowing) and allowed to establish on its own to include herbaceous species like cordgrass, pickleweed, and other marsh plants, with occasional woody plants up to 5-feet-tall. Due to the scarcity of transitional habitat currently, either option would provide benefit in the forms of high tide refugium and early marsh habitat. However, there would be much more such benefit for the ecotone than for the bench option.

Alternative 1 (No-Project): Under the no-project alternative, no actions would be taken for flood risk management or ecosystem restoration. The Service would conduct the same types of maintenance of the existing levees as it does today, however, it is acknowledged that these are non-engineered levees and at insufficient height and quality to withstand tidal floods. As such, these levees would be expected to fail under moderately large events. This would be followed by attempts to repair the levees and restore pre-flood conditions.

Alternative 2: This alternative would combine the common elements with the Alviso North levee alignment (the current north border of NCM), a 13.5 foot levee height throughout, and a

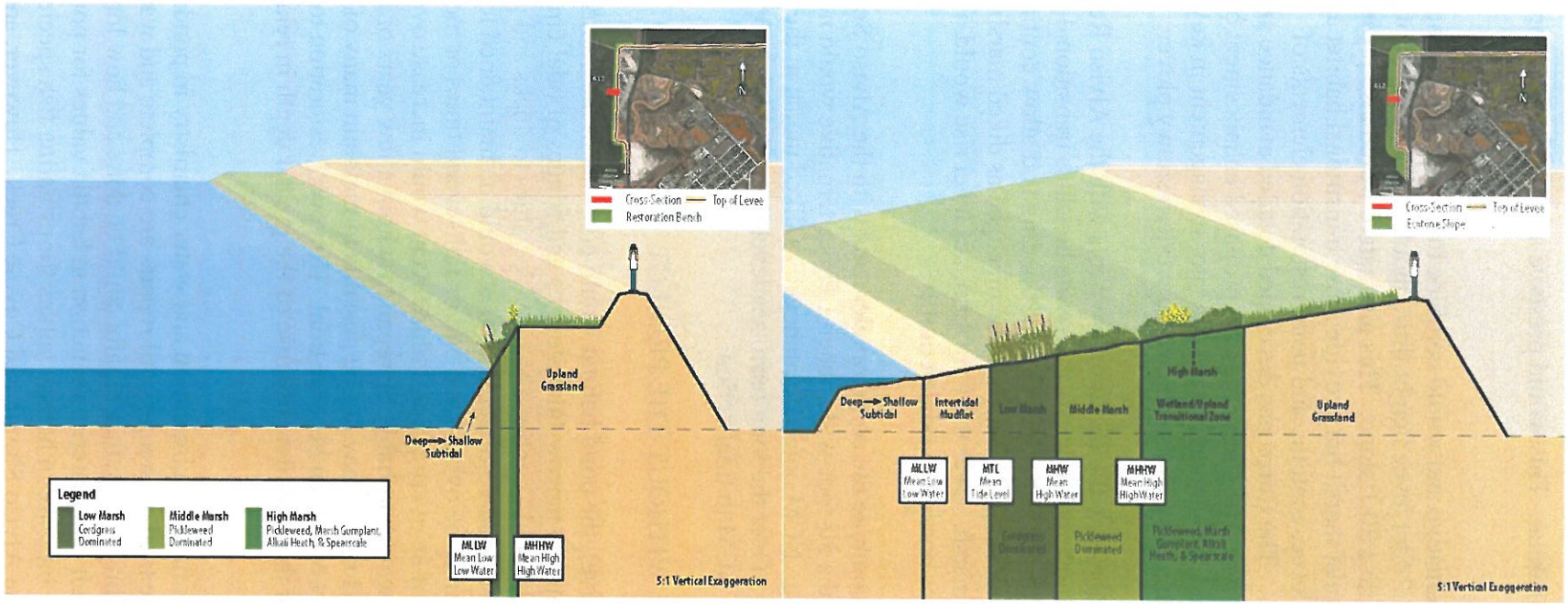

Figure 4. Transitional habitat options: Left - 50-foot-wide "bench"; Right - ~350-foot-wide "ecotone" (from Corps 2014).

flat 50-foot-wide bench as transitional habitat. This would preserve all of NCM in its present state as a diked tidal marsh.

Alternative 3: This is the preferred alternative and would combine the common elements with the Alviso North levee alignment, a 15.2 foot levee height throughout, and a broad, ~350-foot-wide transitional habitat constructed with a 30:1 slope. This alternative would also preserve all of NCM in its present state as a diked tidal marsh but provide more transitional habitat and more flood protection. The locations of the levee, ecotone, and pond restoration elements of Alternative 3 are illustrated in Figure 5. The Corps has developed detailed avoidance and minimization measures for this alternative. The Corps has also proposed enhancement of breeding substrate on one island in Pond A16 and enhanced predator management in key locations as compensatory conservation measures for impacts to western snowy plover.

Alternative 4: This alternative would combine the common elements with the Alviso Railroad alignment, a 15.2 foot levee height throughout, and a 50-foot-wide bench as transitional habitat. This alternative would protect about a third of NCM from tidal flooding and allow continued management as diked marsh. The remainder of NCM could be managed as diked marsh in the short term or actively restored to tidal marsh. Over the long term, sea level rise would overtop the non-engineered levees, exposing this portion to tidal action.

Alternative 5: This alternative would combine the common elements with the Alviso South alignment, a 15.2-foot levee height, and a 50-foot-wide bench. This alternative would not protect any of NCM from tidal flooding. NCM could be managed as diked marsh in the short term or actively restored to tidal marsh. Over the long term, sea level rise would overtop the non-engineered levees, exposing all of NCM to tidal action.

FUTURE WITHOUT THE PROJECT

Without the project (no-action alternative), the pond habitat would continue in the immediate term as managed open water, with relatively narrow tidal sloughs and fringes of tidal emergent marsh. The batch and circulation ponds would continue to provide values to ducks and pond specialists like the American avocet. The non-engineered levees would be maintained to the extent possible, but would almost certainly be overtopped and/or fail several times or more over a 50 year period of analysis. The risk of an overtopping/failure event would increase over this period with sea level rise. The levees would probably be repaired within a few years or less for a few decades. Eventually, with sea level rise, it may not be possible to maintain many of the levees. Most or all of the project area would then become tidal. However, restoration to tidal emergent marsh may not be possible at this later date because of the greater depth in relation to sediment accretion.

When uncontrolled levee failure events happen, circulation and water chemistry in ponds would be unmanaged and there could be some tidal exchange until repairs are complete and water circulation control is restored. Depending on whether repairs could be done and how long they take, uncontrolled breaching could result in an interim reduction in habitat values for pond specialist bird species together with an increase in habitat values for estuarine fish species due to the reconnection between the ponds and Alviso Slough and Coyote Creek. However, any such

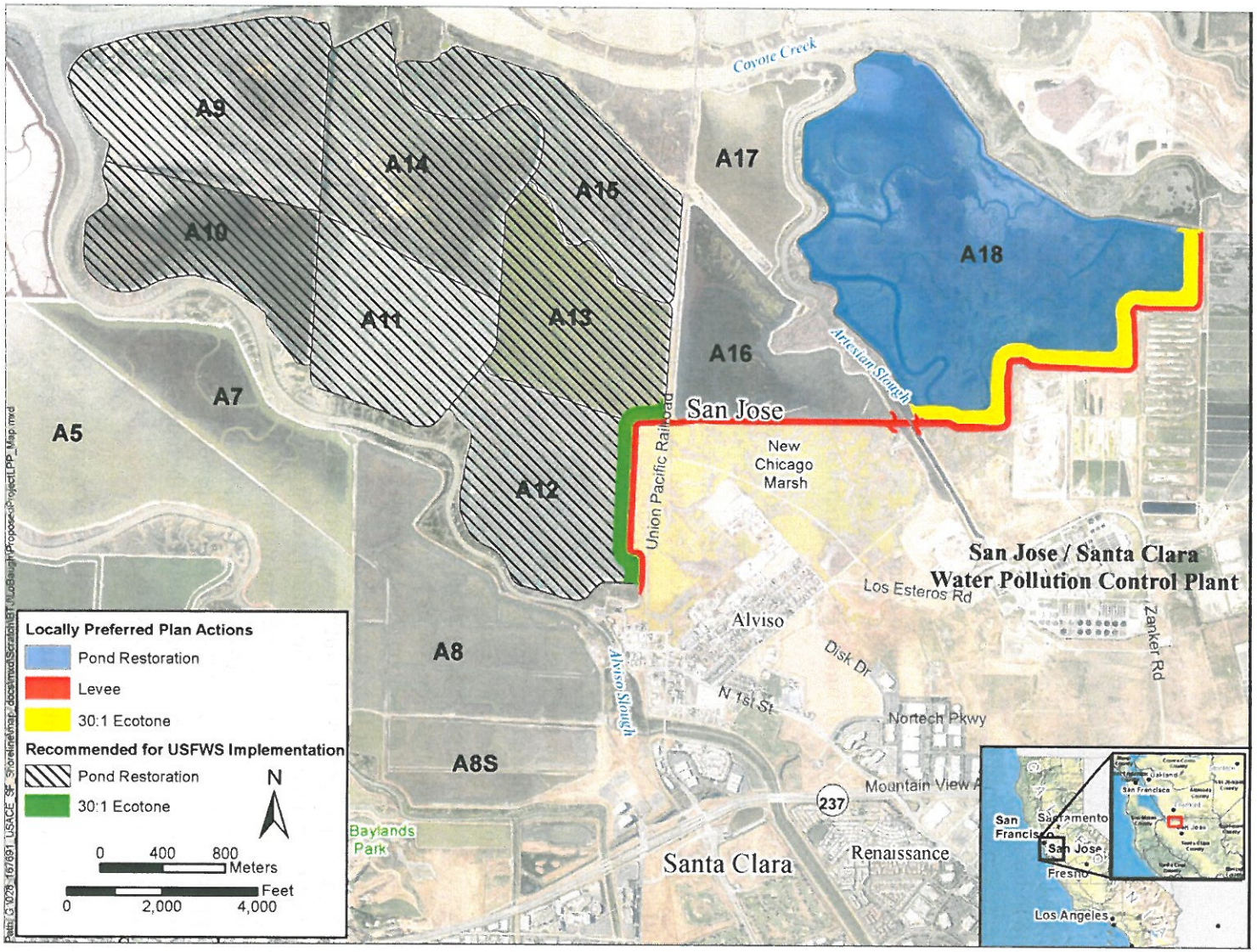

Figure 5. Preferred alternative (alternative 3) features (from Corps 2014).

tidal benefits under the no-action alternative with this kind of uncontrolled breaching would be lower than tidal benefits under the action alternative. The effect of uncontrolled breaching on birds which use ponds cannot be easily estimated because these birds may move to other areas and use habitat created by other regional restoration actions. Mammals, including the salt marsh harvest mouse, may be more adversely affected by levee failure under the no-action alternative because of the limited refugium at the urban-wildland interface, and their limited mobility.

FUTURE WITH THE PROJECT

With the project (alternative 3), pond habitat would be progressively converted from non-tidal managed ponds to tidal influence, beginning with Ponds A12 and A18. The expected result is that these would become emergent tidal marsh over time. However, complete restoration to tidal marsh will take many years and the final outcome is not certain. At the outset, there would be around 3 years of construction needed to build the major levee components and place the fill for the ecotone in both Alviso and WPCP segments (Figure 2). There would be considerable machinery movement and noise associated with this construction which is likely to reduce wildlife use in the immediate vicinity of the work, and could cause displacement of birds away from the levee or to other habitat in the vicinity. The total footprint for this levee work is about 63 ac, including about 9 ac of various wetland types, 38 ac of ponds or open water, and 16 ac of upland or development including the existing levee (Table 4.7-3 *in* Corps 2014). The wetland impact includes about 1.8 ac of muted/diked marsh habitat in NCM.

There would be some direct loss of tidal and diked marsh habitat associated with the new levees, the Artesian Slough flood gate, and excavation of the pilot channels and dike breaches of Pond A18. When a pond is breached, there would be a large increase in tidal prism, depending on specific depth, number and location of breaches, and slough capacity. One major effect of this tidal prism is that it will cause some erosion of outboard habitat at the breach location, and along the edges and bottoms of sloughs between the breach and the bay. The highest erosion rates would likely be near the breach location, at least initially. Initial accretion rates within a pond would be relatively high for the first few years after breaching because of this source of eroded material, and decrease thereafter. The habitat in the pond interiors for most of the next 30-40 years after breaching would be mudflat, with increasing time of mudflat exposure as the marsh plain accretes. This would provide increasing values to wildlife which use mudflat during this period. Whether this remains mudflat or becomes tidal emergent marsh, and how much becomes tidal marsh, would depend largely on the suspended sediment concentration (SSC) over the long term. At 100 milligrams per liter (mg/L) SSC it is predicted to remain mudflat after 50 years, but at 200 mg/L SSC, it is predicted to fully transition to emergent marsh after 40 years (ESA PWA 2012). As sediment accumulates, the initially enlarged tidal prism would decline, which may lead to narrowing of tidal channels and expansion of the outboard fringe marsh. If tidal emergent marsh is formed as is hoped, this would provide substantial ecosystem values in the form of support of tidal marsh wildlife, as well as production of organic matter. This organic matter would not only enhance the productivity of the bay, but would contribute to accretion rates and may offset the effect of sea level rise.

Thus, there is some uncertainty about the future conditions of the pond interiors related to the rate of sediment accretion within breached ponds, as well as the regional responses of wildlife to

the changes in habitat distribution. To guard against adverse effects associated with these uncertainties, monitoring and adaptive management is proposed so that the decision on whether to breach more ponds in later phases, or what additional measures might be needed to promote tidal marsh, can be informed from data collected from initially-restored Ponds A12 and A18.

Because the ecotone area is at a higher elevation initially, we expect marsh vegetation to begin forming within one season of breaching (Figure 4). Planting or seeding could be done to accelerate colonization and favor desired plant species diversity. Once established, the vegetated ecotone would provide up to 60 ac of early tidal marsh habitat. Later, as tidal emergent marsh begins to form within the pond interior, the ecotone would also function as refugium for wildlife during high tides. The maximum post-construction tidal emergent marsh for the preferred alternative 3 is estimated at 2,783 ac (Table 4.6-8 *in* Corps 2014).

The other likely major effect of the increased tidal prism would be the effect of salinity on the plant community. Much of the fringe marsh along the major channels is vegetated by brackish species, and some of it has freshwater species. With the increased tidal prism, average salinity should increase, leading to an expansion of salt tolerant species such as pickleweed and saltgrass. This could have a positive effect on tidal marsh species like the salt marsh harvest mouse and California clapper rail.

Compared to without-project conditions, maintenance activities with the project would be more frequent and regular, but restricted to mowing on the slope of the engineered levees or portions thereof. Erosion of these new levees from windwaves or flood tides, and the need for repair of such damage, would be greatly reduced when the project is complete. Maintenance of the remaining levees around the ponds (also called "dikes"), outside of these engineered levees, would nevertheless remain until the later phases of the project. If later phases involved additional restoration of ponds to tidal action, levee maintenance around these ponds and associated effects of such maintenance on wildlife would be greatly reduced.

The with-project conversion of managed ponds into tidal salt marsh would have some effect on the value for managed pond specialist birds which use these ponds for foraging and roosting. One possible response would be that these specialist species would be displaced to nearby areas which would remain as ponds (e.g., NCM, Pond A16, and other managed ponds in the region). Pond A16 and other vicinity ponds under phase I of the SBSPRP have been separately enhanced under the SBSPRP to increase value to these specialists (Amato and Valoppi 2015). Or, the specialist species populations may decline to some extent. Over time, these specialists may begin to use salt pannes that could form within the restored tidal wetlands. It is expected that monitoring after the initial sequence of restoration will be sufficient to detect any regional, population-level effects on the species. Any initial adverse effects would likely be minimized by delaying further tidal restoration, and/or conducting other actions such as preserving or enhancing additional pond habitat if needed.

The project could also adversely affect diving ducks which currently use the non-tidal ponds for foraging, but the magnitude of these effects are uncertain. These species may not be habitat limited. There will be some remaining pond habitat in the region with the project, and tidal sloughs created by the proposed restoration may have some benefit that offsets the loss.

Migratory waterfowl populations may also be affected by factors in their breeding grounds away from the project area. Monitoring of diving ducks under the SBSPRP is ongoing and can be used to inform decisions on later phases of the project or further study needs if effects are observed.

The effect of the project on listed species (California clapper rail, western snowy plover, and salt marsh harvest mouse) is likely to be beneficial soon after levee construction is complete, with greater benefits over the long term. Flooding of NCM will be prevented, eliminating the effects of flooding and response to flooding (i.e., pumpout, levee repair) on habitat use or the displacement and mortality of individuals. Up to 60 ac of early marsh habitat expected to establish on the ecotone would benefit these species. Over time, restored tidal marsh would provide additional habitat that would allow expansion of populations of these species.

DISCUSSION

Alternative Evaluation: The locally-preferred alternative 3 has several benefits over the other alternatives from a fish and wildlife resource standpoint. Alternative 3 is the only alternative with the 30:1 sloped ecotone as transitional habitat. This type of transitional habitat would provide some substrate for early tidal marsh colonization, and would also serve as refugia from high tide events. The slope and width of the ecotone would result in more transitional habitat than would the flat bench in alternatives 2, 4, and 5. This habitat would also offset the direct loss of marsh on the margin of NCM and Artesian Slough that would have occurred due to construction of the levees and floodgates. Finally, the shallow slope of the ecotone is expected to more efficiently dissipate wave energy than would a flat bench or no transitional habitat. The Alviso North alignment in alternative 3 would preserve and protect the current water management of NCM, which is consistent with long term plans under the SBSPRP (USFWS and CDFW 2007). This current management provides for improved water quality in NCM and promotes salt marsh vegetation used by the salt marsh harvest mouse. NCM also functions as breeding and foraging habitat for the listed western snowy plover, and is adjacent to Pond A16 which is also used by this species for nesting. Other important species present on NCM include Forster's tern, American avocet, and black-necked stilt. Alternative 3 would largely preserve the habitat support for these wildlife species.

The construction impact on muted/diked tidal marsh for alternative 3 is 1.8 ac, compared to 20+ ac of such impact for alternatives 4 and 5. Because the levee section between NCM and Pond A16 under alternative 3 would be wider and taller than the existing dike, there could be some effect on the behavior of western snowy plovers and their use of NCM. For the purpose of this discussion, we assume this behavioral effect to be offset by the benefits of the proposed compensatory conservation measures. By comparison, constructing the levee alignments under alternatives 4 and 5 would not protect much of NCM from flood risk. Under these alternatives, with either active restoration or dike failure/overtopping with eventual sea level rise, the several hundred acres of unprotected muted/diked tidal marsh would become tidal. If active tidal restoration of NCM were attempted, the marsh plain would need to accrete 3 to 5 feet or more of sediment to begin to be recolonized by tidal marsh vegetation. Active tidal restoration of NCM would likely require early breaching, which could delay or affect the restoration of other ponds. Allowing the levees to fail at some later point due to sea level rise may result in permanent open tidal water rather than tidal marsh, due to the higher initial sea level at time of breaching.

The location of NCM poses challenges to tidal restoration. A railroad line is on its west border with Pond A12, which would be the access to tidal waters on Alviso Slough. A breach would be possible on that side, but it would likely be fixed rather than of flexible dimension. Pond A16, which is to be preserved as a managed pond, forms the north border with NCM, so it would be inconsistent with management to connect it to bay waters on that side. The east border is with Artesian Slough, which has a major freshwater influence that could affect (and be affected by) a pond breach. The town of Alviso is south of NCM and has been elevated above NCM by fill. Past subsidence is more pronounced in the south direction (Hecht and Seel 1990), which may explain the deeper surface at the south end of Pond A12 and possibly NCM as well. The result of this topography is that water would pond in the area of NCM, which also receives interior drainage from the town of Alviso. Considering the surroundings, current values to listed species at NCM, and the suite of alternatives evaluated, the Service concurs with the selection of alternative 3 as the preferred alternative, which preserves long-term management of NCM in its current state as a microtidal/diked marsh.

Habitat Evaluation: To assess the habitat values which would be produced by the project, we considered the change in habitat types and value shown in a Combined Habitat Assessment Protocol (CHAP) analysis (NHI 2014) as well as functions not represented by the CHAP method. The habitat type changes used in the CHAP analysis were based on modeled elevation data by ESA PWA (2012). Habitat value calculated by the CHAP method is based on the number of potential species associated with the habitat types. Habitat types with the project are projected to shift from the current dominance of managed pond to largely unvegetated mudflat in the intermediate term (5 to 20 years after initial breaching), and then tidal emergent marsh over the longer term (30 to 50 years after initial breaching). The CHAP method did not show major changes in habitat value over time with the project compared to other alternatives or the baseline condition[1]. This result is believed to be related to the inability of the CHAP method to consider the different conservation values of various habitats and their species associations, and the inherent emphasis of CHAP on species diversity.

Some loss in habitat value may occur with the project due to conversion of managed ponds to mudflat and then tidal marsh, and during associated project construction. Notwithstanding the shortcomings of the CHAP method just mentioned, total habitat units calculated by this method showed only modest differences between baseline and alternative scenarios (Table 3 *in* NHI 2014). While a reduction in habitat value deviates from our Policy goal of no net loss of habitat value for Resource Category 3, it is a small difference (<5%). In reality, we believe habitat values with the project will actually increase significantly due to factors not considered in the CHAP method (i.e., bay-wide benefits of tidal marsh such as from exported organic matter input; benefits to migratory fishes and listed species; large contiguous unit size). Additionally, the remaining managed ponds in the project vicinity along with ongoing and proposed pond enhancements under the SBSPRP are expected to provide adequate habitat, and likely improved habitat values to pond specialists in the region as a whole.

[1] An error in the baseline condition in the CHAP analysis was found involving the assumption that baseline conditions would involve uncontrolled and unrepaired breaching, resulting in similar values for the no project and with project alternatives. We did not correct this error, but do not believe it would change this report's conclusion.

The habitat benefit of the project can also be expressed in terms of its end point contribution to the long term habitat goals to increase tidal emergent marsh. The maximum post-construction total of tidal emergent marsh is estimated from modeling to be 2,783 ac, although the actual amount could be less than this due to formation of tidal channels and a lower SSC than the higher modeled condition (200 mg/L SSC). This habitat would provide a major contribution towards reversal of historical losses of emergent marsh, would benefit an array of wildlife species and native fishes, and would contribute towards the recovery of listed species. The tidal marsh would also contribute to the productivity of the bay through the production of organic matter and forage organisms used by wildlife. Compared to the current managed pond dominance, restoring the majority of the shoreline study area to tidal marsh as proposed would eventually result in less maintenance on refuge lands, allowing the Service to focus its management effort on other needs.

Adaptive Management: The proposed project involves significant uncertainties in how habitat will evolve after breaching, and how different wildlife groups will respond to habitat changes. Key uncertainties in tidal restoration involve: the rate of sediment accretion; the amount of scour of tidal sloughs, outboard marsh and fringe marsh; the associated formation of tidal emergent marsh and use by target species such as the harvest mouse and clapper rail; the productivity of estuarine fish; the extent and controllability of invasive species in restored tidal marsh; the region-wide responses of pond-associated birds to reduction in managed ponds; and any changes in mercury accumulation in the food web. The proposed project shares many of the same goals and objectives as the SBSPRP, and would be subject to the same guiding principles.

The SBSPRP employs two strategies to address the varying wildlife resource needs in the region while achieving restoration goals. These strategies are also applied in the design and implementation of the proposed project. The first strategy is to maintain and enhance a reduced area of managed ponds that can be used by wildlife associated with the ponds which will be converted to marsh. This has already been initiated in the region as part of phase I of the SBSPRP in advance of the proposed project, by enhancing some 477 ac of managed ponds. This will be done in the project area vicinity by retaining Pond A16 and NCM in their current state and by adding gravel to one island in Pond A16 as a compensatory conservation measure to benefit western snowy plover. The second strategy is to use the results of monitoring during the early years of tidal restoration to inform the decision-making process regarding future phases of the project, as well as additional management actions which could be employed to reach restoration targets.

For this project, the Corps has included a set of monitoring actions of key processes as part of the proposed project that can be used to measure early success and guide adaptive management. The physical monitoring includes water levels, sedimentation rates, and SSC. For example, it is hoped that sediment accretion will be sufficient to result in conversion to tidal marsh over the 50-year project life. Modeled rates can vary depending on actual SSC and tidal flows, and observed rates may differ substantially from the model predictions. If sedimentation is too slow to indicate progression towards tidal marsh (or sea level rise is faster than predicted), then the consequences could be examined, and responsive action taken. Potential actions might include importing fill or adding wave breaks to increase accretion, adjusting the project phasing schedule, or reconsideration of the target habitat distribution.

Biological monitoring for this project includes collection of data on coverage of tidal marsh, estuarine fish, invasive vegetation, and early vegetation in the transitional habitat (ecotone). It is less likely that this specific monitoring would have bearing on tidal restoration of later phases because the evolution into tidal marsh can vary and is slower for more deeply subsided sites such as Pond A12.

In addition to the monitoring for the proposed project, the SBSPRP has identified high priority applied study questions, many which would be addressed in association with the recently completed phase I of the SBSPRP (Appendix D *in* USFWS and CDFW 2007). Among these are bird use with changing habitat, effects on non-avian species, mercury effects, and so on. Bay-wide monitoring of wildlife could also be useful in determining whether populations are declining as a result of the project or are redistributing to other locations in the region. Lessons learned from results monitoring restoration efforts throughout the bay are expected to be useful in guiding adaptive management actions within the shoreline project area.

Although marsh evolution and wildlife responses of individual tidal systems cannot be predicted with precision, results of other area work are promising. Early monitoring of other tidal restoration sites under phase I of the SBSPRP indicates significant benefits to fish and wildlife such as an abundance of mysid shrimp and longfin smelt in recently restored Ponds A19-21 (Amato and Valoppi 2015). There are also some effects noted in this early work as well, such as increases in mercury in some ponds and eggs of birds that forage in them. Such effects are being carefully monitored to determine whether they persist or dissipate over time and the best course for management action if needed. Similarly, the use of phasing, monitoring and an adaptive management program for the proposed project are expected to maximize benefits while minimizing the potential for any shortcoming or unforeseen circumstance to become significantly adverse.

CONCLUSION

Based on our evaluation of the effects, uncertainties, and potential benefits of the proposed levee improvement and tidal restoration measures described above for the South San Francisco Bay Shoreline Phase I Study, and considering the restoration performance thus far in phase I of the SBSPRP, we recommend that the preferred alternative 3 be implemented as proposed. No modifications or additional measures have been identified.

RECOMMENDATIONS

We recommend that the Corps:

1. Evaluate measures to maximize the performance of the ecotone. Such measures may include establishing criteria for the physical and chemical properties of fill material. Different fill criteria may be appropriate for the fill within the rooting zone of plants to optimize growth. To promote the desired species of plants, the Corps should consider the use of seed, transplants, or translocated soils from marshes free of invasive species. Interim measures may be needed to suppress unwanted species during the ecotone construction period prior to breaching.

2 Perform pre-planning to identify sources of suitable quality material to raise marsh plain elevations, for possible placement in the event that accretion rates are too low.

3. Consider conducting some pre-construction studies to update baseline information where it is not current. One example might be salt marsh harvest mouse monitoring in the vicinity of the WPCP south alignment where construction is proposed and which has had past captures, but none recently.

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Appendix B8

Endangered Species Act Compliance

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET ST.
SAN FRANCISCO, CALIFORNIA 94103-1399

May 14, 2015

REPLY TO
ATTENTION OF

Planning Branch

Mr. Gary Stern
San Francisco Bay Region Supervisor
National Marine Fisheries Service
777 Sonoma Avenue, Room 325
Santa Rosa, CA 95404

Dear Mr. Stern:

In accordance with section 7(c)(1) of the Endangered Species Act of 1973 (16 U.S. Code 1536[c]), as amended, and section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 104-297), the United States Army Corps of Engineers, San Francisco District (USACE), had previously prepared and submitted to the National Marine Fisheries Service (NMFS) a biological assessment (BA)/essential fish habitat (EFH) assessment evaluating the effects of proposed agency actions associated with the South Bay Shoreline Phase I Study on endangered, threatened, proposed, and candidate species, and designated and proposed critical habitats, designated essential fish habitat (EFH), and EFH-managed species, that are known to occur in the vicinity of the project. The previously drafted BA/EFH assessment was submitted to the NMFS by email on December 15, 2014.

Based on subsequent coordination with NMFS regarding project impacts on Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) Distict Population Segment (DPS) and North American Green Sturgeon southern DPS (*Acipenser medirostris*), USACE has modified our BA/EFH findings regarding project impacts on these species as described below. We now conclude that the proposed South Bay Shoreline Phase I Study project may affect, but is not likely to adversely affect CCC steelhead, green sturgeon, or their critical habitat.

As documented in the enclosed revised BA/EFH assessment, USACE has made the following findings for these species:

Central California Coast (CCC) Steelhead
Proposed construction activities associated with the project are not likely to adversely affect CCC steelhead. The only location where there is any potential for construction activities to affect steelhead is in Artesian Slough. However, steelhead have not been recorded there, there is a low probability that adult steelhead would move up the Slough, and there is the lowest probability of steelhead presence during the time of year in which activities associated with the project will be performed (June 1 to November 30). While construction activities will involve vibratory pile driving, based on the analysis of estimated noise associated with this activity, underwater sound-

pressure levels would not approach injury levels for adult or juvenile salmonids. If coffer dams are used, they will be constructed during low tide at times when water depths are very shallow to prevent entrainment and eliminate the need to relocate fish from isolated areas. Any potential effects related to movement of construction personnel and heavy equipment, increases in turbidity, and chemical leaks and spills associated will be minimized through conservation measures and would be localized and short-term. As a result, adverse impacts to steelhead are not expected to occur from construction.

Excavation of channels in outboard marshes along Artesian Slough could mobilize mercury-laden sediment, but given minimization measures mercury is not expected to result in adverse effects to steelhead. Mercury is present in relatively high concentrations in the slough, but exposure of CCC steelhead to sediments containing legacy mercury will be minimized during the project by a minimal period of disturbance; coordinating sediment disturbance to occur during periods when CCC steelhead are least likely to be in the project area; and the short duration of CCC steelhead presence in the Action Area. Exposure is not likely to result in greater bioaccumulation of mercury than currently exists in the vicinity. Additionally, if herbicides are necessary, the types of herbicides used and their application would be in accordance with methods determined by NMFS to be unlikely to adversely affect salmonids.

Operation of the project after construction is not expected to affect steelhead, given that there is little potential for human disturbance of steelhead resulting from use of the levee trails during project operation.

Finally, while construction activities may have localized, short term impacts on CCC steelhead critical habitat, restoration activities associated with the project are anticipated to have substantial, long-term benefits for steelhead by increasing the quantity and value of their critical habitat. Construction activities may result in degradation of water quality and reductions in forage in Artesian Slough but these would be very localized and short-term. Conversely, tidal restoration in Pond A18 (Led by USACE) and A9-A15 (Led by USFWS) will provide long-term benefits for CCC steelhead by increasing the quality and conservation value of steelhead critical habitat in the South Bay. Combined, these projects will create 2840 acres of new critical habitat providing extensive natural cover in the form of aquatic vegetation, increasing the abundance of invertebrates and prey fish, and likely improving water quality conditions over the long term.

Green Sturgeon

Most of the effects described above for the CCC steelhead and its designated critical habitat also apply to the green sturgeon and its critical habitat. The potential for effects of construction and conservation measures described for steelhead above also apply to green sturgeon. Because green sturgeon are primarily benthic-oriented organisms, and given the lack of any occurrence records in the action area as well as the localized effects of construction activities, the effects on green sturgeon from the proposed project will be minimal. Potential effects of mercury on the green sturgeon would be similar to those described for steelhead above. Due to the even more infrequent occurrence of green sturgeon in the Action Area than salmonids and the brevity of project-related disturbance that could result in mercury mobilization, exposure is not expected to

result in adverse effects on green sturgeon or to result in greater bioaccumulation than currently exists in the vicinity. If herbicides are necessary, the types of herbicides used and their application would be in accordance with methods determined by NMFS to be unlikely to adversely affect salmonids and thus would also be anticipated not to result in adverse effects on green sturgeon. Similarly, there is also little potential for human disturbance of green sturgeon resulting from use of the levee trails during operation of the project after construction.

Construction activities may have the same localized, short term impacts on green sturegon critical habitat as described above for CCC steelhead critical habitat, yet restoration activities associated with the project are anticipated to have substantial, long-term benefits for green sturgeon by increasing the quantity and value of their critical habitat. Construction activities may have minor water quality and prey organism impacts but tidal restoration in Pond A18 (Led by USACE) and A9-A15 (Led by USFWS) will create 2840 acres of new critical habitat. Restoration actions will increase the diversity in depths of aquatic habitats due to scour and restoration of tidal action to large remnant sloughs in managed ponds, thereby creating more deep subtidal habitats used by green sturgeon. Moreover, restoration actions will improve habitat conditions for juvenile rearing by providing a high abundance of benthic invertebrates.

Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions affecting listed species and their critical habitat that are reasonably certain to occur in the action area considered in this biological assessment. The *Integrated Document* for the proposed action (HDR 2014) contains a detailed analysis of past, present, and reasonably foreseeable future projects within the San Francisco Bay area. The most important and relevant of these projects is the South Bay Salt Ponds Restoration Project (SBSPRP). That project will result in the restoration of thousands of acres of high-quality habitat for fish. Sea level rise associated with climate change may also have cumulative effects on species that utilize tidal marshes by reducing tidal marsh area while increasing subtidal habitat. The proposed Phase I Study project is not anticipated to contribute to adverse cumulative impacts on CCC steelhead or green sturgeon, but rather will help to ameliorate adverse effects of other projects on these species.

Based on these revised findings USACE has determined the following:

- The proposed Phase I Study project may affect, but is not likely to adversely affect CCC steelhead and designated critical habitat;

- The proposed Phase I Study project may affect, but is not likely to adversely affect green sturgeon and designated critical habitat;

Given these new determinations, we request that NMFS change the current consultation for these species from formal to informal consultation and provide written concurrence with our not likely to adversely affect determinations.

We further request completion of the EFH consultation as previously requested on December 15, 2014.

If you have any questions, comments, or requests for additional information related to this letter, or the enclosed revisions to the BA/EFH assessment, please contact William DeJager at (415) 503-6866 or at William.R.DeJager@usace.army.mil.

Sincerely,

FOR James L. Howeth Jr.

Thomas R. Kendall, P.E.
Chief, Planning Branch

Anne Morkill
Project Leader
San Francisco Bay National Wildlife
Refuge Complex

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

May 19, 2015 **Refer to NMFS No:** WCR-2014-1850

Thomas R. Kendall, Chief
U.S. Army Corps of Engineers
San Francisco District
1455 Market Street
San Francisco, California 94103-1398

Anne Morkill
Refuge Complex Manager
San Francisco Bay National Wildlife Refuge Complex
U.S. Fish and Wildlife Service
7715 Lakeville Road
Petaluma, California 94954

Re: Endangered Species Act Section 7(a)(2) Concurrence Letter and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the South San Francisco Bay Shoreline Phase 1 Study

Dear Mr. Kendall and Ms. Morkill:

On May 14, 2015, NOAA's National Marine Fisheries Service (NMFS) received your request for written concurrence that the U.S. Army Corps of Engineers' (Corps) and U.S. Fish and Wildlife Service's (USFWS) proposed funding and construction, respectively, of the South San Francisco Bay Shoreline Phase 1 Study in Santa Clara County, California, near the City of Alviso is not likely to adversely affect (NLAA) species listed as threatened or endangered or critical habitats designated under the Endangered Species Act (ESA). This response to your request was prepared by NMFS pursuant to section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402, and agency guidance for preparations of letters of concurrence.

NMFS also reviewed the proposed action for potential effects on essential fish habitat (EFH) designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), including conservation measures and any determination you made regarding the potential effects of the action. This review was pursuant to section 305(b) of the MSA, implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The concurrence letter will be available through NMFS' Public Consultation Tracking System (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts).[1] A complete record of this consultation is on file at NMFS North Central Coast Office, Santa Rosa, California.

Proposed Action and Action Area

The Corps is conducting a flood risk management (FRM) and ecosystem restoration study for the South San Francisco Bay shoreline. Phase I of the study, known as the South Bay Shoreline Phase I Study (proposed project), involves increasing the height and width of certain levees in the Alviso area in northern Santa Clara County, California, and breaching of other levees to restore tidal habitats in existing managed ponds. The proposed project's "Study Area" is bounded on the southwest by Alviso Slough; on the north by Coyote Slough, Ponds A16 and A17, the "Island Ponds" (Ponds A19, A20, and A21), and the Newby Island Landfill; on the east by the Coyote Creek levee; and on the south by State Route (SR) 237.

The proposed project consists of two main sets of actions:

1. Corps-led actions: these include flood risk management levee improvements and public access improvements funded by the Corps and Santa Clara Valley Water District (SCVWD), which will occur on Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) lands and lands of the City of San Jose, as well as tidal restoration actions on City of San Jose lands;

2. USFWS-led actions: these include tidal restoration and public access improvements proposed by the USFWS and SCVWD on Refuge lands.

The Study Area is at risk of tidal flooding due to having large areas of low-lying terrain that are bordered by pond levees originally designed and constructed for commercial salt pond purposes rather than for FRM. The proposed project will address this flooding risk by raising the heights of levees in key areas.

Ecosystem restoration and FRM issues are inseparable in the Study Area because opening up ponds to tidal action changes the hydraulic behavior of the ponds under both normal and high water conditions. Tidal restoration will alter both ecosystem conditions and potential flood risk to the surrounding areas. Engineered levees are necessary to replace the existing non-engineered pond levees, which were not intended to provide any FRM in order to address the potential change in flood risk.

[1] Once on the PCTS homepage, use the following PCTS tracking number within the Quick Search column: WCR-2014-1850

Corps-led Actions

Flood Protection Actions

The Corps will construct 3.7 miles of new levee from the Alviso Marina northeastward to the northwestern corner of the San Jose/Santa Clara Water Pollution Control Plant (WPCP). The levee, which would provide FRM assuming a one percent Annual Chance of Exceedance, consists of the following three components:

1. The Alviso Segment consists of 1.7 miles of new levee construction, which is located entirely on Refuge lands, and will provide FRM for the community of Alviso. This levee segment follows the eastern border of Pond A12 and the southern border of Pond A16.

2. The Artesian Slough crossing will entail construction of a new tide gate across the slough to protect the WPCP from storm waters flooding the slough and backing up into the facility during extreme storm events. The proposed location of the tide gate will be at least 300 feet bayward of the existing WPCP outfall for treated water at Artesian Slough (the location shown in the Biological Assessment is approximate, and the actual location may be farther upstream along Artesian Slough). The gates will only be closed during extreme storm events. When the gates are closed, the WPCP will need to pump water outputs over the gate, or provide for internal excess water storage during a storm event. With or without the proposed project, the WPCP will develop a plan to pump or store waters during such events given increases in Bay water levels that correspond with future sea level rise scenarios.

3. The WPCP Segment consists of 2 miles of new levee construction, which is located on City of San Jose lands, and will provide FRM to the WPCP. It runs west to east in a stair-step pattern along the southern border of Pond A18, from the southwest corner of the pond to its northeast corner.

The engineered levee will be earthen. The proposed change in levee size from the existing levee (*e.g.*, along the southern edge of Pond A16) will be an increase of up to approximately 10 feet in height (after settlement) and about double in existing width. The average width at the crown of the levee will be 16 feet, with 3:1 (horizontal: vertical) slopes except where ecotones having a 30:1 slope will be constructed. Along the east edge of Pond A12, the Alviso Segment levee will have an additional 345-foot-wide ecotone along its west side.

The levee design will include vegetation as erosion protection on the bayward and landward side slopes. The vegetation that will be seeded or planted on the levee following construction will consist of marsh vegetation and peripheral halophytes at the toes of the levee and upland grasses at higher elevations. Where the FRM levee will cross the active railroad line just east of Pond A12, railroad floodgates will be installed. Concrete barriers will be installed on either side of the railroad right-of-way and will tie into the earthen levees. The metal floodgates will be connected to the barrier and will remain open during normal conditions and closed during flood conditions. Other materials such as geotextile fabric, stone column, foundation over-excavation, or replacement with stronger soil may also need to be included in the final FRM levee design.

Fill for the FRM levee will be imported from local sources and delivered by truck. Dredge material originating from areas outside the proposed project area that is used for ditch blocks, or for portions of the ecotone and FRM levee that will be in contact with tidal waters, will need to meet the contaminants screening criteria as described in the Biological Assessment (HTH 2014).

The timing and duration of construction will be governed by both weather conditions and the need to avoid construction in sensitive areas during certain times of the year to avoid and minimize impacts to listed species. Types of construction equipment may include excavators, belly scrapers, front-end loaders, bulldozers, forklifts, vibratory rollers, dump trucks, and water trucks. Ancillary types of equipment that may be used include diesel generators, water pumps, and pile drivers. It is anticipated that dewatering and temporary installation of sheet piling will be necessary during the construction of water control structures such as tide gates. Dredge-locks or coffer dams may be constructed using earth levees or sheet piling to allow access for water-based equipment within a site. When possible, amphibious excavators, vibratory pile drivers, and other less-impacting equipment will be used.

Ecosystem Restoration Actions

The ecosystem restoration strategy to be implemented by the Corps is the conversion of Pond A18, which is currently managed for migratory waterbirds, into vegetated tidal wetlands with goals of maximizing long-term habitat benefits, particularly in consideration of potential sea level rise. Breaching of Pond A18 will restore approximately 736 acres of new tidal habitat (in addition to the upland transitional habitat discussed below). Ecosystem restoration also includes creation of a broad, gently sloping ecotone. In order to convert Pond A18 to tidal marsh it will be drained. This will occur passively, which may take several months, or water may be pumped out to expedite the process. Upland transitional habitat, ditch blocks, and pilot channels will be constructed to facilitate natural tidal flow within the pond. Ditch blocks inhibit flow through existing borrow ditches, promote scour and flow through the remnant historical channels, and provide some initial pickleweed habitat where located at the correct elevations. Three pilot channels will be constructed on the outboard side of Pond A18, two along Artesian Slough, and one will be constructed along South Coyote Slough. These pilot channels will be constructed at the locations of major historical tidal channels. The outboard levee will be breached in four locations along Artesian Slough and one location along South Coyote Slough. Breach size will be determined based on the hydrologic relationship between the tidal channel and marsh drainage area and on data from tidal channels in mature marshes throughout the Bay (ESA and Philip Williams & Associates, Ltd. 2012). Breaches are sized to long-term equilibrium dimensions to balance between excavation costs, scour potential, and tidal drainage consistent with Design Guidelines for Tidal Wetland Restoration in San Francisco Bay (Philip Williams & Associates, Ltd. and Faber 2004). Dimensions are adjusted to provide a cross-section with side slopes of 4:1 to 5:1 and a bottom width of approximately 10 feet. On the inboard side of the levee, the breach excavation will extend to the levee toe. The Pond A18 transitional habitat will be constructed simultaneously with levee construction.

When Pond A18 is breached, its bottom elevation will be too low for vegetated marshes to form immediately. Several feet of sediment will need to be deposited by natural processes before the pond bottom reaches a sufficient elevation for marsh vegetation to grow. This sedimentation process is expected to proceed at rates determined in part by suspended solids concentrations as

well as by factors causing re-suspension of sediment, such as wave action and tidal currents, in the breached pond (ESA and Philip Williams & Associates, Ltd. 2012). Because these factors cannot currently be predicted, it is not known how quickly vegetated marsh will form in Pond A18.

Monitoring of the restoration process, and adaptive management if necessary to achieve vegetated tidal marsh, will occur per the Shoreline Study Monitoring and Adaptive Management Plan (MAMP). Once tidal marshes have begun to form in the former ponds, the rate of sedimentation will increase as the vegetation slows the water, catches sediment, and retains it. Eventually, with sufficient sediment, it is expected that Pond A18 will be largely vegetated, aside from tidal channels.

USFWS-led Actions

Ecosystem Restoration Actions

USFWS-led ecosystem restoration activities will involve tidal restoration of up to 2,010 acres in Ponds A9-A15, and ecotone construction along the eastern edge of Pond A12, similar to those described above for Pond A18. However, there is an additional activity that will occur in Ponds A9-A15 that will not be necessary in Pond A18 because A18 has no internal berms. For restoration of Ponds A9-A15, breaches in the internal berms will be necessary to reconnect historical channels and restore the hydrologic connections to the innermost ponds in the proposed project footprint. Breach excavations will be sized in a similar manner to those applied to the outboard levees and will extend beyond the levee into the remnant historical channels. Existing internal berms may be lowered in some areas during the breach excavation to create wave breaks to limit wave action, enhance sedimentation, and create vegetated marsh habitat on the berm crests in the short term while the ponds develop from mudflat to vegetated marsh. As Ponds A9-A15 are breached in a phased manner, berms in adjacent ponds not yet being breached will be temporarily raised to provide increased FRM inboard of the current pond breaching actions.

Pond A12 has experienced the greatest degree of subsidence and is proposed for the first phase of restoration (though see above for a discussion of the possibility that Pond A18 may be breached first). By limiting new tidal exchange to this pond (rather than breaching multiple ponds in the first phase), Pond A12 can undergo maximum tidal interaction and sediment deposition, thus helping to raise its bottom elevation to a point where colonization by marsh vegetation will occur. During the first three years (2017–2019), Pond A12 will be prepared for breaching and inundation through excavation of pilot channels in two locations along Alviso Slough and construction of borrow ditch blocks. Berms between Pond A12 and Ponds A11 and A13 will be temporarily (i.e., until tidal restoration in A11 and A13) raised to provide flood protection for A11 and A13. Surplus material excavated from pond preparation will be used to contribute to other in-pond construction activities requiring material, such as raising of internal levees, if determined suitable by Refuge staff. Subsequently, levee breaches will be implemented in Pond A12 to introduce tidal flow.

Following restoration of tidal flow to Pond A12, monitoring will be conducted to measure the effectiveness of tidal function equilibrium and restorative values. If necessary, corrective measures will be implemented. A period of approximately four years has been established for MAM associated with Pond A12.

Pond preparation for Ponds A9, A10, A11, and A18 would potentially be implemented based on the lessons learned as a result of monitoring and adaptive management conducted for Pond A18, including whether to breach these ponds and restore them to tidal marsh. This decision will be made according to the MAMP, which includes a series of decisions (based on those in the SBSPRP MAMP) regarding whether to continue breaching that involve monitoring of populations of pond-associated birds, monitoring of sediment accretion in the South Bay, and other factors. If the decision is made to breach these ponds, borrow ditch blocks and pilot channels will be constructed. Pond A11 will be connected to Ponds A10 and A12 with inboard berm breaches, but it will not be breached directly to Alviso Slough. Two breaches to Alviso Slough are planned in Pond A10, and one breach each to Alviso Slough and Coyote Slough are planned for Pond A9. Internal berms between Ponds A9-A11 and Ponds A13-A14 will be temporarily (i.e., until tidal restoration in A13 and A14) raised to provide flood protection for A13 and A14. Levee breaches for Ponds A9-A11 will be implemented in Year 8 (2025) of the proposed project.

Pond preparation for Ponds A13, A14, and A15 will potentially be implemented based on the lessons learned as a result of MAM conducted for previous ponds, including whether to breach these ponds and restore them to tidal marsh. If the decision is made to breach these ponds, borrow ditch blocks and a pilot channel will be constructed. Only one outboard breach will occur for tidal restoration in these three ponds; this breach will connect Pond A15 to Coyote Slough along a major historical channel. Inboard berm breaches at the locations of historical sloughs will connect Ponds A13 and A14 to surrounding ponds (A9, A11, A15, and A12) to provide tidal flows to A13 and A14. Levee breaches will be implemented in Year 13 (2030) of the proposed project.

Ecotone (low marsh, middle marsh, and wetland/upland transitional habitat) habitat will be created along approximately 4,000 linear feet of levee on the east side of Pond A12. Approximately 30 acres of new upland transitional habitat will be created in this area. Following construction of the ecotone area, it will be seeded with native grasses, forbs, and low shrubs.

Following the breaching of levees around Pond A18 and Ponds A9-A15, the only management activities that might occur within the restored tidal habitats are predator management and, if necessary, invasive plant management, both of which would be performed on an as-needed basis. Invasive plant management will be needed for the first few years following construction of the ecotone to ensure that perennial pepperweed and other invasives do not become dominant. Otherwise, invasive plant management would be performed if monitoring indicates that particularly invasive species colonize the newly restored ponds in a way that would jeopardize the habitat enhancements achieved through tidal restoration. The non-Federal sponsors (the CSCC, SCVWD, and City of San Jose) will be responsible for the operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of the Pond A18 tidal restoration and ecotone, as well as the entire levee adjacent to Pond A18 and on Refuge property). An OMRR&R Manual will be prepared to describe these activities.

Recreation Actions

Multi-use trails on top of the new FRM levee, with connections to the Bay Trail network, along with viewing platforms, and trail upgrades to be made to an existing segment of the Bay Trail system along SR 237. A pedestrian bridge over Artesian Slough will be constructed to link the

multi-use trails on top of the new FRM levee. The bridge would span the slough atop sets of four parallel piles spaced every 50 feet. This would result in the installation of a total of forty 12-inch-thick steel piles that would form the pedestrian bridge piers. A barge-mounted pile driver/crane or an in-water excavator with a vibratory hammer would be used to drive the 12-inch-thick steel piles. In addition, the proposed project will construct a trail segment along the north side of SR 237 between the Guadalupe River and Zanker Road (see Figure 18 in the Biological Assessment [HTH 2014]).

Construction of the recreation and public access components may consist of grading and, for all-weather trails, gravel application. Equipment required for trail construction may include small, Bobcat-sized equipment, backhoes or front-end loaders, graders, bulldozers, asphalt placement equipment, and dump trucks. Interpretive stations of varying size and scope and viewing platforms will also be constructed. Viewing platforms will be made of wood, metal, or plastic material and assembled in-place using a backhoe or excavator and hand tools. Interpretive stations will be built on-site, or will be prefabricated structures. Assembly and installation will require a backhoe or excavator and hand tools.

Avoidance and Minimization Measures

The Corps and USFWS propose the following measures to protect listed fish and the aquatic environment:

1. Construction activities in, or directly adjacent to, waters where CCC steelhead and longfin smelt are likely to be present will be performed between June 1 and November 30.

2. Levee breaching will not occur between February 1 and May 31 for the protection of out-migrating juvenile steelhead in, or directly adjacent to, waters where steelhead are likely to be present.

3. Activities that extend into the waters where listed fish and fish species managed according to Fisheries Management Plans may be present, such as pilot channel excavation, will be performed at low tide and/or under de-watered conditions.

4. Cofferdams will be used during construction and maintenance activities, as well as during implementation of any adaptive management actions, that could potentially result in substantial siltation of protected fish habitat.

5. All pumps used for dewatering where salmonids may be present will be screened according to NMFS and CDFW criteria for juvenile salmonids.

6. During tide gate construction on Artesian Slough, all pile driving will be performed using a vibratory hammer to minimize the potential effects of noise and pressure-waves on fish.

7. NMFS personnel will be immediately notified of any observed fish mortality events.

8. Tidally restored ponds will contain channels that are adequate for the ingress and egress of fish with tidal circulation. Inspections will be documented in a record that is available for review on request.

9. Treated wood will not be used in structures that may come into contact with water.

There are no interrelated or interdependent activities associated with the proposed action.

The action area includes the construction footprints for FRM and recreational access activities; the entirety of Ponds A9 through A15 and A18; portions of Pond A16 adjacent to the proposed project footprint; the northern and western boundaries of New Chicago Marsh; areas on the outboard (bayward) sides of those ponds where pilot channel excavation will occur; all staging, stockpiling, and access areas; the portions of Alviso Slough, Coyote Slough, South Coyote Slough, and Artesian Slough downstream from proposed levee breaches that may be subject to additional scour from increased tidal prism or temporarily increased sedimentation during construction; and areas surrounding the construction footprint.

Action Agency's Effects Determination

The Corps and USFWS have determined that the proposed project is not likely to adversely affect ESA-listed fish and designated critical habitat, and has requested NMFS' concurrence with this determination. The Corps and USFWS's finding of NLAA is based on the proposed measures to protect listed fish and the aquatic environment.

Available information indicates the following listed species (Distinct Population Segments [DPS] and Evolutionary Significant Units [ESU]) and critical habitat under the jurisdiction of NMFS may be affected by the proposed project:

Central California Coast steelhead (*Oncorhynchus mykiss*) **DPS**
Threatened (71 FR 834; January 5, 2006)
Critical habitat (70 FR 52488; September 2, 2005); and

North American Green Sturgeon southern DPS (*Acipenser medirostris*)
Threatened (71 FR 17757; April 7, 2006)
Critical Habitat (74 FR 52300; October 9, 2009).

The life history of steelhead is summarized in Busby *et al.* (1996). Alviso Slough and Coyote Slough represent the lower tidal portions of the Guadalupe River and Coyote Creek systems, respectively. Central California Coast (CCC) steelhead spawn and rear in the Guadalupe River and Coyote Creek watersheds upstream from the action area. Juvenile CCC steelhead seasonally occur in the action area during their downstream migration from these watersheds during the months of February to May. Adult CCC steelhead migrate into the Guadalupe River and Coyote Creek to reach their natal streams for spawning primarily between the months of December and March, peaking in January and February.

The life history of green sturgeon in California is summarized in Adams et al. (2002) and NMFS (2005). The southern DPS of North American green sturgeon spawn in the deep turbulent sections of the upper reaches of the Sacramento River. As juvenile green sturgeon age, they migrate downstream and live in the lower delta and bays, spending from three to four years there before entering the ocean. Adult green sturgeon return from the ocean every few years to spawn, and generally show fidelity to their upper Sacramento River spawning sites. Green sturgeon appear to be relatively rare in the South Bay. Acoustic tag receivers placed in the main channel of Coyote Slough, at the confluence of Coyote and Alviso Sloughs, and in recently breached salt ponds in the Alviso area (Ponds A19 and A21 at the Island Ponds and Pond A6), detected no green sturgeon in those areas. However, given that green sturgeon are known to occur in estuaries away from spawning streams, individuals (particularly juveniles) could occasionally forage in tidal portions of the action area, such as in Alviso Slough, Coyote Slough, and Artesian Slough. Following breaching of ponds for tidal restoration, they could also potentially forage in the larger sloughs in restored tidal marshes.

The Corps and USFWS have determined that the proposed project would not have a substantial adverse impact on EFH. This finding is based on the project's avoidance and minimization measures. The project area is located within an area identified as EFH for various life stages of fish species managed through the Pacific Coast Salmon FMP, the Pacific Groundfish FMP, and the Coastal Pelagic FMP. The project area is also within an area designated as Habitat Areas of Particular Concern (HAPC) for various federally-managed fish species within the Pacific Groundfish FMP. HAPC are described in the regulations as subsets of EFH that are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. Designated HAPC are not afforded any additional regulatory protection under MSA; however, federal projects with potential adverse impacts to HAPC are more carefully scrutinized during the consultation process. As defined in the Pacific Groundfish FMP, San Francisco Bay, including the project area, is identified as estuary HAPC.

Consultation History

By letter dated December 11, 2014, the Corps and USFWS requested formal consultation for the proposed project. Corps, USFWS, NMFS, and the California State Coastal Conservancy (CSCC) representatives attended a site visit on January 23, 2015. A conference call with representatives of the Corps, USFWS, NMFS, and the CSCC was held on April 23, 2015, to clarify the effects of the proposed action and the consultation schedule. During this conference call, NMFS explained that their review of the project suggests construction activities may be conducted without adverse effects to listed fish or designated critical habitat if the proposed minimization measures were slightly modified. NMFS suggested the Corps and USFWS modify the minimization measures and reconsider their finding of "adverse effects" to NMFS-listed species. By letter dated May 14, 2015, the Corps and USFWS transmitted their revised determination that the proposed project is not likely to adversely affect ESA-listed fish and designated critical habitat, and requested NMFS' concurrence with this determination.

ENDANGERED SPECIES ACT

Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

The effects of construction of the FRM levee, tide gate, and pedestrian bridge, as well as restoration-related activities such as pilot channel construction, breaching, and scour from increased tidal prism are reasonably likely to include degradation of water quality, disturbance of benthic habitat, and elevated sound levels during construction and breaching activities. Internal pond improvements and recreational activities (i.e., use of recreational trails) will occur within diked areas isolated from tidal waters or on top of levees, respectively. Therefore, these activities will have no effect on steelhead and green sturgeon.

Construction of FRM levee, tide gate, and pedestrian bridge, as well as restoration-related activities such as pilot channel construction, breaching, and scour from increased tidal prism may result in temporary increases in turbidity. During these activities disturbance of the bottom substrate will likely result in suspension of sediment in the adjacent water column. In areas with a direct connection to tidal waters of San Francisco Bay, the Corps and USFWS will perform construction activities between June 1 and November 30, and limit these activities to periods of low tide when work sites are dry or very shallow. If the timing of tides does not allow the work to be done in dry conditions, a coffer dam will be installed at low tide to protect tidal waters from entering the work sites. Adequate water depths and carrying capacity in adjacent Bay waters will provide sufficient area for fish to disperse and disturbance associated with construction should not result in more than an insignificant effect on them. With these measures, NMFS anticipates turbidity will be localized, minor and temporary. Increased levels of turbidity and suspended sediment can affect listed fish species by disrupting normal feeding behavior, reducing growth rates, increasing stress levels, and reducing respiratory functions. However, increased levels of turbidity in the action area associated with implementation of this project are expected to be minor, localized and very short term. Steelhead are very unlikely to be present during the June 1 to November 30 in-water construction timeframe, and are therefore not expected to be exposed to increases in turbidity related to construction activities. Green sturgeon are expected to be tolerant of levels of turbidity that exceed levels expected to result from this project. For these reasons, the potential effects of minor and localized areas of elevated turbidity within this project's construction activities are expected to be insignificant to green sturgeon and steelhead.

Construction and restoration activities that are expected to disturb the substrate and result in increases in turbidity are likely to also result in re-suspension of sediment-borne contaminants. Mobilization and transport of suspended sediments from these activities make their adsorbed

contaminants available to fish. Sediment within the action area may contain high concentrations of mercury. High concentrations of mercury in the water column and sediments can alter fish behavior and affect sensory systems involved in growth, reproduction, and survival (Eisler 2000). It can also affect prey sources through contamination or reduced availability. As described above, the Corps and USFWS have proposed several measures to reduce exposure of green sturgeon and steelhead to increases in turbidity and mercury. With these measures, NMFS anticipates mercury exposure will be less than the thresholds commonly cited as the cause of these possible behavioral and physical impacts. Re-suspension of sediment-borne mercury associated with project construction is expected to be insignificant to green sturgeon and steelhead.

The installation of forty 12-inch diameter steel piles for the pedestrian bridge with a vibratory hammer may affect listed fish through exposure to high underwater sound levels. Available information indicates that fish may be injured or killed when exposed to very high levels of elevated underwater sound pressure waves generated from use of impact hammers to install piles. However, vibratory hammers generate lower sound levels and different sound wave forms that are less injurious than impact hammers. The use of a vibratory hammer by this project is expected to avoid generation of underwater sound levels that are harmful to fish, so elevated sound levels during construction will not result in the injury or mortality of listed fish. Additionally, the Corps and USFWS propose to restrict in-water pile driving to the period between June 1 and November 30. Because of the included work window, ESA-listed steelhead are very unlikely to be present in the project's action area when in-water pile driving is occurring. If listed fish are present during use of the vibratory hammer, they may react behaviorally to elevated underwater sound levels and temporarily vacate the project action area during construction. Adequate water depths and carrying capacity in open water areas adjacent to the project site will provide startled fish sufficient area to disperse and these elevated sound levels should not result in more than an insignificant behavioral effect on green sturgeon and steelhead.

Perennial pepperweed control at restored sites will necessitate the use of glyohosate and/or imazapyr-based aquatic herbicides. Glyphosate and imazapyr-based herbicides are highly soluble in water. The USFWS and Corps propose the following general conservation measures related to herbicide application:

a. Herbicides will be applied by a certified applicator and in accordance with application guidelines and the manufacturer label.

b. Herbicide applications would be timed to coincide with ebbing tides to protect non-target vegetation, to allow a minimum of six hours dry time for glyphosate/imazapyr mixture applications, and at least one-hour dry time for imazapyr applications.

c. Herbicides will be applied directly to perennial pepperweed plants and at low or receding tide to minimize the potential application of herbicide directly on the water surface.

d. All certified applicators will be trained to correctly identify perennial pepperweed, to distinguish this species from native species in the action area.

Implementation of these conservation measures are expected to reduce the potential for green sturgeon and steelhead to be exposed to glyphosate or imazapyr at concentrations known to be harmful to fish. Since these herbicides are considered relatively non-toxic to fish and do not bioaccumulate in the tissues of aquatic organisms (Gardener and Grue 1996; Giesy et al. 2000), NMFS does not expect any listed fish mortality, changes in growth rates, reduction of reproductive success or detectable effects on designated critical habitat in the action area associated with the application of these herbicides. For these reasons, the potential effects of vegetation removal with herbicides are expected to be insignificant.

The action area is located within designated critical habitat for CCC steelhead and the southern DPS of green sturgeon. Primary constituent elements (PCEs) of designated critical habitat for CCC steelhead include estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- 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 PCEs of designated critical habitat for the southern DPS of green sturgeon in estuarine areas include food resources, water flow, water quality, migratory corridor, water depth, and sediment quality. PCEs include sites essential to support one or more life stages of the species. These sites in turn contain physical and biological features that are essential to the conservation of the species.

During construction, critical habitat will be temporarily affected by minor increases in turbidity and disturbance of benthic habitat. As discussed above, water quality effects in the form of increased turbidity are expected to be temporary and insignificant. Construction activities are expected to disturb bottom sediments and the associated benthic community in the action area. This disturbance could result in the temporary loss of benthic invertebrates. However, impacts to the benthic community are expected to be temporary and localized. Once completed, the project is expected to benefit designated critical habitat by creating 2,840 acres of new tidal marshland foraging areas for threatened green sturgeon and steelhead in South San Francisco Bay.

Conclusion

Based on this analysis, NMFS concurs with Corps and USFWS that the proposed action is not likely to adversely affect the subject listed species and designated critical habitats.

Reinitiation of Consultation

Reinitiation of consultation is required and shall be requested by the Corps, USFWS, or by NMFS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and (1) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (2) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this concurrence letter; or if (3) a new species is listed or critical habitat designated that may be affected by the identified action (50 CFR 402.16). This concludes the ESA portion of this consultation.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

Under the MSA, this consultation is intended to promote the protection, conservation and enhancement of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the associated physical, chemical, and biological properties that are used by fish (50 CFR 600.10), and "adverse effect" means any impact which reduces either the quality or quantity of EFH (50 CFR 600.910(a)). Adverse effects may include direct, indirect, site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

Based on information provided by the Corps and USFWS, the proposed action may result in localized and temporary degradation of water quality, disturbance of the benthic habitat, and temporary increases in noise during pile installation and construction. Therefore, NMFS has determined the proposed action would adversely affect EFH. However, adverse effects are localized, temporary and minimal in nature. Furthermore, the proposed action will benefit EFH after completion by restoring tidal connectivity and creating 2,840 acres of tidal marsh along South San Francisco Bay. Therefore, NMFS has no practical EFH Conservation Recommendations to provide to avoid or reduce the magnitude of these effects.

USFWS or the Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH (50 CFR 600. 920(l)). This concludes the MSA portion of this consultation.

Please direct questions regarding this letter to Amanda Morrison, North Central Coast Office in Santa Rosa, California at (707) 575-6083, or via e-mail at Amanda.morrison@noaa.gov.

Sincerely,

for

William W. Stelle, Jr.
Regional Administrator

cc: William DeJager, Corps San Francisco District, San Francisco, CA
Anne Morkill, USFWS National Wildlife Refuges, Petaluma, CA
Copy to ARN File # 151422WCR2014SR00303
Copy to Chron File

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
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Sacramento, California 95825-1846

In Reply Refer to:
08ESMF00-
2012-F-0450-2

APR 2 7 2015

Mr. Thomas R. Kendall
Department of the Army
San Francisco District
U.S. Army Corps of Engineers
1455 Market Street
San Francisco, California 94103-1398

Subject: Biological Opinion on the South San Francisco Bay (South Bay) Shoreline Phase 1 Study in Santa Clara County, California

Dear Mr. Kendall:

This letter is in response to your December 11, 2014, request for formal consultation for the proposed South Bay Shoreline Phase 1 Study (proposed project) in Santa Clara County, California. Your request for consultation was received in our office on December 22, 2014. The proposed project involves flood risk management, levee construction, upland transitional habitat (ecotone) berm construction along Ponds A12 and A18, tidal marsh restoration in Ponds A9-A15 and Pond A18, trail construction, and operation and maintenance activities on lands owned and managed by the City of San Jose and the U.S. Fish and Wildlife Service's (Service) Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) in the South Bay. The U.S. Army Corps of Engineers (Corps) and the Service are each requesting the initiation of consultation for the Corps-led actions and Service-led actions of the proposed project, respectively. Your letter requested consultation on the endangered California clapper rail (*Rallus longirostris obsoletus*), endangered salt marsh harvest mouse (*Reithrodontomys raviventris*), threatened Pacific coast population of the western snowy plover (*Charadrius alexandrinus nivosus*), and endangered California least tern (*Sternula antillarum browni*). Critical habitat has been designated for the Pacific coast population of the western snowy plover but does not occur within the action area for the proposed project. This document is issued under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

This document represents the Service's biological opinion on the effects of the proposed project on the California clapper rail, salt marsh harvest mouse, Pacific Coast population of the western snowy plover, and California least tern. The same biological opinion is being submitted to the Service. Currently the biological opinion is to both the Corps and the Service because the Corps is not authorized to expend funds on ecosystem restoration on lands controlled by another Federal agency, but it can expend funds on flood control on such lands. However, it is a possibility that the Corps may implement the entire action and, therefore, all aspects of the proposed project will be

implemented by the Corps except those that were addressed in the South Bay Salt Pond Restoration Project (SBSPRP) Phase 1 Actions (Service file number 81420-F-08-0621-1, Service 2008).

The following sources of information were used to develop this biological opinion: (1) your letter requesting consultation on the proposed project dated December 11, 2014; (2) the November 2014 *Draft South San Francisco Bay Shoreline Phase 1 Biological Assessment for the Salt Marsh Harvest Mouse, California Ridgway's Rail, Western Snowy Plover, California Least Tern, Central California Coast Steelhead, Green Sturgeon, and Longfin Smelt and Essential Fish Habitat Assessment* (Biological Assessment) (H.T. Harvey & Associates (HTH) 2014); (3) the August 2008 *Formal Endangered Species Consultation on the South Bay Salt Pond Restoration Project Long-term Plan and the Project-level Phase 1 Actions, Alameda, Santa Clara, and San Mateo Counties, California* (Programmatic Biological Opinion) (Service file number 81420-F-08-0621-1, Service 2008); (4) electronic mail and conversations among the Corps, the Refuge, HTH, California State Coastal Conservancy (CSCC), San Francisco Bay Conservation and Development Commission (BCDC), Santa Clara Valley Water District (SCVWD), the City of San Jose, California Department of Fish and Wildlife (CDFW), the National Oceanic and Atmospheric Administration/National Marine Fisheries Service (NMFS), and the Service; and (5) other information available to the Service.

CONSULTATION HISTORY

August 12, 2008	The Service issued the Programmatic Biological Opinion for the SBSPRP Phase 1 Actions (Service file number 81420-F-08-0621-1, Service 2008).
2008 – 2014	The Service continued coordination with the Corps, the Refuge, HTH, CSCC, BCDC, SCVWD, the City of San Jose, and CDFW on the SBSPRP and the proposed project.
October 15, 2014	The Service received via electronic mail from the Corps, the Refuge, and CSCC the October 2014 Draft Biological Assessment for the proposed project.
October 17, 2014	The Service provided via electronic mail comments on the October 2014 Draft Biological Assessment for the proposed project to the Corps, the Refuge, HTH, CSCC, SCVWD, and the City of San Jose.
October 28, 2014	The Service participated in a conference call among the Corps, the Refuge, HTH, CSCC, SCVWD, and the City of San Jose discussing the Service's comments on the Draft Biological Assessment for the proposed project.
November 17, 2014	The Service received via electronic mail from the Refuge and the Corps the revised Biological Assessment for the proposed project (HTH 2014).
December 22, 2014	The Service received from the Corps and the Refuge the letter requesting the initiation of formal consultation on the proposed project.
April 9, 2015	The Service submitted the draft biological opinion for the proposed project at the request of the Corps.

April 17, 2015 The Service received via electronic mail from the Corps comments on the draft biological opinion for the proposed project.

BIOLOGICAL OPINION

Description of the Proposed Project

Background

The Corps is conducting a flood risk management and ecosystem restoration study for the South Bay shoreline. Phase I of the study, known as the South Bay Shoreline Phase I Study (proposed project), involves increasing the height and width of certain levees in the Alviso area in northern Santa Clara County, California, and breaching of other levees to restore tidal habitats in existing managed ponds. The proposed project's "Study Area" (Figure 1) is bounded on the southwest by Alviso Slough; on the north by Coyote Slough, Ponds A16 and A17, the "Island Ponds" (Ponds A19, A20, and A21), and the Newby Island Landfill; on the east by the Coyote Creek levee; and on the south by State Route (SR) 237.

The proposed project consists of two main sets of actions:

1. Corps-led actions: these include flood risk management levee improvements and public access improvements funded by the Corps and SCVWD, which will occur on Refuge lands and lands of the City of San Jose, as well as tidal restoration actions on City of San Jose lands;

2. Service-led actions: these include tidal restoration and public access improvements proposed by the Service and SCVWD on Refuge lands.

Proposed project activities on Refuge lands were included in the intra-Service Programmatic Biological Opinion for the SBSPRP, which addressed flood control, public access, and habitat restoration and management (Service file number 81420-F-08-0621-1, Service 2008). As a result, the intra-Service consultation for the South Bay Shoreline Phase I Study Project will tier off the programmatic consultation for the SBSPRP. However, portions of the South Bay Shoreline Phase I Study Project on City of San Jose lands were not included in the action area for the Programmatic Biological Opinion. Also, the Programmatic Biological Opinion did not cover effects to the longfin smelt which is currently a candidate for Federal listing but was not in 2008.

Flood Risk Management (FRM)

The Study Area is at risk of tidal flooding due to having large areas of low-lying terrain that are bordered by pond levees originally designed and constructed for commercial salt pond purposes rather than for FRM. The proposed project will address this flooding risk by raising the heights of levees in key areas.

Ecosystem Restoration

Ecosystem restoration and FRM issues are inseparable in the Study Area because opening up ponds to tidal action changes the hydraulic behavior of the ponds under both normal and high-water

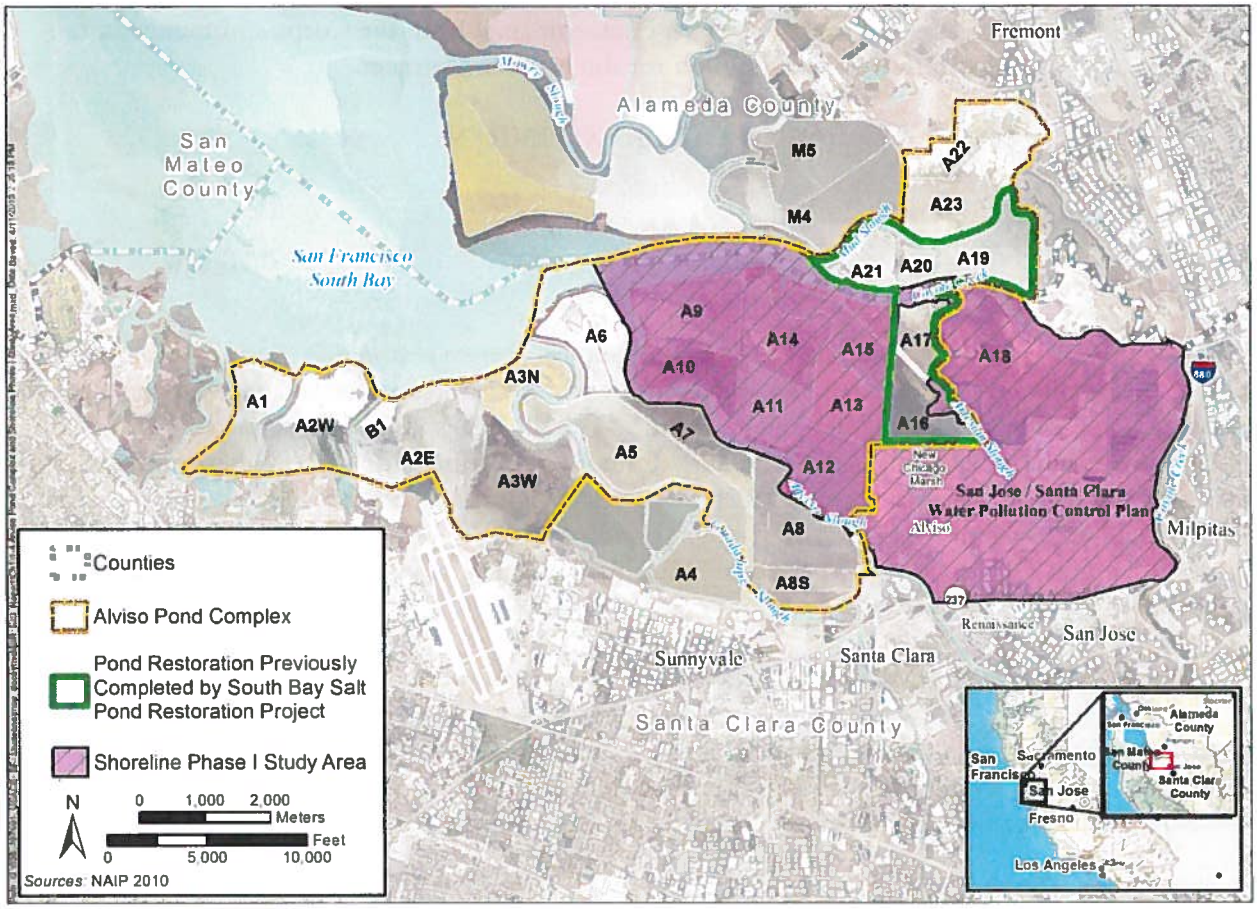

Figure 1. Map of the SBSPRP Phase 1 Actions and the Study Area for the South Bay Shoreline Phase I Study Project.

conditions. Tidal restoration will alter both ecosystem conditions and potential flood risk to the surrounding areas. Engineered levees are necessary to replace the existing non-engineered pond levees, which were not intended to provide any FRM in order to address the potential change in flood risk.

Tidal salt marshes are in dynamic equilibrium with water levels in San Francisco Bay (Bay) and can keep pace with rising sea levels through accretion of sediment if restoration activities begin soon, based on current and projected sediment availability. In addition, a vegetated marsh plain can slow down tidal surge velocity and reduce wave heights as they traverse the marsh surface. Therefore, having an established marsh in front of FRM infrastructure would increase the resiliency of the shoreline relative to the projected impacts of sea level rise (HDR 2014).

Project Components

Overview

Figures 2 and 3 below depict the portions of the Study Area where long-term physical changes are expected to occur as a result of proposed project activities led by the Corps and the Service,

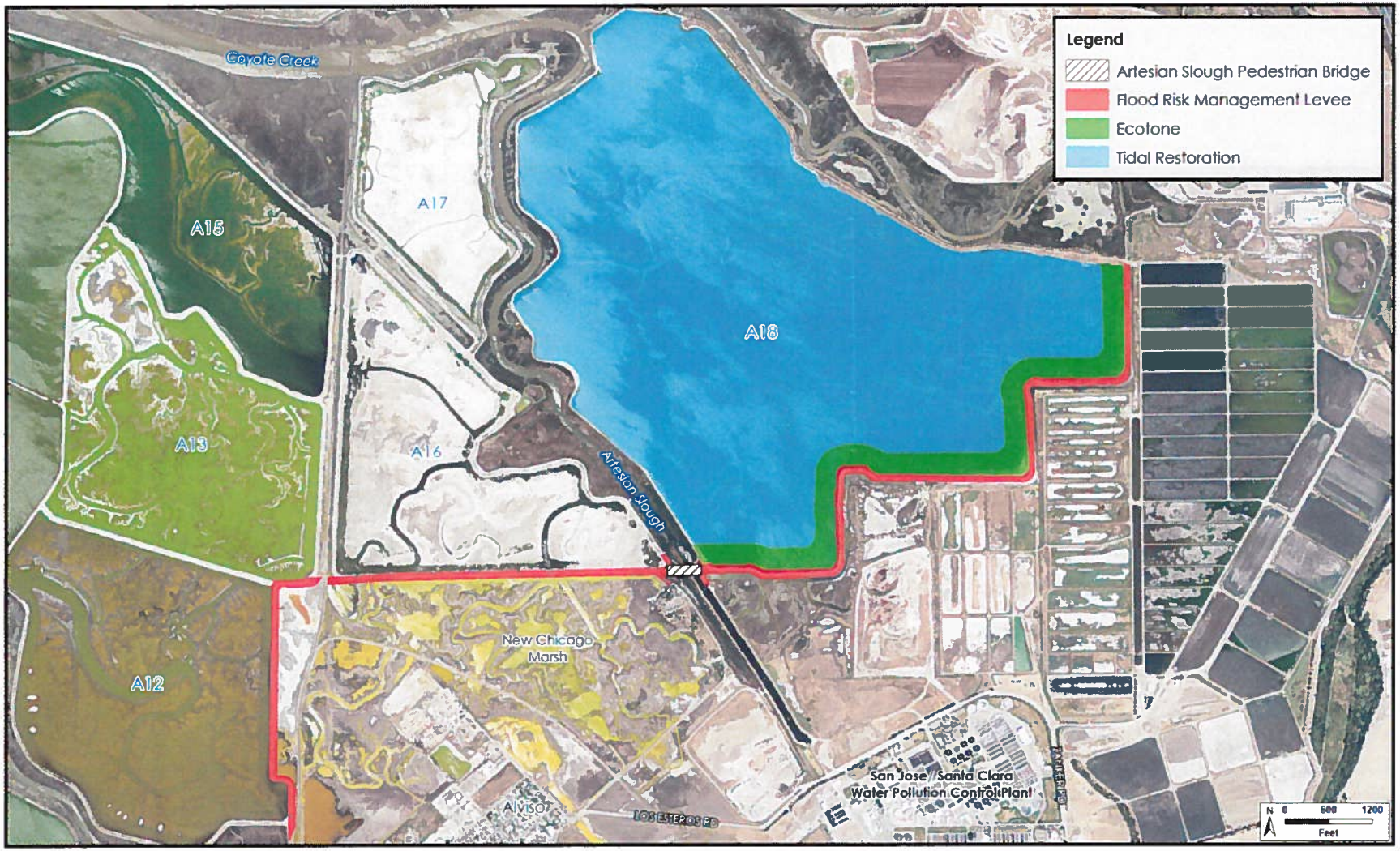

Figure 2. Corps-led Actions in the South Bay Shoreline Phase 1 Study Project (copied from HTH 2014).

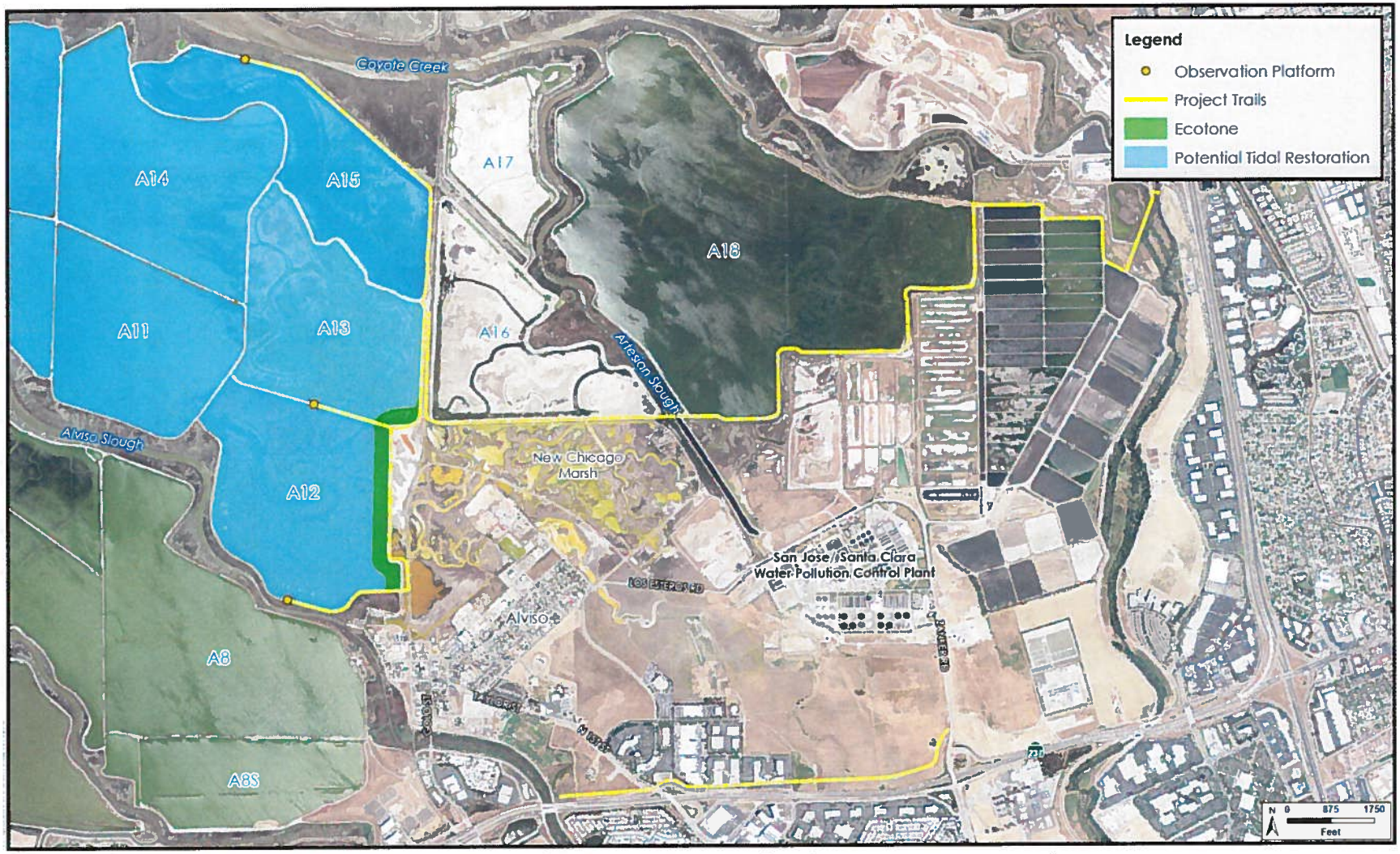

Figure 3. Service-led Actions in the South Bay Shoreline Phase 1 Study Project (copied from HTH 2014).

respectively. As noted previously, the proposed project consists of two main sets of actions: tidal restoration and public access improvements proposed by the Service and SCVWD on the Refuge (Figure 3), and flood control levee improvements, public access improvements, and tidal restoration funded by the Corps and SCVWD, both on Refuge lands and lands of the City of San Jose (Figure 2). For the purposes of this biological opinion, the Corps-led actions and the Service-led actions are described separately because the Corps is not authorized to expend funds on ecosystem restoration on lands controlled by another Federal agency, but it can expend funds on flood control on such lands. As a result, the Corps-led actions include flood improvements and public access improvements on Refuge lands, but the Corps cannot fund ecosystem restoration activities on the Refuge. The Corps can, however, fund ecosystem restoration on City of San Jose-owned portions of the Study Area, and thus the tidal restoration and ecotone (upland transitional zone) activities in Pond A18 are part of the Corps-led actions.

Regardless of the source of funding for various proposed project actions or the ownership of the lands on which these actions occur, all the actions described in this biological opinion are interrelated and interdependent. Tidal restoration in the proposed project area necessitates improved tidal FRM, the nature of tidal FRM along levees depends on whether adjacent ponds are tidal or not (*e.g.*, with higher and more robust levees needed if adjacent areas are tidal than if they are managed ponds), and public access and recreation opportunities differ depending on whether and where levee improvements and tidal restoration occur.

Project Schedule and Phasing

The construction-phasing schedule is illustrated in Figure 4 below. This schedule includes both Corps-led and Service-led activities and indicates the lead agency for each task. The South Bay Shoreline Phase I Study timeline includes a 50-year span (2017–2067).

Figure 4 and subsequent discussion regarding the sequence of proposed project activities reflect a scenario in which the first pond to be breached would be Pond A12; this is likely to be the case if the Corps is able to expend funds on restoration on Refuge lands. However, as noted above, the Corps is not currently authorized to expend funds on ecosystem restoration on lands controlled by another Federal agency. As a result, Pond A18 (which is not on Refuge lands) may be breached first, in which case the sequencing and timing of activities associated with A12 and A18 may be reversed. Resolution of the sequence will occur when the proposed project obtains interpretation of the Water Resources Reform and Development Act from Corps Headquarters.

Construction will commence in 2017 beginning with FRM levee construction; the ecotones at Ponds A12 and A18 will be constructed during the same period. Subsequently, Pond A12 will be prepared for breaching. The first breach is scheduled for 2020, followed by monitoring and adaptive management to inform the next potential phases of restoration. This period of monitoring and adaptive management will also be used to inform potential adjustments to Pond A12 and may extend beyond this four-year period. The second phase of ponds (Ponds A9-A11 and Pond A18) will be breached in 2025, assuming that monitoring results from the previous phase indicate that tidal marsh restoration should proceed, and will also be followed by a similar period of monitoring and adaptive management. The last phase of ponds will be breached in 2030 and will be followed by continued monitoring and adaptive management for all areas. Maintenance (e.g., of levees and trails) and management according to a long-term management plan (described in the "Conservation Measures" section below) will continue throughout the life of the proposed project.

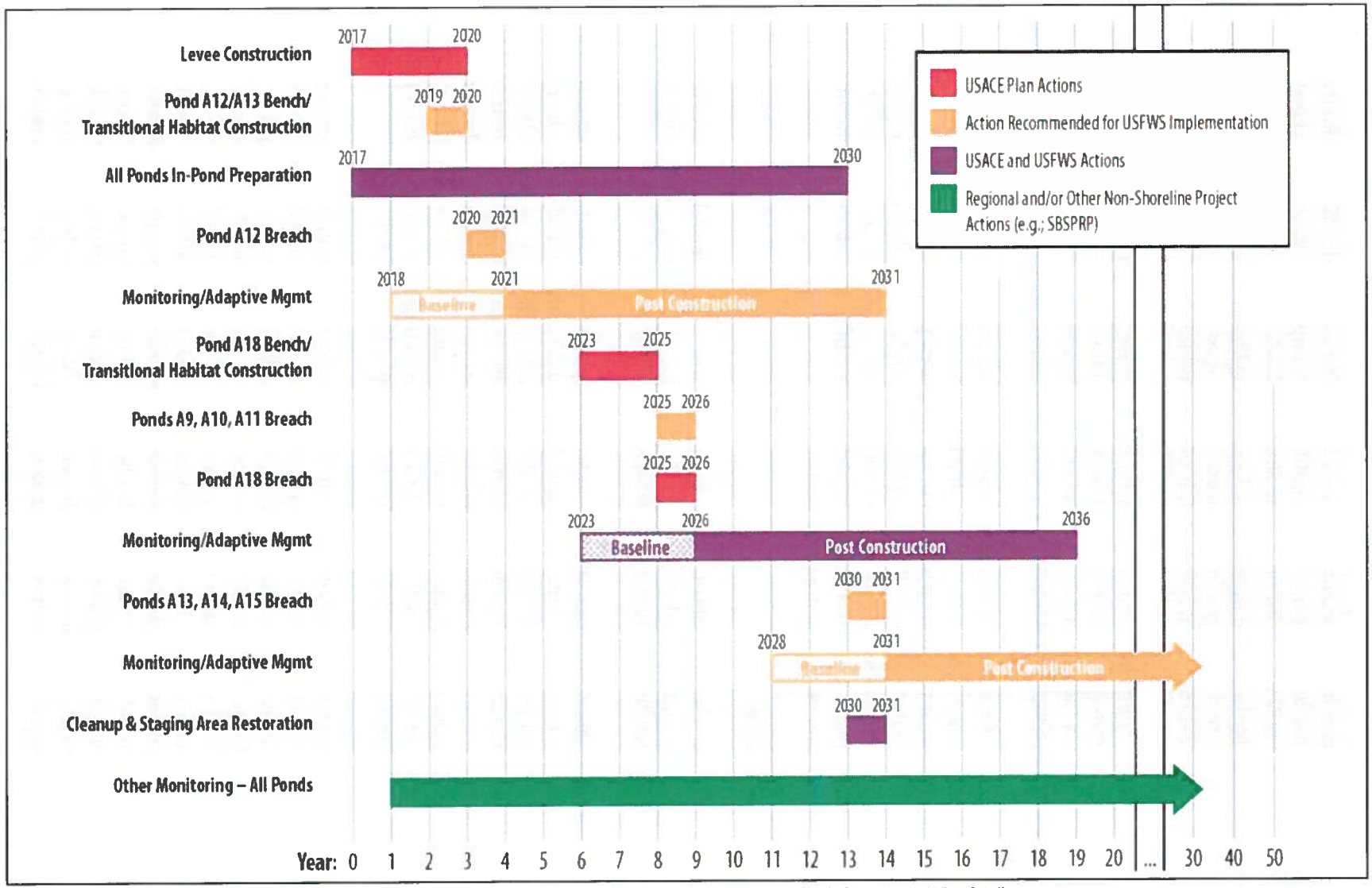

Figure 4. Construction Schedule for the South Bay Shoreline Phase 1 Study (copied from HTH 2014).

For the ecotone at Ponds A12 and A18, separate time frames are identified to construct each of these features. Material for construction of the ecotone at both ponds is assumed to be available on site and free of charge. This material is provided through agreements that the Refuge makes with local construction companies to acquire materials excavated from other regional construction sites, and with the SCVWD to acquire sediment dredged for stream maintenance purposes. After the new FRM levees are constructed, the Refuge and/or SCVWD will use these materials to construct transitional habitat. The construction phasing strategy allows for the accumulation of material needed to build the 345-foot-wide ecotones with 30:1 side slopes at Ponds A12 and A18.

Monitoring will continue throughout the life of the proposed project.

Corps-led Actions

Flood Protection Actions

The Corps conducted an analysis of potential FRM actions in order to identify the proposed project activities. Details of the analysis, including potential actions that were considered but that are not proposed and potential alternatives to the proposed project, are discussed in the Integrated Document (HDR 2014).

Construction

The Corps will construct 3.1 miles of new levee from the Alviso Marina northeastward to the northwestern corner of the San Jose/Santa Clara Water Pollution Control Plant (WPCP) (Figure 2). The levee, which would provide FRM assuming a one percent Annual Chance of Exceedance, consists of the following three components:

1. The 1.7-mile Alviso Segment, which is located entirely on Refuge lands, will provide FRM for the community of Alviso. This segment follows the eastern border of Pond A12 and the southern border of Pond A16.

2. The Artesian Slough crossing will entail construction of a new tide gate across the slough to protect the WPCP from storm waters flooding the slough and backing up into the facility during extreme storm events. The proposed location of the tide gate will be at least 300 feet bayward of the existing WPCP outfall for treated water at Artesian Slough (the location shown in the Biological Assessment is approximate, and the actual location may be farther upstream along Artesian Slough). The gates will only be closed during extreme storm events. When the gates are closed, the WPCP will need to pump water outputs over the gate, or provide for internal excess water storage during a storm event. With or without the proposed project, the WPCP will develop a plan to pump or store waters during such events given increases in Bay water levels that correspond with future sea level rise scenarios. To best meet the general operations requirements for the WPCP and allow for discharge during storm events, the tide gate will be designed in coordination with WPCP engineers.

3. The 2.1-mile WPCP Segment, which is located on City of San Jose lands, will provide FRM to the WPCP. It runs west to east in a stair-step pattern along the southern border of Pond A18, from the southwest corner of the pond to its northeast corner.

The engineered levee will be earthen. The proposed change in levee size from the existing levee (*e.g.*, along the southern edge of Pond A16) will be an increase of up to approximately 10 feet in height (after settlement) and about double in existing width. For example, the Alviso Segment levee along the southern edge of Pond A16 will increase in height from approximately 6 feet to 16 feet and increase in width at the toe from approximately 55 feet to 115 feet. The average width at the crown of the levee will be 16 feet, with 3:1 (horizontal: vertical) slopes except where ecotones having a 30:1 slope will be constructed (Figure 5). Along the east edge of Pond A12, the Alviso Segment levee will have an additional 345-foot-wide ecotone along its west side.

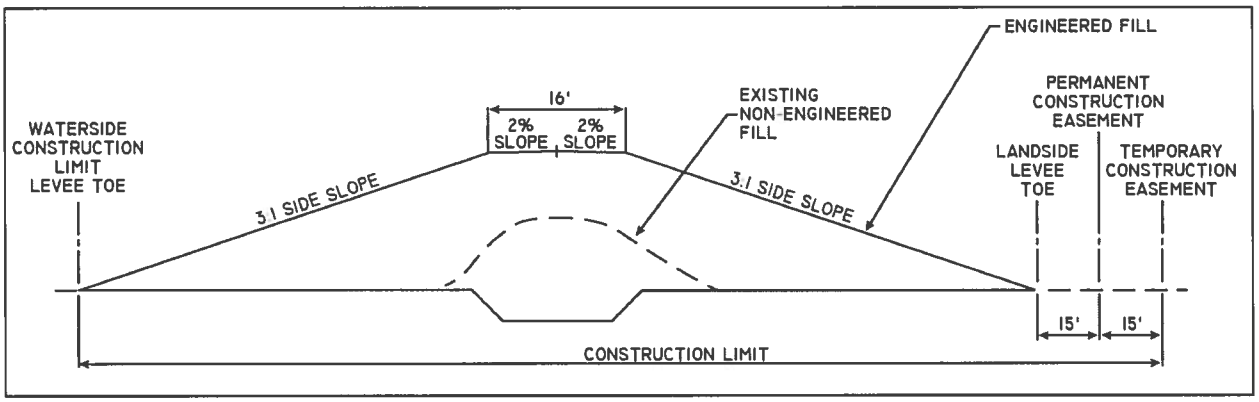

Figure 5. Example Cross-Section of Engineered FRM Levee.

Dredge material originating from areas outside the proposed project area that is used for ditch blocks, or for portions of the ecotone and FRM levee that will be in contact with tidal waters, will need to meet the contaminants screening criteria as described in the Biological Assessment (HTH 2014).

The levee design will include vegetation as erosion protection on the bayward and landward side slopes. Vegetation is anticipated to be continuous and able to provide erosion protection from overtopping of the levee. The vegetation that will be seeded or planted on the levee following construction will consist of marsh vegetation and peripheral halophytes at the toes of the levee and upland grasses at higher elevations. The combination of vegetation, buried stone, and/or transitional habitat fills (*i.e.*, planting berms) is proposed to balance requirements for levee safety with the need to limit disturbance from traditional maintenance activity (described below) such as regular mowing in/near habitat for sensitive species such as the salt marsh harvest mouse.

Proposed vegetation will include marsh species and peripheral halophytes, such as 12 to 18-inch tall pickleweed, from elevation 0 feet to 3 feet above the typical high water elevation. The high water elevation corresponds to approximately elevation 6 feet and 10 feet on the landward and bayward side slope, respectively. Upland grasses will occupy the side slopes between the levee crest and the pickleweed. Combinations of buried stone protection and buried gravel may be necessary to stunt the growth of native vegetation in lieu of regular mowing (i.e., to reduce the frequency of mowing) in an environmentally sensitive area, or to provide erosion protection where vegetation cannot be supported.

Where the FRM levee will cross the active railroad line just east of Pond A12, railroad floodgates will be installed. Concrete barriers will be installed on either side of the railroad right-of-way and will tie into the earthen levees. The metal floodgates will be connected to the barrier and will remain open during normal conditions and closed during flood conditions.

Certain locations may require special structures or treatment as follows:

1. Where the levee crosses an existing water feature such as a slough, structures will be installed to allow drainage during normal conditions and closure during flood conditions.

2. Where the levee crosses below-ground infrastructure (utilities, etc.), load-bearing structures may be needed to support the weight of levee materials.

Other materials such as geotextile fabric, stone column, foundation over-excavation, or replacement with stronger soil may also need to be included in the final FRM levee design.

Fill for the FRM levee will be imported from local sources and delivered by truck. Proposed staging areas and ingress/egress routes are shown on Figure 6 below. Potential staging areas #1 and #2 are both on WPCP land. Ingress and egress truck routes for these two areas are proposed on existing levee roads used currently by WPCP for materials hauling. Potential staging area #3 is on Zanker Landfill land and will be restricted in use for dirt stockpiling only.

The timing and duration of construction will be governed by both weather conditions and the need to avoid construction in sensitive areas during certain times of the year to avoid and minimize impacts to listed species. Types of construction equipment may include excavators, belly scrapers, front-end loaders, bulldozers, forklifts, vibratory rollers, dump trucks, and water trucks. Ancillary types of equipment that may be used include diesel generators, water pumps, and pile drivers. It is anticipated that dewatering and temporary installation of sheet piling will be necessary during the construction of water control structures such as tide gates. Dredge-locks or coffer dams may be constructed using earth levees or sheet piling to allow access for water-based equipment within a site. When possible, amphibious excavators, vibratory pile drivers, and other less-impacting equipment will be used.

Maintenance

Once construction of the Corps-led components is complete, the non-Federal sponsors (the CSCC, SCVWD, and City of San Jose) will be responsible for the operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of these components (*i.e.*, the Pond A18 tidal restoration and ecotone, as well as the entire levee both adjacent to Pond A18 and on Refuge property). An OMRR&R Manual will be prepared to describe these activities. It is anticipated that the following OMRR&R activities will be performed on the FRM levees:

1. Trash and anthropogenic debris removal along levee slopes and where it is causing obstruction in culverts or other problems.

2. Repairs on levee due to damage by small burrowing mammals, runoff/erosion, storm activities, or other factors.

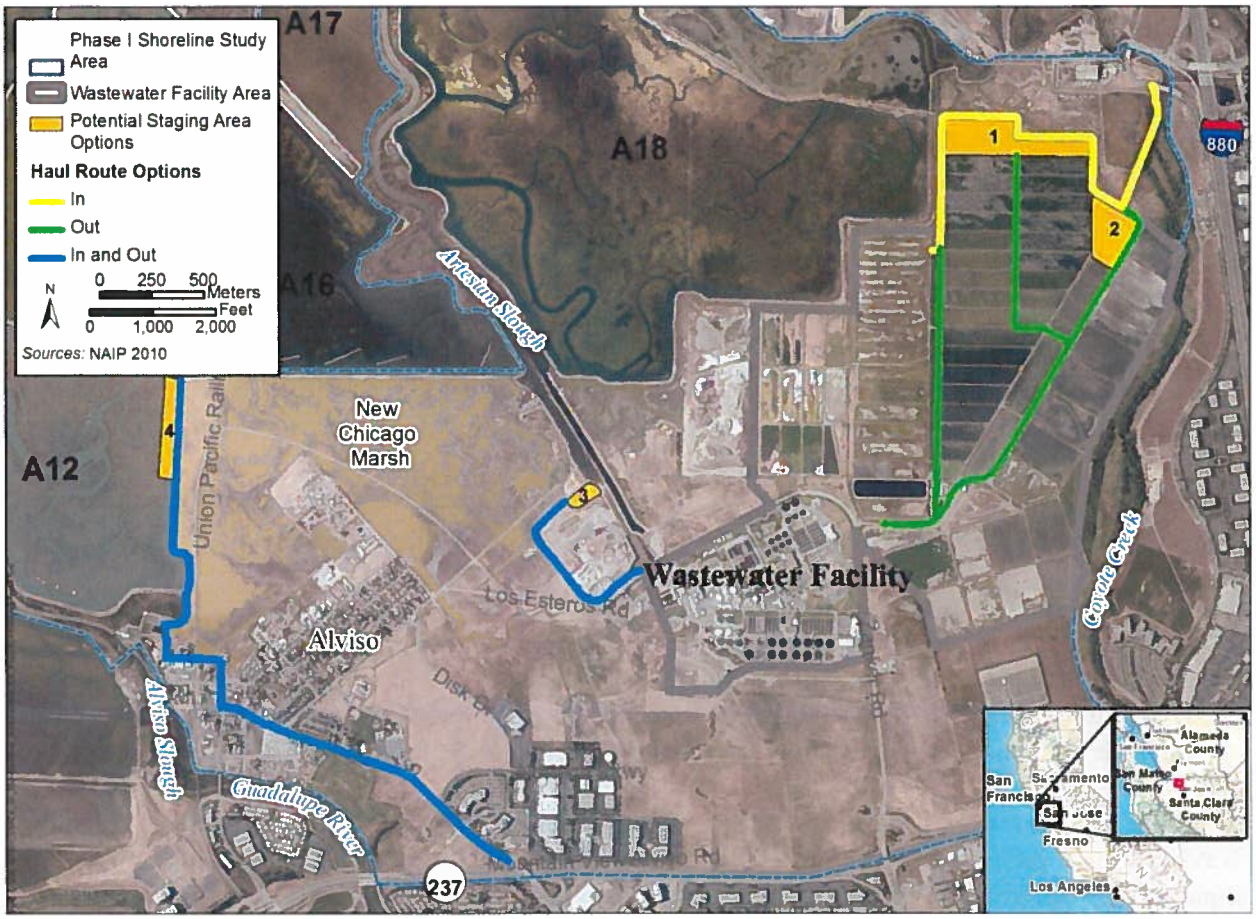

Figure 6. Proposed Access and Staging Areas.

3. Repairs along concrete flood wall structures (if included in plan) and other features, such as bridges and culverts.

4. Levee inspections conducted by SCVWD and the Corps.

5. Graffiti removal.

6. Access improvements and upkeep.

7. Vector monitoring (presence of mosquitoes and their larvae).

8. Vegetation management – As mentioned previously, the levee design will include vegetation as erosion protection on the bayward and landward side slopes.

    a. Combinations of buried stone protection and buried gravel may be used to stunt the growth of native vegetation to reduce the frequency of mowing in this environmentally sensitive area, or to provide erosion protection where vegetation cannot be supported.

b. It is anticipated that a reduced need for regular mowing will still include annual mowing of the levee side slopes within 12 to 15 feet of the levee crown. Such a narrow swath of vegetation management will likely require only two or three passes of a mower, once per year, which would minimize the disturbance of sensitive species in adjacent areas. Mowing will proceed from the top (closest to the crown, where habitat is of lowest quality) downward toward higher-quality habitat so that if any wildlife is using the area to be mown, the noise and movement of the mower may encourage wildlife to move downslope into the higher-quality habitat and out of the impact area. This area of mowing will correspond to the area above elevation 9 feet on the levee side slopes and higher elevations in reaches with ecotone fills.

c. No woody plant species greater than two inches in diameter will be allowed to become established on the levees to prevent roots from damaging the structural integrity of the levee. Due to salinity levels in lower-elevation areas, there is a low likelihood of woody vegetation establishment in many areas. Any woody vegetation that germinates in the higher-elevation mowing zone will be managed by mowing. Below the mowing zone, any woody plant removal that becomes necessary will be performed by hand; such hand-removal is expected to be necessary very infrequently (*e.g.*, once every few years, at most).

9. Burrowing mammal management – California ground squirrels may burrow into levees deep enough to affect the structural integrity of the levees, and thus squirrel management may be necessary. Ground squirrels are uncommon along the existing levees in the proposed project area and are thus not expected to require frequent or intensive management efforts. If ground squirrel management becomes necessary, it will be implemented using live traps with screens that have holes large enough to allow small mammals such as salt marsh harvest mice to easily exit the traps. Any mammals caught during such trapping that are potential predators of the salt marsh harvest mouse or California clapper rail, such as rats, striped skunks, red foxes, feral cats, raccoons, or opossums will be lethally removed.

Ecosystem Restoration Actions

The ecosystem restoration strategy to be implemented by the Corps is the conversion of Pond A18, which is currently managed for migratory waterbirds, into vegetated tidal wetlands with goals of maximizing long-term habitat benefits, particularly in consideration of potential sea level rise. Ecosystem restoration also includes creation of a broad, gently sloping ecotone.

Tidal Habitat Restoration

The following ground preparation actions will be involved in converting Pond A18 to tidal marsh:

1. Drain the pond to the extent feasible. The pond will be drained passively, so it may take several months to dry out; pumping would expedite the process and may be considered. Due to historic pond subsidence, some pond areas are not able to be completely dried. This step is also dependent on temporal proximity to the western snowy plover nesting season and/or if access to the area can be obtained without impacts to western snowy plovers, as dried pond areas may invite western snowy plover nesting.

2. Remove vegetation where needed (*i.e.*, around the breach locations) to discourage salt marsh harvest mice from using the impact areas.

3. Construct upland transitional habitat (described below).

4. Construct ditch blocks to inhibit flow through existing borrow ditches, promote scour and flow through the remnant historical channels, and provide some initial pickleweed habitat where located at the correct elevations. Without the construction of ditch blocks, the borrow ditches around the perimeter of the restored pond would capture the bulk of the flow, reducing the formation of complex dendritic channels in the restored marsh habitat.

5. Construct pilot channels on the outboard side of the A18 levee to facilitate flow between tidal sloughs and the restored tidal habitat in Pond A18. Three pilot channels will be constructed along Artesian Slough, and one will be constructed along South Coyote Slough. These pilot channels will be constructed at the locations of major historical tidal channels.

6. Breach the outboard levee in four locations along Artesian Slough and one location along South Coyote Slough. Breach size will be determined based on the hydrologic relationship between the tidal channel and marsh drainage area and on data from tidal channels in mature marshes throughout the Bay (ESA and Philip Williams & Associates, Ltd. 2012). Breaches are sized to long-term equilibrium dimensions to balance between excavation costs, scour potential, and tidal drainage consistent with *Design Guidelines for Tidal Wetland Restoration in San Francisco Bay* (Philip Williams & Associates, Ltd. and Faber 2004). Dimensions are adjusted to provide a cross-section with side slopes of 4:1 to 5:1 and a bottom width of approximately 10 feet. On the inboard side of the levee, the breach excavation will extend to the levee toe.

Pond A18 will be breached in five locations to facilitate flow of water into and through the pond, allow the tides to carry sediment into the pond, and allow for the retention of remnant channels in the pond bottom. Breaching of Pond A18 will restore approximately 736 acres of new tidal habitat (in addition to the upland transitional habitat discussed below). When Pond A18 is breached, its bottom elevation will be too low for vegetated marshes to form immediately. Several feet of sediment will need to be deposited by natural processes before the pond bottom reaches a sufficient elevation for marsh vegetation to grow. This sedimentation process is expected to proceed at rates determined in part by suspended solids concentrations as well as by factors causing re-suspension of sediment, such as wave action and tidal currents, in the breached pond (ESA and Philip Williams & Associates, Ltd. 2012). Because these factors cannot currently be predicted, it is not known how quickly vegetated marsh will form in Pond A18. Monitoring of the restoration process, and adaptive management if necessary to achieve vegetated tidal marsh, will occur per the *Shoreline Study Monitoring and Adaptive Management Plan* (MAMP) described previously. Once tidal marshes have begun to form in the former ponds, the rate of sedimentation will increase as the vegetation slows the water, catches sediment, and retains it. Eventually, with sufficient sediment, it is expected that Pond A18 will be largely vegetated, aside from tidal channels.

Because of the tidal flood protection functions currently provided by the outboard levees around Ponds A9-A15, tidal restoration within those ponds would not be feasible without enhancement of flood protection inboard from those ponds. As a result, the Service-led tidal restoration on Refuge lands described below could not occur but for the Corps-led construction of the levee and tide gate. Thus, tidal restoration on Refuge lands is dependent on Corps-led levee construction.

Upland Transitional Habitat Creation

Transitional habitat can attenuate waves and reduce wave run-up, increase habitat resiliency by providing space for marshes to retreat inland in the face of sea level rise, and provide refugia for animals such as the California clapper rail and salt marsh harvest mouse during very high tides, when the marsh plain is inundated. The upland transitional habitat adjacent to Pond A18 will be constructed along the interface between the new levee (along the southern and eastern edges of Pond A18) and the newly restored tidal habitat in the pond.

The non-Federal sponsors (the CSCC and SCVWD) recognize the enhanced value of having a gently sloped upland transitional habitat. As a result, the transitional habitat along Pond A18 will be constructed to incorporate a 30:1 slope, which will add up to 345 feet to the width of the bay side of the levee footprint. This ecotone will be constructed along approximately 14,000 linear feet of levee along Pond A18, for a total extent of 67 acres of new upland transitional habitat. Following construction of the ecotone area, it will be seeded and/or planted with native grasses, forbs, and low shrubs. Such an ecotone will provide substantial benefits for wildlife in the Study Area, as this sort of upland transitional habitat is not well represented in the South Bay. Vegetation allowed to establish in the upland transitional areas would be limited to non-woody and semi-woody plants (and possibly shallow-rooted shrubs) and would be otherwise unmanaged, except to control invasive plants from establishing. Figures 13 and 14 in the Biological Assessment (HTH 2014) depict cross-sectional views of how the upland transitional habitat will relate to restored tidal habitats (using Pond A12 as an example) at construction completion (2020) and as anticipated to evolve by 2067, respectively. Within a narrow (15 feet or less) strip of ecotone fill along the edge of the exposed levee surface, vegetation will be managed the same as on the levee (see "Maintenance" section above) to ensure compliance with the Corps' levee vegetation policy.

As indicated in Figure 4, the Pond A12 ecotone will be constructed concurrently with construction of the FRM levee, using the same staging areas and access routes as for levee construction. The Pond A18 ecotone will similarly be constructed simultaneously with levee construction.

Maintenance

Following the breaching of levees around Pond A18, the only management activities that might occur within the restored tidal habitats are predator management and, if necessary, invasive plant management, both of which would be performed on an as-needed basis. If monitoring determines that predator management is necessary to protect special-status and sensitive species, such as California clapper rails and salt marsh harvest mice, from predators such as California gulls, northern harriers, American crows, common ravens, red foxes, striped skunks, feral cats, and raccoons, then adaptive predator management would be implemented. Predator management would be focused on specific areas where predation problems are occurring (or areas, such as poles or towers, used as nesting sites or hunting perches by raptors), and culling would be limited to certain individuals; target mammalian predators that are captured would be lethally removed, while target avian predators would be either lethally removed (*e.g.*, crows and ravens) or relocated (*e.g.*, raptors). Because it is not currently known whether, and to what extent, predator management at Pond A18 will be needed, and habitat for the California clapper rail and salt marsh harvest mouse will take years to develop after A18 is breached, the local sponsor (*e.g.*, the SCVWD), rather than the Corps, will fund any necessary predator management. Invasive plant management will be needed for the first few years following construction of the ecotone to ensure that perennial pepperweed and other

invasives do not become dominant. Otherwise, invasive plant management would be performed if monitoring indicates that particularly invasive species colonize Pond A18 in a way that would jeopardize the habitat enhancements achieved through tidal restoration.

Monitoring and Adaptive Management Actions

The Corps and/or local sponsors (*i.e.*, the SCVWD, CSCC, or the City of San Jose) will provide initial funding for monitoring and adaptive management (MAM) at Pond A18, whereas MAM at the other proposed project ponds will be funded by the Service, SCVWD, City of San Jose, or CSCC. Funding for maintenance and MAM provided by the SCVWD will take the form of an allocation in the SCVWD's annual budget. Given the stability of, and the public need for, the SCVWD, the commitment of long-term funding through the SCVWD's annual budget process will ensure the availability of adequate funding to meet its responsibilities to the proposed project. The entity that will manage Pond A18 in the long-term is not currently known. The City of San Jose and the Corps will identify an appropriate manager for Pond A18 after breaching occurs, and that manager will then be subject to Service approval. Funding for maintenance and MAM at Pond A18 will be provided by the SCVWD, CSCC, and/or City of San Jose. If in the future, Pond A18 is conveyed to the Refuge, an agreement between the City of San Jose, SCVWD, and the Refuge to provide funding for maintenance and MAM at Pond A18 would need to be reached.

MAM for the proposed project falls into three categories: (1) MAM associated with meeting ecosystem restoration objectives, (2) MAM associated with "adaptive implementation" (*i.e.*, decisions about whether to continue or halt the restoration of tidal marsh habitat depending on the monitoring of the effects of pond-to-marsh conversion), and (3) MAM associated with permit compliance. The Corps will cost-share activities associated with meeting ecosystem restoration objectives at Pond A18, for a period of 10 years; the non-Federal sponsors will provide funding for other required MAM. The MAMP includes a discussion of MAM's scientific basis and institutional structure, specific MAM activities, and cost estimates. Because the South Bay Shoreline Phase I Study Project includes a subset of ponds within the SBSPRP, the MAMP for the South Bay Shoreline Phase I Study Project draws heavily from the monitoring and applied studies being conducted by the larger SBSPRP. Monitoring activities to be funded by the Corps at Pond A18 include the following:

1. Water levels, sediment accretion rates, and suspended sediment concentrations;

2. Tidal marsh habitat acreage;

3. Presence and abundance of California clapper rails and salt marsh harvest mice in newly established tidal habitat; given the length of time that may be required for suitable habitat for these species to become established in Pond A18, it is possible that this monitoring may not occur within the 10-year period of Corps cost-shared monitoring, although salt marsh harvest mice may occupy the ecotone within 10 years;

4. Abundance and health of estuarine fish;

5. Count of migrating salmonids;

6. Abundance of non-native plants;

7. Plant species composition in upland transition zones; and

8. Mammalian and avian predators of California clapper rails and salt marsh harvest mice.

Recreation Actions

The only specific recreation-related action that will be funded by the Corps is the construction of a pedestrian bridge over Artesian Slough. This bridge will be constructed to link the multi-use trails on top of the new FRM levee (construction of the trails will not be Corps-funded). The bridge would span the slough atop sets of four parallel piles spaced every 50 feet. This would result in the installation of a total of forty 12-inch-thick steel piles that would form the pedestrian bridge piers. A barge-mounted pile driver/crane or an in-water excavator with a vibratory hammer would be used to drive the 12-inch-thick steel piles.

Service-led Actions

Ecosystem Restoration Actions

The activities involved in tidal restoration in Ponds A9-A15, and ecotone construction along the eastern edge of Pond A12, are similar to those described in above for Pond A18. However, there is an additional activity that will occur in Ponds A9-A15 that will not be necessary in Pond A18 because A18 has no internal berms. For restoration of Ponds A9-A15, breaches in the internal berms will be necessary to reconnect historical channels and restore the hydrologic connections to the innermost ponds in the proposed project footprint. Breach excavations will be sized in a similar manner to those applied to the outboard levees and will extend beyond the levee into the remnant historical channels. Existing internal berms may be lowered in some areas during the breach excavation to create wave breaks to limit wave action, enhance sedimentation, and create vegetated marsh habitat on the berm crests in the short term while the ponds develop from mudflat to vegetated marsh. As Ponds A9-A15 are breached in a phased manner, berms in adjacent ponds not yet being breached will be temporarily raised to provide increased FRM inboard of the current pond breaching actions.

Pond A12 has experienced the greatest degree of subsidence and is proposed for the first phase of restoration (though see above for a discussion of the possibility that Pond A18 may be breached first). By limiting new tidal exchange to this pond (rather than breaching multiple ponds in the first phase), Pond A12 can undergo maximum tidal interaction and sediment deposition, thus helping to raise its bottom elevation to a point where colonization by marsh vegetation will occur. During the first three years (2017–2019), Pond A12 will be prepared for breaching and inundation through excavation of pilot channels in two locations along Alviso Slough and construction of borrow ditch blocks. Berms between Pond A12 and Ponds A11 and A13 will be temporarily (*i.e.*, until tidal restoration in A11 and A13) raised to provide flood protection for A11 and A13. Surplus material excavated from pond preparation will be used to contribute to other in-pond construction activities requiring material, such as raising of internal levees, if determined suitable by Refuge staff. Subsequently, levee breaches will be implemented in Pond A12 to introduce tidal flow.

Following restoration of tidal flow to Pond A12, monitoring will be conducted to measure the effectiveness of tidal function equilibrium and restorative values. If necessary, corrective measures

will be implemented. A period of approximately four years has been established for MAM associated with Pond A12.

Pond preparation for Ponds A9, A10, A11, and A18 would potentially be implemented based on the lessons learned as a result of MAM conducted for Pond A18, including whether to breach these ponds and restore them to tidal marsh. As described previously, this decision will be made according to the MAMP, which includes a series of decisions (based on those in the SBSPRP MAMP) regarding whether to continue breaching that involve monitoring of populations of pond-associated birds, monitoring of sediment accretion in the South Bay, and other factors. If the decision is made to breach these ponds, borrow ditch blocks and pilot channels will be constructed. Pond A11 will be connected to Ponds A10 and A12 with inboard berm breaches, but it will not be breached directly to Alviso Slough. Two breaches to Alviso Slough are planned in Pond A10, and one breach each to Alviso Slough and Coyote Slough are planned for Pond A9. Internal berms between Ponds A9-A11 and Ponds A13-A14 will be temporarily (*i.e.*, until tidal restoration in A13 and A14) raised to provide flood protection for A13 and A14. Levee breaches for Ponds A9-A11 will be implemented in Year 8 (2025) of the proposed project.

Pond preparation for Ponds A13, A14, and A15 will potentially be implemented based on the lessons learned as a result of MAM conducted for previous ponds, including whether to breach these ponds and restore them to tidal marsh. If the decision is made to breach these ponds, borrow ditch blocks and a pilot channel will be constructed. Only one outboard breach will occur for tidal restoration in these three ponds; this breach will connect Pond A15 to Coyote Slough along a major historical channel. Inboard berm breaches at the locations of historical sloughs will connect Ponds A13 and A14 to surrounding ponds (A9, A11, A15, and A12) to provide tidal flows to A13 and A14. Levee breaches will be implemented in Year 13 (2030) of the proposed project.

Ecotone habitat will be created along approximately 4,000 linear feet of levee on the east side of Pond A12. Approximately 30 acres of new upland transitional habitat will be created in this area. Following construction of the ecotone area, it will be seeded with native grasses, forbs, and low shrubs.

Breaching of Ponds A9-A15 would restore up to 2,010 acres of new tidal habitat (including the upland transitional habitat discussed below). As discussed for Pond A18 above, sediment accretion will need to occur within these ponds in order to raise pond bottoms to elevations that will support marsh vegetation. Once tidal marshes have begun to form in the former ponds, the rate of sedimentation will increase as the vegetation slows the water, catches sediment, and retains it. Eventually, with sufficient sediment, it is expected that, if breached, Ponds A9-A15 will be largely vegetated, aside from tidal sloughs. The considerable increase in tidal prism that will occur once these ponds are breached is expected to draw saline water from the Bay into these ponds, resulting in dominance of restored marsh by salt marsh species. An analysis performed by HTH (2012) predicted that the majority of the Pond A9-A15 system will be dominated by salt marsh vegetation. In addition, this increase in tidal prism will draw more saline water into and around the marshes downstream, thus converting some existing brackish marsh along Alviso and Coyote Sloughs to salt marsh habitat.

Maintenance

Following the breaching of levees around Ponds A9-A15, the only management activities that might occur within the restored tidal habitats are predator management and invasive plant management, as discussed previously. Predator management currently performed according to the Refuge's predator management plan (Foerster and Takekawa 1991, as updated in Service 2012a; Refuge 2012) will continue to be implemented on Refuge lands.

Recreation Actions

Recreation activities were incorporated into the proposed project to replace the loss of public access as the ponds in the Service-managed Refuge are breached and restored to tidal marsh. The proposed recreation measures associated with Service-led actions are multi-use trails on top of the new FRM levee, with connections to the Bay Trail network, along with viewing platforms, and trail upgrades to be made to an existing segment of the Bay Trail system along SR 237 (Figure 3).

Under existing conditions, a loop trail extends around Ponds A9 through A15, with an interior trail also existing between A15 and A13/14. These trails can be accessed from the Alviso Marina or via a spur that crosses the railroad tracks between Ponds A16 and A15. Restoration of tidal action to Ponds A9 through A15 will involve breaches in the outboard levees, thus interrupting the perimeter trail. Around Ponds A9-A15, the only trails that would remain following the completion of tidal restoration would consist of short segments in the eastern part of this group of ponds, as shown on Figure 3 (see also Figure 18 in the Biological Assessment (HTH 2014)).

The proposed project includes a new section of maintenance trail along the crest of the new WPCP Segment, which will be available for pedestrian traffic. Consistent with the WPCP Master Plan, the eastern extent of the levee maintenance trail will connect to a designated route at the existing bridge at McCarthy Boulevard. The existing pedestrian walkway on the bridge will take recreationists to the Coyote Creek Trail that runs along the east bank of the creek. This proposed trail connection will be refined in final design with consideration of both public safety and the addition of features (*e.g.*, fencing) to limit public access to sensitive wildlife areas. In addition, because the westernmost extent of the proposed levee's maintenance trail will end (with the levee itself) at existing high ground adjacent to the Alviso Marina, this will facilitate another connection to the Bay Trail if the City of San Jose's proposed plans to connect the Alviso Marina to the larger trail network are realized. In addition, the proposed project will construct a trail segment along the north side of SR 237 between the Guadalupe River and Zanker Road (see Figure 18 in the Biological Assessment (HTH 2014)).

Construction Equipment/Activities for Recreation Components

Construction of the recreation and public access components may consist of the following activities:

1. Grading and, for all-weather trails, gravel application. Equipment required for trail construction may include small, Bobcat-sized equipment, backhoes or front-end loaders, graders, bulldozers, asphalt placement equipment, and dump trucks.

2. Constructing trails, including some trails designed to accommodate vehicular use, trails to provide access to a staging area, and trails for disabled access.

3. Constructing interpretive stations of varying size and scope, which will include interactive features that can operate independently or can be enhanced with the assistance of docents.

4. Constructing viewing platforms at vista points where important information about the landscape can be described. Viewing platforms will be made of wood, metal, or plastic material and assembled in-place using a backhoe or excavator and hand tools. Interpretive stations will be built on-site, or will be prefabricated structures. Assembly and installation will require a backhoe or excavator and hand tools.

Maintenance of Recreation Components

Once construction of the recreation components is complete, the SCVWD, likely in a cooperative agreement with the City of San Jose, will be responsible for their operation, maintenance, repair, replacement, and rehabilitation. It is anticipated that the following operations and maintenance activities will be performed on the trails and the Artesian Slough pedestrian bridge:

1. Trash and anthropogenic debris removal;

2. Repairs due to damage by people, small mammals, storm activities, or other factors;

3. Trail and bridge inspections;

4. Graffiti removal;

5. Access improvements and upkeep;

6. Predator and invasive species management;

7. Enforcement of conservation measures; and

8. A long-term management plan will be prepared to describe the implementation of these activities.

Monitoring and Adaptive Management Actions

MAM will be implemented in Ponds A9-A15 as described previously for Pond A18. The MAMP includes a discussion of the scientific basis and institutional structure for implementation, specific MAM activities, and cost estimates. Monitoring activities to be performed for the restoration activities at Ponds A9-A15 include those listed previously. Other monitoring of more regional issues, such as regional changes in mudflat and tidal marsh acreages, changes in bird populations (including sensitive species and predators such as gulls), and mercury bioavailability, will continue to occur through the SBSPRP as it currently does.

Conservation Measures

The operational implementation of proposed project activities incorporates a number of measures, including general and species-specific measures, to avoid and minimize impacts during construction. All of these measures apply both to Corps-led and Service-led activities. Residual impacts remaining

after implementation of the general and species-specific avoidance and minimization measures are addressed through compensatory conservation measures. These conservation measures are further described below.

General Avoidance and Minimization Measures

Below, the general conservation measures that will be implemented during proposed project activities to avoid and minimize adverse effects on sensitive species and habitats are described, followed by conservation measures specific to individual special-status species. Additional details and measures are provided in the proposed project's *Integrated Document* (HDR 2014). All permit conditions, legal requirements, and appropriate excavation and engineering practices shall be followed to avoid and minimize environmental impacts associated with the proposed project. The term "project site" below refers to any of the potential work locations related to FRM and restoration activities that will occur throughout the proposed project's action area.

1. Earthen materials (*e.g.*, existing levees) will be reused to the extent feasible to reduce the amount of imported material and stockpile and landfill material.

2. Staging, access, and parking areas will be located outside of sensitive habitats to the extent feasible.

3. Areas of disturbance will be limited to the smallest footprint necessary.

4. All equipment will be maintained free of petroleum leaks. 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.

5. Spill prevention kits will always be in close proximity to construction activities (*e.g.*, crew trucks and other logical locations) when using hazardous materials. Feasible measures will be implemented to ensure that hazardous materials are properly handled and the quality of aquatic resources is protected.

6. No fueling will be performed in wetland or aquatic habitats unless equipment stationed in these locations is not readily relocated (*e.g.*, Aquamog, pumps, generators, dredge barges). For stationary equipment that must be fueled on site, containment will be provided in such a manner that any accidental spill of fuel will not be able to enter the water or contaminate sediments that may come in contact with water.

7. A hazardous materials management/fuel spill containment plan will be developed and implemented by the construction contractor and given to all contractors and biological monitors working on the proposed project, with at least one copy of the plan located onsite at all times. The purpose of the plan is to provide onsite construction managers, environmental compliance monitors, and regulatory agencies with a detailed description of hazardous materials management, spill prevention, and spill response/cleanup measures associated with the construction of the proposed project elements. The primary objective of the plan is to prevent a spill of hazardous materials. Elements of the plan include, but are not limited to the following:

a. A discussion of hazardous materials management, including delineation of hazardous material and hazardous waste storage area, access and egress routes, waterways, emergency assembly areas, and temporary hazardous waste storage areas;

b. Materials Safety Data Sheets for all chemicals used and stored on site;

c. An inventory list of emergency equipment;

d. Spill control and countermeasures including employee spill prevention/response training;

e. Notification and documentation procedures; and

f. Monthly reporting plan.

8. Vehicles will be washed only at an approved area. No washing of vehicles will occur at job sites.

9. A berm or other sediment-control devise will be installed around stockpiled soil material to prevent runoff from transporting sediment into sensitive habitats.

10. Any large wood or weed-free topsoil displaced by construction will be stockpiled for use during site restoration. Native vegetation displaced by construction will be stockpiled if it would be useful during site restoration.

11. The work site, areas adjacent to the work site, and access roads will be maintained in an orderly condition, free and clear from debris and discarded materials. Personnel will not sweep, grade, or flush surplus materials, rubbish, debris, or dust into storm drains, water bodies, or waterways. Upon completion of work, all building materials, debris, unused materials, concrete forms, and other construction-related materials will be removed from the work site.

12. A stormwater management plan will be developed to ensure that, during rain events, construction activities do not increase the levels of erosion and sedimentation. This plan will include the use of erosion-control materials (*e.g.*, baffles, fiber rolls, or hay bales; temporary containment berms) and erosion-control measures such as straw application or hydroseeding with native grasses on disturbed slopes; and floating sediment booms and/or curtains to minimize any impacts that may occur due to increased mobilization of sediments. Suitable erosion control, sediment control, source control, treatment control, material management, and non-stormwater management best management practices will be implemented consistent with the latest edition of the California Stormwater Quality Association "Stormwater Best Management Practices Handbook," available at www.capmphandbooks.com.

13. All disturbed areas will be stabilized within 12 hours of any break in work unless construction will resume work within seven days. Earthwork will be completed as quickly as possible, and site restoration will occur immediately following use.

14. For each activity, the supervising construction personnel will participate in a Service-approved worker environmental awareness program. Under this program, construction personnel will be informed about the presence of listed species and habitats associated with the species and that unlawful take of the animal or destruction of its habitat is a violation of the Act. Prior to construction activities, a qualified biologist approved by the Service will instruct all construction personnel about: (1) the description and status of the species; (2) the importance of their associated habitats; and (3) a list of measures being taken to reduce impacts on these species during proposed project construction and implementation. The awareness program will apply to construction occurring within or adjacent to tidal marsh or slough habitat and within or adjacent to managed pond habitat. A fact sheet conveying this information will be prepared for distribution to the construction crew and anyone else who enters the proposed project site. A Service representative will be appointed who will be the contact source for any employee or contractor who might encounter a listed species. The representative(s) will be identified during the environmental awareness program. The representative's name and telephone number will be provided to the Service prior to the initiation of any activities.

15. No firearms (except for Federal, State, or local law enforcement officers and security personnel) will be permitted at the proposed project site to avoid harassment, killing, or injuring of wildlife, with the exception of hunters who are authorized by the Service to pass through an area to access hunting areas.

16. No animals (*e.g.*, dogs or cats) will be brought to the proposed project site to avoid harassment, killing, or injuring of wildlife.

17. Ingress and egress points will be clearly identified in the field using orange construction fence. Work will not be conducted outside the designated work area.

18. In order to minimize the spread of invasive plants, all equipment (including personal gear) will be cleaned of soil, seeds, and plant material prior to arriving on the proposed project site to prevent introduction of undesirable plant species.

19. The proposed project site will be maintained trash-free, and food refuse will be contained in secure bins and removed daily during construction.

20. Nighttime work near tidal marsh habitat will be avoided to the extent feasible. If nighttime work cannot be avoided, lighting will be directed to the work area and away from habitat for the salt marsh harvest mouse, California clapper rail, and western snowy plover.

21. Interpretive signage prohibiting access to areas that are closed to the public, and indicating the importance of protection of sensitive biological resources, will be placed in key locations, such as along trails near sensitive habitats.

22. Prior to construction, all high-quality habitat for listed species will be mapped and provided to the Service. Vehicles driving on levees adjacent to such habitat for construction or monitoring activities will then travel at speeds no greater than 10 miles per hour to minimize noise and dust disturbance.

23. All clean fill material proposed for upland and wetland placement will meet the qualifications set forth in the Regional Water Quality Control Board's (RWQCB's) waste discharge requirements (Tentative Order), and will meet the screening criteria listed in the Biological Assessment (HTH 2014). If the above-mentioned thresholds are not attained but the material is approved for use by the RWQCB, consultation will be reinitiated to analyze the potential effects of the contaminated material to listed species.

24. The restored tidal marsh wetlands will be monitored for possible infestation by non-native cordgrass, perennial pepperweed, and other invasive, non-native plant species that could result in a substantial reduction in the ecological value of the tidal restoration and ecotone construction. It is expected that some non-natives that are not particularly invasive will colonize the ecotones, but if any particularly invasive plant species are found, a qualified botanist will recommend specific measures to control the spread of non-native plant species. All infestations of non-native cordgrass within the restored tidal marsh wetlands will be controlled and removed in coordination with the San Francisco Estuary Invasive *Spartina* Project without substantially hindering or harming the establishment of native vegetation in the restored wetlands. If perennial pepperweed control is necessary, spraying with glyphosate or imazapyr formulated for aquatic use may be necessary, as described by Hogle *et al.* (2007) for the San Pablo Bay National Wildlife Refuge. Otherwise, preferred vegetation management will involve non-mechanized methods of removal including hand-pulling, saline spray, pond flooding (during non-breeding seasons), and substrate-based controls. Aside from glyphosate and imazapyr for pepperweed control, the use of any herbicides will be subject to Service and NMFS approval.

25. If spraying for perennial pepperweed is necessary, the following general conservation measures will be implemented (measures specific to the California clapper rail are described below):

    a. Herbicides will be applied by a certified applicator and in accordance with application guidelines and the manufacturer label.

    b. Herbicide applications would be timed to coincide with ebbing tides to protect non-target vegetation, to allow a minimum of six hours dry time for glyphosate/imazapyr mixture applications, and at least one-hour dry time for imazapyr applications.

    c. Herbicides will be applied directly to perennial pepperweed plants and at low or receding tide to minimize the potential application of herbicide directly on the water surface.

    d. All certified applicators will be trained to correctly identify perennial pepperweed, to distinguish this species from native species in the action area, and to adhere to the conservation measures in this biological opinion.

26. Long-term maintenance and monitoring will be performed outside of peak migration periods of, and breeding seasons of, sensitive wildlife species to the maximum extent feasible.

27. A Service-approved biological monitor will be present during all work activities in or immediately adjacent to habitat that could be occupied by federally listed species to look for

individuals that may be impacted by construction; activities are considered "immediately adjacent" to sensitive habitat if those activities could result in the physical disturbance of the habitat (*e.g.*, as a result of mobilization of sediment into the habitat) or if individual listed species could move from that habitat into the proposed project area (*e.g.*, seeking refuge under construction equipment). The biologist will have stop-work authority if any individual of a federally listed species is detected in an area where it may be injured or killed by construction activities.

28. Any fencing near habitat for the salt marsh harvest mouse, California clapper rail, or western snowy plover will incorporate raptor perch deterrents to minimize raptor predation on listed species.

29. To avoid the loss of individual California clapper rails and salt marsh harvest mice, construction, maintenance, and management activities (including mowing) within or adjacent to habitat for these species will not occur within two hours before or after extreme high tides (6.5 feet or above, as measured at the Golden Gate Bridge and adjusted to the timing of local high tides), when the marsh plain is inundated, because protective cover for these species is limited and activities could prevent them from reaching available cover.

30. No dogs will be allowed on trails (or elsewhere) on Refuge lands. On City of San Jose lands, all dogs must be on leashes and must remain on established trails.

31. Long-term Predator Management and Invasive Plant Species Control Plans: A long-term management plan will be prepared to describe predator management, invasive plant species control, litter cleanup, and patrols/enforcement along the trails in the proposed project area. This plan will be implemented under a cooperative agreement between the SCVWD, the Refuge, and the City of San Jose, and it will be funded by the SCVWD.

Avoidance and Minimization Measures for the California Clapper Rail

The following measures will be implemented to avoid and minimize effects on California clapper rails:

1. To avoid causing the abandonment of an active California clapper rail nest, activities (including construction and maintenance activities) within 700 feet of vegetated tidal marsh providing suitable breeding habitat for California clapper rails will be avoided during the rail's breeding season from February 1 through August 31 unless protocol-level surveys are conducted by a Service-approved biologist to determine California clapper rail locations and territories. If breeding California clapper rails are determined to be present, activities will not occur within 700 feet of an identified calling center. If the intervening distance across a major slough channel (*e.g.*, Alviso, Coyote, or Artesian Sloughs) or across a substantial barrier between the California clapper rail calling center and any activity area is greater than 200 feet, then work may proceed at that location within the breeding season. Aside from continued use of recreational trails established prior to the start of the breeding season (which may continue), only inspection, maintenance, research, or monitoring activities that have little potential for effects on California clapper rails due to their short durations, distance from rail habitat, or low-magnitude effects may be performed during the California clapper rail's breeding season in areas within or adjacent to California clapper rail breeding

habitat, with approval of the Service under the supervision of a qualified biologist. Otherwise, with Service approval on a case-by-case basis, construction activities may take place after July 15 in a given area if the activity is thought to be minimally disturbing to breeding California clapper rails.

2. To be effective, perennial pepperweed control has to occur when the plant is in bud (May-July), during the California clapper rail breeding season. If perennial pepperweed control must be performed in California clapper rail habitat, the following measures will be implemented to minimize impacts on rails:

    a. Vehicle and foot access pathways to perennial pepperweed through tidal marsh will be minimized and use of existing roads and trails for control work will be maximized. Shortest possible access paths through the marsh to treatment patches will be identified prior to marsh access. Control methods to be used in each area will be selected to minimize potential impacts to marsh habitat and listed species from control operations.

    b. If breeding California clapper rails are determined to be present in a marsh, marsh access using aquatic-tracked vehicles (ARGOs) will not be allowed in contiguous marsh areas within 700 feet of an identified California clapper rail calling center (also referred to as the "700-ft Buffer Area") to avoid nest destruction, nest abandonment, and harassment of breeding California clapper rails. If the intervening distance across a major slough channel or across a substantial physical barrier between the California clapper rail calling center and the proposed access area is greater than 200 feet, then access may proceed within the breeding season.

    c. ARGOs will not travel within 50 feet of slough channels to avoid crushing high vegetation, such as gumplant, that grows along channels.

    d. Boats will be used to access marsh areas (where feasible) to treat large areas of perennial pepperweed along slough edges (*e.g.*, use of intelli-sprayer with 300 feet of hoseline) to further reduce the necessity of walking long distances through the marsh.

    e. Crews will be instructed to walk carefully through the marsh, avoiding high pickleweed cover (*e.g.*, greater than one foot) and wrack where salt marsh harvest mice are likely to nest or find cover.

    f. All personnel entering the marsh will be trained to identify and avoid direct and indirect disturbance to listed species and associated habitats. Training material will include taped recordings of California clapper rail calls and the "Walking in the Marsh" protocol (see Appendix A of this biological opinion) which addresses potential disturbance effects to California clapper rails and salt marsh harvest mice.

    g. Before spray operations commence each year, a qualified California clapper rail biologist familiar with the project area will familiarize the spray crew with the area and ensure that all crew members know the location of each "700-ft Buffer Area"

for protection of nesting California clapper rails. Crews will be instructed to avoid these areas unless accompanied by a qualified California clapper rail biologist.

h. During the California clapper rail breeding season, before crews are allowed to enter a California clapper rail "700-ft Buffer Area" to conduct control work, the Refuge Biologist, or designee, will work with other qualified California clapper rail biologists and the spray crew to develop a strategy for control that will minimize the amount of time the crew spends in each "700-ft Buffer Area" while conducting control. This planning session will include use of detailed maps showing perennial pepperweed locations within each "700-ft Buffer Area".

i. During the California clapper rail breeding season, a qualified California clapper rail biologist such as a Refuge Biologist, will accompany spray crews into "700-ft Buffer Areas" and will supervise and guide control operations within these areas.

j. Crews will limit time within a California clapper rail nesting area (call center + 700-ft Buffer Area) to 30 minutes or less to minimize disturbance to adult rails and to avoid potential nest destruction or nest abandonment.

k. If California clapper rail nests are encountered during control work, observers will immediately leave the vicinity of the nest and report findings to the Service.

l. If California clapper rail adults are encountered during control work, observers will move away from the birds if they are giving alarm calls or otherwise appear agitated.

Avoidance and Minimization Measures for the Salt Marsh Harvest Mouse

To minimize potential effects on the salt marsh harvest mouse, the following measures (in addition to those described above for the California clapper rail during perennial pepperweed control) will be implemented:

1. To avoid the loss of individual salt marsh harvest mice from any excavation, fill, or construction activities in suitable habitat, vegetation removal will be limited to the minimum amount necessary to permit the activity to occur. Wherever feasible, sufficient pickleweed habitat, as determined by a Service-approved biologist, will remain adjacent to the activity area to provide refugia for displaced individuals.

2. Within areas where vegetation potentially supporting salt marsh harvest mice will be impacted, vegetation and debris that could provide cover for salt marsh harvest mice will be removed using only hand tools at least three weeks prior to the commencement of construction activities. Vegetation removal will occur under the supervision of a Service-approved biologist. This vegetation will be removed on a progressive basis, such that the advancing front of vegetation removal moves toward vegetation that would not be disturbed. In some cases, temporary berms may need to be constructed over borrow ditches to enable suitable escape routes, or temporary shelter consisting of dead vegetation may be positioned to provide escape routes to suitable habitat. A Service-approved biologist will monitor the vegetation removal and make specific recommendations with respect to the rate of vegetation removal (to ensure that any salt marsh harvest mice present are able to escape

to cover that will not be impacted), whether vegetation needs to remain in a certain area temporarily to facilitate dispersal of salt marsh harvest mice into habitat outside the impact area, and whether any berms are necessary to allow salt marsh harvest mice to disperse across channels.

3. Following the hand-removal of vegetation, exclusion fencing will be erected as needed between construction areas and salt marsh harvest mouse habitat that is to remain unimpacted to define and isolate protected salt marsh harvest mouse habitat. This fencing will consist of heavy plastic sheeting or metal material that cannot be climbed by salt marsh harvest mice, buried at least four inches below the ground's surface, and with at least one foot (but no more than four feet) above the ground. All supports for the fencing will be placed on the inside of the work area. A four-foot buffer will be maintained free of vegetation around the outside of the exclusion fencing. The fencing will be inspected daily during construction, and any necessary repairs will be made within 24 hours of when they are found. If any breaks in the fencing are found, the Service-approved biologist will inspect the work area for salt marsh harvest mice.

4. Although individual salt marsh harvest mice cannot be handled on non-Federal land, because the species is fully protected according to the California Fish and Game Code, individuals can be handled on Federal land (*i.e.*, the Refuge). If any individual salt marsh harvest mice are found within the impact footprint on Refuge land, and they do not move on their own to vegetated areas outside the impact footprint, they will be relocated by hand to suitable habitat outside the impact zone by a qualified biologist.

5. During construction, a Service-approved biologist will check underneath vehicles and equipment for salt marsh harvest mice before such equipment is moved, unless the equipment is surrounded by salt marsh harvest mouse-proof exclusion fencing.

6. During mowing of vegetation along the FRM levee, mowing will start from the top (the area of least suitable habitat) and proceed downslope toward more suitable habitat so any salt marsh harvest mice present in the narrow swath to be mown can move away from the disturbance of the mower and out of the mowing area.

7. Below the zone at the top of the levee that will be mown, any woody plant removal that becomes necessary will be performed by hand; such hand-removal is expected to be necessary very infrequently (*e.g.*, once every few years, at most).

Avoidance and Minimization Measures for the Western Snowy Plover

The following measures will be implemented to avoid and minimize effects on western snowy plovers:

1. No activities will be performed within 600 feet of an active western snowy plover nest during the western snowy plover's breeding season, March 1 through September 14 (or as determined through surveys). Vehicles driving on levees and pedestrians walking on recreational trails established prior to the start of the breeding season (which may continue) will remain at least 300 feet away from western snowy plover nests and broods to the extent feasible, although because these trails are already accessible to the public, nesting western

plovers are expected to continue to adjust the location of nesting based on their tolerance of distance from these trails. If necessary, signage, temporary fencing such as roped-off areas, or other markers will indicate areas that vehicles and pedestrians should avoid to protect nesting western snowy plovers, and Refuge staff will enforce these closures. In addition, personnel that must stop at a specific site for brief inspections, maintenance, or monitoring activities will remain 600 feet away from western snowy plover nests and broods. *Exception*: Only inspection, minor maintenance (such as water level management within a pond), research, or monitoring activities may be performed during the western snowy plover breeding season in areas within or adjacent to western snowy plover breeding habitat with approval of the Service under the supervision of a qualified biologist. If western snowy plover chicks are present and are foraging along any levee that will be accessed by vehicles (*e.g.*, for construction, inspection, or access), vehicle use will be under the supervision of a qualified biologist (to ensure that no chicks are present within the path of the vehicle).

2. Breaching of ponds that contain suitable western snowy plover habitat will not be performed during the breeding season (March 1 through September 14) unless surveys have documented that no active nests or unfledged chicks are present within the ponds to be flooded by breaching.

3. Viewing platforms, kiosks, benches, interpretive displays, and other focal areas for public use will be located a minimum of 600 feet from suitable western snowy plover nesting habitat.

Avoidance and Minimization Measures for the California Least Tern

Although California least terns are not known or expected to nest in or very near the action area, the following measures required by the Service's biological opinion for the SBSPRP are incorporated into the proposed project:

1. No activities will be performed within 300 feet of an active California least tern nest during the California least tern's breeding season, which is April 15 to August 15 (or as determined through surveys). *Exception*: Only inspection, maintenance, research, or monitoring activities may be performed during the California least tern's breeding season in areas within or adjacent to California least tern breeding habitat with approval of the Service under the supervision of a qualified biologist.

2. Breaching of ponds that contain suitable California least tern nesting habitat will not be performed during the breeding season unless surveys have documented that no active nests or unfledged chicks are present within the ponds to be flooded by breaching.

3. To avoid or minimize potential adverse effects from public access and recreation features constructed near tidal marsh, trails adjacent to some nesting areas for sensitive bird species will be closed during the breeding season. Public trails within 300 feet of suitable California least tern nesting habitat will be closed during the breeding season. In addition, if trails are to be open during the breeding season of this species, viewing platforms, kiosks, benches, interpretive displays, and other focal areas for public use will be located a minimum of 600 feet from suitable nesting habitat. The locations of trail segments to be closed, and the periods of closure will depend on whether sensitive bird species, such as California least terns, are nesting in certain areas in a given year and whether nesting areas are located in

close proximity to the trails. Decisions about whether to close a particular trail segment will be made early in the breeding season (and possibly later in the season as conditions change) following surveys for nesting birds within a given pond adjacent to a trail.

Avoidance and Minimization Measures for the Longfin Smelt and Other Special-Status Fish Species

To minimize potential effects on the longfin smelt and other special-status fish species managed according to the Fishery Management Plans, the following measures will be implemented:

1. Construction activities in, or directly adjacent to, waters where Central California Coast steelhead and longfin smelt are likely to be present will be performed between June 1 and November 30.

2. Levee breaching will not occur between February 1 and May 31 for the protection of out-migrating juvenile steelhead in, or directly adjacent to, waters where steelhead are likely to be present.

3. Activities that extend into the waters where listed fish and fish species managed according to Fishery Management Plans may be present, such as pilot channel excavation, will be performed at low tide and/or under de-watered conditions, to the extent practicable.

4. Cofferdams will be used to the extent feasible during construction and maintenance activities, as well as during implementation of any adaptive management actions, that could potentially result in substantial siltation of protected fish habitat.

5. All pumps used for dewatering where salmonids may be present will be screened according to NMFS and CDFW criteria for juvenile salmonids.

6. During tide gate construction on Artesian Slough, all pile driving will be performed using a vibratory hammer to minimize the potential effects of noise and pressure-waves on fish.

7. NMFS personnel will be immediately notified of any observed fish mortality events.

8. Tidally restored ponds will contain channels that are adequate for the ingress and egress of fish with tidal circulation. Inspections will be documented in a record that is available for review on request.

9. Treated wood will not be used in structures that may come into contact with water.

Western Snowy Plover Compensatory Conservation Measures

The Corps will implement the following compensatory mitigation for effects to western snowy plovers from levee construction:

1. Breeding habitat for the western snowy plover will be enhanced on an island in Pond A16. Islands were constructed in Pond A16 in 2012 and 2013 as part of Phase I activities of the SBSPRP, for the purpose of providing nesting, roosting, and foraging habitat for a variety of pond-associated bird species, including western snowy plovers. Western snowy plovers

nested on one of these islands in 2013. However, the dark substrate of the islands, and their relatively homogeneous surfaces, could make western snowy plovers on the islands relatively conspicuous to predators. The South Bay Shoreline Phase I Study Project will provide small gravel (or other appropriate substrate) that will be distributed in patches on one of the islands in A16 (with the island to be selected by the Refuge), and the proposed project will fund the maintenance of this gravel. Pea gravel has been intentionally provided in some areas as a substrate for use by nesting western snowy plovers (Paton and Bachman 1996, Sexson and Farley 2012), and in the Bay, some western snowy plovers at the Eden Landing Ecological Reserve nest in fine gravel along roads.

2. Predator management is currently performed on Refuge lands, but as partial compensation for adverse proposed project effects on western snowy plovers, the intensity of this management will be increased in Pond A16 and New Chicago Marsh during the western snowy plover breeding season. This enhanced predator management will include more frequent monitoring for predators nesting (*e.g.*, gulls and corvids), roosting, or foraging in these areas islands; more frequent trapping of mammalian predators in New Chicago Marsh and along Artesian Slough; and ongoing identification and implementation of deterrence or removal measures for those predators. This measure will consist of funding a predator management technician for an additional 10 hours per week during the period March 1 through September 14 (approximately 28 weeks).

The Corps will fund the initial enhancement of nesting islands in Pond A16 with gravel. The SCVWD will fund the long-term maintenance of the gravel substrate on those islands and the incremental increase in predator management in Pond A16 and New Chicago Marsh. This funding will take the form of annual allocations in the SCVWD's budget specifically for these purposes.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The "effects of the action" to be analyzed in this biological opinion are defined as the direct and indirect effects of the action, together with the effects of other activities that are interrelated or interdependent with that action (such as activities implemented or funded by the local sponsors, the CSCC and SCVWD, in conjunction with the Corps' and Service's activities). The action area includes the construction footprints for FRM and recreational access activities; the entirety of Ponds A9 through A15 and A18; portions of Pond A16 adjacent to the proposed project footprint and on the island where western snowy plover habitat enhancement will occur; the northern and western boundaries of New Chicago Marsh; areas on the outboard (bayward) sides of those ponds where pilot channel excavation will occur; all staging, stockpiling, and access areas; the portions of Alviso Slough, Coyote Slough, South Coyote Slough, and Artesian Slough downstream from proposed levee breaches that may be subject to additional scour from increased tidal prism or temporarily increased sedimentation during construction; and areas surrounding the construction footprint and trails where indirect effects such as disturbance (*e.g.*, areas within 600 feet for nesting western snowy plovers and 700 feet for nesting California clapper rails) may occur.

Analytical Framework for the Jeopardy Analysis

In accordance with policy and regulation, the jeopardy analyses in this biological opinion relies on four components: (1) the *Status of the Species*, which evaluates the California clapper rail's, salt marsh harvest mouse's, western snowy plover's, and California least tern's range-wide condition, the factors responsible for that condition, and their survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of these species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of these listed species; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the California clapper rail, salt marsh harvest mouse, western snowy plover, and California least tern; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on these species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the California clapper rail's, salt marsh harvest mouse's, western snowy plover's, and California least tern's current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of these species in the wild.

The jeopardy analysis in this biological opinion places an emphasis on consideration of the range-wide survival and recovery needs of the California clapper rail, salt marsh harvest mouse, western snowy plover, and California least tern and the role of the action area in the survival and recovery of the California clapper rail, salt marsh harvest mouse, western snowy plover, and California least tern as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Status of the Species

California Clapper Rail

The status of the California clapper rail and information about its biology, ecology, distribution, and current threats is available in the *Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (Recovery Plan; http://www.fws.gov/sacramento/es/Recovery-Planning/Tidal-Marsh/es_recovery_tidal-marsh-recovery.htm; Service 2013). Critical habitat has not been designated for this species. Recent genetic analyses of rail species resulted in a change in the common name and taxonomy of the large, "clapper-type" rails (*Rallus longirostris*) of the west coast of North America to Ridgway's rail (*Rallus obsoletus*) (Maley and Brumfield 2013, Chesser *et al.* 2014). Thus the California clapper rail is now referred to in the scientific community as the California Ridgway's rail (*Rallus obsoletus obsoletus*). The change in the common name and taxonomy of the California clapper rail, however, does not change the listing status of the species.

Salt Marsh Harvest Mouse

There are two subspecies of the salt marsh harvest mouse: the northern subspecies (*R. r. halicoetes*) and the southern subspecies (*R. r. raviventris*). Both subspecies are listed as endangered. The status of the salt marsh harvest mouse and information about its biology, ecology, distribution, and current threats is available in the Recovery Plan (http://www.fws.gov/sacramento/es/Recovery-

Planning/Tidal-Marsh/es_recovery_tidal-marsh-recovery.htm; Service 2013). Critical habitat has not been designated for this species.

Pacific Coast Population of the Western Snowy Plover

The status of the Pacific coast population of the western snowy plover and information about its biology, ecology, distribution, and current threats is available in the *Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (Charadrius alexandrinus nivosus)* (http://ecos.fws.gov/docs/recovery_plan/070924_2.pdf, Service 2007).

California Least Tern

The status of the California least tern and information about its biology, ecology, distribution, and current threats is available in the five-year review (http://ecos.fws.gov/docs/five_year_review/doc775.pdf, Service 2006).

Environmental Baseline

Proposed Project Location and Existing Conditions

The proposed project is located in the community of Alviso, part of the City of San Jose, Santa Clara County, California. The Study Area is bounded on the southwest by Alviso Slough; on the north by Coyote Slough, Ponds A16 and A17, the "Island Ponds" (Ponds A19, A20, and A21), and the Newby Island Landfill; on the east by the Coyote Creek levee; and on the south by SR 237 (Figure 1).

Figure 1 depicts the Study Area in relation to the Alviso complex of the SBSPRP (on Refuge lands). The Alviso pond complex of the SBSPRP area bisects the Study Area, with managed ponds A9 through A17, Alviso Slough, and portions of Coyote Slough within the SBSPRP's Alviso complex, and Pond A18, New Chicago Marsh, and the WPCP being outside the SBSPRP's Alviso complex. However, the entire Study Area is within the action area for the SBSPRP's section 7 consultation (Service 2008).

Tidal marshes along both Alviso Slough and Coyote Slough are fresh/brackish in their upper reaches, where they are dominated by California bulrush, alkali bulrush, cattails, and invasive perennial pepperweed, but this vegetation transitions into salt marsh species such as Pacific cordgrass, pickleweed, and marsh gumplant toward the downstream portions of these sloughs. Artesian Slough, into which the WPCP discharges treated wastewater, is dominated primarily by freshwater marsh, which transitions to brackish marsh toward its confluence with Coyote Slough. Marshes along all three of these sloughs are relatively narrow and thus, in most places, lack the extensive channel networks that characterize larger marshes. Pond A17 has only recently been opened to tidal action, and thus rather than being vegetated, is inundated during the higher portion of the tidal cycle and consists mostly of mudflat at low tide; eventually, it is expected and intended that A17 will be dominated by tidal marsh. New Chicago Marsh is a diked, muted tidal salt marsh dominated by pickleweed, saltgrass, jaumea, and other halophytes in some areas, but with extensive open water and salt panne habitat as well.

Ponds A9, A10, A11, A14, A16, and A18 are managed ponds, with varying water depths and salinities similar to or slightly higher than Bay salinities. Ponds A9, A10, A11, and A14 are joined by breaches in their levees; water control structures along Alviso Slough at Pond A9 and Coyote Slough at Pond A14 allow water to enter these ponds. Ponds A12, A13, and A15 are also managed ponds, but are referred to as "batch ponds", because they are managed for higher salinities. Pond A16, which will be a managed pond under the SBSPRP, receives water from Pond A17 through a control structure, and water flows out of A16 through another structure in its southeastern corner; a structure along the southern edge of Pond A16 allows water to discharge into New Chicago Marsh as well. Pond A18 is not managed in concert with the other ponds; water in this pond is managed via two control structures, one in the northwest and one in the southwest portion of the pond. Currently, all managed and batch ponds on Refuge lands (A9-A15) are managed primarily as habitat for pond-associated waterbirds; Pond A18 is managed to maintain ambient conditions, with ancillary benefits to waterbirds. The Study Area also includes developed areas associated with the community of Alviso and an electrical generation plant, landfills, the WPCP water/sewage treatment areas, and upland grassland/ruderal habitat in the WPCP buffer lands.

The South Bay Shoreline Study is closely interrelated, and in some cases overlaps, with the ongoing implementation of the SBSPRP. The planning process for the South Bay Shoreline Phase I Study is being coordinated with the SBSPRP actions, as both efforts have similar FRM, ecosystem restoration, and recreation objectives. A final SPSPRP Environmental Impact Statement/ Environmental Impact Report, including both programmatic and project-specific actions, was released in December 2007 (EDAW *et al.* 2007). The total SBSPRP area consists of 15,100 acres of former salt ponds and adjacent habitats in the South Bay that the Service and CDFW acquired from Cargill, Inc. in 2003. The SBSPRP area includes the Eden Landing pond complex in the cities of Hayward and Fremont, Alameda County; the Ravenswood pond complex in the City of Menlo Park, San Mateo County; and the Alviso pond complex, which extends from the City of Mountain View southeastward to the Alviso area in Santa Clara County. The SBSPRP also includes ponds A22 and A23 in the City of Fremont, Alameda County, and the aforementioned Island Ponds (Figure 1).

The Refuge owns and manages the 8,000-acre Alviso pond complex, within which are located New Chicago Marsh and 2,100 acres of ponds included in the current South Bay Shoreline Phase I Study Area. Pond A18 (about 856 acres), owned by the City of San Jose, is also included in the South Bay Shoreline Phase I Study Area, although it is not included in the SBSPRP Study Area and was not covered by the SBSPRP's section 7 consultations. Although Pond A18 was not considered in the SBSPRP, primarily due to not being a Service-managed property, the actions being proposed for the pond are similar to those proposed for the rest of the Alviso complex ponds, and the addition of Pond A18 to the South Bay Shoreline Phase I Study Area is consistent with the goals for the greater South Bay tidal restoration.

SBSPRP Phase I construction started in 2008; the final SBSPRP Phase I restoration actions were initiated in 2011 at Alviso Complex Ponds A16 and A17. Because both Ponds A16 and A17 were restored or reconfigured as part of SBSPRP Phase I implementation, no focused South Bay Shoreline Phase I restoration actions are proposed for these two ponds (although one of the islands in A16 will be enhanced for use by western snowy plovers).

California Clapper Rail

Central/South San Francisco Bay Recovery Unit

The action area for the proposed project occurs within the Recovery Plan's Central/South San Francisco Bay Recovery Unit for the California clapper rail (Service 2013). The Central/South San Francisco Bay Recovery Unit supports the majority of California clapper rail populations. Populations in this unit are widely separated from northern ones, but there may be occasional dispersal between these areas. Predation by mammalian and avian predators is one of the primary threats to California clapper rails in the Central/South San Francisco Bay Recovery Unit (Albertson 1995, Service 2013, Overton *et al.* 2014). Overton *et al.* (2014) tracked 108 radio-marked California clapper rails at four marshes within the Central/South San Francisco Bay Recovery Unit (*i.e.*, Colma Marsh, Arrowhead Marsh, Laumeister Marsh, and Cogswell Marsh) and estimated survival rates over 166 weeks between 2007 and 2009. Overton *et al.* (2014) found that most of the California clapper rails (53 percent) died due to predation with raptors depredating 30 individual California clapper rails (28 percent) and mammals depredating 27 individual California clapper rails (25 percent). The annual survival rate for California clapper rails at Laumeister Marsh, a native tidal marsh managed by the Refuge near the City of East Palo Alto, San Mateo County, was 0.227 (Overton *et al.* 2014). The Refuge intermittently conducts mammal predator management on some Refuge lands within the Central/South San Francisco Bay Recovery Unit; however, the extent of mammal predator management implemented at the Refuge is limited by the lack of funding. The Refuge recently finalized an avian predator management plan to control avian predators of the California clapper rail on Refuge lands within the Central/South San Francisco Bay Recovery Unit; however, the Refuge lacks the resources to adequately monitor and control avian predators at the Refuge.

Breeding-season surveys of South Bay marshes for California clapper rails through the early 1990s, summarized by Foin *et al.* (1997), indicated that the most substantial populations of California clapper rails in the South Bay were, predictably, in the largest sections of tidal salt marsh at: Mowry Marsh and Dumbarton Marsh (in the eastern Bay between the Dumbarton Bridge and Mowry Slough in Alameda County), the Faber/Laumeister Tracts and other marshes in the Palo Alto/East Palo Alto area in San Mateo and Santa Clara counties, and Greco Island in the City of Redwood City, San Mateo County. California clapper rails occurred in many other marshes as well, including Ideal Marsh, La Riviera Marsh, and Calaveras Marsh in the City of Fremont, Alameda County, and Triangle Marsh in the community of Alviso, Santa Clara County. Surveys by HTH and others since the early 1990s, as well as observation by birders (including HTH staff), have documented California clapper rails in a number of areas in the far South Bay, including lower San Francisquito Creek; the Palo Alto Baylands; Hook's Isle; the mouth of Charleston Slough; lower Permanente and Stevens creeks; Guadalupe Slough (primarily from its confluence with Moffett Channel downstream); Alviso Slough; a number of locations along Coyote Slough, extending upstream through the reach of the slough between Newby Island Landfill and the WPCP (known as South Coyote Slough or the lower Coyote Creek Bypass); and in the Warm Springs marshes. Although site-specific surveys have not been conducted in all suitable habitat for California clapper rails in the South Bay, this species is likely to occur in tidal salt marsh habitats in a number of additional areas as well.

Habitats and Occurrences within the Action Area

Within the action area, California clapper rails are most likely to occur in tidal salt marsh and brackish marsh along the lower and middle reaches of Alviso Slough (*e.g.*, from the northwest corner

of Pond A12 downstream) and Coyote Slough (*e.g.*, from the vicinity of the Artesian Slough confluence downstream), and near the mouth of Artesian Slough. Although California clapper rails are known to be present in the downstream reaches of these sloughs, where the tidal marsh is dominated by salt-marsh plant species, they are less likely to occur in areas dominated by freshwater vegetation (*e.g.*, California bulrush and cattail) along the upper portions of Coyote, Artesian, and Alviso sloughs. In recent years, few surveys for California clapper rails have been conducted along the upper reaches of Alviso Slough, or anywhere in Artesian Slough or along upper Coyote Slough (upstream from its confluence with Artesian Slough).

In 2007, PRBO Conservation Science conducted surveys for California clapper rails along the middle and lower reaches of Guadalupe and Alviso sloughs (L. Liu, PRBO Conservation Science, pers. comm. cited in HTH 2013). Single California clapper rails were detected near the mouths of these sloughs (*i.e.*, along Guadalupe Slough near the Pond A5/A6 levee and along Alviso Slough east of Pond A6), but none were heard farther upstream.

More recently, surveys for the Invasive *Spartina* Project have been conducted along Alviso Slough from Pond A11 downstream to its confluence with Coyote Slough, and along Coyote Slough from the vicinity of the railroad tracks downstream along Ponds A12, A14, and A9 (data provided by Olofson Environmental, Inc.). From 2010 through 2014, all California clapper rail detections along Alviso Slough were at its mouth, near the northwest corner of Pond A9: between nine and 10 California clapper rails were detected in 2010, between four and six were detected in 2011, between one and two were detected in 2012, and between two and four California clapper rails were detected in 2014 near the mouth of Alviso Slough (Olofson Environmental, Inc. 2012, 2014).

On one occasion, a California clapper rail was recorded in brackish/freshwater transition marsh along upper Alviso Slough between the Alviso Marina and the Gold Street Bridge (February 14, 1997; Scott B. Terrill, pers. obs.). Earlier (approximately 1989) an individual California clapper rails was detected in the Alviso Marina (Ron Duke, pers. obs. cited in HTH 2013). However, no California clapper rails have been observed along upper Alviso Slough within recent years. For example, surveys conducted by the San Francisco Bay Bird Observatory at the Alviso Marina found no California clapper rails during early spring 2003 and 2004 (C. Strong, Refuge, pers. comm. 2012). Also, pre-construction California clapper rail surveys conducted by the Refuge prior to Pond A8 notch construction in 2010 did not find any California clapper rails in this reach of upper Alviso Slough (C. Strong, Refuge, pers. comm. 2012). Therefore, any occurrence of California clapper rails in upper Alviso Slough would likely be by occasional non-breeding birds.

California clapper rails have also been detected along Guadalupe Slough as far as the nontidal freshwater ponds between Calabazas and San Tomas Aquino Creeks north of SR 237 (16 August 1998; Steve Rottenborn, HTH, pers. obs.). Between one and two California clapper rails were detected along upper Guadalupe Slough again in 2012 near the Moffett Channel (Olofson Environmental, Inc. 2012). However, such rails are likely wandering and foraging individuals, and their occurrence in these areas is expected to be sporadic.

Along Coyote Slough, all California clapper rails detections since 2010 have been from Triangle Marsh (north of Pond A15) downstream to Pond A9 except for a single detection near the northwest corner of Pond A18, at the Coyote Slough/Artesian Slough confluence. Call count surveys along South Coyote Slough detected between nine and 10 California clapper rails in 2011,

between six and 10 rails in 2012, and between eight and 10 rails in 2014 between Pond A15 and Triangle Marsh (Olofson Environmental, Inc. 2012, 2014).

Therefore, based on the known occurrences of the California clapper rail within the action area, the Service believes the California clapper rail is likely to occur within the action area in all suitable tidal salt marsh and tidal brackish marsh habitat along Alviso Slough, Artesian Slough, Coyote Slough, and South Coyote Slough.

Salt Marsh Harvest Mouse

Central/South San Francisco Bay Recovery Unit

The action area for the proposed project occurs within the Recovery Plan's Central/South San Francisco Bay Recovery Unit for the salt marsh harvest mouse (Service 2013). The Central/South San Francisco Bay Recovery Unit is within the range of the southern subspecies of the salt marsh harvest mouse (*R. r. raviventris*) (Service 2013). The population status of the southern subspecies is more precarious than that of the northern subspecies (*R. r. halicoetes*). Few major, resilient, or secure populations of the southern subspecies of the salt marsh harvest mouse persist within the Central/ South San Francisco Bay Recovery Unit. The current populations within this recovery unit are very small and isolated compared with the historical pattern of distribution and abundance of the subspecies. All major population centers of the southern subspecies are remote from one another based on dispersal distances known for the species. Predation by mammalian and avian predators and spread of invasive plant species (*e.g.,* perennial pepperweed) are major threats to salt marsh harvest mice in the Central/South San Francisco Bay Recovery Unit (Albertson 1995, Service 2010, Service 2013).

Occurrences near the Action Area

The salt marsh harvest mouse has been detected during trapping studies in a number of locations within and near the action area, including Alviso Slough near the northwest corner of Pond A12, Triangle Marsh, New Chicago Marsh, the mitigation wetlands on the south side of Pond A18, the Coyote Creek Bypass area, and Guadalupe Slough (San Francisco Estuary Institute, http://www.sfei.org/content/salt-marsh-harvest-mouse-database-and-maps, site numbers 21, 57, 249, and 306; California Natural Diversity Database (CNDDB) occurrence numbers 91, 92, 115, 116, 147, 132, and 133; CDFW 2014). The highest-quality habitat for this species within the action area occurs in tidal salt marsh along the lower reaches of Alviso and Coyote Sloughs, and at the mouth of Artesian Slough, as well as in diked salt marsh within New Chicago Marsh and within the mitigation wetlands on the south side of Pond A18. Brackish marshes farther upstream along Alviso, Coyote, and Artesian Sloughs represent lower-quality habitat, and salt marsh harvest mice have a lower probability of occurrence (and if present, likely occur in lower densities) in such brackish marshes. However, as a result of this species' detection in brackish marshes in the Warm Springs area in 2006 (HTH 2007), it could occur in at least small numbers in brackish marshes. The freshwater marshes in the upper reaches of Alviso Slough (*i.e.*, from the southwestern part of Pond A12 upstream to the Alviso Marina and above) and Artesian Slough (*i.e.*, from the vicinity of the southeastern corner of Pond A17 upstream), as well as those in the South Coyote Slough area north of the northeastern corner of Pond A18, are less suitable habitat for the species.

There is no recent survey data available for salt marsh harvest mice within or near the action area. However, based on known occurrences of the salt marsh harvest mouse within and near the action area and the occurrence of suitable habitat within the action area, the Service believes that the salt marsh harvest mouse is likely to occur within all suitable tidal salt and brackish marshes, diked salt and brackish marshes, and adjacent upland habitats (*e.g.*, contiguous grassland habitat within 328 feet of suitable marsh habitat (Service 2010, 2013)) throughout the action area.

Pacific Coast Population of the Western Snowy Plover

San Francisco Bay Recovery Unit

The action area for the proposed project occurs within the San Francisco Bay Recovery Unit for the Pacific coast population of the western snowy plover (http://ecos.fws.gov/docs/recovery_plan/070924_2.pdf, Service 2007). One of the delisting criteria for the Pacific coast population of the western snowy plover is for the maintenance of 500 individual breeding western snowy plovers within the San Francisco Bay Recovery Unit (Service 2007). The SBSPRP has committed to the maintenance of at least 250 individual breeding western snowy plovers in the South Bay through adaptive management of salt pond breeding habitat and predator management within the SBSPRP area. The Refuge intermittently conducts avian and mammal predator management within some of the larger western snowy plover nesting populations in the South Bay.

In the South Bay, the highest numbers of nesting western snowy plovers occur in portions of Alameda and San Mateo counties outside the action area. Nearly all of the Bay nesting occurs south of State Route 92 (San Mateo Bridge) in the South Bay (Page and Stenzel 1981, Page *et al.* 1991, Service 2007). Abundance of western snowy plovers during surveys around the Bay may vary considerably from year to year. Summer window-survey data for the years 2009-2014 detected 147, 275, 249, 147, 202, and 178 individual western snowy plovers within the San Francisco Bay Recovery Unit during those six years (http://www.fws.gov/arcata/es/birds/WSP/plover.html, Service 2014b).

Habitats and Occurrences within the Action Area

Western snowy plover summer window-survey data for the years 2009-2014 detected eight, zero, 11, 20, 10, and zero individual western snowy plovers during those six years in the Alviso area of northern Santa Clara County (http://www.fws.gov/arcata/es/birds/WSP/plover.html, Service 2014b). In the action area itself, western snowy plovers have nested recently (*i.e.*, 2012-2014) in New Chicago Marsh, Ponds A9, A12, A13, and A16, and in the impoundment between Pond A12 and the railroad tracks (just north of the old Alviso Marina; hereafter "Alviso impoundment"). Of 13 western snowy plover nests in 2012, four each were in Ponds A16 and A17, which were being dried out for construction of islands in A16 and tidal restoration in A17 (Donehower *et al.* 2012). The other five western snowy plover nests were in Pond A13. Of the 10 western snowy plover nests in the vicinity of the action area in 2013, six were in Pond A16; one was on a recently constructed island and five were on the dried-out pond bottom when the pond was drawn down for island creation, but this area was eventually re-flooded (Robinson-Nilsen *et al.* 2013). The others included single western snowy plover nests in New Chicago Marsh and the Alviso impoundment, and two in Pond A9. In 2014, western snowy plovers have been documented nesting in Pond A9 (one nest that was flooded) and A13 (two nests that hatched young). Due to variability in water level management in Ponds A9-A15, the suitability of habitat for nesting in these ponds has varied

from year to year, and Pond A12 has provided nesting habitat in some years. Western snowy plovers have never been known or suspected to breed in the action area east of Artesian Slough (*i.e.*, in the vicinity of Pond A18).

California Least Tern

In the Bay, the primary California least tern breeding colonies are at Alameda Point in the City of Alameda and Hayward Regional Shoreline in Alameda County, and at the Montezuma Wetlands near Suisun City, Solano County. California least terns also nested in 2000 and 2001 in the City of Albany (near Alameda), Alameda County, with up to 12 pairs in 2000. In the City of Pittsburg, Contra Costa County on Suisun Bay, 13 pairs nested in 2001 and eight pairs nested in 2003. Historically, small numbers of birds have nested at the Oakland International Airport (last reported in 1995), Bay Farm Island (last reported 1975), Bair Island (last reported 1984), Port Chicago (last reported in 1988), the Bay Bridge Sand Spit (one-time attempt in 1985), and Tern Island (one-time attempt in 1990, U.S. Geological Survey preliminary data, unpubl.)

California least terns have never been recorded nesting in the vicinity of the South Bay Shoreline Phase I Study Project's action area, or anywhere else in Santa Clara County or nearby areas of Alameda County. In recent years, the main post-breeding staging area for California least terns in the South Bay has been in the complex of ponds immediately north of Moffett Field (Ponds AB1, A2E, and AB2), which are located approximately two miles west of the action area. These areas are used for roosting and foraging by adults and juveniles in July and August every year, with typical counts of 20 to 100 California least terns, although 276 were observed there in July 2004 (S. Rottenborn, HTH, pers. obs.). California least terns have also been recorded foraging or roosting at other South Bay ponds, including A1, A2E, A3N, A3W, A4, A5, A7, A9, A10, A11, and A14 (Marschalek 2006; J. Krause, CDFW, pers. comm.; U.S. Geological Survey preliminary data, unpubl.). Ravenswood ponds in San Mateo County are also used occasionally for foraging and roosting, with counts of 96 California least terns in July 2002, 42 in July 2003, and 110 in July 2004 (U.S. Geological Survey preliminary data, unpubl.). Eden Landing ponds in Alameda County are used irregularly for foraging including E2, E4, E5, E8A, E9, E10, and E11. California least terns do not generally forage in smaller sloughs or channels adjacent to managed ponds but rather prefer more open waters, including the Bay waters; 50 of 58 California least terns observed foraging at one South Bay location in July 2004 were doing so over the open waters of the Bay while the other eight were foraging in ponds (S. Rottenborn, HTH, pers. obs.).

California least terns are not known to nest in the action area. California least terns have been observed foraging in the action area's ponds (A9, A11, and A14) only rarely, and they have not been observed foraging in Pond A18, despite occasional visits by birders and biologists to A18 and birder coverage of A18 (using spotting scopes) from the Pond A16 levee. Although California least terns could potentially forage in any of these ponds that contain fish, survey data collected for the SBSPRP and incidental observations by birders indicate that California least terns visit the action area (as a post-breeding forager) irregularly and in low numbers.

Effects of the Proposed Project

The footprint of ground disturbance from the proposed project consists of a total of approximately 165 acres. Table 1 below lists the acreages of each of habitat type that will be disturbed by the proposed Corps-led actions (*e.g.*, construction of the levees, the Artesian Slough tide gate, the

Table 1. Habitat Disturbance from the Proposed Project.

Habitat Type	Impacts of Corps-Led Actions (acres)		Impacts of Service-Led Actions (acres)	Total Habitat Disturbance (acres)
	Levee/Tide Gate/ Bridge Construction	A18 Ecotone/ Tidal Restoration	A12 Ecotone/ Tidal Restoration	
Brackish marsh	0.20	0.07	0.03	0.3
Freshwater marsh	1.04	0.06	<0.01	1.1
Muted tidal/diked marsh	1.80	0.00	0.00	1.8
Tidal salt marsh	1.64	0.03	0.03	1.7
Non-tidal salt marsh	8.20	0.00	0.00	8.2
Seasonal wetland	3.65	0.00	0.05	3.7
Mudflat	0.59	0.01	0.00	0.6
Batch pond	3.60	0.00	29.00	32.6
Managed pond	12.07	66.13	0.00	78.2
Open water	9.40	0.00	0.00	9.4
Upland vegetation	1.00	0.00	0.00	1.0
Water/sewage treatment	0.10	0.00	0.00	0.1
Levee	18.49	0.33	0.88	19.7
Developed	6.15	0.24	0.01	6.4
TOTAL	67.93	66.87	30.00	164.8

pedestrian bridge, and the Pond A18 ecotone and tidal restoration activities) and Service-led actions (*e.g.*, construction of the Pond A12 ecotone and Ponds A9-A15 tidal restoration activities). Construction of trails and other recreational facilities, which is a Service-led activity, will occur entirely on existing levees and berms, or in ruderal grassland along SR 237, and thus the acreage of such habitat disturbance from trail construction is not included in Table 1.

In the following sections discussing effects on individual listed species, effects are separated for Corps-led and Service-led activities as appropriate. Because of the tidal flood protection functions currently provided by the outboard levees around Ponds A9-A15, tidal restoration within those ponds would not be feasible without enhancement of flood protection inboard from those ponds. As a result, the effects of Service-led tidal restoration on Refuge lands could not occur but for the Corps-led construction of the levee and tide gate, and thus, the benefits that accrue from tidal restoration on Refuge lands are dependent on Corps-led levee construction.

California Clapper Rail and Salt Marsh Harvest Mouse

Habitat Restoration

Effects of Corps-led Actions

The highest-quality habitat for the California clapper rail and salt marsh harvest mouse consists of tidal salt marsh, although these species will also use tidal brackish marshes to some extent. Tidal restoration in Pond A18 is expected to result in the creation of approximately 119 acres of tidal salt marsh and 398 acres of brackish marsh habitat for the California clapper rail and salt marsh harvest mouse (HTH 2012). In addition, approximately 67 acres of ecotone habitat will be created along the southern and eastern edges of Pond A18. The ecotone created along the southern and eastern edges of Pond A18 will provide high quality extreme high tide refugia cover for California clapper rails and salt marsh harvest mice which will reduce the risk of predation. The grassland habitat along the ecotone will also provide foraging and dispersal habitat for salt marsh harvest mice. The ecotone will also allow for the landward transgression of the tidal marsh in the face of sea level rise and provide a buffer between the marsh and developed areas. This ecotone habitat is expected to develop more quickly than the tidal marsh in A18, which will not become vegetated until sedimentation has elevated the former pond bottom to the point where vegetation can colonize it. Within a few years, it is expected that vegetation along the ecotone will provide habitat that is of higher quality for salt marsh harvest mice than the narrow strip of vegetation that is currently present along the southern and eastern edges of Pond A18.

Effects of Service-led Actions

Assuming that all of Ponds A9-A15 are eventually restored to tidal action, approximately 2,010 acres of new tidal marsh will be restored within these ponds. All of this restored tidal marsh is predicted to be salt marsh (HTH 2012). In addition, 30 acres of ecotone habitat will be created along the eastern edge of Pond A12; habitat along the ecotone is expected to become suitable for use by salt marsh harvest mice within a few years after seeding and planting occur. If only Ponds A12 and A18 are restored, then approximately 300 acres of suitable tidal marsh will be restored in A12 and 517 acres of suitable tidal/brackish marsh habitat will be restored in A18. The ecotone habitat created along the eastern edge of the restored tidal marsh in Pond A12 will benefit the California clapper rail and salt marsh harvest mouse by providing transitional habitat for the rail and the mouse to utilize as cover during extreme high tide and flooding events which will reduce the risk of predation. The ecotone will also provide foraging and dispersal habitat for the salt marsh harvest mouse. The ecotone will also allow for the landward transgression of the tidal marsh in the face of sea level rise and provide a buffer between the marsh and developed areas.

Habitat Restoration Effects Common to Corps-led and Service-led Actions

All of these marshes (in Pond A18 and A9-A15) will support complex channel networks. These channels will provide extensive foraging habitat for California clapper rails, and the larger channels will provide natural levees supporting taller cordgrass and gumplant, which serve as rail nesting habitat and high-tide refugia.

Because the rate of evolution of tidal habitats is dependent largely on sediment availability, which is difficult to predict, the precise rates of evolution of these marshes are unknown. However, the

following general timeline of expected marsh evolution predicted for restored South Bay marshes by the SBSPRP indicates the likely habitat progression expected over the 50-year timeline of the South Bay Shoreline Phase I Study Project.

Habitat restoration in the action area described above for California clapper rail will result in similar benefits for the salt marsh harvest mouse. Because salt marsh harvest mice reach their highest densities in mature marshes with pickleweed, which form in the highest marshes, the evolution of suitable habitat for salt marsh harvest mice within restored marshes will be slower than for California clapper rails, as it will take longer for marsh elevations to reach elevations appropriate for pickleweed dominance. However, development of suitable habitat for salt marsh harvest mice in the ecotones will be relatively rapid. Once suitable habitat is restored, the high fecundity of salt marsh harvest mice will ensure that this species will rapidly colonize and spread throughout the restored pickleweed marshes from occupied habitat along Coyote or Alviso sloughs or other suitable habitat.

The amount of habitat for the California clapper rail and salt marsh harvest mouse that will be restored by both the Corps-led and Service-led actions is expected to substantially increase South Bay populations of these species, and contribute greatly to their survival and recovery. In addition, the restoration of ecotones in Ponds A18 and A12 will provide high-quality refugia during extreme high tides that inundate the rest of the marsh plain, thus helping to improve winter survival rates. The ecotones will also provide seasonal foraging and dispersal habitat for the salt marsh harvest mouse in addition to providing some residence habitat for this species.

Estimated Timeline for Tidal Marsh Establishment

In 2020, Pond A12 will be breached, restoring full tidal action to approximately 300 acres of salt pond (though see the previous discussion of the possibility that Pond A18 may be breached first). By Year 10 (2027), enough sediment is expected to have accumulated in other areas of this former pond that low tidal marsh vegetation dominated by Pacific cordgrass will start to become established. Use of the restored marshes by California clapper rails is expected to occur as soon as enough vegetation is present to provide cover for foraging California clapper rails. Even though this vegetation may not be dense and/or extensive enough to provide nesting habitat by Year 10, California clapper rails are expected to forage on intertidal mudflats near vegetative cover, which may occur near the breach locations.

In 2023, the Pond A18 ecotone will be constructed and seeded providing suitable habitat for colonization by salt marsh harvest mice from nearby areas. In 2025, additional breaching may restore tidal action to approximately 875 acres in Ponds A9, A10, A11, and 736 acres in Pond A18. By 2027, tidal marsh vegetation will begin to colonize the edges of levees and berms, but by the end of Year 10 (2027), the bottoms of Ponds A9, A10, A11, and A18 may still be too low for substantial vegetation establishment.

As sediment continues to accumulate in the restored ponds, bottom elevations will be raised, and the areas at elevations suitable for colonization by tidal marsh vegetation will increase. By Year 20 (2037), vegetation will be expanding outward from the ecotone area and the edges of other levees and berms, and it is expected that sufficient sediment will have accumulated in other portions of Ponds A9-A12 and A18 that low marsh suitable for use by California clapper rails for nesting and foraging will have developed.

In 2030, an additional 850 acres of tidal restoration may occur via breaching of Ponds A13, A14, and A15. Thus, by Year 13 (2030), approximately 2,010 acres of new tidal habitat in Ponds A9-A15 and 736 acres in Pond A18 will have been restored. Evolution of marshes within Ponds A13-A15 will occur gradually as described above for other ponds.

In Years 20-50 (2037-2067), vegetated marsh will continue to expand in area and increase in elevation as sediment accumulates. Although sea level rise will raise the elevation of water within the restored marshes, thus restricting the rate of marsh development to some extent, it is predicted that the rate of sediment accumulation will outpace sea level rise, so that vegetated marshes will colonize all but the lowest-elevation areas such as tidal sloughs and channels (ESA and Philip Williams & Associates, Ltd. 2012, HTH 2012). Suitable nesting habitat and cover for the California clapper rail and salt marsh harvest mouse will continue to expand, and higher-marsh areas that form on natural levees along the larger tidal sloughs will provide high-tide refugia. By Year 50, it is expected that approximately 2,130 acres of restored tidal salt marsh and 398 acres of restored brackish marsh suitable for use by California clapper rails and salt marsh harvest mice will have been restored.

Increased Salinity and Beneficial Marsh-Type Conversion

Effects of Corps-led Actions

Breaching of Pond A18 will result in an increased tidal prism and salinization of brackish and fresh marshes throughout all of Artesian Slough and Coyote Slough, thus resulting in the expansion and enhancement of California clapper rail and salt marsh harvest mouse habitat over large areas of existing brackish and freshwater marsh along these sloughs. In addition, this change in the tidal gradient will result in the development of higher-quality habitat in already-breached Pond A17 and the Island Ponds than would develop in the absence of breaching of A18. The effects on salinities within existing marshes would be immediate, and within a period of just a few years, it is expected that considerable expanses of brackish marshes dominated by bulrush and pepperweed will have begun conversion to marshes dominated by Pacific cordgrass, pickleweed, and gumplant.

Effects of Service-led Actions

Restoration of tidal action to Ponds A9-A15 will result in an increased tidal prism and salinization of brackish and fresh marshes along Alviso Slough upstream to Pond A12 and along lower Coyote Slough, thus resulting in the expansion and enhancement of California clapper rail and salt marsh harvest mouse habitat in these areas. In addition, this change in the tidal gradient will result in the development of higher-quality habitat in already-breached Pond A6 and the Island Ponds than would develop in the absence of breaching of Ponds A9-A15. These effects are expected to occur rapidly.

Increased Salinization Effects Common to Corps-led and Service-led Actions

As levees are breached and ponds are subjected to tidal action, these ponds will draw considerable amounts of water through the breaches on rising tides. As a result, the rate of water flowing "upstream" along Alviso, Artesian, and Coyote sloughs, from the Bay into the breached ponds, on rising tides will be considerably higher than it currently is. This will result in the transportation of more saline Bay water upstream, and higher upstream, along these sloughs than currently occurs.

The effect of this change in tidal prism and the upstream migration of the salinity gradient will be the salinization of marshes along these sloughs that are currently brackish and fresh marshes due to the inputs of freshwater from Coyote Creek, the Guadalupe River, and WPCP effluent. Because outboard levee breaches will be located high up these sloughs, such as at Pond A12 along Alviso Slough, in the southwest corner of Pond A18 along Artesian Slough, and in the northeast corner of Pond A18 along Coyote Slough, more saline water will be drawn far up these sloughs, and this salinization will affect the plant species composition of marshes on a very large scale. The result will be the conversion of extensive areas of brackish marsh to salt marsh and conversion of extensive areas of freshwater marsh to brackish marsh. As a result, habitat conditions within existing brackish and fresh marshes along Alviso Slough, Artesian Slough, and Coyote Slough will become much more suitable for California clapper rails and salt marsh harvest mice. Furthermore, the upstream migration of the salinity gradient will result in higher-salinity marshes in recently restored areas such as the Island Ponds, Pond A6, and Pond A17, thus helping to enhance habitat for California clapper rails and salt marsh harvest mice beyond the conditions that would be created in the absence of the South Bay Shoreline Phase I Study Project.

In particular, given the vast extent of brackish and freshwater marsh along Coyote Slough, the breaching of Pond A18 will result in considerable expansion of California clapper rail and salt marsh harvest mouse habitat up Coyote Slough and much higher-quality rail and mouse habitat in Pond A17 and the Island Ponds. Marsh evolution predictions for the proposed project took the increased tidal prism along Coyote Slough, resulting from Pond A18 breaching into account when predicting that the entirety of restored tidal habitat in Ponds A9-A15 would be salt marsh instead of brackish marsh (HTH 2012). Thus, the increase in California clapper rail and salt marsh harvest mouse habitat and enhancement of rail and mouse habitat quality as a result of both the Corps-led and Service-led actions will be far greater than just the increase in tidal marsh within the ponds to be breached.

The salinization of tidal marsh that will result from the proposed project will also expedite project benefits to the California clapper rail and salt marsh harvest mouse. As described previously, there will be a lag between breaching of levees and development of California clapper rail and salt marsh harvest mouse habitat due to the need for sediment accumulation to elevate pond bottoms enough that vegetation can colonize the restored habitat. In the case of increased salinization, however, the effects on salinities within existing marshes would be immediate, and within a period of just a few years, it is expected that considerable expanses of brackish marshes dominated by bulrush and pepperweed will have begun the conversion to marshes dominated by Pacific cordgrass, pickleweed, and gumplant.

Loss of Habitat

Effects of Corps-led Actions

Artesian Slough Tide Gate and Pedestrian Bridge

Construction of the Artesian Slough tide gate and Artesian Slough pedestrian bridge will result in the loss of suitable habitat for the California clapper rail and salt marsh harvest mouse through the placement of fill in salt and brackish marsh habitat, but no suitable nesting habitat for California clapper rails will be directly affected. Construction of the tide gate and pedestrian bridge in Artesian Slough will result in the direct disturbance of about 1.04 acres of non-breeding tidal freshwater

marsh habitat that may be occasionally utilized by a low number of foraging and dispersing California clapper rails and salt marsh harvest mice. As indicated in Table 1, 1.64 acres of tidal salt marsh will be disturbed; however, this marsh is located in a narrow strip along the Alviso impoundment and is not truly tidal, receiving tidal inflow only during the highest tides. As a result, the disturbance of muted tidal marsh along the Alviso impoundment will disturb potential habitat for the salt marsh harvest mouse but not the California clapper rail.

Excavation of Pilot Channels and Pond A18 Breaches

Excavation of pilot channels in the outboard marsh around Pond A18 will occur in five locations, four along Artesian Slough and one at South Coyote Slough. The marsh vegetation at these breach locations consists of brackish marsh at three locations and freshwater marsh at two locations. Excavation of pilot channels and breaching will result in the direct disturbance of about 0.07 acre of brackish marsh and 0.04 acre of tidal salt marsh that could potentially support low densities of California clapper rails and salt marsh harvest mice. It is possible that the salt and brackish marsh provides suitable nesting and foraging habitat for California clapper rail. However, given the paucity of California clapper rail occurrences along Artesian Slough and the extreme eastern end of South Coyote Slough in recent years, it is likely that very few rails use this habitat, and then only occasionally (and likely only during the non-breeding season).

FRM Levee Construction

Construction of the FRM levee will result in the loss of non-tidal salt and brackish marsh habitat and adjacent upland habitat along the edges of Ponds A16 and A18 and New Chicago Marsh that are suitable habitat for the salt marsh harvest mouse but not the California clapper rail. Areas with vegetation that potentially supports the salt marsh harvest mouse, and that will be disturbed by fill placed for the levee, include non-tidal and muted tidal/diked salt marsh along the southern, western, and northern edges of the Alviso impoundment; the northern edge of New Chicago Marsh, adjacent to the southern levee of Pond A16; and both the northern and southern sides of the existing Pond A18 levee. The loss of suitable salt marsh harvest mouse habitat will result from the widening of the levee, relative to its existing footprint, and will affect a total of about 13.65 acres of vegetation dominated by pickleweed, alkali heath, grasses, and non-native weedy species that provide at least marginal-quality habitat for salt marsh harvest mice. No suitable California clapper rail habitat will be disturbed by the widening of the levee footprint because the marshes along the existing levee are non-tidal and thus not likely to support the rail.

No high-quality salt marsh harvest mouse habitat will be impacted by widening of the levee. The habitat that will be disturbed consists of narrow strips of vegetation located between the existing bare levee and either bare salt panne/mud (along the Alviso impoundment), the waters of Ponds A16 and A18, or a borrow ditch (on the south side of the levee at Ponds A16 and A18). The impacted habitat is very narrow, which increases the risk of predation on any salt marsh harvest mice that might be present in those strips of vegetation, and is separated by unsuitable habitat (*e.g.*, open ground without vegetation or open water) from more extensive, higher-quality expanses of habitat, such as that in New Chicago Marsh and in the wetlands south of Pond A18 and east of Artesian Slough. Even along the southern edge of the Pond A16 levee, the strip of pickleweed and other vegetation between the levee and New Chicago Marsh is narrow, includes much dead and sparse vegetation, and supports only a patchy distribution of dense, tall, high-quality pickleweed. As a result, the quality of habitat, and the expected density of salt marsh harvest mice within the habitat

to be impacted, is low, and the effects on salt marsh harvest mouse populations from the loss of these narrow strips of vegetation will be low.

Furthermore, these narrow strips of vegetation do not provide high-quality dispersal habitat for the salt marsh harvest mouse. The strips on the outboard (northern) side of the Pond A18 levee are separated by the bare levee itself from potential source populations of salt marsh harvest mice in New Chicago Marsh, the wetlands east of Artesian Slough, or the Coyote Creek Bypass. Open, unvegetated areas may act as barriers to movement of salt marsh harvest mice (Shellhammer 1978, Geissel *et al.* 1988), and thus salt marsh harvest mice likely cross the levee to and from this habitat very infrequently. In order for this vegetation to serve an important dispersal function, salt marsh harvest mice would have to cross bare levees from one source population, move long distances through the narrow strip of vegetation (or survive over generations within that narrow strip so that progeny eventually disperse long distances over time), and cross the bare levee again to reach another high-quality habitat area. Such occurrences are unlikely, or happen very infrequently. The narrow strip of vegetation along the western edge of the Alviso impoundment is even further removed from high-quality habitat, being separated from New Chicago Marsh by a broad salt panne and the railroad tracks.

Following levee construction, unimpacted pickleweed-vegetated areas between the Zanker Landfills/WPCP and the new levee will continue to provide suitable dispersal and residence habitat for salt marsh harvest mice. More importantly, a broad ecotone along the southern and eastern sides of A18 will be constructed. This ecotone will provide much higher-quality residence and dispersal habitat than what will be impacted. This 345-foot-wide ecotone will extend from the levee top downslope to Pond A18. The native plants that will be seeded or planted on this ecotone area will provide suitable dispersal habitat for salt marsh harvest mice, and wetland vegetation and peripheral halophytes near the lower edge of the ecotone area will provide residence habitat for the salt marsh harvest mouse that is at least as suitable (or of much higher quality) as what will be impacted. This ecotone will thus compensate (and more) for any loss of habitat along Pond A18, both in terms of the acreage of habitat impacted and linearly, replacing low-quality habitat with higher-quality habitat in the same areas linearly along the levee. Although no broad ecotone habitat is proposed at Pond A16 to replace the narrow strips of vegetation lost due to levee widening, the lower slopes of the levee will be allowed to be vegetated, and pickleweed of similar quality and extent to that currently present is expected to colonize these lower slopes. This pickleweed will not be mowed, as mowing would occur only on the higher portions of the levee. Along the eastern edge of Pond A12, the vegetation to be lost (*i.e.*, between the A12 levee and the Alviso impoundment) is so narrow that it likely serves little function, either as residence or dispersal habitat, for salt marsh harvest mice. As a result, the loss of this habitat to FRM levee construction does not warrant immediate compensation in situ by the Corps. Rather, the broad ecotone to be constructed by the Service and local sponsors on the west side of the FRM levee at Pond A12 will more than compensate for any lost salt marsh harvest mouse habitat in the A12 vicinity. Although the construction of the Pond A12 ecotone is a Service-led activity, it would not be feasible but for the construction of the FRM levee by the Corps, and thus the Corps' levee construction is enabling that important habitat restoration component.

Construction of the FRM levee on the existing Pond A18 levee footprint will modify the structures that convey water in and out of the non-tidal wetlands east of Artesian Slough and south of Pond A18. These wetlands contain extensive pickleweed and are thus expected to support resident salt marsh harvest mice. The proposed project will replace any modified or removed water control

structures so that flow in and out of these wetlands can continue and existing conditions within the wetlands will be maintained.

Scour of Tidal Marsh Habitat

Following breaching of Pond A18, the increased tidal prism will result in the scour of sediment, and some vegetated marsh, from channels leading between the Bay and the breach locations. As a result, some loss of existing fringe marsh for the California clapper rail and salt marsh harvest mouse will occur along Artesian and Coyote sloughs. This marsh will consist primarily of brackish and freshwater marsh, but some salt marsh along lower Coyote Slough will be lost to scour as well. The acreage of marsh expected to be lost due to scour resulting from the breaching of Pond A18 is unknown. The SBSPRP predicted that 220-250 acres of marsh loss to scour would occur over a 50-year period resulting from restoration of tidal action to as much as 11,500 acres for the entire SBSPRP (*i.e.*, scour of about 2 percent of the marsh restored). Given the 736 acres of tidal restoration proposed at Pond A18, the extent of marsh loss for the California clapper rail and salt marsh harvest mouse due to scour might be roughly estimated at 17 acres. Such marsh loss would be gradual, and this total represents the total loss due to scour over the 50-year proposed project period.

The fringe marshes of the South Bay, which will be the marshes adversely affected by this scour, often provide the only habitat connecting the larger patches of marsh habitat that contain the "core" populations of salt marsh harvest mice. The loss of these marshes in the short term, before the restored marshes have matured to vegetated high marsh, could temporarily reduce the connectivity between the salt marsh harvest mouse populations of the South Bay. However, the short-term loss of salt marsh harvest mouse habitat and connectivity from fringe marsh scour will be offset by an order of magnitude when the restored marsh matures to a point that it can support salt marsh harvest mice. In the meantime, the marsh loss due to scour will be far less than the expected extent of marsh-type conversion (*i.e.*, from fresh or brackish marsh to salt marsh) due to increased salinization related to increased tidal prism. As a result, the enhancement of California clapper rail and salt marsh harvest mouse habitat from increased salinization will outpace any adverse effects of marsh loss due to levee construction, breaching, and localized scour while new tidal salt marsh is developing within restored Pond A18. The short-term nature of any reduction in connectivity from construction and scour suggests that it will not adversely affect the metapopulation dynamics or genetic diversity of the salt marsh harvest mouse in the South Bay.

To put the loss of marsh from excavation of pilot channels and downstream scour of fringing marsh into perspective, this 17 acres of marsh loss is far less than the expected extent of marsh-type conversion (*i.e.*, fresh or brackish marsh to salt marsh) due to increased salinization related to increased tidal prism. As a result, the beneficial effects on California clapper rail and salt marsh harvest mouse populations due to enhancement of habitat resulting from increased salinization will outpace any adverse effects of marsh loss due to breaching and localized scour in the near term while the much more extensive tidal salt and brackish marsh is developing within restored Pond A18.

During any construction or excavation activities that may result in impacts to tidal marsh habitat, the limits of work will be clearly delineated to limit effects to existing California clapper rail and salt marsh harvest mouse habitat. Side-casting of dredged materials into tidal marsh habitat (*e.g.*, during excavation) will be limited so that a minimum amount of marsh is filled. Conservation measures

incorporated into the proposed project will minimize effects of human activity within marshes on California clapper rail and salt marsh harvest mouse habitat.

Effects of Service-led Actions

The only Service-led activities that could result in the loss of existing California clapper rail and salt marsh harvest mouse habitat will occur as a result of tidal restoration at Ponds A9-A15. Excavation of pilot channels in the outboard tidal marsh around these ponds will disturb about 0.03 acre of salt marsh, 0.03 acre of brackish marsh, and <0.01 acre of freshwater marsh at five breach locations along Alviso Slough and one breach location along Coyote Slough. Because recent surveys for California clapper rails conducted for the Invasive *Spartina* Project along Alviso Slough have only detected California clapper rails at the mouth of the slough, pilot channel construction and breaching at the four breach locations on Ponds A10 and A12 are likely to have little effect on habitat that is used by nesting California clapper rails; rather, this habitat is likely used only by occasional, foraging, non-breeding individuals. The breach in the northwest corner of Pond A9 is closer to areas where California clapper rails have been recently detected, but it is located at an existing tide gate where the marsh along Alviso Slough is extremely narrow, too narrow to provide suitable nesting habitat or high-quality foraging habitat for California clapper rails. The only location where pilot channel excavation could affect habitat that has any likelihood of being used by breeding California clapper rails is in the northeastern corner of Pond A9, where the pilot channel will be excavated out to Coyote Slough. It is likely that salt marsh harvest mouse abundance in most of the breach locations is low owing to the brackish and/or very narrow nature of the marshes at these locations. However, the breach in the northeast corner of Pond A9 is located in tidal salt marsh that is more suitable for this species. Vegetation is almost completely absent from the internal berms within the Ponds A9-A15 system, and thus within-pond preparation activities for tidal breaching will not disturb any suitable salt marsh harvest mouse habitat.

Prior to or concurrent with restoration of tidal action in Ponds A9, A10, and A11, the berm between Ponds A11 and A12 will be breached. If California clapper rail and salt marsh harvest mouse habitat has developed within Pond A12 by that time, there may be a temporary loss of habitat due to breaching. However, that habitat will be quickly offset by continued marsh development. Similarly, berms between A14 and A9/A11, and between A13 and A12, will be breached prior to or concurrent with restoration of tidal action in Ponds A13-A15, potentially resulting in temporary losses of California clapper rail and salt marsh harvest mouse habitat. Again, any such losses will quickly self-restore.

As mentioned above, the increased tidal prism resulting from restoration of tidal action to Ponds A9-A15 will cause the scour of sediment, and some vegetated marsh, from channels leading between the Bay and the breach locations. As a result, some loss of fringe marsh along Alviso Slough and Coyote Slough will occur. Such scour will reduce habitat for the California clapper rail and salt marsh harvest mouse and may limit dispersal of salt marsh harvest mice along these sloughs to some extent in the short term. Assuming that the loss of marsh to scour might comprise approximately 2 percent of that restored, up to 40 acres of tidal marsh might be lost to scour over the 50-year proposed project period. This marsh would be limited to Alviso Slough downstream from Pond A12 and a small area of Coyote Slough from the northwest corner of Pond A9 downstream. Such marsh loss will occur gradually due to the phasing of breaching at these ponds (Pond A12 in 2020, A9-11 in 2025, and A13-15 in 2030). However, the beneficial effects on California clapper rail and salt marsh harvest mouse populations due to enhancement of habitat resulting from increased

salinization are expected to outpace any adverse effects of marsh loss due to breaching and localized scour while new tidal salt and brackish marsh is developing within the restored marshes in Ponds A9-A15. Once cordgrass and pickleweed-dominated habitat colonizes the restored marsh within these former ponds, California clapper rail and salt marsh harvest mouse habitat will be expanded by orders of magnitude.

Small-scale, localized disturbance of habitat for the California clapper rail and salt marsh harvest mouse may also occur from walking through marshes or grounding boats in marshes during monitoring, research, or predator management efforts. Such disturbance would be very limited, particularly with implementation of proposed conservation measures (*e.g.*, for perennial pepperweed control). Effects to California clapper rails and salt marsh harvest mice resulting from monitoring, research, and predator management on the Refuge will be covered by the existing biological opinion for the SBSPRP and a future biological opinion for the Refuge's Comprehensive Conservation Plan. Effects to California clapper rails and salt marsh harvest mice resulting from perennial pepperweed control are discussed below under the "Perennial Pepperweed Control" section."

Direct Effects to Individuals

Effects of Corps-led Actions

California Clapper Rail

Construction of the FRM levee, Artesian Slough tide gate, and Artesian Slough pedestrian bridge has the potential to disturb areas where California clapper rails are occurring only at Artesian Slough. Due to the low quality of this freshwater marsh for use by California clapper rails, there is a very low probability that a rail would be anywhere in the vicinity of the tide gate/pedestrian bridge construction area when activities are occurring in the tidal marsh. Furthermore, because the freshwater habitat in that location is not suitable for use by breeding California clapper rails, no nests, eggs, or young would be affected by activities at that location, and any California clapper rail present in the vicinity would move away from construction activities long before it could be physically injured or killed. Therefore, no loss of individuals, nests, eggs, or young will occur from construction of the FRM levee, Artesian Slough tide gate, and Artesian Slough pedestrian bridge.

Excavation of pilot channels in the outboard marsh around Pond A18 is also unlikely to result in the loss of any California clapper rails. The brackish marsh habitat at three of the pilot channel locations does not provide high-quality nesting habitat, due both to its brackish nature and the narrow nature of the marsh at those locations, and there is a low probability that California clapper rails would be breeding in those areas. Further, if pilot channel excavation in brackish or salt marsh habitat is conducted during the breeding season (February 1 – August 31), surveys for California clapper rails will be conducted prior to proposed project activities to determine whether nesting California clapper rails are present in the vicinity. If California clapper rails are detected, buffers between rail activity centers and construction will be followed. During any construction or excavation activities that may result in effects to California clapper rails, the limits of work will be clearly delineated to limit effects to this species. These conservation measures will minimize effects of human activity within marshes on California clapper rails.

Disturbance such as loud noise or the presence and movement of people and heavy equipment in or near California clapper rail habitat may alter bird behavior in ways that result in altered foraging or

sheltering behavior and reduced nesting success. Such disturbance could result in temporary or permanent habitat loss due to California clapper rail avoidance of areas that have suitable habitat but intolerable levels of disturbance; abandonment of nests, eggs, or young by nesting pairs; a reduction in foraging efficiency if high-quality foraging areas are impacted; and increased movement or flushing from cover, or altered activity patterns, that reduce energy reserves and increase predation risk. The potential for disturbing breeding California clapper rails will be avoided by delaying construction activities within suitable California clapper rail breeding habitat until after the breeding season unless protocol-level surveys determine California clapper rails are absent from a 700-foot-buffer around the proposed work area. The level of disturbance of California clapper rails will also be minimized by having a Service-approved biological monitor supervise the work.

Loss of individual California clapper rails due to predation could be exacerbated by the proposed project. The restoration of tidal marsh habitat will increase habitat for northern harriers, which may prey on California clapper rails (especially chicks). However, because habitat for northern harriers is suitable for California clapper rails as well, the increase in California clapper rail populations due to habitat restoration in a given area is expected to outpace any adverse effects of predation by northern harriers. Local increases in predation on California clapper rails may occur due to marsh restoration in close proximity to areas frequented by California gulls, such as the Newby Island Landfill, Pond A16, and New Chicago Marsh; electrical towers within Pond A18 that provide known nesting sites for common ravens and red-tailed hawks, and perches for peregrine falcons; and upland areas providing sources of predators such as cats, rats, foxes, raccoons, white-tailed kites, and American crows. Although terrestrial pathways used by mammalian predators to access marshes will be reduced through the breaching of levees in some areas, marshes that abut upland areas will be subject to predation by land-based predators. In addition, rock at the bridge abutments and surrounding electrical towers in Pond A18 may provide refugia for rats that may prey on California clapper rail eggs. The risk of predation on California clapper rails will be reduced by the implementation of a Service-approved long-term predator management and litter cleanup program under a cooperative agreement among the SCVWD, the Refuge, and the City of San Jose that will be funded by the SCVWD.

Maintenance activities along the FRM levee have the potential to disturb California clapper rails in Ponds A12, A13, and A18 after tidal restoration has occurred and rail habitat has developed within those former ponds. Recreational use of the Bay Trail segment atop the levee will affect California clapper rails in adjacent areas to the point that rails present in those restored marshes during levee maintenance activities will already be habituated to some level of human activity on the levee. In addition, the 345-foot wide ecotones will limit the potential for levee maintenance activities to adversely affect California clapper rails. As a result, routine inspections and minor maintenance activities are not expected to result in an increase in California clapper rail disturbance, relative to other types of levee use. Even mowing along the levee tops is unlikely to cause substantial disturbance of California clapper rails given the very narrow swaths to be mown, the brevity of mowing operations, and the distance (330 feet or more) between mowing and California clapper rail habitat. However, maintenance activities involving heavy equipment would be conducted outside of the California clapper rail's nesting season to the extent practicable, and if seasonal avoidance is not possible, pre-construction surveys would be conducted for nesting California clapper rails, and appropriate buffers would be implemented between proposed project activities and nesting rails as necessary.

Salt Marsh Harvest Mouse

Construction of the FRM levee, Artesian Slough tide gate, and Artesian Slough pedestrian bridge will result in fill of vegetated areas that could potentially support small numbers of salt marsh harvest mice. Excavation of pilot channels in the outboard marsh around Pond A18 will also result in removal of brackish marsh that could potentially support low densities of salt marsh harvest mice. Although the number of individual salt marsh harvest mice that may be present in habitat to be impacted by levee construction and pilot channel excavation is low, individual salt marsh harvest mice could potentially be injured or killed by crushing or smothering during the placement of sediment or other materials in suitable habitat, or by excavation of habitat. Conservation measures such as hand-removal of vegetation in potential salt marsh harvest mouse habitat under the supervision of a Service-approved biologist, measures to ensure that salt marsh harvest mice leave areas prior to impacts, and salt marsh harvest mouse exclusion fencing will be implemented to minimize the potential for injury and mortality of individual salt marsh harvest mice.

Disturbance such as loud noise or the presence and movement of people and heavy equipment in or near salt marsh harvest mouse habitat may alter mouse behavior in ways that result in alteration of foraging and sheltering activities or reduced breeding success. Disturbance may result in displacement of salt marsh harvest mice from protective cover and their territories/home ranges (through noise and vibrations) and/or direct injury or mortality (through crushing). These disturbances are likely to disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and are likely to result in the displacement of salt marsh harvest mice from their territory/home range in the areas where their habitat is destroyed. Displaced salt marsh harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predators. Disturbance of female salt marsh harvest mice, particularly during the period of March through November, may cause abandonment or failure of the current litter. Thus, displaced salt marsh harvest mice may suffer from increased predation, competition, mortality, and reduced reproductive success.

Noise from construction activities associated with the FRM levee, Artesian Slough tide gate, and Artesian Slough pedestrian bridge close to suitable salt marsh harvest mouse habitat may alter mouse breeding, foraging, and sheltering behavior. Salt marsh harvest mice may be similarly disturbed during excavation of pilot channels, preparation of ponds for breaching (*e.g.*, construction of ditch blocks), and access of construction areas by heavy equipment along existing levee roads.

Loss of individual salt marsh harvest mice due to predation could be exacerbated by the proposed project, at least in localized areas, as described for California clapper rail. Predator management and MAM performed by the Refuge and the SBSPRP will help to minimize the risk of predation.

Vegetation management along the levees has some potential to result in the injury or mortality of individual salt marsh harvest mice and the disturbance of foraging, sheltering, and dispersal activities. However, the potential for take and number of individuals that could be taken is very low, for several reasons. First, the strip of vegetation that will be mowed along the levee top will be very narrow (expected to be 15 feet or less). Only ruderal grassland foraging/dispersal habitat and no suitable pickleweed breeding habitat will be mowed; therefore, the potential for disturbing breeding salt marsh harvest mice or a salt marsh harvest mouse nest will be avoided because breeding mice will not be present in these areas. Mowing from the levee top downslope will result in slight disturbance of downslope areas that might encourage salt marsh harvest mice to move downslope,

away from the mowing activity. In addition, vegetation along the levee top is not expected to be particularly dense, especially in comparison to vegetation lower on the levee/ecotone slopes. As a result, it is possible that salt marsh harvest mice will make little use, if any, of the vegetation that needs to be mown. Maintenance such as mowing in or adjacent to salt marsh harvest mouse habitat will also be avoided during extreme high tides when salt marsh harvest mouse are most likely to approach the levee top to escape the flooding marsh. If trapping of California ground squirrels is necessary to control burrows within the levees, live traps with openings large enough to allow salt marsh harvest mice to exit the traps will be used.

Disturbance of salt marsh harvest mice from recreational trail use may occur, due to the expected occurrence of salt marsh harvest mice in ecotones and vegetated lower levee slopes and in the salt marsh harvest mouse habitat adjacent to lower Coyote Creek, where the levee trail connection to the existing Bay Trail segment will be provided. However, such disturbance will be minimized by the physical separation of the bare-topped trail and the vegetated slopes where salt marsh harvest mice may occur. Trail use may also result in indirect effects, such as increased trash (which may attract predators) and increased invasive plants, which may adversely affect habitat quality. Predator management and invasive plant species control implemented along the trails will minimize these adverse effects.

Effects of Service-led Actions

California Clapper Rail

Excavation of pilot channels in the outboard marsh around Ponds A9-A15 has the potential to affect individual California clapper rails, including nests, eggs, and young, directly. Such effects are most likely along the pilot channel excavation area near the northeast corner of Pond A9, which provides suitable nesting habitat for California clapper rails. As noted above, the probability of nesting California clapper rails is low in the brackish marsh and narrow areas of salt marsh where breaches and pilot channels are proposed along Alviso Slough.

As mentioned previously, prior to or concurrent with restoration of tidal action in Ponds A9, A10, and A11, the berm between Ponds A11 and A12 will be breached. If California clapper rail habitat has developed within Pond A12 by that time, there is some potential for effects to individuals or nests due to breaching. Similarly, berms between A14 and A9/A11, and between A13 and A12, will be breached prior to or concurrent with restoration of tidal action in Ponds A13-A15, potentially resulting in effects to individual California clapper rails.

If pilot channel excavation in brackish or salt marsh habitat, or breaching of berms for Phases 2 and 3 near suitable California clapper rail habitat, is conducted during the breeding season, protocol-level surveys for California clapper rails will be conducted prior to proposed project activities to determine whether nesting rails are present in the vicinity. If any California clapper rails are detected, 700-foot buffers between rail activity centers and construction will be followed. During any construction or excavation activities that may result in effects to California clapper rails, the limits of work will be clearly delineated to limit effects to this species. These conservation measures will minimize effects of human activity within marshes on California clapper rails.

As noted previously, tidal restoration will result in an increase in the abundance of marsh-associated predators such as northern harriers. However, mammalian predators will have less access to these

restored marshes due to the breaching of levees and the presence of Alviso and Coyote sloughs on two sides of the A9-A15 complex. Further, because no high-tension powerlines run through these ponds, perch sites for most predatory raptors will be limited.

A large colony of California gulls nests on the interior berms separating Ponds A9, A10, and A14. Tidal restoration would result in the intentional lowering of these berms or eventual erosion of these berms through tidal action, thus causing these gulls to move elsewhere to nest. These displaced gulls may select nesting sites in close proximity to California clapper rail habitat elsewhere. The displacement of gulls from areas of lower quality California clapper rail habitat to areas of higher quality habitat could result in increased predation pressure by gulls on the rail. Predator management and MAM performed by the Refuge and the SBSPRP will help to minimize the risk of predation.

Monitoring, research, and predator management efforts involving people walking through tidal marshes or boats grounding on marshes could result in effects to individual California clapper rails. Adult California clapper rails are unlikely to be injured or killed during such activities, as they are expected to flee an area subject to such activities before injury or mortality occurs. However, these activities could destroy or damage California clapper rail nests or eggs, or result in the injury or mortality of less mobile young California clapper rails. Such activities are expected to be very localized, and implementation of conservation measures (such as minimizing such activities during the California clapper rail's breeding season) will minimize the potential for such effects.

Following complete restoration of Ponds A9-A15, the extent of trails at these ponds will be limited to a trail along the eastern edges of Ponds A12, A13, and A15, with shorter spurs in three areas. Observation platforms would be constructed at the ends of these spurs. Human activity use may increase in areas where trails and observation platforms are to be opened or improved. Use of the trail along the new FRM levee is likely to increase once this levee is connected to other Bay Trail segments at its northeast end, but the removal of a loop trail in the A9-A15 complex may tend to reduce trail use. Management of potential disturbances in adjacent habitat areas from recreational human activity may not be effectively regulated or controlled, even with the proposed conservation measures to maintain public use and activities along the developed trails.

Increased recreational trail use in areas where existing trails occur adjacent to California clapper rail habitat could result in the flushing of California clapper rails at high tides, increasing predation risk. No new trails are proposed to be opened adjacent to existing California clapper rail habitat, but rails that colonize the restored tidal marshes in Ponds A12, A13, A15, and A18 would be subjected to human disturbance from trail users. The breadth of the ecotone (345 feet) will limit disturbance of California clapper rails by people using the new FRM levee along eastern Pond A12 and southern Pond A18, as humans on the top of the levee will be far removed from suitable rail habitat. People using the spur trails and the levee trail along the southern Pond A12 levee, the Pond A12/A13 levee, and the northern Pond A15 levee will be closer to California clapper rail habitat, however, due to the absence of a constructed ecotone.

Interpretive signage will be installed at the edges of sensitive California clapper rail habitat areas discouraging human entry into those areas. If monitoring indicates that disturbance of California clapper rails by humans is adversely affecting rail populations, seasonal closures of portions of these trails would be considered as an adaptive management measure.

Salt Marsh Harvest Mouse

Excavation of pilot channels in the outboard marsh around Ponds A9-A15 has the potential to injure or kill salt marsh harvest mice by crushing or smothering them during the placement of sediment or other materials in suitable habitat, or by excavation of habitat. Such effects are most likely along the pilot channel excavation area near the northeast corner of Pond A9, which provides the highest-quality habitat for this species of all the breach locations. Abundance of salt marsh harvest mice is low in the brackish marsh and narrow areas of salt marsh where breaches and pilot channels are proposed along Alviso Slough. As mentioned previously, prior to or concurrent with restoration of tidal action in Ponds A9, A10, and A11, the berm between Ponds A11 and A12 will be breached. If salt marsh harvest mouse habitat has developed within Pond A12 by that time, there is some potential for effects to individuals due to breaching. Similarly, berms between A14 and A9/A11, and between A13 and A12, will be breached prior to or concurrent with restoration of tidal action in Ponds A13-A15, potentially resulting in effects to salt marsh harvest mice. Conservation measures will be implemented to minimize the potential for impacts to individual salt marsh harvest mice.

Disturbance of salt marsh harvest mice from pilot channel excavation, ditch block construction, breaching of berms prior to second or third phase breaching, and equipment access for these restoration-related activities would be similar to that described above. Disturbance of salt marsh harvest mice from recreational trail use would be similar to that described for California clapper rail above.

As described for California clapper rail, loss of individual salt marsh harvest mice due to predation could be exacerbated by the proposed project, at least in localized areas, and displacement of the California gull colony from the interior berms separating Ponds A9, A10, and A14 could cause these gulls to relocate in areas where they may be more likely to prey on salt marsh harvest mice.

Monitoring, research, and predator management efforts involving people walking through tidal marshes or boats grounding on marshes could also result in injury or mortality of salt marsh harvest mice or disturbance of breeding, foraging, and sheltering activities. Such activities are expected to be very localized. Effects to salt marsh harvest mice resulting from monitoring, research, and predator management on the Refuge will be covered by the existing biological opinion for the SBSPRP and a future biological opinion for the Refuge's Comprehensive Conservation Plan. Effects to salt marsh harvest mice resulting from perennial pepperweed control are discussed below under the "Perennial Pepperweed Control" section.

Effects Due to an Increase in Mercury Exposure

Effects of Corps-led Actions

It is well known that the Guadalupe River system, including Alviso Slough, has a relatively high concentration of mercury resulting from sediments washed from historical mercury mines in the upper watershed. Recent testing in Artesian Slough has revealed high mercury concentrations there as well, with total mercury being lower but methylmercury, the bioavailable form, being higher in Artesian Slough than Alviso Slough (City of San Jose 2013). Such mercury may be mobilized when pilot channels are excavated in outboard marshes along Artesian Slough prior to breaching, and the

tidal action through those channels, as well as the increase in tidal prism and associated scour of sediments in Artesian Slough, could mobilize mercury-laden sediment from the slough.

Although the abundance of California clapper rails in the immediate vicinity of Artesian Slough is currently very low, mercury could be mobilized downstream into and along Coyote Slough. Mercury accumulation in eggs is known to affect California clapper rails in the Bay Estuary, with the South Bay containing the highest mercury levels. Although intake is generally not acute enough to result in lethal toxosis of adults or young, mercury is extremely toxic to embryos and thus results in low levels of egg viability, and reduced California clapper rail fecundity. Schwarzbach *et al.* (2006) found high mercury levels and low hatching success (due both to predation and, presumably, mercury) in California clapper rail eggs throughout the Bay. They also suggested that mercury exposure could slow or stunt development of young, possibly increasing predation risk. Mercury exposure has been also linked to reduced body condition in California clapper rails (Ackerman *et al.* 2011), suggesting there are potential detrimental effects on survivorship of adult birds as well. Mean mercury concentrations in captured California clapper rail blood samples were 0.56 micrograms/ gram (μg/g; or parts per million), 9.87 μg/g in head feathers, and 9.04 μg/g in breast feathers (Ackerman *et al.* 2011). Birds with mercury concentrations in blood over 1.0 μg/g and 9.0 μg/g in feathers are considered at risk for impaired reproduction (Evers *et al.* 2004, Burger and Gochfeld 1997), and several individuals captured in that study had mercury levels above those thresholds. The mercury concentrations in both head and breast feathers in the Ackerman study suggest that rails were exposed to mercury over long periods of time, as those two feather tracts are grown in different stages of molt. This suggests that mercury exposure was chronic and accumulated over time.

Mercury is taken in by California clapper rails primarily through contaminated prey in the form of methylmercury. Methylmercury, unlike elemental mercury, is bioavailable in that it readily binds to living tissue and accumulates in aquatic food webs. For instance, in failed-to-hatch California clapper rail eggs in the Schwarzbach *et al.* (2006) study, methylmercury accounted for 95 percent of total mercury in those eggs, and this ratio of elemental to methylmercury has been found in previous studies as well (see Ackerman *et al.* 2011). In addition to reproductive failure, studies have shown that captive egrets fed doses of 0.5 milligrams of methylmercury were less motivated to hunt food, and had a reduced appetite (Bouton *et al.* 1999, Spalding *et al.* 2000). These effects may be related to reduced body condition, which could ultimately lower survivorship.

Inorganic mercury tends to be converted to methylmercury, primarily under somewhat anoxic conditions (Marvin-DiPasquale *et al.* 2003). California clapper rails are currently exposed to methylmercury when foraging on mudflats and in sloughs with high levels of mercury contamination. The proposed project has the potential to increase the exposure of California clapper rails to mercury by stirring up sediments during vegetation removal and dredging activities. Methylmercury may also be mobilized by the frequent wetting and drying of mercury-contaminated sediments during construction activities. Mercury-contaminated sediments that are currently buried too deep to adversely affect California clapper rails and other species could be mobilized by these activities, thus entering the food chain. The extent to which excavation of pilot channels and scour of sediments in Artesian Slough will release mercury such that it may be more bioavailable to California clapper rails, and to which any increased level of bioavailable mercury affects California clapper rails, is difficult to quantify.

Compared to a managed pond environment, mercury deposited in well-oxygenated marsh plains is not expected to methylate as readily (Grenier *et al.* 2010). Also, it is likely that there will be a relatively low temporal exposure after breaching occurs for mercury to circulate in the slough or restored ponds, methylate, and be incorporated into the food web. Therefore, if there is an increase in methylmercury, it will likely occur for only a short duration. Preliminary data collected for SBSPRP mercury monitoring suggest this is the case. Mercury levels in fish collected in Alviso Slough increased after the Pond A8 notch was opened in June 2011 but had already decreased by October 2011 (SBSPRP 2013). The increase in mercury levels was more pronounced around the notch than at downstream sampling locations, suggesting the effect was localized. Therefore, the loss of individual California clapper rails or reduction in reproductive success of rails is not expected to occur as a result of increased mercury exposure associated with the proposed project.

The effects of mercury on salt marsh harvest mice are largely unknown. However, this species is likely exposed to methylmercury through the tidal marsh food web and mercury concentrations in tidal marshes. Although Artesian Slough methylmercury concentrations are high, tidal marshes show no evidence of increased bioaccumulation of mercury compared to other South Bay tidal marshes, possibly due to a paucity of organic material in the sediment (Grenier *et al.* 2010). For example, resident songbirds captured in tidal marshes in Alviso Slough showed similar bioaccumulation of mercury as other South Bay marshes (Grenier *et al.* 2010). Because increases in mercury availability are expected to be short-term, as described for the California clapper rail, the potential for increased salt marsh harvest mouse exposure to mercury is relatively low. Therefore, salt marsh harvest mice are not expected to be affected by an increase in mercury exposure related to pilot channel excavation and sediment scour.

Effects of Service-led Actions

Because of the mercury contamination of the Guadalupe River from the New Almaden mine, some of the sediment in Alviso Slough may contain high concentrations of mercury. Such mercury may be mobilized when pilot channels are excavated in outboard marshes along Alviso Slough prior to breaching, and the tidal action through those channels, as well as the increase in tidal prism and associated scour of sediments in Alviso Slough, could mobilize mercury-laden sediment from Alviso Slough and Ponds A9-A15. Effects of this mercury mobilization on California clapper rails would be as described above for Corps-led activities. The effects of mercury mobilization on salt marsh harvest mice from Service-led activities are expected to be relatively low similar to those described above for Corps-led activities.

Perennial Pepperweed Control

Effects of Corps-led and Service-led Actions

Potential effects on California clapper rail and salt marsh harvest mouse foraging and nesting due to perennial pepperweed control could result from habitat alterations (*e.g.*, native plant mortality) and marsh access through California clapper rail and salt marsh harvest mouse habitat for treatment/ eradication, monitoring, or re-vegetation activities. Ground based spraying via foot or ARGOs and post-treatment monitoring requires access through the marsh and may result in vegetation trampling or salt marsh harvest mouse nest disturbance. Use of ARGOs for control will cause temporary disturbance of marsh vegetation. All treatment crew members will be supervised by a qualified biologist and will be trained to follow the guidelines presented in the "Walking In the Marsh:

Methods to Increase Safety and Reduce Impacts to Wildlife & Plants" protocol (Appendix A), thereby minimizing disturbance of California clapper rails, salt marsh harvest mice, and their habitats.

Disturbance of the marsh by field crews on-foot will be minimal because crews will be traversing through the marsh only once or twice per year to conduct treatment and monitoring, trails will not be established through the marsh, and no residual effects on marsh habitat quality are anticipated. Field crews will not crush any salt marsh harvest mice or their nests because they will be supervised by a qualified biologist and will avoid walking on high pickleweed vegetation and on wrack, where salt marsh harvest mice are likely to forage or nest. In addition, since crews will be walking slowly, any salt marsh harvest mice present will be able to move out of the immediate area. Due to the minimal amount of habitat disturbance caused by field crews and avoidance of direct impacts to salt marsh harvest mice, access of marshes by field crews on-foot for perennial pepperweed control will avoid the injury and mortality of salt marsh harvest mice and minimize the level of disturbance.

Field crews accessing the marsh via ARGOs for perennial pepperweed control may result in the temporary disturbance of marsh vegetation (habitat degradation) or crushing of individual salt marsh harvest mice or their nests beneath the ARGOs. These vehicles are designed to operate with low ground pressure (about 0.67 pounds per square inch) and distribute weight on specialized tracks. ARGOs exert a ground pressure approximately five times less than that of humans; however, a greater area of marsh vegetation would be disturbed by fields crews on ARGOs than on-foot.

ARGOs may crush and cause dieback of marsh vegetation, particularly sub-shrubby vegetation with brittle stems, such as pickleweed, the primary habitat of the salt marsh harvest mouse. Due to this identified impact, the quantity of suitable California clapper rail and salt marsh harvest mouse habitat directly affected by ARGOs is calculated by the distance within tidal marsh they will be driven to access and treat perennial pepperweed patches. There is a five-foot wide "track impact" from an ARGO traveling through the marsh. This impact would consist of temporary compaction or crushing of pickleweed and other marsh plants, with the vegetation expected to recover fully within a few months of impact. The travel path of ARGOs will be planned to minimize the amount of impact to California clapper rail and salt marsh harvest mouse habitat by traveling in mudflats whenever feasible.

The only perennial pepperweed control action that may temporarily disturb nesting California clapper rails is a portion of the marsh access for eradication activities. Backpack spraying will be used to treat perennial pepperweed within "700-ft Buffer Areas", and disturbance will be localized and very temporary (usually less than 30 minutes). California clapper rails may be harassed by treatment access within "700-ft Buffer Areas" where there is greater than one acre of infested perennial pepperweed and where treatment is likely to exceed 30 minutes. Boat-mounted spraying will be used to treat relatively larger clones along slough edges and may result in a larger scale disturbance (noise), but little immediate habitat destruction. ARGOs will not be used in "700-ft Buffer Areas" for California clapper rails. It is expected that control activities in areas with large acreages targeted for control will result in relatively more disturbance than in those areas with small acreages, given similar California clapper rail densities.

Any ARGOs used in control activities will stay 700 feet from known California clapper rail calling centers and will stay at least 50 feet from channel edges, thereby avoiding rail nest destruction or rail disturbance. However, if the intervening distance across a major slough channel or across a

substantial physical barrier between the California clapper rail calling center and the proposed access area is greater than 200 feet, then access may proceed within the breeding season.

Areas where California clapper rails have been detected contain channels and low marsh vegetation used for mating, foraging, and nesting. The majority of perennial pepperweed patches occur in the transition zone and along channel edges dominated by gumplant. Perennial pepperweed patches also occur adjacent to *Spartina foliosa* patches of low marsh tidal deposition areas (wrack lines). Sensitive eradication areas include channel edges and areas where low marsh (*S. foliosa*-dominated) interfaces the pickleweed plain. Herbicide applications are not expected to cause direct mortality of *S. foliosa* and other native plant species if conservation measures are implemented to reduce herbicide spray drift and subsequent mortality of non-target plants. The eradication of perennial pepperweed is not likely to harm California clapper rails as a result of habitat loss because: (1) California clapper rails are not known to use perennial pepperweed as a habitat component, and (2) conservation measures will be implemented that avoid non-target plant eradication.

The herbicides, adjuvants, and dyes proposed for eradication of perennial pepperweed within the action area are also being used to eradicate invasive *Spartina* species in other parts of the Bay Estuary. The herbicides proposed were determined not to have any direct toxic effects to California clapper rails (California State Coastal Conservancy and Service 2003, California State Coastal Conservancy 2005). Direct toxicity of herbicide, surfactant, and colorant applications is unlikely to have significant toxic effects to California clapper rails since herbicides are directed to the upper portion of the plant and dry quickly on the plant leaf surface (usually within a few minutes of application), and exposure of rails to spray solutions would be very temporary. Even if California clapper rails are exposed to small amounts of spray solutions, they will not be injured since these chemicals are considered practically non-toxic to birds (California State Coastal Conservancy and Service 2003). The chemical treatment of perennial pepperweed will reduce expansion and formation of perennial pepperweed monocultures which alter soil conditions and crowd out native plant species used by California clapper rails for nesting and sheltering.

Salt marsh harvest mice are unlikely to come into contact with spray solutions applied to perennial pepperweed since the mice primarily inhabit pickleweed and other high marsh vegetation not targeted for control. Even if salt marsh harvest mice are exposed to small amounts of imazapyr, glyphosate, surfactants, or colorants used in the spray solutions, they would not likely be harmed since these chemicals are considered non-toxic to mammals (California State Coastal Conservancy and Service 2003, California State Coastal Conservancy 2005).

California clapper rails and salt marsh harvest mice will not lose habitat when perennial pepperweed is removed, since the rail and the mouse are not known to utilize perennial pepperweed. Removal of invasive perennial pepperweed and revegetation of the marsh-upland transition zone will provide high quality high tide refugia, a critical component of the habitat for the California clapper rail and salt marsh harvest mouse. Non-native perennial pepperweed threatens the transition zone refugia and tidal marsh habitat for the California clapper rail and salt marsh harvest mouse. Perennial pepperweed displaces higher quality tidal marsh vegetation including marsh gumplant and pickleweed. Perennial pepperweed also provides poor quality high tide refugia cover for the California clapper rail and salt marsh harvest mouse because it is leafless in the winter when the rail and the mouse are in most need of suitable upland cover during the frequent winter extreme high tide and storm events. Without suitable cover, the California clapper rail and salt marsh harvest mouse are vulnerable to predation during extreme high tide events. Therefore, perennial

pepperweed control will provide a long-term benefit to the California clapper rail and salt marsh harvest mouse.

Revegetation will occur within the transition zone. Revegetation is not expected to disturb breeding California clapper rails because this activity will occur outside of the rail's breeding season. The transition zone is used by California clapper rails and salt marsh harvest mice primarily during extreme high tide events; therefore, restricting revegetation of the transition zone to low tides will minimize the potential for disturbing any California clapper rails and salt marsh harvest mice. The restoration of native plants within the transition zone will provide California clapper rails and salt marsh harvest mice with high quality high tide refugia, a critical component of population recovery for the rails and the mice.

Pacific Coast Population of the Western Snowy Plover

Loss of Habitat

Effects of Corps-led Actions

Western snowy plovers are not known or expected to nest or forage along the WPCP segment of the FRM levee or in or around Pond A18 under current conditions. As a result, construction and restoration east of Artesian Slough will not result in a net loss of western snowy plover habitat. However, prior to breaching, Pond A18 may be drawn down to facilitate within-pond preparations such as construction of ditch blocks. When Ponds A16 and A17 were drawn down prior to SBSPRP Phase I activities, western snowy plovers used the dried-out pond bottoms for nesting. If Pond A18 is drawn down prior to breaching, then the dried-out pond bottom is likely to attract nesting western snowy plovers. As a result, breaching will flood this temporarily created western snowy plover habitat.

Aside from impacts to temporarily created habitat if Pond A18 is drawn down, construction of the FRM levee will not directly affect any suitable nesting habitat for the western snowy plover. Although this species has nested in the Alviso impoundment, in Ponds A12, A13, and A16, and in New Chicago Marsh, portions of which will be directly impacted by levee construction, the western snowy plover does not nest near the existing non-engineered levees that occur within the proposed construction footprint. Rather, western snowy plovers nest farther from levees, apparently due to the disturbance associated with human use of the levees, use of levees by predatory mammals, and the species' inability to see over levees (and thus detect approaching predators) if the nest is placed too close to the levee. Thus, even under existing conditions, there is a zone close to the levees that has not been used for nesting by western snowy plovers.

However, for these same reasons, FRM levee construction could result in indirect effects to western snowy plovers by causing plovers to avoid using habitat that is otherwise suitable. The ultimate height of the FRM levee is expected to be approximately 10 feet higher than the existing levee on the south side of Pond A16, and the very low levee along the eastern side of A12 is likely to be raised even more, relative to its existing height. The levees may initially be built even higher, as some subsidence is expected over time as materials settle. As a result, the FRM levee will be substantially taller and wider than the existing levees. Western snowy plovers are unlikely to nest very close to the levee for the reasons discussed above, especially when the Bay Trail is developed

atop the levee and human activity is even greater than it currently is. As a result, the zone near levees that western snowy plovers avoid for nesting would shift farther from the levee.

The extent of this indirect effect (*i.e.*, the amount of otherwise suitable nesting habitat that will no longer be used by nesting western snowy plovers) is unknown. Western snowy plovers nesting in New Chicago Marsh, on islands in Pond A16, and in Ponds A12 and A13 tend to nest well away from the Pond A16 levee. As a result, it is possible that they nest so far from the levee already that an increase in height of, and human activity along, the levee would have no effect on the plovers' perception of suitable habitat availability. In addition, tidal restoration in Ponds A12 and A13 would make those ponds completely unsuitable for use by nesting western snowy plovers. However, it is possible that increasing the height of the levee would cause plovers to retreat even farther from the levee. It is unknown whether western snowy plovers would continue to nest in the Alviso impoundment after FRM levee construction, and it is possible that plovers might view the entire impoundment as being no longer suitable due to the taller, wider levee. Use of this impoundment by nesting western snowy plovers has been sporadic (*i.e.*, less than annual), and usually by only a single pair when it is used at all.

Although the number of pairs of western snowy plovers that may no longer nest in the vicinity of the action area as a result of raising the height of the levee is unknown, it is likely that no more than one or two pairs would be affected because areas near the action area levees have been inconsistently used by few plovers in the past. The proposed project will implement compensatory conservation measures by distributing pea gravel or other appropriate substrate on an island in Pond A16, maintaining this island for use by nesting western snowy plovers, and increasing the intensity of predator management in the vicinity. Gravel may make it more difficult for predators such as California gulls and northern harriers to detect western snowy plovers due to camouflage (*e.g.*, plovers may be difficult to distinguish within the gravel from a distance) and increased topographic relief associated with the gravel and footprints left by people distributing the gravel. As a result, predation rates on both western snowy plover eggs and chicks are likely to be lower in areas with such gravel, and more plovers may be attracted to nest in areas with gravel. Providing gravel on an island in Pond A16 is expected to increase western snowy plover nesting abundance, and possibly nesting success, thus compensating for the adverse effects of other proposed project activities on nesting western snowy plovers. These measures are expected to minimize any adverse effects of Corps-led actions on the availability of suitable western snowy plover habitat, or western snowy plover abundance or productivity.

Expansion of the FRM levee into pond, seasonal wetland, and muted tidal/diked marsh habitat will result in filling of ostensibly suitable foraging habitat and, as discussed above, the possible avoidance of foraging habitat that is otherwise suitable but would be too close to the levee following construction. However, western snowy plovers are very rarely seen foraging close to the eastern edges of Ponds A12 and A13, the southern edge of Pond A16, or the northern edge of New Chicago Marsh. As a result, effects of levee construction on western snowy plover foraging habitat are likely limited to reduced use of the Alviso impoundment. As foraging habitat in the vicinity is not likely limiting western snowy plover populations (based on the expanses of suitable foraging habitat present in managed ponds and New Chicago Marsh that is unoccupied at any given time, as well as the abundance of prey in these area), the effects of Corps-led actions on western snowy plover foraging habitat are unlikely to have a substantive effect on western snowy plover populations.

Effects of Service-led Actions

Service-led tidal restoration will result in the loss of all western snowy plover nesting habitat in Ponds A9-A15, as western snowy plovers do not nest in tidal habitats. Further, because this species forages infrequently on tidal mudflats, western snowy plovers are expected to make little use of Ponds A9-A15, even for foraging, once they are restored to tidal action. Based on data from 2012, when five of 13 nests in the proposed project vicinity were in Pond A13 (Donehower *et al.* 2012), and 2013, when two of 10 nests in the proposed project vicinity were in Pond A9 (Robinson-Nilsen *et al.* 2013), up to five pairs of western snowy plovers may be displaced by tidal restoration. Because restoration will be phased, some western snowy plover nesting habitat is expected to be present in Ponds A9-A15 until 2030, when the last of these ponds may be breached.

As discussed previously, the MAM for the SBSPRP will help to achieve the goal of supporting at least 250 individual breeding western snowy plovers in the SBSPRP area, which is half of the number of breeding western snowy plovers required within the San Francisco Bay Recovery Unit for delisting (Service 2007). The SBSPRP will implement adaptive management measures, such as more intensive management of certain ponds for western snowy plovers, as necessary to achieve that goal. The MAM associated with the SBSPRP would therefore assist in compensating for impacts to western snowy plovers from loss of nesting habitat in Ponds A9-A15 by helping to manage for plovers in other SBSPRP ponds. Because some western snowy plover nesting habitat will remain in the Ponds A9-A15 complex until 2030, there is ample time for the MAM associated with the SBSPRP to determine how to increase western snowy plover densities elsewhere prior to complete loss of plover nesting habitat from Ponds A9-A15. As described in previous sections, if the MAM indicates impacts to waterbirds (including western snowy plovers) are too severe, then fewer ponds will be restored to tidal action.

Development of a Bay Trail segment on the FRM levee, which is a Service-led activity, will increase recreational use of the levee top. This will contribute to disturbance of western snowy plovers nesting in adjacent areas, leading to an effective loss of habitat use. Research shows that nesting western snowy plovers within the South Bay are very sensitive to disturbance by recreational trail users and construction activities within 600 feet of their nests (Robinson 2008, San Francisco Bay Bird Observatory and Service 2010).

Direct Effects to Individuals

Effects of Corps-led Actions

As described for California clapper rail above, disturbance such as loud noise or the presence and movement of people, and heavy equipment near western snowy plover habitat may alter bird behavior in ways that result in injury, mortality, or reduced nesting success. Such disturbance could result in temporary or permanent habitat loss due to western snowy plover avoidance of areas that have suitable habitat but intolerable levels of disturbance; abandonment of nests, eggs, or young by nesting pairs; a reduction in foraging efficiency if high-quality foraging areas are impacted; and increased movement or flushing, or altered activity patterns, that reduce energy reserves and increase predation risk. Construction of the Alviso Segment of the FRM levee near western snowy plover habitat in Ponds A12 and A13, the Alviso impoundment, New Chicago Marsh, and A16 could result in disturbance of nesting and foraging plovers in those areas. However, moderate to fairly heavy human use already exists along the levees adjacent to western snowy plover habitat in the proposed

project area. Numerous pedestrians and cyclists use the levees around the Ponds A9-A15 complex, between Ponds A15 and A13/A14, and between A16 and New Chicago Marsh on a daily basis. As a result, the western snowy plovers that use habitat adjacent to these levees (a) tend to avoid areas close to the levees used by humans, and (b) are already habituated to the use of humans along those levees. This reduces the extent to which western snowy plovers will be disturbed by levee construction and use of the levees by humans following levee completion.

Nevertheless, to minimize such impacts, work in and adjacent to potential western snowy plover nesting habitat would be conducted outside of the nesting season to the extent practicable. If seasonal avoidance is not possible, surveys before and during construction would be conducted for nesting western snowy plovers, and appropriate buffers (*i.e.*, 600 feet during construction activities) would be implemented between proposed project activities and nesting western snowy plovers.

Because western snowy plovers are not known or expected to nest very close to the existing levees, no western snowy plover nests or eggs would be located within the footprint of FRM levee construction. If nesting has occurred in areas adjacent to the levees, such as the Alviso impoundment, it is possible that young western snowy plovers could move into the construction footprint. However, if nesting occurs in the construction zone, then a Service-approved biologist will need to clear the area before construction can continue.

If Pond A18 is drawn down prior to breaching, as described previously, then breeding western snowy plovers could be nesting in the pond when construction of ditch blocks and breaching occurs. While adult breeding western snowy plovers would not be injured or killed by restoration-related construction activities or breaching, as they would flee the vicinity of any such activities, their nests, eggs, or young could be crushed, trampled, buried, or lost to flooding as a result of displacement of sediment into nesting habitat during construction of ditch blocks, or levee breaching and flooding of occupied habitat. For example, in 2010, two western snowy plovers nests at Ravenswood Pond SF2 were depredated when construction crews for the SBSPRP were working within 600 feet of the nests (San Francisco Bay Bird Observatory and Service 2010). Therefore, there is the potential for construction activities within 600 feet of a western snowy plover nest to flush the western snowy plover from its nest exposing the nest to depredation. To minimize such impacts, work in and adjacent to potential breeding western snowy plover nesting habitat would be conducted outside of the nesting season to the extent practicable. If seasonal avoidance is not possible, surveys prior to and during construction would be conducted for nesting breeding western snowy plovers, and appropriate buffers (*i.e.*, 600 feet during construction activities) would be implemented between proposed project activities and nesting western snowy plovers.

Loss of individual western snowy plovers (including eggs and chicks) due to predation could be exacerbated by the proposed project, at least in localized areas. The restoration of tidal marsh habitat will increase habitat for northern harriers, which are known to prey on western snowy plovers. Compensatory mitigation involving an increase in predator management in the New Chicago Marsh/A16 vicinity will reduce any increase in predation resulting from increased northern harrier populations from Corps-led activities.

Maintenance activities along the FRM levee have the potential to disturb nesting and foraging western snowy plovers as well. Recreational use of the Bay Trail segment atop the levee will affect western snowy plovers in adjacent areas to the point that plovers present in areas such as Pond A16 or New Chicago Marsh during levee maintenance activities will already be habituated to some level

of human activity on the levee. As a result, routine inspections and minor maintenance activities are not expected to result in an increase in western snowy plover disturbance, relative to other types of levee use. Even mowing along the levee tops is unlikely to cause substantial disturbance of western snowy plovers given the very narrow swaths to be mowed, the brevity of mowing operations, and the distance (330 feet or more) between mowing and western snowy plover habitat. Other maintenance activities involving heavy equipment would be conducted outside of the nesting season to the extent practicable, and if seasonal avoidance is not possible, pre-construction surveys would be conducted for nesting western snowy plovers, and appropriate buffers would be implemented between proposed project activities and nesting western snowy plovers as necessary.
Even with the implementation of conservation measures to minimize disturbance of nesting western snowy plovers, snowy plovers that disperse away from disturbance may not successfully establish new breeding territories and breed. Plovers forced to disperse would need to either maintain existing pair bonds or develop new pair bonds and establish new breeding territories in other suitable habitat areas. Disturbance that occurs during the non-breeding season could also result in injury, mortality, or the disturbance of western snowy plover foraging and sheltering activities. Displaced individuals could be subjected to injury or mortality from starvation, physiological stress, and increased predation.

Effects of Service-led Actions

Disturbance of western snowy plovers using Ponds A9-A15 may occur due to pilot channel excavation, ditch block construction, and equipment access for these restoration-related activities. The effects of such disturbance would be similar to that described above.

If drawdown of Ponds A9-A15 occurs to facilitate within-pond preparations, western snowy plovers are expected to nest in at least some of these ponds. While adult western snowy plovers would not be injured or killed by restoration-related construction activities, as they would flee the vicinity of any such activities, their nests, eggs, or young could be crushed, trampled, buried, or lost to flooding as a result of displacement of sediment into nesting habitat during berm lowering or construction of ditch blocks, or levee breaching and flooding of occupied habitat. To minimize such impacts, work in and adjacent to potential western snowy plover nesting habitat would be conducted outside of the nesting season to the extent practicable. If seasonal avoidance is not possible, pre-and during construction surveys would be conducted for nesting western snowy plovers, and appropriate buffers would be implemented between proposed project activities and nesting western snowy plovers.

As described for California clapper rail above, loss of individual western snowy plovers, eggs, and young may increase as a result of predation. An increase in tidal marsh habitat will result in an increase in northern harrier populations, and displacement of the California gull colony on the interior berms separating Ponds A9, A10, and A14 may cause gulls to relocate to areas closer to high densities of nesting western snowy plovers. Both the northern harrier and California gull are important predators of western snowy plovers in the South Bay. Predator management and MAM performed by the Refuge and the SBSPRP will help to minimize the risk of predation on western snowy plovers.

Service-led activities include the provision of recreational trails. Human activity may increase in areas where trails and observation platforms are to be opened or improved. Studies of the effects of recreational trail use in the South Bay on western snowy plovers showed that trail users caused

western snowy plovers to flush from their nests when walkers approached on average within 538 feet when approached directly or 478 feet when passed tangentially (Robinson 2008). Use of the trail along the new FRM levee is likely to increase once this levee is connected to other Bay Trail segments at its northeast end, but the removal of a loop trail in the A9-A15 complex may tend to reduce trail use. Management of potential disturbances in adjacent habitat areas (such as Ponds A9-A15 that have not yet been converted to tidal habitats) from recreational human activity may not be effectively regulated or controlled, even with the proposed conservation measures to maintain public use and activities along the developed trails. Increased recreational trail use adjacent to western snowy plover habitat could have the same disturbance effects as described above. Interpretive signage will be installed at the edges of sensitive habitat areas discouraging human entry into those areas. If monitoring indicates that disturbance of western snowy plovers by humans is adversely affecting plover populations, seasonal closures of portions of these trails would be considered as an adaptive management measure.

Effects Due to an Increase in Mercury Exposure

Effects of Corps-led Actions

Studies in San Diego County (Hothem and Powell 2000), at Point Reyes (Schwarzbach *et al.* 2005), and in the South Bay (Schwarzbach and Adelsbach 2003) have found elevated mercury levels in western snowy plover eggs. At Point Reyes, high levels of mercury in unhatched eggs were thought to be a possible reason for the inviability of these eggs. In the San Diego County and South Bay studies, however, concentrations of mercury in western snowy plover eggs were below known embyrotoxic thresholds established for other species.

Western snowy plovers are currently exposed to mercury in ponds containing mercury-contaminated water or sediment. Proposed tidal restoration activities that stir up contaminated sediments, such as pilot channel excavation, construction of ditch blocks, and scour due to increased tidal prism would all occur just prior to, or as a result of, tidal restoration. Although western snowy plovers foraging on intertidal mudflats may be affected by increased mercury mobilization resulting from these activities, activities that stir up mercury-laden sediments in tidal habitats are expected to have little effect on snowy plovers due to the infrequency with which snowy plovers forage in intertidal habitats in the proposed project area. Furthermore, western snowy plovers are not known to use the Pond A18 area under existing conditions, and proposed project activities are not expected to enhance conditions for western snowy plovers in A18 after proposed project completion.

Effects of Service-led Actions

Potential effects of mercury mobilization and exposure on western snowy plovers, resulting from Service-led activities, are expected to be similar to those described above for the Corps-led activities.

California Least Tern

California least terns do not nest in the action area, and thus the proposed project is not expected to result in in any effects to nesting California least terns. California least terns have been observed foraging in the action area's ponds (A9, A11, and A14) only rarely, and they have not been observed foraging in Pond A18. Although they could potentially forage in any of these ponds that contain fish, survey data collected for the SBSPRP and incidental observations by birders indicate that

California least terns visit the action area (as a post-breeding forager) only irregularly and in low numbers.

Habitat Modification

Effects of Corps-led Actions

Construction of the FRM levee and the tide gate and pedestrian bridge in Artesian Slough will not affect California least tern foraging or roosting habitat. Although California least terns have not been recorded foraging in Pond A18, they could potentially forage there (albeit irregularly and in low numbers, given the lack of records). Drawing down Pond A18 prior to breaching would eliminate California least tern foraging habitat in the pond in the short term, and restoration of Pond A18 to tidal habitats would reduce the extent of suitable foraging habitat available to California least terns in the longer term. However, tidal marsh restoration is expected to benefit fish populations considerably by providing nursery habitat in the extensive channel networks that will be restored and by exporting organic material to aquatic habitats outside the restored habitat. As a result, tidal restoration is expected to increase fish abundance (through improved water quality, food resources, and spawning and rearing habitat) in the open waters of the Bay where California least terns also forage (in addition to foraging in managed ponds), thus increasing prey availability in the South Bay for California least terns. Due to the low level of California least tern use of Pond A18 and the benefits of tidal restoration to prey fish populations, Corps-led actions will not have a substantive adverse effect on California least tern habitat and prey, and they may have a beneficial effect.

Effects of Service-led Actions

Service-led tidal restoration will result in the conversion of managed pond habitat in Ponds A9-A15 to tidal habitats. Drawing down these ponds prior to breaching would eliminate California least tern foraging habitat in the ponds in the short term, and in the longer term, there would be a net reduction in potential foraging habitat for the California least tern due to the conversion of aquatic habitat within these ponds to mostly vegetated habitats. However, California least terns have only been recorded foraging in Ponds A9-A15 infrequently and in low numbers. Also, as noted previously, tidal restoration is expected to have substantial beneficial effects on South Bay fish populations. Due to the low level of California least tern use of Ponds A9-A15 and the benefits of tidal restoration to prey fish populations, Service-led restoration activities will not have a substantive adverse effect on California least tern habitat and prey, and they may have a beneficial effect.

Disturbance of Foraging Individuals

Effects of Corps-led Actions

Because California least terns have not been recorded using Pond A18 or any of the other ponds near the FRM levee (*i.e.*, A12, A13, or A16), there is little potential for disturbance of foraging California least terns from Corps-led actions. If individuals were to forage in these ponds during FRM levee construction and they were disturbed by construction activities, they would simply move away to other, more traditionally used foraging areas.

Effects of Service-led Actions

Disturbance such as loud noise or the presence and movement of people and heavy equipment near California least tern foraging habitat may alter the tern's foraging behavior. Such disturbance could result in temporary or permanent habitat loss due to California least tern avoidance of areas that have suitable habitat but intolerable levels of disturbance; a reduction in foraging efficiency if high-quality foraging areas are impacted; and increased movement or altered activity patterns that reduce energy reserves and increase predation risk.

Because California least terns have been recorded using Ponds A9-A15 for foraging infrequently and in low numbers, the number of individuals that could be disturbed by Service-led construction or recreational activities is very low. If individuals were to forage in these ponds during restoration-related construction or breaching activities, or during high levels of recreation-related activity, and they were disturbed by those activities, they would simply move away to other, more traditionally used foraging areas.

Effects Due to an Increase in Mercury Exposure

Effects of Corps-led Actions

Because fish bio-accumulate methylmercury, and California least terns eat almost exclusively small fish, there is some potential for mercury mobilized by Corps-led restoration activities (as described above for California clapper rail) to adversely affect California least terns. California least terns are currently exposed to mercury in the South Bay by foraging on fish in contaminated tidal habitats containing mercury-contaminated water or sediment during their post-breeding period. Restoration activities in Pond A18 will mobilize contaminated sediments, and therefore there is the potential to increase California least terns' exposure to mercury. Methylmercury may also be mobilized by the frequent wetting and drying of mercury-contaminated sediments during construction activities. Such exposure could potentially affect the development of juveniles that ingest mercury in food taken during the post-breeding period and may affect fecundity in adults that ingest contaminated fish.

Recent biosentinel sampling in South Bay managed ponds and marshes indicates that mercury concentrations in fish are above the Bay mercury total maximum daily load of 0.03 μg/g for small fish (San Francisco Bay Regional Water Quality Control Board 2006). Mean mercury levels of longjaw mudsuckers and threespine sticklebacks in Alviso Slough fringe marshes were 0.11 μg/g and 0.16 μg/g, respectively (Grenier *et al.* 2010). These levels were higher (but not significantly) than in other South Bay reference sites (mudsuckers: 0.08 μg/g, stickleback: 0.11 μg/g). Based on this information, California least terns foraging in the South Bay could be exposed to mercury levels that are detrimental to piscivorous birds even in the absence of the proposed project. This is evident in Forster's terns (*Sterna forsteri*), a better-studied tern species that breeds in the South Bay, and thus has higher exposure to mercury than California least terns. In a contaminants study of Forster's terns, approximately 50 percent of captured terns were considered at or above moderate risk (> 1.0 μg/g), 13 percent were at or above high risk (>3.0 μg/g), and 9 percent were at or above extra-high risk (>4.0 μg/g) for impaired reproduction based on their blood mercury concentrations (Ackerman *et al.* 2008a). Blood sampling over time (between pre-breeding and breeding stages), suggests that breeding terns were at higher risk due to mercury increasing in their blood, suggesting terns' mercury concentrations increased with the time they spent foraging while in the Bay (Ackerman *et al.* 2008a).

Blood mercury concentrations were highest in terns captured in the southernmost portions of the Bay, in the Alviso salt pond complex, including Pond A8 (Ackerman *et al.* 2008a). Unexpectedly, blood mercury concentrations in Forster's terns were substantially higher approximately two months after arriving in the Bay (*i.e.*, the period between pre-breeding and breeding) than observed in Caspian terns (*Hydroprogne caspia*) during the same time period (Eagles-Smith *et al.* 2009). Caspian terns had much higher mercury levels upon arriving, but Forster's terns mercury levels were soon elevated beyond those of Caspian terns, despite the fact that Caspian terns forage on larger prey (*i.e.*, at higher trophic levels). This was likely due to differences in foraging ecology, as Caspian terns tend to forage in the open bay waters or at inland reservoirs and Forster's terns forage mainly in ponds and tidal marsh channels (Ackerman *et al.* 2008b). As noted above, open waters in the Bay are less likely to methylate mercury than tidal marsh areas (Marvin-DiPasquale *et al.* 2003), and ponds have the potential to methylate mercury due to high levels of degradable organic matter (Grenier *et al.* 2010). Therefore, terns that forage in ponds are much more likely to be exposed to mercury than those foraging in open bay waters.

Although mercury concentrations in post-breeding California least terns in the South Bay are largely unknown, it would be expected that California least terns' exposure to mercury in the South Bay is substantially less than both Caspian and Forster's terns. Because California least terns occur only in the South Bay during post-breeding periods, they would be exposed to mercury for a relatively brief period of time. Further, because they tend to forage in open bay waters or in managed ponds in the Mountain View area (where legacy contamination by mercury should be lower than in areas that receive drainage from the mercury mines in the Guadalupe River watershed or in Artesian Slough), their exposure to mercury should be less than those of Forster's terns. Also, because they eat smaller fish than Caspian terns, California least terns likely accumulate mercury slower than Caspian terns.

California least terns do appear to have some exposure to mercury from central San Francisco Bay (Central Bay) foraging areas near their colonies. Hothem and Zador (1995) analyzed contaminant levels in California least tern eggs collected at the Oakland airport and Alameda Point colonies, and from five colonies along San Diego Bay. Mercury was detected in all eggs, but concentrations were higher in eggs from the Central Bay, with an average of 1.88 μg/g in Central Bay colonies and 1.07 μg/g in San Diego colonies. In comparison, concentrations of mercury in collected Forster's tern eggs averaged 1.35 μg/g (Ackerman and Eagles-Smith 2009). Egg mercury concentrations above 1.0 μg/g is considered high enough for impaired hatchability and embryonic mortality in birds (Scheuhammer *et al.* 2007), and although eggs with concentrations above 1.0 μg/g can hatch, there may be residual effects of mercury on chick mortality after hatching (Ackerman and Eagles-Smith 2009). This suggests that Forster's terns' exposure to mercury during the pre-breeding and breeding periods in the South Bay is higher than California least terns foraging in the Central Bay during the same periods, due in part to overall higher mercury concentrations in the South Bay and their use of pond and tidal marsh foraging sites (as opposed to open bay waters). Because maternally-deposited mercury in eggs is a result of recent dietary exposure (Heinz and Hoffman 2003), mercury in California least tern eggs likely is associated with foraging sites near colonies and not associated with mercury from the South Bay that they are exposed to during post-breeding periods.

Although the potential effects of increased mercury exposure on California least terns resulting from the proposed project are difficult to determine, California least terns are unlikely to be affected substantially by an increase in mercury exposure from the proposed project. This is because California least terns tend to forage in open water habitats in the Bay or managed ponds in the

Mountain View area, where their exposure to mercury is lower than if they foraged more frequently in ponds in the Alviso area and/or in marshes like Forster's terns. Also, mercury that may impair California least tern reproduction is more likely to be derived from pre-breeding and breeding foraging sites than post-breeding staging areas in the South Bay. Finally, the increase in mercury mobilization resulting from Corps-led activities is expected to be relatively brief in duration.

Effects of Service-led Actions

Potential effects of mercury mobilization and exposure on California least terns, resulting from Service-led activities in Ponds A9-A15, are expected to be similar to those described above for Corps-led activities.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions unrelated to the proposed project are not considered in this section, because they require separate consultation pursuant to section 7 of the Act.

Climate Change

The global average temperature has risen by approximately 0.6 degree Centigrade during the 20th Century (International Panel on Climate Change [IPCC] 2001, 2007a, 2007b; Adger *et al.* 2007). There is an international scientific consensus that most of the warming observed has been caused by human activities (IPCC 2001, 2007a, 2007b; Adger *et al.* 2007), and that it is "very likely" that it is largely due to man-made emissions of carbon dioxide and other greenhouse gases (Adger *et al.* 2007). Ongoing climate change (Inkley *et al.* 2004, Adger *et al.* 2007, Kanter 2007) likely imperils the California clapper rail, salt marsh harvest mouse, Pacific Coast population of the western snowy plover, and California least tern and the resources necessary for their survival, since climate change threatens to disrupt annual weather patterns, it may result in a loss of their habitats and/or prey, and/or increased numbers of their predators, parasites, diseases, and non-native competitors. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat. Rising sea levels are likely to inundate much of the remaining salt marsh habitat available for the California clapper rail and salt marsh harvest mouse. Without upland habitat buffers available for the landward transgression of the marsh, the amount of suitable salt marsh habitat is likely to decrease with rising sea levels. The proposed project will reduce the cumulative effects of the loss of suitable salt marsh habitat within the action area from sea level rise by construction of the 345-foot-wide ecotone berms along Ponds A12 and A18 which will create an upland habitat buffer that will allow for the landward transgression of the marsh.

Conclusion

After reviewing the current status of the California clapper rail and salt marsh harvest mouse, the environmental baseline for these species within the action area, the effects of the proposed project and the cumulative effects, it is the Service's biological opinion that the proposed project is not likely to jeopardize the continued existence of these species. We based this determination on the following: (1) successful implementation of the conservation measures described in this biological opinion will minimize the adverse effects on individual California clapper rails and salt marsh

harvest mice; (2) the avoidance of disturbing any breeding California clapper rails; (3) the restoration of at least 517 acres of tidal salt marsh/brackish marsh habitat and creation of 67 acres of ecotone habitat for the California clapper rail and salt marsh harvest mouse within Pond A18; (4) the restoration of at least 300 acres of tidal salt marsh habitat and creation of 30 acres of ecotone for the California clapper rail and salt marsh harvest mouse within Pond A12; (5) the restoration of additional tidal marsh habitat for the California clapper rail and salt marsh harvest mouse within some of the Ponds A9-A15 under an adaptive management plan; (6) the enhancement of tidal marsh habitat for the California clapper rail and salt marsh harvest mouse along Artestian, Coyote, and Alviso sloughs through salinization of freshwater and brackish marsh habitat from increased tidal prism; and (7) the implementation of a long-term predator management plan and invasive plant species control plan.

After reviewing the current status of the Pacific coast population of the western snowy plover, the environmental baseline for this species within the action area, the effects of the proposed project and the cumulative effects, it is the Service's biological opinion that the proposed project is not likely to jeopardize the continued existence of this species. We based this determination on the following: (1) successful implementation of the conservation measures described in this biological opinion will minimize the adverse effects on individual western snowy plovers; (2) the avoidance of disturbing any breeding western snowy plovers during construction of the proposed project; (3) the implementation of a long-term predator management plan; (4) the enhancement of nesting habitat for western snowy plovers within Pond A16; and (5) the proposed project will enable the SBSPRP to fulfill their commitment to maintaining at least 250 breeding individual western snowy plovers within the SBSPRP area through adaptive management of suitable nesting habitat.

After reviewing the current status of the California least tern, the environmental baseline for this species within the action area, the effects of the proposed project and the cumulative effects, it is the Service's biological opinion that the proposed project is not likely to jeopardize the continued existence of this species. We based this determination on the following: (1) successful implementation of the conservation measures described in this biological opinion will minimize the adverse effects on individual California least terns; (2) the avoidance of disturbing any breeding California least terns; and (3) the increase in the abundance of prey fish populations for the California least tern in the South Bay through tidal marsh restoration.

INCIDENTAL TAKE STATEMENT

Section 9 of the Endangered Species Act and Federal regulations pursuant to section 4(d) of the Act, prohibit take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. The Service defines harassment as an intentional or negligent act or omission that creates the likelihood of injury to listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. The Service defines harm to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), take that is incidental to and not intended as part of the agency action is not considered to be prohibited, provided such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below for the California clapper rail, salt marsh harvest mouse, Pacific coast population of the western snowy plover, and California least tern are nondiscretionary, and must be implemented by the Corps and the Refuge so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption under section 7(o)(2) to apply. The Corps and the Refuge have a continuing duty to regulate the activity that is covered by this incidental take statement. If the Corps or the Refuge: (1) fail to require the applicant or any of its contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms, and/or (2) fail to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps or the Refuge must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

California Clapper Rail

The Service anticipates incidental take of individual California clapper rails will be difficult to detect or quantify because of the variable, unknown size of any resident population over time, their elusive and cryptic behavior, and the difficulty of finding killed or injured animals. Due to the difficulty in quantifying the number of California clapper rails that will be taken as a result of the proposed project, the Service is quantifying take incidental to the proposed project as the following:

Corps-led Actions

1. The harassment of all California clapper rails within the 1.04 acres of tidal freshwater marsh foraging/dispersal habitat disturbed along Artesian Slough during tide gate and pedestrian bridge construction.

2. The harassment of all California clapper rails within the 0.11 acre of tidal/brackish marsh foraging/dispersal habitat disturbed along the outboard Pond A18 levee during breaching and excavating the pilot channels.

3. The harassment and non-lethal harm of all California clapper rails within 17 acres of tidal marsh habitat lost due to scour along Artesian and Coyote sloughs.

4. The annual harassment of all California clapper rails within perennial pepperweed treatment areas in Pond A18.

5. The ongoing harassment by trail users of all California clapper rails within 50 feet of the pedestrian bridge constructed over Artesian Slough.

Service-led Actions

1. The harassment of all California clapper rails within the 0.06 acre of tidal/brackish marsh foraging/dispersal habitat disturbed along the outboard levees of Ponds A9-A15 during breaching and excavating the pilot channels.

2. The harassment and non-lethal harm of all California clapper rails within 40 acres of tidal marsh habitat lost due to scour along Alviso and Coyote sloughs.

3. The ongoing harassment by trail users of all California clapper rails within 50 feet of the segments of the trails constructed without a wide ecotone berm along the southern Pond A12 levee, the Pond A12/A13 levee, and the northern Pond A15 levee once tidal marsh is restored to these ponds.

4. The ongoing harassment of all California clapper rails within 50 feet of the Ponds A9-A15 levees during levee operation and maintenance activities.

5. The annual harassment of all California clapper rails within perennial pepperweed treatment areas in Ponds A9-A15.

Salt Marsh Harvest Mouse

The Service anticipates incidental take of individual salt marsh harvest mice will be difficult to detect or quantify because of the variable, unknown size of any resident population over time, their elusive and cryptic behavior, and the difficulty of finding killed or injured animals. Due to the difficulty in quantifying the number of salt marsh harvest mice that will be taken as a result of the proposed project, the Service is quantifying take incidental to the proposed project as the following:

Corps-led Actions

1. The harassment and harm of all salt marsh harvest mice within the 13.65 acres of low quality salt marsh habitat disturbed along the edges of the Alviso impoundment, the northern edge of New Chicago Marsh, adjacent to the southern levee of Pond A16, and along both northern and southern sides of the existing Pond A18 levee during construction of the FRM levee and the Artesian Slough tide gate and pedestrian bridge.

2. The harassment and harm of all salt marsh harvest mice within the 0.11 acre of salt/brackish marsh habitat disturbed on the outboard Pond A18 levee along Artesian and South Coyote sloughs during breaching and excavation of the pilot channels.

3. The harassment and non-lethal harm of all salt marsh harvest mice within 17 acres of tidal marsh habitat lost due to scour along Artesian and Coyote sloughs.

4. The ongoing harassment and harm of all salt marsh harvest mice within 25 feet of the FRM levee top during levee operation and maintenance activities (*e.g.*, mowing a 15-foot wide strip of ruderal grassland habitat adjacent to the levee crown once per year).

5. The ongoing harassment by trail users of all salt marsh harvest mice within 25 feet of the pedestrian bridge constructed over Artesian Slough.

6. The annual harassment of all salt marsh harvest mice within perennial pepperweed treatment areas in Pond A18.

Service-led Actions

1. The harassment and harm of all salt marsh harvest mice within the 0.06 acre of tidal/brackish marsh habitat disturbed along the outboard levees of Ponds A9-A15 during breaching and excavating the pilot channels.

2. The harassment and non-lethal harm of all salt marsh harvest mice within 40 acres of tidal marsh habitat lost due to scour along Alviso and Coyote sloughs.

3. The capture of all salt marsh harvest mice on Refuge lands within the construction footprint in the action area during construction of the proposed project.

4. The ongoing harassment by trail users of all salt marsh harvest mice within 25 feet of the trails constructed along New Chicago Marsh and Ponds A12, A13, A15, and A18 once tidal marsh is restored to these ponds and ecotone habitat is created along Ponds A12 and A18.

5. The ongoing harassment of all salt marsh harvest mice within 25 feet of the Ponds A9-A15 levees during levee operation and maintenance activities.

6. The annual harassment of all salt marsh harvest mice within perennial pepperweed treatment areas in Ponds A9-A15.

Pacific Coast Population of the Western Snowy Plover

The Service is quantifying take incidental to the proposed project as the following:

Corps-led Actions

1. The harassment of all western snowy plovers within 600 feet of the Alviso Segment of the FRM levee in Ponds A12 and A13, the Alviso impoundment, New Chicago Marsh, and Pond A16 during construction of the proposed project.

2. The harassment and harm of two (2) breeding pairs of western snowy plovers due to the loss of breeding habitat in the Alviso impoundment and northern New Chicago Marsh due to the raising and widening of the FRM levee.

3. The annual harassment of all of western snowy plovers within 600 feet of the FRM levee during levee operation and maintenance activities adjacent to Pond A16, New Chicago Marsh, and the Alviso impoundment.

Service-led Actions

1. The harassment and harm of five (5) breeding pairs of western snowy plovers after the permanent loss of 2,010 acres of potential salt pond nesting habitat within Ponds A9-A15.

2. The ongoing harassment by trail users of all western snowy plovers within 600 feet of the Bay Trail along the FRM levee adjacent to Pond A16, New Chicago Marsh, and the Alviso impoundment.

California Least Tern

The Service is quantifying take incidental to the proposed project as the following:

Corps-led Actions

1. The harassment of all foraging and roosting California least terns within 300 feet of construction activities at Pond A18 and the FRM levee.

2. The harassment and harm of two (2) individual California least terns after the permanent loss of 736 acres of salt pond foraging habitat within Pond A18.

Service-led Actions

1. The harassment of all foraging and roosting California least terns within 300 feet of construction activities at Ponds A9-A15.

2. The harassment and harm of four (4) individual California least terns after the permanent loss of 2,010 acres of salt pond foraging habitat within Ponds A9-A15.

3. The ongoing harassment of all foraging and roosting California least terns by trail users within 300 feet of the trails along Ponds A18, A12, A13, and A15 until these ponds are restored to tidal marsh.

Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the California clapper rail, salt marsh harvest mouse, Pacific coast population of western snowy plover, and California least tern.

Reasonable and Prudent Measures

The Service has determined that the following reasonable and prudent measures are necessary and appropriate to minimize the effects of the proposed project on the California clapper rail, salt marsh harvest mouse, Pacific coast population of western snowy plover, and California least tern:

1. The Corps through the CSCC, City of San Jose, and SCVWD will minimize adverse effects to the California clapper rail, salt marsh harvest mouse, Pacific coast population of western snowy plover, and California least tern in the action area for the Corps-led actions by following the project description as modified by the terms and conditions.

2. The Refuge through the CSCC, City of San Jose, and SCVWD will minimize adverse effects to the California clapper rail, salt marsh harvest mouse, Pacific coast population of western snowy plover, and California least tern in the action area for the Service-led actions by following the project description as modified by the terms and conditions.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps and the Refuge shall ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These Terms and Conditions are nondiscretionary.

The following Term and Condition implements Reasonable and Prudent Measure Number One (1):

1. The Corps shall ensure that the CSCC, City of San Jose, and SCVWD minimize proposed project related effects of mobilization of methylmercury by minimizing the frequency and duration of methylization by minimizing the number of times mercury-contaminated soils are wetted and dried during construction of the proposed project (this measure does not apply to imported soils that meet contaminants screening criteria for mercury).

The following Term and Condition implements Reasonable and Prudent Measure Number Two (2):

1. The Refuge shall ensure that the CSCC, City of San Jose, and SCVWD minimize proposed project related effects of mobilization of methylmercury by minimizing the frequency and duration of methylization by minimizing the number of times mercury-contaminated soils are wetted and dried during construction of the proposed project (this measure does not apply to imported soils that meet contaminants screening criteria for mercury).

Reporting Requirements

In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, the Corps and the Refuge shall adhere to the following reporting requirements. Should this anticipated amount or extent of incidental take be exceeded, the Corps or the Refuge must reinitiate formal consultation as per 50 CFR 402.16.

1. The Service must be notified within one (1) working day of the finding of any injured or dead listed species or any unanticipated damage to its habitat associated with the proposed project. Notification will be made to the Coast/Bay Division Chief of the Endangered Species Program at the Sacramento Fish and Wildlife Office at (916) 414-6600, and must include the date, time, and precise location of the individual/incident clearly indicated on a U.S. Geological Survey 7.5 minute quadrangle or other maps at a finer scale, as requested by the Service, and any other pertinent information. When an injured or dead individual of the listed species is found, the Corps or the Refuge shall follow the steps outlined in the Disposition of Individuals Taken section below.

2. The Corps and/or the Refuge shall provide annual updates and interim progress reports to the Service on the status of the implementation of the proposed project, avoidance and minimization measures, predator management, monitoring of the tidal marsh restoration areas, monitoring of the Pond A16 western snowy plover nesting habitat enhancements, and adaptive management.

Disposition of Individuals Taken

Injured listed species must be cared for by a licensed veterinarian or other qualified person(s), such as the Service-approved biologist. Dead individuals must be sealed in a resealable plastic bag containing a paper with the date and time when the animal was found, the location where it was found, avoidance and minimization measures implemented, and the name of the person who found it, and the bag containing the specimen frozen in a freezer located in a secure site, until instructions are received from the Service regarding the disposition of the dead specimen. The Service contact person is the Coast/Bay Division Chief of the Endangered Species Program at the Sacramento Fish and Wildlife Office at (916) 414-6600.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following actions:

1. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should develop, fund, and annually implement an avian and mammalian predator monitoring and management program within suitable habitat for the salt marsh harvest mouse, California clapper rail, western snowy plover, and California least tern around the Bay.

2. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should remove raptor nest and perch sites or install raptor perching deterrents within suitable habitat for the salt marsh harvest mouse, California clapper rail, western snowy plover, and California least tern around the Bay.

3. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should control invasive plant species (*e.g.*, perennial pepperweed) within suitable habitat for the salt marsh harvest mouse and California clapper rail.

4. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should import clean fill to raise the elevations of subsided salt ponds to accelerate the timeline of tidal marsh restoration.

5. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should install high-tide refugia islands planted with marsh gumplant for salt marsh harvest mice and California clapper rails within tidal marshes that lack sufficient high-tide refugia.

6. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should minimize the effects of atmospheric nitrogen deposition from nitrogen oxides emissions in construction vehicle traffic exhaust in facilitating the spread of invasive plant species into naturally nutrient-poor serpentine grassland habitat for the threatened Bay checkerspot butterfly and listed serpentine plants in the Santa Clara Valley by contributing funding to the management of invasive plant species in serpentine grassland habitat that supports these listed species.

7. The Corps and the Refuge should report sightings of any listed or sensitive animal species to the CNDDB of the CDFW. A copy of the reporting form and a topographic map clearly marked with the location the animals were observed also should be provided to the Service.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the proposed South Bay Shoreline Phase 1 Study in Santa Clara County, California. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any additional take will not be exempt from the prohibitions of section 9 of the Act, pending reinitiation.

If you have any questions regarding this biological opinion on the effects of the proposed South Bay Shoreline Phase 1 Study, please contact Joseph Terry, Senior Biologist, or Ryan Olah, Coast/Bay Division Chief, at the Sacramento Fish Wildlife Office at the letterhead address, telephone at (916) 414-6600, or via email (Joseph_Terry@fws.gov or Ryan_Olah@fws.gov). The Service contacts at the San Francisco Bay-Delta Fish and Wildlife Office are Armin Halston, Fish and Wildlife Biologist, or Kim Squires, Section 7 Coordinator, by telephone at (916) 930-5670 or via email (Armin_Halston@fws.gov or Kim_Squires@fws.gov).

Sincerely,

Jennifer M. Norris
Field Supervisor

cc:
Kim Squires, San Francisco Bay/Delta Fish and Wildlife Office, Sacramento, California
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Appendix A: Walking In the Marsh: Methods to Increase Safety and Reduce Impacts to Wildlife & Plants

December 15, 2004

I. Safety

A. *Before heading out into the marsh check the tides*: tides can affect your ability to move through the marsh. Be aware of how long you plan to be in the marsh, what channels you may have to cross, and how the tides will change while you are in the field.

B. *Plan your route through the marsh*: use existing aerial imagery and maps to identify channels and sloughs that may impede access. When available, use high points such as boardwalks or levees to scope out a route. Scoping a route can be especially important in scenarios where visibility across the marsh is low (*e.g.,* South Bay, Suisun). It may be necessary to flag stations and/or access corridors through the marsh prior to surveys. If more than one person is accessing the marsh, travel together along major access routes to avoid the development of multiple paths. At the end of the sampling period, persons furthest out should walk out first, meeting up with others along the major access route…this minimizes the potential of people getting lost and ensures that anyone who is injured will be found in a timely manner (before everyone else has left the marsh). The goal should be to plan a safe route into and out of the marsh while minimizing travel and pathways.

C. *Channels and sloughs*: Avoid jumping channels in locations where you cannot see through vegetation on the opposite bank. Thick vegetation (*e.g.*, pickleweed, gumplant) can obscure the edge of the bank. Considerations before jumping: depth of water/channel, steepness of the channel edges, tide levels. If you are not confident that you can make the jump and the edges have high dense vegetation that you cannot see through…..DO NOT JUMP.

D. *Getting stuck in the mud*: If you are sinking into mud, try to keep moving to avoid getting stuck further. If a leg gets stuck, try to twist your leg to break the suction while leaning your weight on your other leg or knee. Use whatever material you have available (e.g., clipboard, backpack) for leverage (*e.g.*, lean on those items).

E. *Other*: Besides general items such as water and food, it's a good idea to bring a flashlight and a phone (+GPS) in cases of an emergency. Let someone know what marsh area you will be in and when you plan to complete work for the day. Designate an end time and final meeting place when more than one person is out in the marsh at the same time.

II. Avoiding Impacts to Wildlife and Plants

A. *Movement through the Marsh.* While walking through the marsh, keep noise to a minimum. Avoid using multiple pathways through the marsh. Use trails if they exist. Plan and map your route to minimize environmental impacts and decrease running into hazards/barriers such as large channels. When looking for a suitable place to jump a channel, do not walk along the edge of the channel/slough because these areas provide nesting habitat for many species including the endangered California clapper rail. To find an alternate jump site, walk parallel to the channel at a distance where vegetation is lower in height and where visibility

of the ground surface is greater. At all times, observe the environment you are walking through to avoid disturbance. Choose channel jump sites where vegetation is lower or you can clearly discern what you are jumping onto. In general, avoid walking adjacent and parallel to channels/sloughs.

B. *Avoiding nests and nest substrates.* Tidal marsh species have nests that are well concealed and therefore easy to disturb when walking through the marsh. To avoid stepping on a nest, do not walk through thick vegetation or areas where you cannot see through to the ground. Avoid walking on vegetation whenever possible since plants serve as nesting substrate for many species in the marsh. In general, be aware of the area you are walking through.

C. *Bird Behavior.* If a bird vocalizes or flushes within close range of where you are standing or walking (*e.g.*, < 10-m), it is possible that a nest or young are nearby. When these circumstances arise, stop whatever you are doing and leave the immediate area (be sure to watch where and what you are walking on). Choose an alternate route through the marsh, identify the new route and location of the sighting/occurrence on a map, and record coordinates of the location if possible. Be sure to pass this information on to others that may use the same route or are conducting surveys in the same area. Be very observant of where you walk as you leave the area. There exists the possibility that you could step on a nest or young, both of which can be concealed by vegetation and are cryptic. When alarmed, individuals may freeze in place (especially juveniles).

D. *Tidal lagoons/ponds.* Avoid walking along tidal lagoons and ponds in marsh interiors that support foraging, roosting, or nesting shorebirds and waterfowl. Be observant of the distance at which birds flush or become alarmed.

E. *Tides.* Avoid conducting surveys during high tides as much as possible. These are periods when many wildlife species are at greatest risk (*e.g.*, predation). If your surveys require a high tide, be aware of the increased risk you may cause for wildlife and take all precautions to reduce that risk (*e.g.*, avoiding areas where sensitive species are known to occur).

United States Department of the Interior

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

In Reply Refer to:
08ESMF00-
2012-F-0450-3

APR 2 7 2015

Memorandum

To: Refuge Complex Manager, San Francisco Bay National Wildlife Refuge Complex, Fremont, California

From: Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, California

Subject: Biological Opinion and Conference Opinion on the South San Francisco Bay (South Bay) Shoreline Phase 1 Study in Santa Clara County, California

This memorandum is in response to your December 11, 2014, request for intra-U.S. Fish and Wildlife Service (Service) consultation for the proposed South Bay Shoreline Phase 1 Study (proposed project) in Santa Clara County, California. Your request for intra-Service consultation was received in our office on December 22, 2014. The proposed project involves flood risk management, levee construction, upland transitional habitat (ecotone) berm construction along Ponds A12 and A18, tidal marsh restoration in Ponds A9-A15 and Pond A18, trail construction, and operation and maintenance activities on lands owned and managed by the City of San Jose and the Service's Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) in the South Bay. The U.S. Army Corps of Engineers (Corps) and the Service are each requesting the initiation of consultation for the Corps-led actions and Service-led actions of the proposed project, respectively. Your letter requested consultation on the endangered California clapper rail (*Rallus longirostris obsoletus*), endangered salt marsh harvest mouse (*Reithrodontomys raviventris*), threatened Pacific coast population of the western snowy plover (*Charadrius alexandrinus nivosus*), endangered California least tern (*Sternula antillarum browni*), and Federal candidate San Francisco Bay-Delta Distinct Population Segment (DPS) of the longfin smelt (*Spirinchus thaleichthys*). Critical habitat has been designated for the Pacific coast population of the western snowy plover but does not occur within the action area for the proposed project. This document is issued under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act), and in accordance with the policies governing intra-Service consultations (Service 1998), which call for candidate species like the San Francisco Bay-Delta DPS of the longfin smelt to be considered as if proposed for listing.

This document represents the Service's biological opinion on the effects of the proposed project on the California clapper rail, salt marsh harvest mouse, Pacific Coast population of the western snowy plover, and California least tern. The same biological opinion is being submitted to the Corps. Currently the biological opinion is to both the Corps and the Service because the Corps is not authorized to expend funds on ecosystem restoration on lands controlled by another Federal agency, but it can expend funds on flood control on such lands. However, it is a possibility that the Corps

may implement the entire action and, therefore, all aspects of the proposed project will be implemented by the Corps except those that were addressed in the South Bay Salt Pond Restoration Project (SBSPRP) Phase 1 Actions (Service file number 81420-F-08-0621-1, Service 2008). This document also represents the Service's conference opinion on the effects of the proposed project on the San Francisco Bay-Delta DPS of the longfin smelt.

The following sources of information were used to develop this biological opinion and conference opinion: (1) your letter requesting consultation on the proposed project dated December 11, 2014; (2) the November 2014 *Draft South San Francisco Bay Shoreline Phase 1 Biological Assessment for the Salt Marsh Harvest Mouse, California Ridgway's Rail, Western Snowy Plover, California Least Tern, Central California Coast Steelhead, Green Sturgeon, and Longfin Smelt and Essential Fish Habitat Assessment* (Biological Assessment) (H.T. Harvey & Associates (HTH) 2014); (3) the August 2008 *Formal Endangered Species Consultation on the South Bay Salt Pond Restoration Project Long-term Plan and the Project-level Phase 1 Actions, Alameda, Santa Clara, and San Mateo Counties, California* (Programmatic Biological Opinion) (Service file number 81420-F-08-0621-1, Service 2008); (4) electronic mail and conversations among the Corps, the Refuge, HTH, California State Coastal Conservancy (CSCC), San Francisco Bay Conservation and Development Commission (BCDC), Santa Clara Valley Water District (SCVWD), the City of San Jose, California Department of Fish and Wildlife (CDFW), the National Oceanic and Atmospheric Administration/National Marine Fisheries Service (NMFS), and the Service; and (5) other information available to the Service.

CONSULTATION HISTORY

August 12, 2008	The Service issued the Programmatic Biological Opinion for the SBSPRP Phase 1 Actions (Service file number 81420-F-08-0621-1, Service 2008).
2008 – 2014	The Service continued coordination with the Corps, the Refuge, HTH, CSCC, BCDC, SCVWD, the City of San Jose, and CDFW on the SBSPRP and the proposed project.
October 15, 2014	The Service received via electronic mail from the Corps, the Refuge, and CSCC the October 2014 Draft Biological Assessment for the proposed project.
October 17, 2014	The Service provided via electronic mail comments on the October 2014 Draft Biological Assessment for the proposed project to the Corps, the Refuge, HTH, CSCC, SCVWD, and the City of San Jose.
October 28, 2014	The Service participated in a conference call among the Corps, the Refuge, HTH, CSCC, SCVWD, and the City of San Jose discussing the Service's comments on the Draft Biological Assessment for the proposed project.
November 17, 2014	The Service received via electronic mail from the Refuge and the Corps the revised Biological Assessment for the proposed project (HTH 2014).
December 22, 2014	The Service received from the Corps and the Refuge the letter requesting the initiation of formal consultation on the proposed project.

April 9, 2015 The Service submitted the draft biological opinion for the proposed project at the request of the Corps.

April 17, 2015 The Service received via electronic mail from the Corps comments on the draft biological opinion for the proposed project.

BIOLOGICAL OPINION AND CONFERENCE OPINION

Description of the Proposed Project

Background

The Corps is conducting a flood risk management and ecosystem restoration study for the South Bay shoreline. Phase I of the study, known as the South Bay Shoreline Phase I Study (proposed project), involves increasing the height and width of certain levees in the Alviso area in northern Santa Clara County, California, and breaching of other levees to restore tidal habitats in existing managed ponds. The proposed project's "Study Area" (Figure 1) is bounded on the southwest by Alviso Slough; on the north by Coyote Slough, Ponds A16 and A17, the "Island Ponds" (Ponds A19, A20, and A21), and the Newby Island Landfill; on the east by the Coyote Creek levee; and on the south by State Route (SR) 237.

The proposed project consists of two main sets of actions:

1. Corps-led actions: these include flood risk management levee improvements and public access improvements funded by the Corps and SCVWD, which will occur on Refuge lands and lands of the City of San Jose, as well as tidal restoration actions on City of San Jose lands;

2. Service-led actions: these include tidal restoration and public access improvements proposed by the Service and SCVWD on Refuge lands.

Proposed project activities on Refuge lands were included in the intra-Service Programmatic Biological Opinion for the SBSPRP, which addressed flood control, public access, and habitat restoration and management (Service file number 81420-F-08-0621-1, Service 2008). As a result, the intra-Service consultation for the South Bay Shoreline Phase I Study Project will tier off the programmatic consultation for the SBSPRP. However, portions of the South Bay Shoreline Phase I Study Project on City of San Jose lands were not included in the action area for the Programmatic Biological Opinion. Also, the Programmatic Biological Opinion did not cover effects to the longfin smelt which is currently a candidate for Federal listing but was not in 2008.

Flood Risk Management (FRM)

The Study Area is at risk of tidal flooding due to having large areas of low-lying terrain that are bordered by pond levees originally designed and constructed for commercial salt pond purposes rather than for FRM. The proposed project will address this flooding risk by raising the heights of levees in key areas.

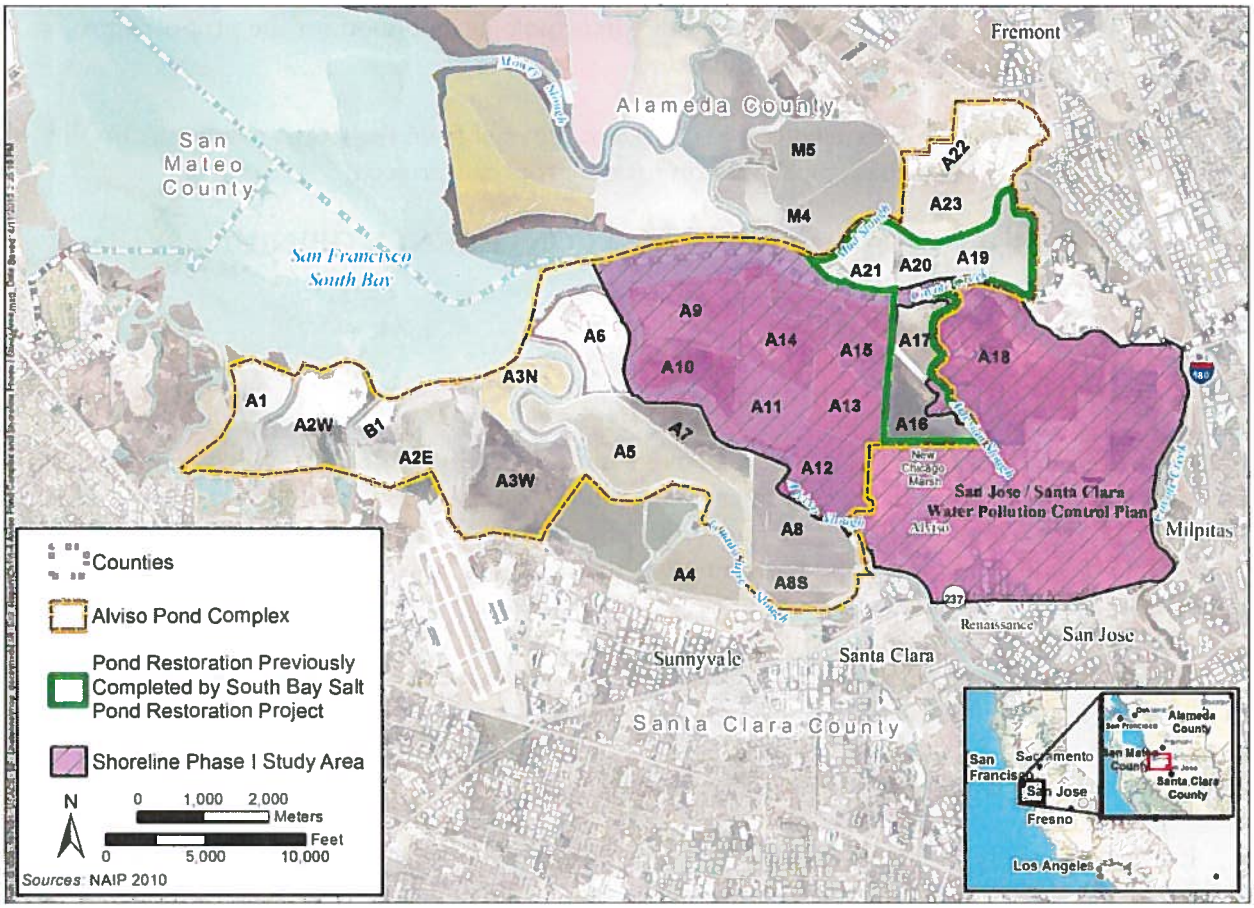

Figure 1. Map of the SBSPRP Phase 1 Actions and the Study Area for the South Bay Shoreline Phase I Study Project.

Ecosystem Restoration

Ecosystem restoration and FRM issues are inseparable in the Study Area because opening up ponds to tidal action changes the hydraulic behavior of the ponds under both normal and high-water conditions. Tidal restoration will alter both ecosystem conditions and potential flood risk to the surrounding areas. Engineered levees are necessary to replace the existing non-engineered pond levees, which were not intended to provide any FRM in order to address the potential change in flood risk.

Tidal salt marshes are in dynamic equilibrium with water levels in San Francisco Bay (Bay) and can keep pace with rising sea levels through accretion of sediment if restoration activities begin soon, based on current and projected sediment availability. In addition, a vegetated marsh plain can slow down tidal surge velocity and reduce wave heights as they traverse the marsh surface. Therefore, having an established marsh in front of FRM infrastructure would increase the resiliency of the shoreline relative to the projected impacts of sea level rise (HDR 2014).

Project Components

Overview

Figures 2 and 3 below depict the portions of the Study Area where long-term physical changes are expected to occur as a result of proposed project activities led by the Corps and the Service, respectively. As noted previously, the proposed project consists of two main sets of actions: tidal restoration and public access improvements proposed by the Service and SCVWD on the Refuge (Figure 3), and flood control levee improvements, public access improvements, and tidal restoration funded by the Corps and SCVWD, both on Refuge lands and lands of the City of San Jose (Figure 2). For the purposes of this biological opinion and conference opinion, the Corps-led actions and the Service-led actions are described separately because the Corps is not authorized to expend funds on ecosystem restoration on lands controlled by another Federal agency, but it can expend funds on flood control on such lands. As a result, the Corps-led actions include flood improvements and public access improvements on Refuge lands, but the Corps cannot fund ecosystem restoration activities on the Refuge. The Corps can, however, fund ecosystem restoration on City of San Jose-owned portions of the Study Area, and thus the tidal restoration and ecotone (upland transitional zone) activities in Pond A18 are part of the Corps-led actions.

Regardless of the source of funding for various proposed project actions or the ownership of the lands on which these actions occur, all the actions described in this biological opinion and conference opinion are interrelated and interdependent. Tidal restoration in the proposed project area necessitates improved tidal FRM, the nature of tidal FRM along levees depends on whether adjacent ponds are tidal or not (e.g., with higher and more robust levees needed if adjacent areas are tidal than if they are managed ponds), and public access and recreation opportunities differ depending on whether and where levee improvements and tidal restoration occur.

Project Schedule and Phasing

The construction-phasing schedule is illustrated in Figure 4 below. This schedule includes both Corps-led and Service-led activities and indicates the lead agency for each task. The South Bay Shoreline Phase I Study timeline includes a 50-year span (2017–2067).

Figure 4 and subsequent discussion regarding the sequence of proposed project activities reflect a scenario in which the first pond to be breached would be Pond A12; this is likely to be the case if the Corps is able to expend funds on restoration on Refuge lands. However, as noted above, the Corps is not currently authorized to expend funds on ecosystem restoration on lands controlled by another Federal agency. As a result, Pond A18 (which is not on Refuge lands) may be breached first, in which case the sequencing and timing of activities associated with A12 and A18 may be reversed. Resolution of the sequence will occur when the proposed project obtains interpretation of the Water Resources Reform and Development Act from Corps Headquarters.

Construction will commence in 2017 beginning with FRM levee construction; the ecotones at Ponds A12 and A18 will be constructed during the same period. Subsequently, Pond A12 will be prepared for breaching. The first breach is scheduled for 2020, followed by monitoring and adaptive management to inform the next potential phases of restoration. This period of monitoring and adaptive management will also be used to inform potential adjustments to Pond A12 and may extend beyond this four-year period. The second phase of ponds (Ponds A9-A11 and Pond A18)



Figure 2. Corps-led Actions in the South Bay Shoreline Phase 1 Study Project (copied from HTH 2014).

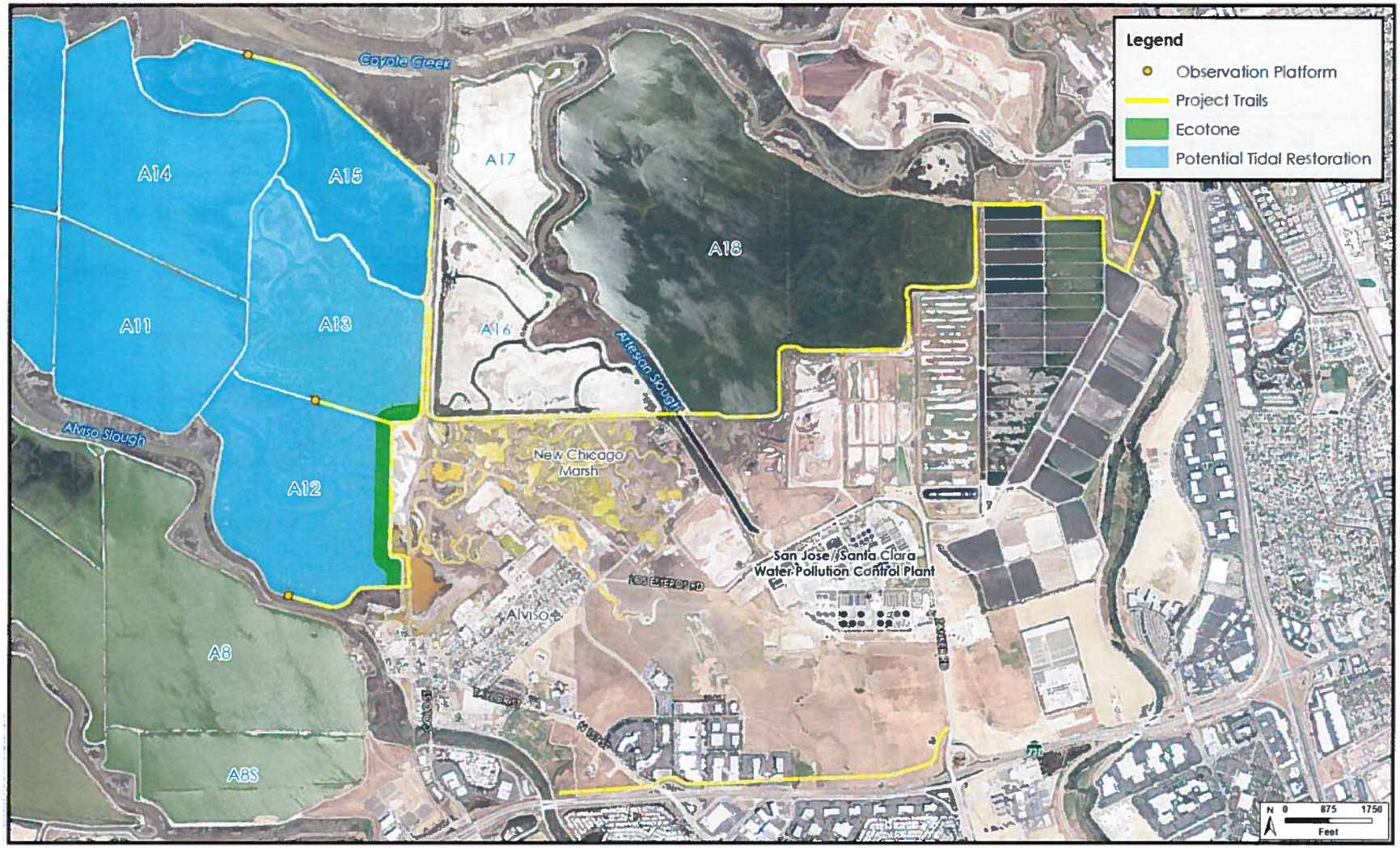

Figure 3. Service-led Actions in the South Bay Shoreline Phase 1 Study Project (copied from HTH 2014).

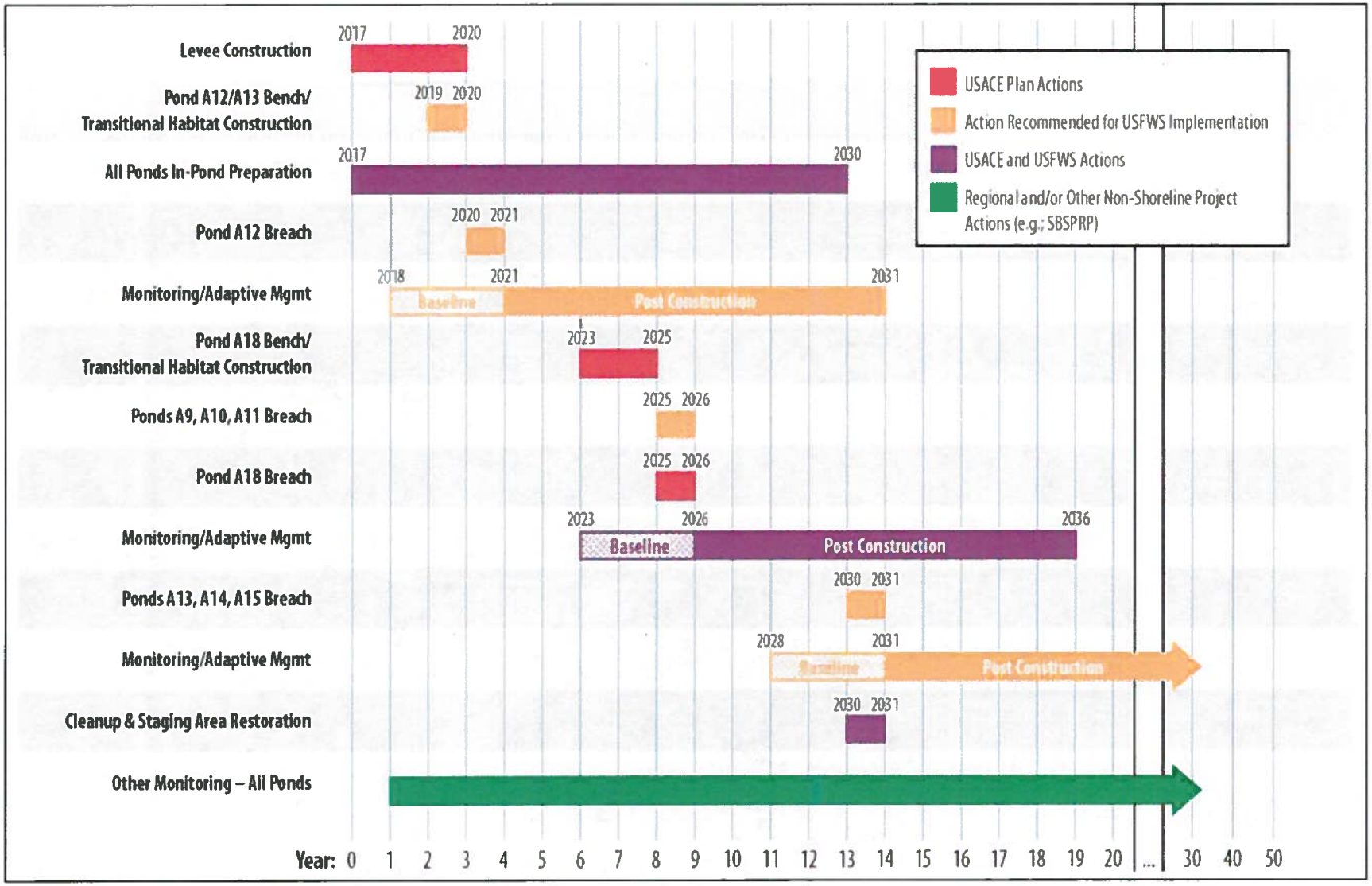

Figure 4. Construction Schedule for the South Bay Shoreline Phase 1 Study (copied from HTH 2014).

will be breached in 2025, assuming that monitoring results from the previous phase indicate that tidal marsh restoration should proceed, and will also be followed by a similar period of monitoring and adaptive management. The last phase of ponds will be breached in 2030 and will be followed by continued monitoring and adaptive management for all areas. Maintenance (e.g., of levees and trails) and management according to a long-term management plan (described in the "Conservation Measures" section below) will continue throughout the life of the proposed project.

For the ecotone at Ponds A12 and A18, separate time frames are identified to construct each of these features. Material for construction of the ecotone at both ponds is assumed to be available on site and free of charge. This material is provided through agreements that the Refuge makes with local construction companies to acquire materials excavated from other regional construction sites, and with the SCVWD to acquire sediment dredged for stream maintenance purposes. After the new FRM levees are constructed, the Refuge and/or SCVWD will use these materials to construct transitional habitat. The construction phasing strategy allows for the accumulation of material needed to build the 345-foot-wide ecotones with 30:1 side slopes at Ponds A12 and A18.

Monitoring will continue throughout the life of the proposed project.

Corps-led Actions

Flood Protection Actions

The Corps conducted an analysis of potential FRM actions in order to identify the proposed project activities. Details of the analysis, including potential actions that were considered but that are not proposed and potential alternatives to the proposed project, are discussed in the Integrated Document (HDR 2014).

Construction

The Corps will construct 3.1 miles of new levee from the Alviso Marina northeastward to the northwestern corner of the San Jose/Santa Clara Water Pollution Control Plant (WPCP) (Figure 2). The levee, which would provide FRM assuming a one percent Annual Chance of Exceedance, consists of the following three components:

1. The 1.7-mile Alviso Segment, which is located entirely on Refuge lands, will provide FRM for the community of Alviso. This segment follows the eastern border of Pond A12 and the southern border of Pond A16.

2. The Artesian Slough crossing will entail construction of a new tide gate across the slough to protect the WPCP from storm waters flooding the slough and backing up into the facility during extreme storm events. The proposed location of the tide gate will be at least 300 feet bayward of the existing WPCP outfall for treated water at Artesian Slough (the location shown in the Biological Assessment is approximate, and the actual location may be farther upstream along Artesian Slough). The gates will only be closed during extreme storm events. When the gates are closed, the WPCP will need to pump water outputs over the gate, or provide for internal excess water storage during a storm event. With or without the proposed project, the WPCP will develop a plan to pump or store waters during such events given increases in Bay water levels that correspond with future sea level rise scenarios. To

best meet the general operations requirements for the WPCP and allow for discharge during storm events, the tide gate will be designed in coordination with WPCP engineers.

3. The 2.1-mile WPCP Segment, which is located on City of San Jose lands, will provide FRM to the WPCP. It runs west to east in a stair-step pattern along the southern border of Pond A18, from the southwest corner of the pond to its northeast corner.

The engineered levee will be earthen. The proposed change in levee size from the existing levee (*e.g.*, along the southern edge of Pond A16) will be an increase of up to approximately 10 feet in height (after settlement) and about double in existing width. For example, the Alviso Segment levee along the southern edge of Pond A16 will increase in height from approximately 6 feet to 16 feet and increase in width at the toe from approximately 55 feet to 115 feet. The average width at the crown of the levee will be 16 feet, with 3:1 (horizontal: vertical) slopes except where ecotones having a 30:1 slope will be constructed (Figure 5). Along the east edge of Pond A12, the Alviso Segment levee will have an additional 345-foot-wide ecotone along its west side.

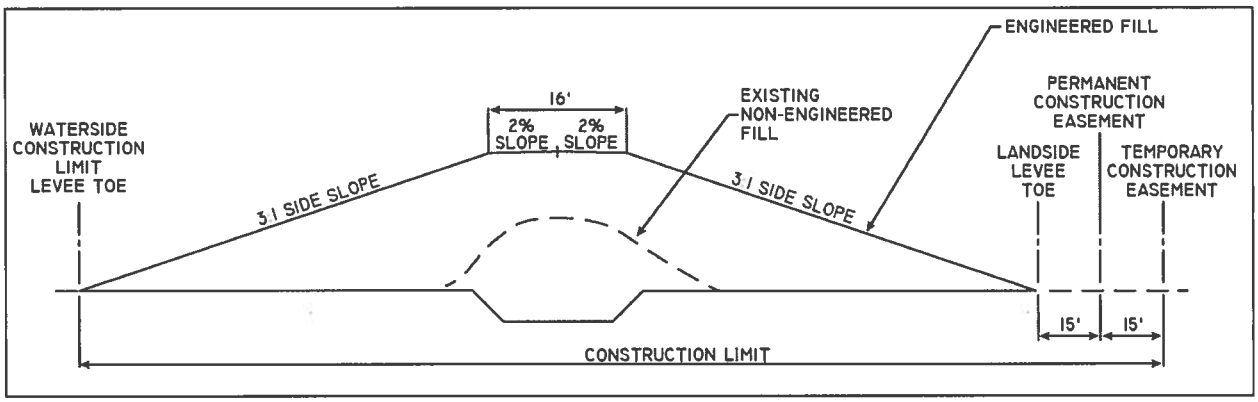

Figure 5. Example Cross-Section of Engineered FRM Levee.

Dredge material originating from areas outside the proposed project area that is used for ditch blocks, or for portions of the ecotone and FRM levee that will be in contact with tidal waters, will need to meet the contaminants screening criteria as described in the Biological Assessment (HTH 2014).

The levee design will include vegetation as erosion protection on the bayward and landward side slopes. Vegetation is anticipated to be continuous and able to provide erosion protection from overtopping of the levee. The vegetation that will be seeded or planted on the levee following construction will consist of marsh vegetation and peripheral halophytes at the toes of the levee and upland grasses at higher elevations. The combination of vegetation, buried stone, and/or transitional habitat fills (*i.e.*, planting berms) is proposed to balance requirements for levee safety with the need to limit disturbance from traditional maintenance activity (described below) such as regular mowing in/near habitat for sensitive species such as the salt marsh harvest mouse.

Proposed vegetation will include marsh species and peripheral halophytes, such as 12 to 18-inch tall pickleweed, from elevation 0 feet to 3 feet above the typical high water elevation. The high water elevation corresponds to approximately elevation 6 feet and 10 feet on the landward and bayward

side slope, respectively. Upland grasses will occupy the side slopes between the levee crest and the pickleweed. Combinations of buried stone protection and buried gravel may be necessary to stunt the growth of native vegetation in lieu of regular mowing (i.e., to reduce the frequency of mowing) in an environmentally sensitive area, or to provide erosion protection where vegetation cannot be supported.

Where the FRM levee will cross the active railroad line just east of Pond A12, railroad floodgates will be installed. Concrete barriers will be installed on either side of the railroad right-of-way and will tie into the earthen levees. The metal floodgates will be connected to the barrier and will remain open during normal conditions and closed during flood conditions.

Certain locations may require special structures or treatment as follows:

1. Where the levee crosses an existing water feature such as a slough, structures will be installed to allow drainage during normal conditions and closure during flood conditions.

2. Where the levee crosses below-ground infrastructure (utilities, etc.), load-bearing structures may be needed to support the weight of levee materials.

Other materials such as geotextile fabric, stone column, foundation over-excavation, or replacement with stronger soil may also need to be included in the final FRM levee design.

Fill for the FRM levee will be imported from local sources and delivered by truck. Proposed staging areas and ingress/egress routes are shown on Figure 6 below. Potential staging areas #1 and #2 are both on WPCP land. Ingress and egress truck routes for these two areas are proposed on existing levee roads used currently by WPCP for materials hauling. Potential staging area #3 is on Zanker Landfill land and will be restricted in use for dirt stockpiling only.

The timing and duration of construction will be governed by both weather conditions and the need to avoid construction in sensitive areas during certain times of the year to avoid and minimize impacts to listed species. Types of construction equipment may include excavators, belly scrapers, front-end loaders, bulldozers, forklifts, vibratory rollers, dump trucks, and water trucks. Ancillary types of equipment that may be used include diesel generators, water pumps, and pile drivers. It is anticipated that dewatering and temporary installation of sheet piling will be necessary during the construction of water control structures such as tide gates. Dredge-locks or coffer dams may be constructed using earth levees or sheet piling to allow access for water-based equipment within a site. When possible, amphibious excavators, vibratory pile drivers, and other less-impacting equipment will be used.

Maintenance

Once construction of the Corps-led components is complete, the non-Federal sponsors (the CSCC, SCVWD, and City of San Jose) will be responsible for the operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of these components (*i.e.*, the Pond A18 tidal restoration and ecotone, as well as the entire levee both adjacent to Pond A18 and on Refuge property). An OMRR&R Manual will be prepared to describe these activities. It is anticipated that the following OMRR&R activities will be performed on the FRM levees:

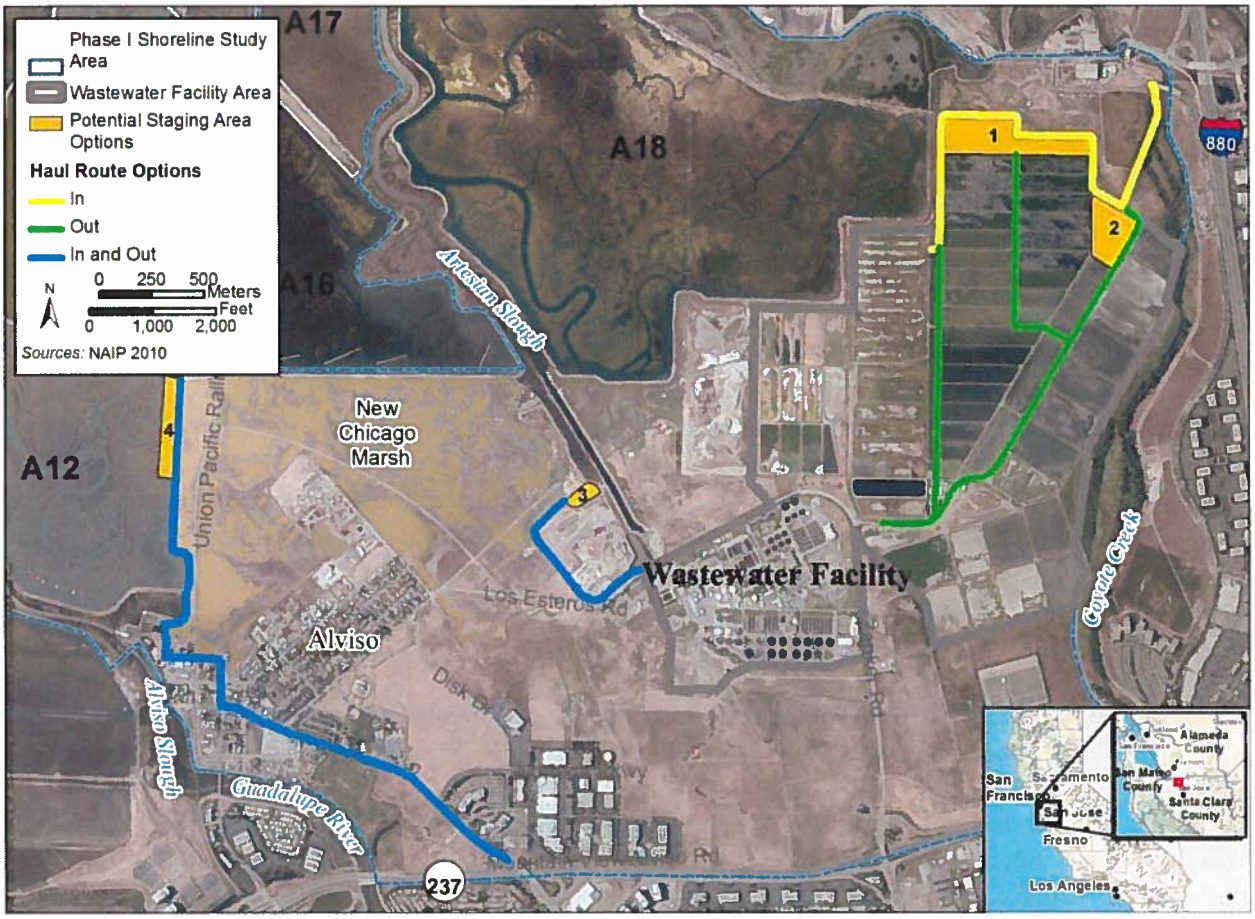

Figure 6. Proposed Access and Staging Areas.

1. Trash and anthropogenic debris removal along levee slopes and where it is causing obstruction in culverts or other problems.

2. Repairs on levee due to damage by small burrowing mammals, runoff/erosion, storm activities, or other factors.

3. Repairs along concrete flood wall structures (if included in plan) and other features, such as bridges and culverts.

4. Levee inspections conducted by SCVWD and the Corps.

5. Graffiti removal.

6. Access improvements and upkeep.

7. Vector monitoring (presence of mosquitoes and their larvae).

8. Vegetation management – As mentioned previously, the levee design will include vegetation as erosion protection on the bayward and landward side slopes.

a. Combinations of buried stone protection and buried gravel may be used to stunt the growth of native vegetation to reduce the frequency of mowing in this environmentally sensitive area, or to provide erosion protection where vegetation cannot be supported.

b. It is anticipated that a reduced need for regular mowing will still include annual mowing of the levee side slopes within 12 to 15 feet of the levee crown. Such a narrow swath of vegetation management will likely require only two or three passes of a mower, once per year, which would minimize the disturbance of sensitive species in adjacent areas. Mowing will proceed from the top (closest to the crown, where habitat is of lowest quality) downward toward higher-quality habitat so that if any wildlife is using the area to be mown, the noise and movement of the mower may encourage wildlife to move downslope into the higher-quality habitat and out of the impact area. This area of mowing will correspond to the area above elevation 9 feet on the levee side slopes and higher elevations in reaches with ecotone fills.

c. No woody plant species greater than two inches in diameter will be allowed to become established on the levees to prevent roots from damaging the structural integrity of the levee. Due to salinity levels in lower-elevation areas, there is a low likelihood of woody vegetation establishment in many areas. Any woody vegetation that germinates in the higher-elevation mowing zone will be managed by mowing. Below the mowing zone, any woody plant removal that becomes necessary will be performed by hand; such hand-removal is expected to be necessary very infrequently (*e.g.*, once every few years, at most).

9. Burrowing mammal management – California ground squirrels may burrow into levees deep enough to affect the structural integrity of the levees, and thus squirrel management may be necessary. Ground squirrels are uncommon along the existing levees in the proposed project area and are thus not expected to require frequent or intensive management efforts. If ground squirrel management becomes necessary, it will be implemented using live traps with screens that have holes large enough to allow small mammals such as salt marsh harvest mice to easily exit the traps. Any mammals caught during such trapping that are potential predators of the salt marsh harvest mouse or California clapper rail, such as rats, striped skunks, red foxes, feral cats, raccoons, or opossums will be lethally removed.

Ecosystem Restoration Actions

The ecosystem restoration strategy to be implemented by the Corps is the conversion of Pond A18, which is currently managed for migratory waterbirds, into vegetated tidal wetlands with goals of maximizing long-term habitat benefits, particularly in consideration of potential sea level rise. Ecosystem restoration also includes creation of a broad, gently sloping ecotone.

Tidal Habitat Restoration

The following ground preparation actions will be involved in converting Pond A18 to tidal marsh:

1. Drain the pond to the extent feasible. The pond will be drained passively, so it may take several months to dry out; pumping would expedite the process and may be considered.

Due to historic pond subsidence, some pond areas are not able to be completely dried. This step is also dependent on temporal proximity to the western snowy plover nesting season and/or if access to the area can be obtained without impacts to western snowy plovers, as dried pond areas may invite western snowy plover nesting.

2. Remove vegetation where needed (*i.e.*, around the breach locations) to discourage salt marsh harvest mice from using the impact areas.

3. Construct upland transitional habitat (described below).

4. Construct ditch blocks to inhibit flow through existing borrow ditches, promote scour and flow through the remnant historical channels, and provide some initial pickleweed habitat where located at the correct elevations. Without the construction of ditch blocks, the borrow ditches around the perimeter of the restored pond would capture the bulk of the flow, reducing the formation of complex dendritic channels in the restored marsh habitat.

5. Construct pilot channels on the outboard side of the A18 levee to facilitate flow between tidal sloughs and the restored tidal habitat in Pond A18. Three pilot channels will be constructed along Artesian Slough, and one will be constructed along South Coyote Slough. These pilot channels will be constructed at the locations of major historical tidal channels.

6. Breach the outboard levee in four locations along Artesian Slough and one location along South Coyote Slough. Breach size will be determined based on the hydrologic relationship between the tidal channel and marsh drainage area and on data from tidal channels in mature marshes throughout the Bay (ESA and Philip Williams & Associates, Ltd. 2012). Breaches are sized to long-term equilibrium dimensions to balance between excavation costs, scour potential, and tidal drainage consistent with *Design Guidelines for Tidal Wetland Restoration in San Francisco Bay* (Philip Williams & Associates, Ltd. and Faber 2004). Dimensions are adjusted to provide a cross-section with side slopes of 4:1 to 5:1 and a bottom width of approximately 10 feet. On the inboard side of the levee, the breach excavation will extend to the levee toe.

Pond A18 will be breached in five locations to facilitate flow of water into and through the pond, allow the tides to carry sediment into the pond, and allow for the retention of remnant channels in the pond bottom. Breaching of Pond A18 will restore approximately 736 acres of new tidal habitat (in addition to the upland transitional habitat discussed below). When Pond A18 is breached, its bottom elevation will be too low for vegetated marshes to form immediately. Several feet of sediment will need to be deposited by natural processes before the pond bottom reaches a sufficient elevation for marsh vegetation to grow. This sedimentation process is expected to proceed at rates determined in part by suspended solids concentrations as well as by factors causing re-suspension of sediment, such as wave action and tidal currents, in the breached pond (ESA and Philip Williams & Associates, Ltd. 2012). Because these factors cannot currently be predicted, it is not known how quickly vegetated marsh will form in Pond A18. Monitoring of the restoration process, and adaptive management if necessary to achieve vegetated tidal marsh, will occur per the *Shoreline Study Monitoring and Adaptive Management Plan* (MAMP) described previously. Once tidal marshes have begun to form in the former ponds, the rate of sedimentation will increase as the vegetation slows the water, catches sediment, and retains it. Eventually, with sufficient sediment, it is expected that Pond A18 will be largely vegetated, aside from tidal channels.

Because of the tidal flood protection functions currently provided by the outboard levees around Ponds A9-A15, tidal restoration within those ponds would not be feasible without enhancement of flood protection inboard from those ponds. As a result, the Service-led tidal restoration on Refuge lands described below could not occur but for the Corps-led construction of the levee and tide gate. Thus, tidal restoration on Refuge lands is dependent on Corps-led levee construction.

Upland Transitional Habitat Creation

Transitional habitat can attenuate waves and reduce wave run-up, increase habitat resiliency by providing space for marshes to retreat inland in the face of sea level rise, and provide refugia for animals such as the California clapper rail and salt marsh harvest mouse during very high tides, when the marsh plain is inundated. The upland transitional habitat adjacent to Pond A18 will be constructed along the interface between the new levee (along the southern and eastern edges of Pond A18) and the newly restored tidal habitat in the pond.

The non-Federal sponsors (the CSCC and SCVWD) recognize the enhanced value of having a gently sloped upland transitional habitat. As a result, the transitional habitat along Pond A18 will be constructed to incorporate a 30:1 slope, which will add up to 345 feet to the width of the bay side of the levee footprint. This ecotone will be constructed along approximately 14,000 linear feet of levee along Pond A18, for a total extent of 67 acres of new upland transitional habitat. Following construction of the ecotone area, it will be seeded and/or planted with native grasses, forbs, and low shrubs. Such an ecotone will provide substantial benefits for wildlife in the Study Area, as this sort of upland transitional habitat is not well represented in the South Bay. Vegetation allowed to establish in the upland transitional areas would be limited to non-woody and semi-woody plants (and possibly shallow-rooted shrubs) and would be otherwise unmanaged, except to control invasive plants from establishing. Figures 13 and 14 in the Biological Assessment (HTH 2014) depict cross-sectional views of how the upland transitional habitat will relate to restored tidal habitats (using Pond A12 as an example) at construction completion (2020) and as anticipated to evolve by 2067, respectively. Within a narrow (15 feet or less) strip of ecotone fill along the edge of the exposed levee surface, vegetation will be managed the same as on the levee (see "Maintenance" section above) to ensure compliance with the Corps' levee vegetation policy.

As indicated in Figure 4, the Pond A12 ecotone will be constructed concurrently with construction of the FRM levee, using the same staging areas and access routes as for levee construction. The Pond A18 ecotone will similarly be constructed simultaneously with levee construction.

Maintenance

Following the breaching of levees around Pond A18, the only management activities that might occur within the restored tidal habitats are predator management and, if necessary, invasive plant management, both of which would be performed on an as-needed basis. If monitoring determines that predator management is necessary to protect special-status and sensitive species, such as California clapper rails and salt marsh harvest mice, from predators such as California gulls, northern harriers, American crows, common ravens, red foxes, striped skunks, feral cats, and raccoons, then adaptive predator management would be implemented. Predator management would be focused on specific areas where predation problems are occurring (or areas, such as poles or towers, used as nesting sites or hunting perches by raptors), and culling would be limited to certain individuals; target mammalian predators that are captured would be lethally removed, while target avian

predators would be either lethally removed (*e.g.*, crows and ravens) or relocated (*e.g.*, raptors). Because it is not currently known whether, and to what extent, predator management at Pond A18 will be needed, and habitat for the California clapper rail and salt marsh harvest mouse will take years to develop after A18 is breached, the local sponsor (*e.g.*, the SCVWD), rather than the Corps, will fund any necessary predator management. Invasive plant management will be needed for the first few years following construction of the ecotone to ensure that perennial pepperweed and other invasives do not become dominant. Otherwise, invasive plant management would be performed if monitoring indicates that particularly invasive species colonize Pond A18 in a way that would jeopardize the habitat enhancements achieved through tidal restoration.

Monitoring and Adaptive Management Actions

The Corps and/or local sponsors (*i.e.*, the SCVWD, CSCC, or the City of San Jose) will provide initial funding for monitoring and adaptive management (MAM) at Pond A18, whereas MAM at the other proposed project ponds will be funded by the Service, SCVWD, City of San Jose, or CSCC. Funding for maintenance and MAM provided by the SCVWD will take the form of an allocation in the SCVWD's annual budget. Given the stability of, and the public need for, the SCVWD, the commitment of long-term funding through the SCVWD's annual budget process will ensure the availability of adequate funding to meet its responsibilities to the proposed project. The entity that will manage Pond A18 in the long-term is not currently known. The City of San Jose and the Corps will identify an appropriate manager for Pond A18 after breaching occurs, and that manager will then be subject to Service approval. Funding for maintenance and MAM at Pond A18 will be provided by the SCVWD, CSCC, and/or City of San Jose. If in the future, Pond A18 is conveyed to the Refuge, an agreement between the City of San Jose, SCVWD, and the Refuge to provide funding for maintenance and MAM at Pond A18 would need to be reached.

MAM for the proposed project falls into three categories: (1) MAM associated with meeting ecosystem restoration objectives, (2) MAM associated with "adaptive implementation" (*i.e.*, decisions about whether to continue or halt the restoration of tidal marsh habitat depending on the monitoring of the effects of pond-to-marsh conversion), and (3) MAM associated with permit compliance. The Corps will cost-share activities associated with meeting ecosystem restoration objectives at Pond A18, for a period of 10 years; the non-Federal sponsors will provide funding for other required MAM. The MAMP includes a discussion of MAM's scientific basis and institutional structure, specific MAM activities, and cost estimates. Because the South Bay Shoreline Phase I Study Project includes a subset of ponds within the SBSPRP, the MAMP for the South Bay Shoreline Phase I Study Project draws heavily from the monitoring and applied studies being conducted by the larger SBSPRP. Monitoring activities to be funded by the Corps at Pond A18 include the following:

1. Water levels, sediment accretion rates, and suspended sediment concentrations;

2. Tidal marsh habitat acreage;

3. Presence and abundance of California clapper rails and salt marsh harvest mice in newly established tidal habitat; given the length of time that may be required for suitable habitat for these species to become established in Pond A18, it is possible that this monitoring may not occur within the 10-year period of Corps cost-shared monitoring, although salt marsh harvest mice may occupy the ecotone within 10 years;

4. Abundance and health of estuarine fish;

5. Count of migrating salmonids;

6. Abundance of non-native plants;

7. Plant species composition in upland transition zones; and

8. Mammalian and avian predators of California clapper rails and salt marsh harvest mice.

Recreation Actions

The only specific recreation-related action that will be funded by the Corps is the construction of a pedestrian bridge over Artesian Slough. This bridge will be constructed to link the multi-use trails on top of the new FRM levee (construction of the trails will not be Corps-funded). The bridge would span the slough atop sets of four parallel piles spaced every 50 feet. This would result in the installation of a total of forty 12-inch-thick steel piles that would form the pedestrian bridge piers. A barge-mounted pile driver/crane or an in-water excavator with a vibratory hammer would be used to drive the 12-inch-thick steel piles.

Service-led Actions

Ecosystem Restoration Actions

The activities involved in tidal restoration in Ponds A9-A15, and ecotone construction along the eastern edge of Pond A12, are similar to those described in above for Pond A18. However, there is an additional activity that will occur in Ponds A9-A15 that will not be necessary in Pond A18 because A18 has no internal berms. For restoration of Ponds A9-A15, breaches in the internal berms will be necessary to reconnect historical channels and restore the hydrologic connections to the innermost ponds in the proposed project footprint. Breach excavations will be sized in a similar manner to those applied to the outboard levees and will extend beyond the levee into the remnant historical channels. Existing internal berms may be lowered in some areas during the breach excavation to create wave breaks to limit wave action, enhance sedimentation, and create vegetated marsh habitat on the berm crests in the short term while the ponds develop from mudflat to vegetated marsh. As Ponds A9-A15 are breached in a phased manner, berms in adjacent ponds not yet being breached will be temporarily raised to provide increased FRM inboard of the current pond breaching actions.

Pond A12 has experienced the greatest degree of subsidence and is proposed for the first phase of restoration (though see above for a discussion of the possibility that Pond A18 may be breached first). By limiting new tidal exchange to this pond (rather than breaching multiple ponds in the first phase), Pond A12 can undergo maximum tidal interaction and sediment deposition, thus helping to raise its bottom elevation to a point where colonization by marsh vegetation will occur. During the first three years (2017–2019), Pond A12 will be prepared for breaching and inundation through excavation of pilot channels in two locations along Alviso Slough and construction of borrow ditch blocks. Berms between Pond A12 and Ponds A11 and A13 will be temporarily (*i.e.*, until tidal restoration in A11 and A13) raised to provide flood protection for A11 and A13. Surplus material excavated from pond preparation will be used to contribute to other in-pond construction activities

requiring material, such as raising of internal levees, if determined suitable by Refuge staff. Subsequently, levee breaches will be implemented in Pond A12 to introduce tidal flow.

Following restoration of tidal flow to Pond A12, monitoring will be conducted to measure the effectiveness of tidal function equilibrium and restorative values. If necessary, corrective measures will be implemented. A period of approximately four years has been established for MAM associated with Pond A12.

Pond preparation for Ponds A9, A10, A11, and A18 would potentially be implemented based on the lessons learned as a result of MAM conducted for Pond A18, including whether to breach these ponds and restore them to tidal marsh. As described previously, this decision will be made according to the MAMP, which includes a series of decisions (based on those in the SBSPRP MAMP) regarding whether to continue breaching that involve monitoring of populations of pond-associated birds, monitoring of sediment accretion in the South Bay, and other factors. If the decision is made to breach these ponds, borrow ditch blocks and pilot channels will be constructed. Pond A11 will be connected to Ponds A10 and A12 with inboard berm breaches, but it will not be breached directly to Alviso Slough. Two breaches to Alviso Slough are planned in Pond A10, and one breach each to Alviso Slough and Coyote Slough are planned for Pond A9. Internal berms between Ponds A9-A11 and Ponds A13-A14 will be temporarily (*i.e.*, until tidal restoration in A13 and A14) raised to provide flood protection for A13 and A14. Levee breaches for Ponds A9-A11 will be implemented in Year 8 (2025) of the proposed project.

Pond preparation for Ponds A13, A14, and A15 will potentially be implemented based on the lessons learned as a result of MAM conducted for previous ponds, including whether to breach these ponds and restore them to tidal marsh. If the decision is made to breach these ponds, borrow ditch blocks and a pilot channel will be constructed. Only one outboard breach will occur for tidal restoration in these three ponds; this breach will connect Pond A15 to Coyote Slough along a major historical channel. Inboard berm breaches at the locations of historical sloughs will connect Ponds A13 and A14 to surrounding ponds (A9, A11, A15, and A12) to provide tidal flows to A13 and A14. Levee breaches will be implemented in Year 13 (2030) of the proposed project.

Ecotone habitat will be created along approximately 4,000 linear feet of levee on the east side of Pond A12. Approximately 30 acres of new upland transitional habitat will be created in this area. Following construction of the ecotone area, it will be seeded with native grasses, forbs, and low shrubs.

Breaching of Ponds A9-A15 would restore up to 2,010 acres of new tidal habitat (including the upland transitional habitat discussed below). As discussed for Pond A18 above, sediment accretion will need to occur within these ponds in order to raise pond bottoms to elevations that will support marsh vegetation. Once tidal marshes have begun to form in the former ponds, the rate of sedimentation will increase as the vegetation slows the water, catches sediment, and retains it. Eventually, with sufficient sediment, it is expected that, if breached, Ponds A9-A15 will be largely vegetated, aside from tidal sloughs. The considerable increase in tidal prism that will occur once these ponds are breached is expected to draw saline water from the Bay into these ponds, resulting in dominance of restored marsh by salt marsh species. An analysis performed by HTH (2012) predicted that the majority of the Pond A9-A15 system will be dominated by salt marsh vegetation. In addition, this increase in tidal prism will draw more saline water into and around the marshes

downstream, thus converting some existing brackish marsh along Alviso and Coyote Sloughs to salt marsh habitat.

Maintenance

Following the breaching of levees around Ponds A9-A15, the only management activities that might occur within the restored tidal habitats are predator management and invasive plant management, as discussed previously. Predator management currently performed according to the Refuge's predator management plan (Foerster and Takekawa 1991, as updated in Service 2012a; Refuge 2012) will continue to be implemented on Refuge lands.

Recreation Actions

Recreation activities were incorporated into the proposed project to replace the loss of public access as the ponds in the Service-managed Refuge are breached and restored to tidal marsh. The proposed recreation measures associated with Service-led actions are multi-use trails on top of the new FRM levee, with connections to the Bay Trail network, along with viewing platforms, and trail upgrades to be made to an existing segment of the Bay Trail system along SR 237 (Figure 3).

Under existing conditions, a loop trail extends around Ponds A9 through A15, with an interior trail also existing between A15 and A13/14. These trails can be accessed from the Alviso Marina or via a spur that crosses the railroad tracks between Ponds A16 and A15. Restoration of tidal action to Ponds A9 through A15 will involve breaches in the outboard levees, thus interrupting the perimeter trail. Around Ponds A9-A15, the only trails that would remain following the completion of tidal restoration would consist of short segments in the eastern part of this group of ponds, as shown on Figure 3 (see also Figure 18 in the Biological Assessment (HTH 2014)).

The proposed project includes a new section of maintenance trail along the crest of the new WPCP Segment, which will be available for pedestrian traffic. Consistent with the WPCP Master Plan, the eastern extent of the levee maintenance trail will connect to a designated route at the existing bridge at McCarthy Boulevard. The existing pedestrian walkway on the bridge will take recreationists to the Coyote Creek Trail that runs along the east bank of the creek. This proposed trail connection will be refined in final design with consideration of both public safety and the addition of features (*e.g.*, fencing) to limit public access to sensitive wildlife areas. In addition, because the westernmost extent of the proposed levee's maintenance trail will end (with the levee itself) at existing high ground adjacent to the Alviso Marina, this will facilitate another connection to the Bay Trail if the City of San Jose's proposed plans to connect the Alviso Marina to the larger trail network are realized. In addition, the proposed project will construct a trail segment along the north side of SR 237 between the Guadalupe River and Zanker Road (see Figure 18 in the Biological Assessment (HTH 2014)).

Construction Equipment/Activities for Recreation Components

Construction of the recreation and public access components may consist of the following activities:

1. Grading and, for all-weather trails, gravel application. Equipment required for trail construction may include small, Bobcat-sized equipment, backhoes or front-end loaders, graders, bulldozers, asphalt placement equipment, and dump trucks.

2. Constructing trails, including some trails designed to accommodate vehicular use, trails to provide access to a staging area, and trails for disabled access.

3. Constructing interpretive stations of varying size and scope, which will include interactive features that can operate independently or can be enhanced with the assistance of docents.

4. Constructing viewing platforms at vista points where important information about the landscape can be described. Viewing platforms will be made of wood, metal, or plastic material and assembled in-place using a backhoe or excavator and hand tools. Interpretive stations will be built on-site, or will be prefabricated structures. Assembly and installation will require a backhoe or excavator and hand tools.

Maintenance of Recreation Components

Once construction of the recreation components is complete, the SCVWD, likely in a cooperative agreement with the City of San Jose, will be responsible for their operation, maintenance, repair, replacement, and rehabilitation. It is anticipated that the following operations and maintenance activities will be performed on the trails and the Artesian Slough pedestrian bridge:

1. Trash and anthropogenic debris removal;

2. Repairs due to damage by people, small mammals, storm activities, or other factors;

3. Trail and bridge inspections;

4. Graffiti removal;

5. Access improvements and upkeep;

6. Predator and invasive species management;

7. Enforcement of conservation measures; and

8. A long-term management plan will be prepared to describe the implementation of these activities.

Monitoring and Adaptive Management Actions

MAM will be implemented in Ponds A9-A15 as described previously for Pond A18. The MAMP includes a discussion of the scientific basis and institutional structure for implementation, specific MAM activities, and cost estimates. Monitoring activities to be performed for the restoration activities at Ponds A9-A15 include those listed previously. Other monitoring of more regional issues, such as regional changes in mudflat and tidal marsh acreages, changes in bird populations (including sensitive species and predators such as gulls), and mercury bioavailability, will continue to occur through the SBSPRP as it currently does.

Conservation Measures

The operational implementation of proposed project activities incorporates a number of measures, including general and species-specific measures, to avoid and minimize impacts during construction. All of these measures apply both to Corps-led and Service-led activities. Residual impacts remaining after implementation of the general and species-specific avoidance and minimization measures are addressed through compensatory conservation measures. These conservation measures are further described below.

General Avoidance and Minimization Measures

Below, the general conservation measures that will be implemented during proposed project activities to avoid and minimize adverse effects on sensitive species and habitats are described, followed by conservation measures specific to individual special-status species. Additional details and measures are provided in the proposed project's *Integrated Document* (HDR 2014). All permit conditions, legal requirements, and appropriate excavation and engineering practices shall be followed to avoid and minimize environmental impacts associated with the proposed project. The term "project site" below refers to any of the potential work locations related to FRM and restoration activities that will occur throughout the proposed project's action area.

1. Earthen materials (*e.g.*, existing levees) will be reused to the extent feasible to reduce the amount of imported material and stockpile and landfill material.

2. Staging, access, and parking areas will be located outside of sensitive habitats to the extent feasible.

3. Areas of disturbance will be limited to the smallest footprint necessary.

4. All equipment will be maintained free of petroleum leaks. 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.

5. Spill prevention kits will always be in close proximity to construction activities (*e.g.*, crew trucks and other logical locations) when using hazardous materials. Feasible measures will be implemented to ensure that hazardous materials are properly handled and the quality of aquatic resources is protected.

6. No fueling will be performed in wetland or aquatic habitats unless equipment stationed in these locations is not readily relocated (*e.g.*, Aquamog, pumps, generators, dredge barges). For stationary equipment that must be fueled on site, containment will be provided in such a manner that any accidental spill of fuel will not be able to enter the water or contaminate sediments that may come in contact with water.

7. A hazardous materials management/fuel spill containment plan will be developed and implemented by the construction contractor and given to all contractors and biological monitors working on the proposed project, with at least one copy of the plan located onsite at all times. The purpose of the plan is to provide onsite construction managers,

environmental compliance monitors, and regulatory agencies with a detailed description of hazardous materials management, spill prevention, and spill response/cleanup measures associated with the construction of the proposed project elements. The primary objective of the plan is to prevent a spill of hazardous materials. Elements of the plan include, but are not limited to the following:

a. A discussion of hazardous materials management, including delineation of hazardous material and hazardous waste storage area, access and egress routes, waterways, emergency assembly areas, and temporary hazardous waste storage areas;

b. Materials Safety Data Sheets for all chemicals used and stored on site;

c. An inventory list of emergency equipment;

d. Spill control and countermeasures including employee spill prevention/response training;

e. Notification and documentation procedures; and

f. Monthly reporting plan.

8. Vehicles will be washed only at an approved area. No washing of vehicles will occur at job sites.

9. A berm or other sediment-control devise will be installed around stockpiled soil material to prevent runoff from transporting sediment into sensitive habitats.

10. Any large wood or weed-free topsoil displaced by construction will be stockpiled for use during site restoration. Native vegetation displaced by construction will be stockpiled if it would be useful during site restoration.

11. The work site, areas adjacent to the work site, and access roads will be maintained in an orderly condition, free and clear from debris and discarded materials. Personnel will not sweep, grade, or flush surplus materials, rubbish, debris, or dust into storm drains, water bodies, or waterways. Upon completion of work, all building materials, debris, unused materials, concrete forms, and other construction-related materials will be removed from the work site.

12. A stormwater management plan will be developed to ensure that, during rain events, construction activities do not increase the levels of erosion and sedimentation. This plan will include the use of erosion-control materials (*e.g.*, baffles, fiber rolls, or hay bales; temporary containment berms) and erosion-control measures such as straw application or hydroseeding with native grasses on disturbed slopes; and floating sediment booms and/or curtains to minimize any impacts that may occur due to increased mobilization of sediments. Suitable erosion control, sediment control, source control, treatment control, material management, and non-stormwater management best management practices will be implemented consistent with the latest edition of the California Stormwater Quality Association

"Stormwater Best Management Practices Handbook," available at www.capmphandbooks.com.

13. All disturbed areas will be stabilized within 12 hours of any break in work unless construction will resume work within seven days. Earthwork will be completed as quickly as possible, and site restoration will occur immediately following use.

14. For each activity, the supervising construction personnel will participate in a Service-approved worker environmental awareness program. Under this program, construction personnel will be informed about the presence of listed species and habitats associated with the species and that unlawful take of the animal or destruction of its habitat is a violation of the Act. Prior to construction activities, a qualified biologist approved by the Service will instruct all construction personnel about: (1) the description and status of the species; (2) the importance of their associated habitats; and (3) a list of measures being taken to reduce impacts on these species during proposed project construction and implementation. The awareness program will apply to construction occurring within or adjacent to tidal marsh or slough habitat and within or adjacent to managed pond habitat. A fact sheet conveying this information will be prepared for distribution to the construction crew and anyone else who enters the proposed project site. A Service representative will be appointed who will be the contact source for any employee or contractor who might encounter a listed species. The representative(s) will be identified during the environmental awareness program. The representative's name and telephone number will be provided to the Service prior to the initiation of any activities.

15. No firearms (except for Federal, State, or local law enforcement officers and security personnel) will be permitted at the proposed project site to avoid harassment, killing, or injuring of wildlife, with the exception of hunters who are authorized by the Service to pass through an area to access hunting areas.

16. No animals (*e.g.*, dogs or cats) will be brought to the proposed project site to avoid harassment, killing, or injuring of wildlife.

17. Ingress and egress points will be clearly identified in the field using orange construction fence. Work will not be conducted outside the designated work area.

18. In order to minimize the spread of invasive plants, all equipment (including personal gear) will be cleaned of soil, seeds, and plant material prior to arriving on the proposed project site to prevent introduction of undesirable plant species.

19. The proposed project site will be maintained trash-free, and food refuse will be contained in secure bins and removed daily during construction.

20. Nighttime work near tidal marsh habitat will be avoided to the extent feasible. If nighttime work cannot be avoided, lighting will be directed to the work area and away from habitat for the salt marsh harvest mouse, California clapper rail, and western snowy plover.

21. Interpretive signage prohibiting access to areas that are closed to the public, and indicating the importance of protection of sensitive biological resources, will be placed in key locations, such as along trails near sensitive habitats.

22. Prior to construction, all high-quality habitat for listed species will be mapped and provided to the Service. Vehicles driving on levees adjacent to such habitat for construction or monitoring activities will then travel at speeds no greater than 10 miles per hour to minimize noise and dust disturbance.

23. All clean fill material proposed for upland and wetland placement will meet the qualifications set forth in the Regional Water Quality Control Board's (RWQCB's) waste discharge requirements (Tentative Order), and will meet the screening criteria listed in the Biological Assessment (HTH 2014). If the above-mentioned thresholds are not attained but the material is approved for use by the RWQCB, consultation will be reinitiated to analyze the potential effects of the contaminated material to listed species.

24. The restored tidal marsh wetlands will be monitored for possible infestation by non-native cordgrass, perennial pepperweed, and other invasive, non-native plant species that could result in a substantial reduction in the ecological value of the tidal restoration and ecotone construction. It is expected that some non-natives that are not particularly invasive will colonize the ecotones, but if any particularly invasive plant species are found, a qualified botanist will recommend specific measures to control the spread of non-native plant species. All infestations of non-native cordgrass within the restored tidal marsh wetlands will be controlled and removed in coordination with the San Francisco Estuary Invasive *Spartina* Project without substantially hindering or harming the establishment of native vegetation in the restored wetlands. If perennial pepperweed control is necessary, spraying with glyphosate or imazapyr formulated for aquatic use may be necessary, as described by Hogle *et al.* (2007) for the San Pablo Bay National Wildlife Refuge. Otherwise, preferred vegetation management will involve non-mechanized methods of removal including hand-pulling, saline spray, pond flooding (during non-breeding seasons), and substrate-based controls. Aside from glyphosate and imazapyr for pepperweed control, the use of any herbicides will be subject to Service and NMFS approval.

25. If spraying for perennial pepperweed is necessary, the following general conservation measures will be implemented (measures specific to the California clapper rail are described below):

    a. Herbicides will be applied by a certified applicator and in accordance with application guidelines and the manufacturer label.

    b. Herbicide applications would be timed to coincide with ebbing tides to protect non-target vegetation, to allow a minimum of six hours dry time for glyphosate/imazapyr mixture applications, and at least one-hour dry time for imazapyr applications.

    c. Herbicides will be applied directly to perennial pepperweed plants and at low or receding tide to minimize the potential application of herbicide directly on the water surface.

d. All certified applicators will be trained to correctly identify perennial pepperweed, to distinguish this species from native species in the action area, and to adhere to the conservation measures in this biological opinion and conference opinion.

26. Long-term maintenance and monitoring will be performed outside of peak migration periods of, and breeding seasons of, sensitive wildlife species to the maximum extent feasible.

27. A Service-approved biological monitor will be present during all work activities in or immediately adjacent to habitat that could be occupied by federally listed species to look for individuals that may be impacted by construction; activities are considered "immediately adjacent" to sensitive habitat if those activities could result in the physical disturbance of the habitat (*e.g.*, as a result of mobilization of sediment into the habitat) or if individual listed species could move from that habitat into the proposed project area (*e.g.*, seeking refuge under construction equipment). The biologist will have stop-work authority if any individual of a federally listed species is detected in an area where it may be injured or killed by construction activities.

28. Any fencing near habitat for the salt marsh harvest mouse, California clapper rail, or western snowy plover will incorporate raptor perch deterrents to minimize raptor predation on listed species.

29. To avoid the loss of individual California clapper rails and salt marsh harvest mice, construction, maintenance, and management activities (including mowing) within or adjacent to habitat for these species will not occur within two hours before or after extreme high tides (6.5 feet or above, as measured at the Golden Gate Bridge and adjusted to the timing of local high tides), when the marsh plain is inundated, because protective cover for these species is limited and activities could prevent them from reaching available cover.

30. No dogs will be allowed on trails (or elsewhere) on Refuge lands. On City of San Jose lands, all dogs must be on leashes and must remain on established trails.

31. Long-term Predator Management and Invasive Plant Species Control Plans: A long-term management plan will be prepared to describe predator management, invasive plant species control, litter cleanup, and patrols/enforcement along the trails in the proposed project area. This plan will be implemented under a cooperative agreement between the SCVWD, the Refuge, and the City of San Jose, and it will be funded by the SCVWD.

Avoidance and Minimization Measures for the California Clapper Rail

The following measures will be implemented to avoid and minimize effects on California clapper rails:

1. To avoid causing the abandonment of an active California clapper rail nest, activities (including construction and maintenance activities) within 700 feet of vegetated tidal marsh providing suitable breeding habitat for California clapper rails will be avoided during the rail's breeding season from February 1 through August 31 unless protocol-level surveys are conducted by a Service-approved biologist to determine California clapper rail locations and territories. If breeding California clapper rails are determined to be present, activities will

not occur within 700 feet of an identified calling center. If the intervening distance across a major slough channel (*e.g.*, Alviso, Coyote, or Artesian Sloughs) or across a substantial barrier between the California clapper rail calling center and any activity area is greater than 200 feet, then work may proceed at that location within the breeding season. Aside from continued use of recreational trails established prior to the start of the breeding season (which may continue), only inspection, maintenance, research, or monitoring activities that have little potential for effects on California clapper rails due to their short durations, distance from rail habitat, or low-magnitude effects may be performed during the California clapper rail's breeding season in areas within or adjacent to California clapper rail breeding habitat, with approval of the Service under the supervision of a qualified biologist. Otherwise, with Service approval on a case-by-case basis, construction activities may take place after July 15 in a given area if the activity is thought to be minimally disturbing to breeding California clapper rails.

2. To be effective, perennial pepperweed control has to occur when the plant is in bud (May-July), during the California clapper rail breeding season. If perennial pepperweed control must be performed in California clapper rail habitat, the following measures will be implemented to minimize impacts on rails:

    a. Vehicle and foot access pathways to perennial pepperweed through tidal marsh will be minimized and use of existing roads and trails for control work will be maximized. Shortest possible access paths through the marsh to treatment patches will be identified prior to marsh access. Control methods to be used in each area will be selected to minimize potential impacts to marsh habitat and listed species from control operations.

    b. If breeding California clapper rails are determined to be present in a marsh, marsh access using aquatic-tracked vehicles (ARGOs) will not be allowed in contiguous marsh areas within 700 feet of an identified California clapper rail calling center (also referred to as the "700-ft Buffer Area") to avoid nest destruction, nest abandonment, and harassment of breeding California clapper rails. If the intervening distance across a major slough channel or across a substantial physical barrier between the California clapper rail calling center and the proposed access area is greater than 200 feet, then access may proceed within the breeding season.

    c. ARGOs will not travel within 50 feet of slough channels to avoid crushing high vegetation, such as gumplant, that grows along channels.

    d. Boats will be used to access marsh areas (where feasible) to treat large areas of perennial pepperweed along slough edges (*e.g.*, use of intelli-sprayer with 300 feet of hoseline) to further reduce the necessity of walking long distances through the marsh.

    e. Crews will be instructed to walk carefully through the marsh, avoiding high pickleweed cover (*e.g.*, greater than one foot) and wrack where salt marsh harvest mice are likely to nest or find cover.

f. All personnel entering the marsh will be trained to identify and avoid direct and indirect disturbance to listed species and associated habitats. Training material will include taped recordings of California clapper rail calls and the "Walking in the Marsh" protocol (see Appendix A of this biological opinion) which addresses potential disturbance effects to California clapper rails and salt marsh harvest mice.

g. Before spray operations commence each year, a qualified California clapper rail biologist familiar with the project area will familiarize the spray crew with the area and ensure that all crew members know the location of each "700-ft Buffer Area" for protection of nesting California clapper rails. Crews will be instructed to avoid these areas unless accompanied by a qualified California clapper rail biologist.

h. During the California clapper rail breeding season, before crews are allowed to enter a California clapper rail "700-ft Buffer Area" to conduct control work, the Refuge Biologist, or designee, will work with other qualified California clapper rail biologists and the spray crew to develop a strategy for control that will minimize the amount of time the crew spends in each "700-ft Buffer Area" while conducting control. This planning session will include use of detailed maps showing perennial pepperweed locations within each "700-ft Buffer Area".

i. During the California clapper rail breeding season, a qualified California clapper rail biologist such as a Refuge Biologist, will accompany spray crews into "700-ft Buffer Areas" and will supervise and guide control operations within these areas.

j. Crews will limit time within a California clapper rail nesting area (call center + 700-ft Buffer Area) to 30 minutes or less to minimize disturbance to adult rails and to avoid potential nest destruction or nest abandonment.

k. If California clapper rail nests are encountered during control work, observers will immediately leave the vicinity of the nest and report findings to the Service.

l. If California clapper rail adults are encountered during control work, observers will move away from the birds if they are giving alarm calls or otherwise appear agitated.

Avoidance and Minimization Measures for the Salt Marsh Harvest Mouse

To minimize potential effects on the salt marsh harvest mouse, the following measures (in addition to those described above for the California clapper rail during perennial pepperweed control) will be implemented:

1. To avoid the loss of individual salt marsh harvest mice from any excavation, fill, or construction activities in suitable habitat, vegetation removal will be limited to the minimum amount necessary to permit the activity to occur. Wherever feasible, sufficient pickleweed habitat, as determined by a Service-approved biologist, will remain adjacent to the activity area to provide refugia for displaced individuals.

2. Within areas where vegetation potentially supporting salt marsh harvest mice will be impacted, vegetation and debris that could provide cover for salt marsh harvest mice will be

removed using only hand tools at least three weeks prior to the commencement of construction activities. Vegetation removal will occur under the supervision of a Service-approved biologist. This vegetation will be removed on a progressive basis, such that the advancing front of vegetation removal moves toward vegetation that would not be disturbed. In some cases, temporary berms may need to be constructed over borrow ditches to enable suitable escape routes, or temporary shelter consisting of dead vegetation may be positioned to provide escape routes to suitable habitat. A Service-approved biologist will monitor the vegetation removal and make specific recommendations with respect to the rate of vegetation removal (to ensure that any salt marsh harvest mice present are able to escape to cover that will not be impacted), whether vegetation needs to remain in a certain area temporarily to facilitate dispersal of salt marsh harvest mice into habitat outside the impact area, and whether any berms are necessary to allow salt marsh harvest mice to disperse across channels.

3. Following the hand-removal of vegetation, exclusion fencing will be erected as needed between construction areas and salt marsh harvest mouse habitat that is to remain unimpacted to define and isolate protected salt marsh harvest mouse habitat. This fencing will consist of heavy plastic sheeting or metal material that cannot be climbed by salt marsh harvest mice, buried at least four inches below the ground's surface, and with at least one foot (but no more than four feet) above the ground. All supports for the fencing will be placed on the inside of the work area. A four-foot buffer will be maintained free of vegetation around the outside of the exclusion fencing. The fencing will be inspected daily during construction, and any necessary repairs will be made within 24 hours of when they are found. If any breaks in the fencing are found, the Service-approved biologist will inspect the work area for salt marsh harvest mice.

4. Although individual salt marsh harvest mice cannot be handled on non-Federal land, because the species is fully protected according to the California Fish and Game Code, individuals can be handled on Federal land (*i.e.*, the Refuge). If any individual salt marsh harvest mice are found within the impact footprint on Refuge land, and they do not move on their own to vegetated areas outside the impact footprint, they will be relocated by hand to suitable habitat outside the impact zone by a qualified biologist.

5. During construction, a Service-approved biologist will check underneath vehicles and equipment for salt marsh harvest mice before such equipment is moved, unless the equipment is surrounded by salt marsh harvest mouse-proof exclusion fencing.

6. During mowing of vegetation along the FRM levee, mowing will start from the top (the area of least suitable habitat) and proceed downslope toward more suitable habitat so any salt marsh harvest mice present in the narrow swath to be mown can move away from the disturbance of the mower and out of the mowing area.

7. Below the zone at the top of the levee that will be mown, any woody plant removal that becomes necessary will be performed by hand; such hand-removal is expected to be necessary very infrequently (*e.g.*, once every few years, at most).

Avoidance and Minimization Measures for the Western Snowy Plover

The following measures will be implemented to avoid and minimize effects on western snowy plovers:

1. No activities will be performed within 600 feet of an active western snowy plover nest during the western snowy plover's breeding season, March 1 through September 14 (or as determined through surveys). Vehicles driving on levees and pedestrians walking on recreational trails established prior to the start of the breeding season (which may continue) will remain at least 300 feet away from western snowy plover nests and broods to the extent feasible, although because these trails are already accessible to the public, nesting western plovers are expected to continue to adjust the location of nesting based on their tolerance of distance from these trails. If necessary, signage, temporary fencing such as roped-off areas, or other markers will indicate areas that vehicles and pedestrians should avoid to protect nesting western snowy plovers, and Refuge staff will enforce these closures. In addition, personnel that must stop at a specific site for brief inspections, maintenance, or monitoring activities will remain 600 feet away from western snowy plover nests and broods. *Exception*: Only inspection, minor maintenance (such as water level management within a pond), research, or monitoring activities may be performed during the western snowy plover breeding season in areas within or adjacent to western snowy plover breeding habitat with approval of the Service under the supervision of a qualified biologist. If western snowy plover chicks are present and are foraging along any levee that will be accessed by vehicles (*e.g.*, for construction, inspection, or access), vehicle use will be under the supervision of a qualified biologist (to ensure that no chicks are present within the path of the vehicle).

2. Breaching of ponds that contain suitable western snowy plover habitat will not be performed during the breeding season (March 1 through September 14) unless surveys have documented that no active nests or unfledged chicks are present within the ponds to be flooded by breaching.

3. Viewing platforms, kiosks, benches, interpretive displays, and other focal areas for public use will be located a minimum of 600 feet from suitable western snowy plover nesting habitat.

Avoidance and Minimization Measures for the California Least Tern

Although California least terns are not known or expected to nest in or very near the action area, the following measures required by the Service's biological opinion for the SBSPRP are incorporated into the proposed project:

1. No activities will be performed within 300 feet of an active California least tern nest during the California least tern's breeding season, which is April 15 to August 15 (or as determined through surveys). *Exception*: Only inspection, maintenance, research, or monitoring activities may be performed during the California least tern's breeding season in areas within or adjacent to California least tern breeding habitat with approval of the Service under the supervision of a qualified biologist.

2. Breaching of ponds that contain suitable California least tern nesting habitat will not be performed during the breeding season unless surveys have documented that no active nests or unfledged chicks are present within the ponds to be flooded by breaching.

3. To avoid or minimize potential adverse effects from public access and recreation features constructed near tidal marsh, trails adjacent to some nesting areas for sensitive bird species will be closed during the breeding season. Public trails within 300 feet of suitable California least tern nesting habitat will be closed during the breeding season. In addition, if trails are to be open during the breeding season of this species, viewing platforms, kiosks, benches, interpretive displays, and other focal areas for public use will be located a minimum of 600 feet from suitable nesting habitat. The locations of trail segments to be closed, and the periods of closure will depend on whether sensitive bird species, such as California least terns, are nesting in certain areas in a given year and whether nesting areas are located in close proximity to the trails. Decisions about whether to close a particular trail segment will be made early in the breeding season (and possibly later in the season as conditions change) following surveys for nesting birds within a given pond adjacent to a trail.

Avoidance and Minimization Measures for the Longfin Smelt and Other Special-Status Fish Species

To minimize potential effects on the longfin smelt and other special-status fish species managed according to the Fishery Management Plans, the following measures will be implemented:

1. Construction activities in, or directly adjacent to, waters where Central California Coast steelhead and longfin smelt are likely to be present will be performed between June 1 and November 30.

2. Levee breaching will not occur between February 1 and May 31 for the protection of out-migrating juvenile steelhead in, or directly adjacent to, waters where steelhead are likely to be present.

3. Activities that extend into the waters where listed fish and fish species managed according to Fishery Management Plans may be present, such as pilot channel excavation, will be performed at low tide and/or under de-watered conditions, to the extent practicable.

4. Cofferdams will be used to the extent feasible during construction and maintenance activities, as well as during implementation of any adaptive management actions, that could potentially result in substantial siltation of protected fish habitat.

5. All pumps used for dewatering where salmonids may be present will be screened according to NMFS and CDFW criteria for juvenile salmonids.

6. During tide gate construction on Artesian Slough, all pile driving will be performed using a vibratory hammer to minimize the potential effects of noise and pressure-waves on fish.

7. NMFS personnel will be immediately notified of any observed fish mortality events.

8. Tidally restored ponds will contain channels that are adequate for the ingress and egress of fish with tidal circulation. Inspections will be documented in a record that is available for review on request.

9. Treated wood will not be used in structures that may come into contact with water.

Western Snowy Plover Compensatory Conservation Measures

The Corps will implement the following compensatory mitigation for effects to western snowy plovers from levee construction:

1. Breeding habitat for the western snowy plover will be enhanced on an island in Pond A16. Islands were constructed in Pond A16 in 2012 and 2013 as part of Phase I activities of the SBSPRP, for the purpose of providing nesting, roosting, and foraging habitat for a variety of pond-associated bird species, including western snowy plovers. Western snowy plovers nested on one of these islands in 2013. However, the dark substrate of the islands, and their relatively homogeneous surfaces, could make western snowy plovers on the islands relatively conspicuous to predators. The South Bay Shoreline Phase I Study Project will provide small gravel (or other appropriate substrate) that will be distributed in patches on one of the islands in A16 (with the island to be selected by the Refuge), and the proposed project will fund the maintenance of this gravel. Pea gravel has been intentionally provided in some areas as a substrate for use by nesting western snowy plovers (Paton and Bachman 1996, Sexson and Farley 2012), and in the Bay, some western snowy plovers at the Eden Landing Ecological Reserve nest in fine gravel along roads.

2. Predator management is currently performed on Refuge lands, but as partial compensation for adverse proposed project effects on western snowy plovers, the intensity of this management will be increased in Pond A16 and New Chicago Marsh during the western snowy plover breeding season. This enhanced predator management will include more frequent monitoring for predators nesting (*e.g.*, gulls and corvids), roosting, or foraging in these areas islands; more frequent trapping of mammalian predators in New Chicago Marsh and along Artesian Slough; and ongoing identification and implementation of deterrence or removal measures for those predators. This measure will consist of funding a predator management technician for an additional 10 hours per week during the period March 1 through September 14 (approximately 28 weeks).

The Corps will fund the initial enhancement of nesting islands in Pond A16 with gravel. The SCVWD will fund the long-term maintenance of the gravel substrate on those islands and the incremental increase in predator management in Pond A16 and New Chicago Marsh. This funding will take the form of annual allocations in the SCVWD's budget specifically for these purposes.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The "effects of the action" to be analyzed in this biological opinion and conference opinion are defined as the direct and indirect effects of the action, together with the effects of other activities that are interrelated or interdependent with that action (such as activities implemented or funded by the local sponsors, the

CSCC and SCVWD, in conjunction with the Corps' and Service's activities). The action area includes the construction footprints for FRM and recreational access activities; the entirety of Ponds A9 through A15 and A18; portions of Pond A16 adjacent to the proposed project footprint and on the island where western snowy plover habitat enhancement will occur; the northern and western boundaries of New Chicago Marsh; areas on the outboard (bayward) sides of those ponds where pilot channel excavation will occur; all staging, stockpiling, and access areas; the portions of Alviso Slough, Coyote Slough, South Coyote Slough, and Artesian Slough downstream from proposed levee breaches that may be subject to additional scour from increased tidal prism or temporarily increased sedimentation during construction; and areas surrounding the construction footprint and trails where indirect effects such as disturbance (*e.g.*, areas within 600 feet for nesting western snowy plovers and 700 feet for nesting California clapper rails) may occur.

Analytical Framework for the Jeopardy Analysis

In accordance with policy and regulation, the jeopardy analyses in this biological opinion and conference opinion relies on four components: (1) the *Status of the Species*, which evaluates the California clapper rail's, salt marsh harvest mouse's, western snowy plover's, California least tern's, and longfin smelt's range-wide condition, the factors responsible for that condition, and their survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of these species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of these listed species; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the California clapper rail, salt marsh harvest mouse, western snowy plover, California least tern, and longfin smelt; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on these species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the California clapper rail's, salt marsh harvest mouse's, western snowy plover's, California least tern's, and longfin smelt's current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of these species in the wild.

The jeopardy analysis in this biological opinion and conference opinion places an emphasis on consideration of the range-wide survival and recovery needs of the California clapper rail, salt marsh harvest mouse, western snowy plover, California least tern, and longfin smelt and the role of the action area in the survival and recovery of the California clapper rail, salt marsh harvest mouse, western snowy plover, California least tern, and longfin smelt as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Status of the Species

California Clapper Rail

The status of the California clapper rail and information about its biology, ecology, distribution, and current threats is available in the *Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (Recovery Plan; http://www.fws.gov/sacramento/es/Recovery-Planning/Tidal-

Marsh/es_recovery_tidal-marsh-recovery.htm; Service 2013). Critical habitat has not been designated for this species. Recent genetic analyses of rail species resulted in a change in the common name and taxonomy of the large, "clapper-type" rails (*Rallus longirostris*) of the west coast of North America to Ridgway's rail (*Rallus obsoletus*) (Maley and Brumfield 2013, Chesser *et al.* 2014). Thus the California clapper rail is now referred to in the scientific community as the California Ridgway's rail (*Rallus obsoletus obsoletus*). The change in the common name and taxonomy of the California clapper rail, however, does not change the listing status of the species.

Salt Marsh Harvest Mouse

There are two subspecies of the salt marsh harvest mouse: the northern subspecies (*R. r. halicoetes*) and the southern subspecies (*R. r. raviventris*). Both subspecies are listed as endangered. The status of the salt marsh harvest mouse and information about its biology, ecology, distribution, and current threats is available in the Recovery Plan (http://www.fws.gov/sacramento/es/Recovery-Planning/Tidal-Marsh/es_recovery_tidal-marsh-recovery.htm; Service 2013). Critical habitat has not been designated for this species.

Pacific Coast Population of the Western Snowy Plover

The status of the Pacific coast population of the western snowy plover and information about its biology, ecology, distribution, and current threats is available in the *Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (Charadrius alexandrinus nivosus)* (http://ecos.fws.gov/docs/recovery_plan/070924_2.pdf, Service 2007).

California Least Tern

The status of the California least tern and information about its biology, ecology, distribution, and current threats is available in the five-year review (http://ecos.fws.gov/docs/five_year_review/doc775.pdf, Service 2006).

San Francisco Bay-Delta DPS of the Longfin Smelt

The status of the San Francisco Bay-Delta DPS of the longfin smelt and information about its biology, ecology, distribution, and current threats is available in the 12-month finding (http://www.fws.gov/sfbaydelta/species/longfin_smelt.cfm, 77 FR 19756, Service 2012b) and the 2014 annual Candidate Notice of Review (79 FR 72449, Service 2014a).

Environmental Baseline

Proposed Project Location and Existing Conditions

The proposed project is located in the community of Alviso, part of the City of San Jose, Santa Clara County, California. The Study Area is bounded on the southwest by Alviso Slough; on the north by Coyote Slough, Ponds A16 and A17, the "Island Ponds" (Ponds A19, A20, and A21), and the Newby Island Landfill; on the east by the Coyote Creek levee; and on the south by SR 237 (Figure 1).

Figure 1 depicts the Study Area in relation to the Alviso complex of the SBSPRP (on Refuge lands). The Alviso pond complex of the SBSPRP area bisects the Study Area, with managed ponds A9 through A17, Alviso Slough, and portions of Coyote Slough within the SBSPRP's Alviso complex, and Pond A18, New Chicago Marsh, and the WPCP being outside the SBSPRP's Alviso complex. However, the entire Study Area is within the action area for the SBSPRP's section 7 consultation (Service 2008).

Tidal marshes along both Alviso Slough and Coyote Slough are fresh/brackish in their upper reaches, where they are dominated by California bulrush, alkali bulrush, cattails, and invasive perennial pepperweed, but this vegetation transitions into salt marsh species such as Pacific cordgrass, pickleweed, and marsh gumplant toward the downstream portions of these sloughs. Artesian Slough, into which the WPCP discharges treated wastewater, is dominated primarily by freshwater marsh, which transitions to brackish marsh toward its confluence with Coyote Slough. Marshes along all three of these sloughs are relatively narrow and thus, in most places, lack the extensive channel networks that characterize larger marshes. Pond A17 has only recently been opened to tidal action, and thus rather than being vegetated, is inundated during the higher portion of the tidal cycle and consists mostly of mudflat at low tide; eventually, it is expected and intended that A17 will be dominated by tidal marsh. New Chicago Marsh is a diked, muted tidal salt marsh dominated by pickleweed, saltgrass, jaumea, and other halophytes in some areas, but with extensive open water and salt panne habitat as well.

Ponds A9, A10, A11, A14, A16, and A18 are managed ponds, with varying water depths and salinities similar to or slightly higher than Bay salinities. Ponds A9, A10, A11, and A14 are joined by breaches in their levees; water control structures along Alviso Slough at Pond A9 and Coyote Slough at Pond A14 allow water to enter these ponds. Ponds A12, A13, and A15 are also managed ponds, but are referred to as "batch ponds", because they are managed for higher salinities. Pond A16, which will be a managed pond under the SBSPRP, receives water from Pond A17 through a control structure, and water flows out of A16 through another structure in its southeastern corner; a structure along the southern edge of Pond A16 allows water to discharge into New Chicago Marsh as well. Pond A18 is not managed in concert with the other ponds; water in this pond is managed via two control structures, one in the northwest and one in the southwest portion of the pond. Currently, all managed and batch ponds on Refuge lands (A9-A15) are managed primarily as habitat for pond-associated waterbirds; Pond A18 is managed to maintain ambient conditions, with ancillary benefits to waterbirds. The Study Area also includes developed areas associated with the community of Alviso and an electrical generation plant, landfills, the WPCP water/sewage treatment areas, and upland grassland/ruderal habitat in the WPCP buffer lands.

The South Bay Shoreline Study is closely interrelated, and in some cases overlaps, with the ongoing implementation of the SBSPRP. The planning process for the South Bay Shoreline Phase I Study is being coordinated with the SBSPRP actions, as both efforts have similar FRM, ecosystem restoration, and recreation objectives. A final SPSPRP Environmental Impact Statement/ Environmental Impact Report, including both programmatic and project-specific actions, was released in December 2007 (EDAW *et al.* 2007). The total SBSPRP area consists of 15,100 acres of former salt ponds and adjacent habitats in the South Bay that the Service and CDFW acquired from Cargill, Inc. in 2003. The SBSPRP area includes the Eden Landing pond complex in the cities of Hayward and Fremont, Alameda County; the Ravenswood pond complex in the City of Menlo Park, San Mateo County; and the Alviso pond complex, which extends from the City of Mountain View

southeastward to the Alviso area in Santa Clara County. The SBSPRP also includes ponds A22 and A23 in the City of Fremont, Alameda County, and the aforementioned Island Ponds (Figure 1).

The Refuge owns and manages the 8,000-acre Alviso pond complex, within which are located New Chicago Marsh and 2,100 acres of ponds included in the current South Bay Shoreline Phase I Study Area. Pond A18 (about 856 acres), owned by the City of San Jose, is also included in the South Bay Shoreline Phase I Study Area, although it is not included in the SBSPRP Study Area and was not covered by the SBSPRP's section 7 consultations. Although Pond A18 was not considered in the SBSPRP, primarily due to not being a Service-managed property, the actions being proposed for the pond are similar to those proposed for the rest of the Alviso complex ponds, and the addition of Pond A18 to the South Bay Shoreline Phase I Study Area is consistent with the goals for the greater South Bay tidal restoration.

SBSPRP Phase I construction started in 2008; the final SBSPRP Phase I restoration actions were initiated in 2011 at Alviso Complex Ponds A16 and A17. Because both Ponds A16 and A17 were restored or reconfigured as part of SBSPRP Phase I implementation, no focused South Bay Shoreline Phase I restoration actions are proposed for these two ponds (although one of the islands in A16 will be enhanced for use by western snowy plovers).

California Clapper Rail

Central/South San Francisco Bay Recovery Unit

The action area for the proposed project occurs within the Recovery Plan's Central/South San Francisco Bay Recovery Unit for the California clapper rail (Service 2013). The Central/South San Francisco Bay Recovery Unit supports the majority of California clapper rail populations. Populations in this unit are widely separated from northern ones, but there may be occasional dispersal between these areas. Predation by mammalian and avian predators is one of the primary threats to California clapper rails in the Central/South San Francisco Bay Recovery Unit (Albertson 1995, Service 2013, Overton *et al.* 2014). Overton *et al.* (2014) tracked 108 radio-marked California clapper rails at four marshes within the Central/South San Francisco Bay Recovery Unit (*i.e.*, Colma Marsh, Arrowhead Marsh, Laumeister Marsh, and Cogswell Marsh) and estimated survival rates over 166 weeks between 2007 and 2009. Overton *et al.* (2014) found that most of the California clapper rails (53 percent) died due to predation with raptors depredating 30 individual California clapper rails (28 percent) and mammals depredating 27 individual California clapper rails (25 percent). The annual survival rate for California clapper rails at Laumeister Marsh, a native tidal marsh managed by the Refuge near the City of East Palo Alto, San Mateo County, was 0.227 (Overton *et al.* 2014). The Refuge intermittently conducts mammal predator management on some Refuge lands within the Central/South San Francisco Bay Recovery Unit; however, the extent of mammal predator management implemented at the Refuge is limited by the lack of funding. The Refuge recently finalized an avian predator management plan to control avian predators of the California clapper rail on Refuge lands within the Central/South San Francisco Bay Recovery Unit; however, the Refuge lacks the resources to adequately monitor and control avian predators at the Refuge.

Breeding-season surveys of South Bay marshes for California clapper rails through the early 1990s, summarized by Foin *et al.* (1997), indicated that the most substantial populations of California clapper rails in the South Bay were, predictably, in the largest sections of tidal salt marsh at: Mowry Marsh and Dumbarton Marsh (in the eastern Bay between the Dumbarton Bridge and Mowry

Slough in Alameda County), the Faber/Laumeister Tracts and other marshes in the Palo Alto/East Palo Alto area in San Mateo and Santa Clara counties, and Greco Island in the City of Redwood City, San Mateo County. California clapper rails occurred in many other marshes as well, including Ideal Marsh, La Riviera Marsh, and Calaveras Marsh in the City of Fremont, Alameda County, and Triangle Marsh in the community of Alviso, Santa Clara County. Surveys by HTH and others since the early 1990s, as well as observation by birders (including HTH staff), have documented California clapper rails in a number of areas in the far South Bay, including lower San Francisquito Creek; the Palo Alto Baylands; Hook's Isle; the mouth of Charleston Slough; lower Permanente and Stevens creeks; Guadalupe Slough (primarily from its confluence with Moffett Channel downstream); Alviso Slough; a number of locations along Coyote Slough, extending upstream through the reach of the slough between Newby Island Landfill and the WPCP (known as South Coyote Slough or the lower Coyote Creek Bypass); and in the Warm Springs marshes. Although site-specific surveys have not been conducted in all suitable habitat for California clapper rails in the South Bay, this species is likely to occur in tidal salt marsh habitats in a number of additional areas as well.

Habitats and Occurrences within the Action Area

Within the action area, California clapper rails are most likely to occur in tidal salt marsh and brackish marsh along the lower and middle reaches of Alviso Slough (*e.g.*, from the northwest corner of Pond A12 downstream) and Coyote Slough (*e.g.*, from the vicinity of the Artesian Slough confluence downstream), and near the mouth of Artesian Slough. Although California clapper rails are known to be present in the downstream reaches of these sloughs, where the tidal marsh is dominated by salt-marsh plant species, they are less likely to occur in areas dominated by freshwater vegetation (*e.g.*, California bulrush and cattail) along the upper portions of Coyote, Artesian, and Alviso sloughs. In recent years, few surveys for California clapper rails have been conducted along the upper reaches of Alviso Slough, or anywhere in Artesian Slough or along upper Coyote Slough (upstream from its confluence with Artesian Slough).

In 2007, PRBO Conservation Science conducted surveys for California clapper rails along the middle and lower reaches of Guadalupe and Alviso sloughs (L. Liu, PRBO Conservation Science, pers. comm. cited in HTH 2013). Single California clapper rails were detected near the mouths of these sloughs (*i.e.*, along Guadalupe Slough near the Pond A5/A6 levee and along Alviso Slough east of Pond A6), but none were heard farther upstream.

More recently, surveys for the Invasive *Spartina* Project have been conducted along Alviso Slough from Pond A11 downstream to its confluence with Coyote Slough, and along Coyote Slough from the vicinity of the railroad tracks downstream along Ponds A12, A14, and A9 (data provided by Olofson Environmental, Inc.). From 2010 through 2014, all California clapper rail detections along Alviso Slough were at its mouth, near the northwest corner of Pond A9: between nine and 10 California clapper rails were detected in 2010, between four and six were detected in 2011, between one and two were detected in 2012, and between two and four California clapper rails were detected in 2014 near the mouth of Alviso Slough (Olofson Environmental, Inc. 2012, 2014).

On one occasion, a California clapper rail was recorded in brackish/freshwater transition marsh along upper Alviso Slough between the Alviso Marina and the Gold Street Bridge (February 14, 1997; Scott B. Terrill, pers. obs.). Earlier (approximately 1989) an individual California clapper rails was detected in the Alviso Marina (Ron Duke, pers. obs. cited in HTH 2013). However, no California clapper rails have been observed along upper Alviso Slough within recent years. For

example, surveys conducted by the San Francisco Bay Bird Observatory at the Alviso Marina found no California clapper rails during early spring 2003 and 2004 (C. Strong, Refuge, pers. comm. 2012). Also, pre-construction California clapper rail surveys conducted by the Refuge prior to Pond A8 notch construction in 2010 did not find any California clapper rails in this reach of upper Alviso Slough (C. Strong, Refuge, pers. comm. 2012). Therefore, any occurrence of California clapper rails in upper Alviso Slough would likely be by occasional non-breeding birds.

California clapper rails have also been detected along Guadalupe Slough as far as the nontidal freshwater ponds between Calabazas and San Tomas Aquino Creeks north of SR 237 (16 August 1998; Steve Rottenborn, HTH, pers. obs.). Between one and two California clapper rails were detected along upper Guadalupe Slough again in 2012 near the Moffett Channel (Olofson Environmental, Inc. 2012). However, such rails are likely wandering and foraging individuals, and their occurrence in these areas is expected to be sporadic.

Along Coyote Slough, all California clapper rails detections since 2010 have been from Triangle Marsh (north of Pond A15) downstream to Pond A9 except for a single detection near the northwest corner of Pond A18, at the Coyote Slough/Artesian Slough confluence. Call count surveys along South Coyote Slough detected between nine and 10 California clapper rails in 2011, between six and 10 rails in 2012, and between eight and 10 rails in 2014 between Pond A15 and Triangle Marsh (Olofson Environmental, Inc. 2012, 2014).

Therefore, based on the known occurrences of the California clapper rail within the action area, the Service believes the California clapper rail is likely to occur within the action area in all suitable tidal salt marsh and tidal brackish marsh habitat along Alviso Slough, Artesian Slough, Coyote Slough, and South Coyote Slough.

Salt Marsh Harvest Mouse

Central/South San Francisco Bay Recovery Unit

The action area for the proposed project occurs within the Recovery Plan's Central/South San Francisco Bay Recovery Unit for the salt marsh harvest mouse (Service 2013). The Central/South San Francisco Bay Recovery Unit is within the range of the southern subspecies of the salt marsh harvest mouse (*R. r. raviventris*) (Service 2013). The population status of the southern subspecies is more precarious than that of the northern subspecies (*R. r. halicoetes*). Few major, resilient, or secure populations of the southern subspecies of the salt marsh harvest mouse persist within the Central/South San Francisco Bay Recovery Unit. The current populations within this recovery unit are very small and isolated compared with the historical pattern of distribution and abundance of the subspecies. All major population centers of the southern subspecies are remote from one another based on dispersal distances known for the species. Predation by mammalian and avian predators and spread of invasive plant species (*e.g.*, perennial pepperweed) are major threats to salt marsh harvest mice in the Central/South San Francisco Bay Recovery Unit (Albertson 1995, Service 2010, Service 2013).

Occurrences near the Action Area

The salt marsh harvest mouse has been detected during trapping studies in a number of locations within and near the action area, including Alviso Slough near the northwest corner of Pond A12,

Triangle Marsh, New Chicago Marsh, the mitigation wetlands on the south side of Pond A18, the Coyote Creek Bypass area, and Guadalupe Slough (San Francisco Estuary Institute, http://www.sfei.org/content/salt-marsh-harvest-mouse-database-and-maps, site numbers 21, 57, 249, and 306; California Natural Diversity Database (CNDDB) occurrence numbers 91, 92, 115, 116, 147, 132, and 133; CDFW 2014). The highest-quality habitat for this species within the action area occurs in tidal salt marsh along the lower reaches of Alviso and Coyote Sloughs, and at the mouth of Artesian Slough, as well as in diked salt marsh within New Chicago Marsh and within the mitigation wetlands on the south side of Pond A18. Brackish marshes farther upstream along Alviso, Coyote, and Artesian Sloughs represent lower-quality habitat, and salt marsh harvest mice have a lower probability of occurrence (and if present, likely occur in lower densities) in such brackish marshes. However, as a result of this species' detection in brackish marshes in the Warm Springs area in 2006 (HTH 2007), it could occur in at least small numbers in brackish marshes. The freshwater marshes in the upper reaches of Alviso Slough (*i.e.*, from the southwestern part of Pond A12 upstream to the Alviso Marina and above) and Artesian Slough (*i.e.*, from the vicinity of the southeastern corner of Pond A17 upstream), as well as those in the South Coyote Slough area north of the northeastern corner of Pond A18, are less suitable habitat for the species.

There is no recent survey data available for salt marsh harvest mice within or near the action area. However, based on known occurrences of the salt marsh harvest mouse within and near the action area and the occurrence of suitable habitat within the action area, the Service believes that the salt marsh harvest mouse is likely to occur within all suitable tidal salt and brackish marshes, diked salt and brackish marshes, and adjacent upland habitats (*e.g.*, contiguous grassland habitat within 328 feet of suitable marsh habitat (Service 2010, 2013)) throughout the action area.

Pacific Coast Population of the Western Snowy Plover

San Francisco Bay Recovery Unit

The action area for the proposed project occurs within the San Francisco Bay Recovery Unit for the Pacific coast population of the western snowy plover (http://ecos.fws.gov/docs/recovery_plan/070924_2.pdf, Service 2007). One of the delisting criteria for the Pacific coast population of the western snowy plover is for the maintenance of 500 individual breeding western snowy plovers within the San Francisco Bay Recovery Unit (Service 2007). The SBSPRP has committed to the maintenance of at least 250 individual breeding western snowy plovers in the South Bay through adaptive management of salt pond breeding habitat and predator management within the SBSPRP area. The Refuge intermittently conducts avian and mammal predator management within some of the larger western snowy plover nesting populations in the South Bay.

In the South Bay, the highest numbers of nesting western snowy plovers occur in portions of Alameda and San Mateo counties outside the action area. Nearly all of the Bay nesting occurs south of State Route 92 (San Mateo Bridge) in the South Bay (Page and Stenzel 1981, Page *et al.* 1991, Service 2007). Abundance of western snowy plovers during surveys around the Bay may vary considerably from year to year. Summer window-survey data for the years 2009-2014 detected 147, 275, 249, 147, 202, and 178 individual western snowy plovers within the San Francisco Bay Recovery Unit during those six years (http://www.fws.gov/arcata/es/birds/WSP/plover.html, Service 2014b).

Habitats and Occurrences within the Action Area

Western snowy plover summer window-survey data for the years 2009-2014 detected eight, zero, 11, 20, 10, and zero individual western snowy plovers during those six years in the Alviso area of northern Santa Clara County (http://www.fws.gov/arcata/es/birds/WSP/plover.html, Service 2014b). In the action area itself, western snowy plovers have nested recently (*i.e.*, 2012-2014) in New Chicago Marsh, Ponds A9, A12, A13, and A16, and in the impoundment between Pond A12 and the railroad tracks (just north of the old Alviso Marina; hereafter "Alviso impoundment"). Of 13 western snowy plover nests in 2012, four each were in Ponds A16 and A17, which were being dried out for construction of islands in A16 and tidal restoration in A17 (Donehower *et al.* 2012). The other five western snowy plover nests were in Pond A13. Of the 10 western snowy plover nests in the vicinity of the action area in 2013, six were in Pond A16; one was on a recently constructed island and five were on the dried-out pond bottom when the pond was drawn down for island creation, but this area was eventually re-flooded (Robinson-Nilsen *et al.* 2013). The others included single western snowy plover nests in New Chicago Marsh and the Alviso impoundment, and two in Pond A9. In 2014, western snowy plovers have been documented nesting in Pond A9 (one nest that was flooded) and A13 (two nests that hatched young). Due to variability in water level management in Ponds A9-A15, the suitability of habitat for nesting in these ponds has varied from year to year, and Pond A12 has provided nesting habitat in some years. Western snowy plovers have never been known or suspected to breed in the action area east of Artesian Slough (*i.e.*, in the vicinity of Pond A18).

California Least Tern

In the Bay, the primary California least tern breeding colonies are at Alameda Point in the City of Alameda and Hayward Regional Shoreline in Alameda County, and at the Montezuma Wetlands near Suisun City, Solano County. California least terns also nested in 2000 and 2001 in the City of Albany (near Alameda), Alameda County, with up to 12 pairs in 2000. In the City of Pittsburg, Contra Costa County on Suisun Bay, 13 pairs nested in 2001 and eight pairs nested in 2003. Historically, small numbers of birds have nested at the Oakland International Airport (last reported in 1995), Bay Farm Island (last reported 1975), Bair Island (last reported 1984), Port Chicago (last reported in 1988), the Bay Bridge Sand Spit (one-time attempt in 1985), and Tern Island (one-time attempt in 1990, U.S. Geological Survey preliminary data, unpubl.)

California least terns have never been recorded nesting in the vicinity of the South Bay Shoreline Phase I Study Project's action area, or anywhere else in Santa Clara County or nearby areas of Alameda County. In recent years, the main post-breeding staging area for California least terns in the South Bay has been in the complex of ponds immediately north of Moffett Field (Ponds AB1, A2E, and AB2), which are located approximately two miles west of the action area. These areas are used for roosting and foraging by adults and juveniles in July and August every year, with typical counts of 20 to 100 California least terns, although 276 were observed there in July 2004 (S. Rottenborn, HTH, pers. obs.). California least terns have also been recorded foraging or roosting at other South Bay ponds, including A1, A2E, A3N, A3W, A4, A5, A7, A9, A10, A11, and A14 (Marschalek 2006; J. Krause, CDFW, pers. comm.; U.S. Geological Survey preliminary data, unpubl.). Ravenswood ponds in San Mateo County are also used occasionally for foraging and roosting, with counts of 96 California least terns in July 2002, 42 in July 2003, and 110 in July 2004 (U.S. Geological Survey preliminary data, unpubl.). Eden Landing ponds in Alameda County are used irregularly for foraging including E2, E4, E5, E8A, E9, E10, and E11. California least terns do

not generally forage in smaller sloughs or channels adjacent to managed ponds but rather prefer more open waters, including the Bay waters; 50 of 58 California least terns observed foraging at one South Bay location in July 2004 were doing so over the open waters of the Bay while the other eight were foraging in ponds (S. Rottenborn, HTH, pers. obs.).

California least terns are not known to nest in the action area. California least terns have been observed foraging in the action area's ponds (A9, A11, and A14) only rarely, and they have not been observed foraging in Pond A18, despite occasional visits by birders and biologists to A18 and birder coverage of A18 (using spotting scopes) from the Pond A16 levee. Although California least terns could potentially forage in any of these ponds that contain fish, survey data collected for the SBSPRP and incidental observations by birders indicate that California least terns visit the action area (as a post-breeding forager) irregularly and in low numbers.

San Francisco Bay-Delta DPS of the Longfin Smelt

Longfin smelt larvae and juveniles are found throughout the San Francisco Bay Estuary, including the South Bay during wet years (Rosenfield 2009 and California Department of Fish and Game 2009). Longfin smelt are known to be located in the action area from several different surveys. Surveys conducted in 1982 and 1983 found adults followed by larvae in Coyote Slough, mostly likely indicating that spawning had likely occurred there (Robinson and Greenfield 2011). Longfin smelt have also been collected inside the Island Ponds following breaching to restore tidal action (EDAW Inc. 2007, Robinson and Greenfield 2011, Hobbs *et al.* 2012). Fish surveys conducted during 2010 through 2012 for the SBSPRP by Hobbs *et al.* (2012), which included otter trawls in sloughs and bay waters, between the months of October through March detected longfin smelt in the Alviso pond complex. During these trawls longfin smelt was the seventh most abundant species and were captured in all major sloughs and tributaries. The species was not detected during other surveys conducted from 2010 to 2012, which were at least monthly, indicating absence between the months of May and September.

The action area is located downstream from the Bay's largest source of toxic mercury, the historical Almaden Quicksilver mine in the hills above San Jose. Recent biosentinel sampling in South Bay managed ponds and marshes indicates that mercury concentrations in fish are above the Bay mercury total maximum daily load of 0.03 microgram/gram for small fish (San Francisco Bay Regional Water Quality Control Board 2006).

Effects of the Proposed Project

The footprint of ground disturbance from the proposed project consists of a total of approximately 165 acres. Table 1 below lists the acreages of each of habitat type that will be disturbed by the proposed Corps-led actions (*e.g.*, construction of the levees, the Artesian Slough tide gate, the pedestrian bridge, and the Pond A18 ecotone and tidal restoration activities) and Service-led actions (e.g., construction of the Pond A12 ecotone and Ponds A9-A15 tidal restoration activities). Construction of trails and other recreational facilities, which is a Service-led activity, will occur entirely on existing levees and berms, or in ruderal grassland along SR 237, and thus the acreage of such habitat disturbance from trail construction is not included in Table 1.

In the following sections discussing effects on individual listed species, effects are separated for Corps-led and Service-led activities as appropriate. Because of the tidal flood protection functions

currently provided by the outboard levees around Ponds A9-A15, tidal restoration within those ponds would not be feasible without enhancement of flood protection inboard from those ponds. As a result, the effects of Service-led tidal restoration on Refuge lands could not occur but for the Corps-led construction of the levee and tide gate, and thus, the benefits that accrue from tidal restoration on Refuge lands are dependent on Corps-led levee construction.

Table 1. Habitat Disturbance from the Proposed Project.

Habitat Type	Impacts of Corps-Led Actions (acres)		Impacts of Service-Led Actions (acres)	Total Habitat Disturbance (acres)
	Levee/Tide Gate/ Bridge Construction	A18 Ecotone/ Tidal Restoration	A12 Ecotone/ Tidal Restoration	
Brackish marsh	0.20	0.07	0.03	0.3
Freshwater marsh	1.04	0.06	<0.01	1.1
Muted tidal/diked marsh	1.80	0.00	0.00	1.8
Tidal salt marsh	1.64	0.03	0.03	1.7
Non-tidal salt marsh	8.20	0.00	0.00	8.2
Seasonal wetland	3.65	0.00	0.05	3.7
Mudflat	0.59	0.01	0.00	0.6
Batch pond	3.60	0.00	29.00	32.6
Managed pond	12.07	66.13	0.00	78.2
Open water	9.40	0.00	0.00	9.4
Upland vegetation	1.00	0.00	0.00	1.0
Water/sewage treatment	0.10	0.00	0.00	0.1
Levee	18.49	0.33	0.88	19.7
Developed	6.15	0.24	0.01	6.4
TOTAL	67.93	66.87	30.00	164.8

California Clapper Rail and Salt Marsh Harvest Mouse

Habitat Restoration

Effects of Corps-led Actions

The highest-quality habitat for the California clapper rail and salt marsh harvest mouse consists of tidal salt marsh, although these species will also use tidal brackish marshes to some extent. Tidal restoration in Pond A18 is expected to result in the creation of approximately 119 acres of tidal salt marsh and 398 acres of brackish marsh habitat for the California clapper rail and salt marsh harvest mouse (HTH 2012). In addition, approximately 67 acres of ecotone habitat will be created along the southern and eastern edges of Pond A18. The ecotone created along the southern and eastern edges of Pond A18 will provide high quality extreme high tide refugia cover for California clapper rails and salt marsh harvest mice which will reduce the risk of predation. The grassland habitat along the ecotone will also provide foraging and dispersal habitat for salt marsh harvest mice. The ecotone

will also allow for the landward transgression of the tidal marsh in the face of sea level rise and provide a buffer between the marsh and developed areas. This ecotone habitat is expected to develop more quickly than the tidal marsh in A18, which will not become vegetated until sedimentation has elevated the former pond bottom to the point where vegetation can colonize it. Within a few years, it is expected that vegetation along the ecotone will provide habitat that is of higher quality for salt marsh harvest mice than the narrow strip of vegetation that is currently present along the southern and eastern edges of Pond A18.

Effects of Service-led Actions

Assuming that all of Ponds A9-A15 are eventually restored to tidal action, approximately 2,010 acres of new tidal marsh will be restored within these ponds. All of this restored tidal marsh is predicted to be salt marsh (HTH 2012). In addition, 30 acres of ecotone habitat will be created along the eastern edge of Pond A12; habitat along the ecotone is expected to become suitable for use by salt marsh harvest mice within a few years after seeding and planting occur. If only Ponds A12 and A18 are restored, then approximately 300 acres of suitable tidal marsh will be restored in A12 and 517 acres of suitable tidal/brackish marsh habitat will be restored in A18. The ecotone habitat created along the eastern edge of the restored tidal marsh in Pond A12 will benefit the California clapper rail and salt marsh harvest mouse by providing transitional habitat for the rail and the mouse to utilize as cover during extreme high tide and flooding events which will reduce the risk of predation. The ecotone will also provide foraging and dispersal habitat for the salt marsh harvest mouse. The ecotone will also allow for the landward transgression of the tidal marsh in the face of sea level rise and provide a buffer between the marsh and developed areas.

Habitat Restoration Effects Common to Corps-led and Service-led Actions

All of these marshes (in Pond A18 and A9-A15) will support complex channel networks. These channels will provide extensive foraging habitat for California clapper rails, and the larger channels will provide natural levees supporting taller cordgrass and gumplant, which serve as rail nesting habitat and high-tide refugia.

Because the rate of evolution of tidal habitats is dependent largely on sediment availability, which is difficult to predict, the precise rates of evolution of these marshes are unknown. However, the following general timeline of expected marsh evolution predicted for restored South Bay marshes by the SBSPRP indicates the likely habitat progression expected over the 50-year timeline of the South Bay Shoreline Phase I Study Project.

Habitat restoration in the action area described above for California clapper rail will result in similar benefits for the salt marsh harvest mouse. Because salt marsh harvest mice reach their highest densities in mature marshes with pickleweed, which form in the highest marshes, the evolution of suitable habitat for salt marsh harvest mice within restored marshes will be slower than for California clapper rails, as it will take longer for marsh elevations to reach elevations appropriate for pickleweed dominance. However, development of suitable habitat for salt marsh harvest mice in the ecotones will be relatively rapid. Once suitable habitat is restored, the high fecundity of salt marsh harvest mice will ensure that this species will rapidly colonize and spread throughout the restored pickleweed marshes from occupied habitat along Coyote or Alviso sloughs or other suitable habitat.

The amount of habitat for the California clapper rail and salt marsh harvest mouse that will be restored by both the Corps-led and Service-led actions is expected to substantially increase South Bay populations of these species, and contribute greatly to their survival and recovery. In addition, the restoration of ecotones in Ponds A18 and A12 will provide high-quality refugia during extreme high tides that inundate the rest of the marsh plain, thus helping to improve winter survival rates. The ecotones will also provide seasonal foraging and dispersal habitat for the salt marsh harvest mouse in addition to providing some residence habitat for this species.

Estimated Timeline for Tidal Marsh Establishment

In 2020, Pond A12 will be breached, restoring full tidal action to approximately 300 acres of salt pond (though see the previous discussion of the possibility that Pond A18 may be breached first). By Year 10 (2027), enough sediment is expected to have accumulated in other areas of this former pond that low tidal marsh vegetation dominated by Pacific cordgrass will start to become established. Use of the restored marshes by California clapper rails is expected to occur as soon as enough vegetation is present to provide cover for foraging California clapper rails. Even though this vegetation may not be dense and/or extensive enough to provide nesting habitat by Year 10, California clapper rails are expected to forage on intertidal mudflats near vegetative cover, which may occur near the breach locations.

In 2023, the Pond A18 ecotone will be constructed and seeded providing suitable habitat for colonization by salt marsh harvest mice from nearby areas. In 2025, additional breaching may restore tidal action to approximately 875 acres in Ponds A9, A10, A11, and 736 acres in Pond A18. By 2027, tidal marsh vegetation will begin to colonize the edges of levees and berms, but by the end of Year 10 (2027), the bottoms of Ponds A9, A10, A11, and A18 may still be too low for substantial vegetation establishment.

As sediment continues to accumulate in the restored ponds, bottom elevations will be raised, and the areas at elevations suitable for colonization by tidal marsh vegetation will increase. By Year 20 (2037), vegetation will be expanding outward from the ecotone area and the edges of other levees and berms, and it is expected that sufficient sediment will have accumulated in other portions of Ponds A9-A12 and A18 that low marsh suitable for use by California clapper rails for nesting and foraging will have developed.

In 2030, an additional 850 acres of tidal restoration may occur via breaching of Ponds A13, A14, and A15. Thus, by Year 13 (2030), approximately 2,010 acres of new tidal habitat in Ponds A9-A15 and 736 acres in Pond A18 will have been restored. Evolution of marshes within Ponds A13-A15 will occur gradually as described above for other ponds.

In Years 20-50 (2037-2067), vegetated marsh will continue to expand in area and increase in elevation as sediment accumulates. Although sea level rise will raise the elevation of water within the restored marshes, thus restricting the rate of marsh development to some extent, it is predicted that the rate of sediment accumulation will outpace sea level rise, so that vegetated marshes will colonize all but the lowest-elevation areas such as tidal sloughs and channels (ESA and Philip Williams & Associates, Ltd. 2012, HTH 2012). Suitable nesting habitat and cover for the California clapper rail and salt marsh harvest mouse will continue to expand, and higher-marsh areas that form on natural levees along the larger tidal sloughs will provide high-tide refugia. By Year 50, it is expected that approximately 2,130 acres of restored tidal salt marsh and 398 acres of restored

brackish marsh suitable for use by California clapper rails and salt marsh harvest mice will have been restored.

Increased Salinity and Beneficial Marsh-Type Conversion

Effects of Corps-led Actions

Breaching of Pond A18 will result in an increased tidal prism and salinization of brackish and fresh marshes throughout all of Artesian Slough and Coyote Slough, thus resulting in the expansion and enhancement of California clapper rail and salt marsh harvest mouse habitat over large areas of existing brackish and freshwater marsh along these sloughs. In addition, this change in the tidal gradient will result in the development of higher-quality habitat in already-breached Pond A17 and the Island Ponds than would develop in the absence of breaching of A18. The effects on salinities within existing marshes would be immediate, and within a period of just a few years, it is expected that considerable expanses of brackish marshes dominated by bulrush and pepperweed will have begun conversion to marshes dominated by Pacific cordgrass, pickleweed, and gumplant.

Effects of Service-led Actions

Restoration of tidal action to Ponds A9-A15 will result in an increased tidal prism and salinization of brackish and fresh marshes along Alviso Slough upstream to Pond A12 and along lower Coyote Slough, thus resulting in the expansion and enhancement of California clapper rail and salt marsh harvest mouse habitat in these areas. In addition, this change in the tidal gradient will result in the development of higher-quality habitat in already-breached Pond A6 and the Island Ponds than would develop in the absence of breaching of Ponds A9-A15. These effects are expected to occur rapidly.

Increased Salinization Effects Common to Corps-led and Service-led Actions

As levees are breached and ponds are subjected to tidal action, these ponds will draw considerable amounts of water through the breaches on rising tides. As a result, the rate of water flowing "upstream" along Alviso, Artesian, and Coyote sloughs, from the Bay into the breached ponds, on rising tides will be considerably higher than it currently is. This will result in the transportation of more saline Bay water upstream, and higher upstream, along these sloughs than currently occurs. The effect of this change in tidal prism and the upstream migration of the salinity gradient will be the salinization of marshes along these sloughs that are currently brackish and fresh marshes due to the inputs of freshwater from Coyote Creek, the Guadalupe River, and WPCP effluent. Because outboard levee breaches will be located high up these sloughs, such as at Pond A12 along Alviso Slough, in the southwest corner of Pond A18 along Artesian Slough, and in the northeast corner of Pond A18 along Coyote Slough, more saline water will be drawn far up these sloughs, and this salinization will affect the plant species composition of marshes on a very large scale. The result will be the conversion of extensive areas of brackish marsh to salt marsh and conversion of extensive areas of freshwater marsh to brackish marsh. As a result, habitat conditions within existing brackish and fresh marshes along Alviso Slough, Artesian Slough, and Coyote Slough will become much more suitable for California clapper rails and salt marsh harvest mice. Furthermore, the upstream migration of the salinity gradient will result in higher-salinity marshes in recently restored areas such as the Island Ponds, Pond A6, and Pond A17, thus helping to enhance habitat for California clapper

rails and salt marsh harvest mice beyond the conditions that would be created in the absence of the South Bay Shoreline Phase I Study Project.

In particular, given the vast extent of brackish and freshwater marsh along Coyote Slough, the breaching of Pond A18 will result in considerable expansion of California clapper rail and salt marsh harvest mouse habitat up Coyote Slough and much higher-quality rail and mouse habitat in Pond A17 and the Island Ponds. Marsh evolution predictions for the proposed project took the increased tidal prism along Coyote Slough, resulting from Pond A18 breaching into account when predicting that the entirety of restored tidal habitat in Ponds A9-A15 would be salt marsh instead of brackish marsh (HTH 2012). Thus, the increase in California clapper rail and salt marsh harvest mouse habitat and enhancement of rail and mouse habitat quality as a result of both the Corps-led and Service-led actions will be far greater than just the increase in tidal marsh within the ponds to be breached.

The salinization of tidal marsh that will result from the proposed project will also expedite project benefits to the California clapper rail and salt marsh harvest mouse. As described previously, there will be a lag between breaching of levees and development of California clapper rail and salt marsh harvest mouse habitat due to the need for sediment accumulation to elevate pond bottoms enough that vegetation can colonize the restored habitat. In the case of increased salinization, however, the effects on salinities within existing marshes would be immediate, and within a period of just a few years, it is expected that considerable expanses of brackish marshes dominated by bulrush and pepperweed will have begun the conversion to marshes dominated by Pacific cordgrass, pickleweed, and gumplant.

Loss of Habitat

Effects of Corps-led Actions

Artesian Slough Tide Gate and Pedestrian Bridge

Construction of the Artesian Slough tide gate and Artesian Slough pedestrian bridge will result in the loss of suitable habitat for the California clapper rail and salt marsh harvest mouse through the placement of fill in salt and brackish marsh habitat, but no suitable nesting habitat for California clapper rails will be directly affected. Construction of the tide gate and pedestrian bridge in Artesian Slough will result in the direct disturbance of about 1.04 acres of non-breeding tidal freshwater marsh habitat that may be occasionally utilized by a low number of foraging and dispersing California clapper rails and salt marsh harvest mice. As indicated in Table 1, 1.64 acres of tidal salt marsh will be disturbed; however, this marsh is located in a narrow strip along the Alviso impoundment and is not truly tidal, receiving tidal inflow only during the highest tides. As a result, the disturbance of muted tidal marsh along the Alviso impoundment will disturb potential habitat for the salt marsh harvest mouse but not the California clapper rail.

Excavation of Pilot Channels and Pond A18 Breaches

Excavation of pilot channels in the outboard marsh around Pond A18 will occur in five locations, four along Artesian Slough and one at South Coyote Slough. The marsh vegetation at these breach locations consists of brackish marsh at three locations and freshwater marsh at two locations. Excavation of pilot channels and breaching will result in the direct disturbance of about 0.07 acre of

brackish marsh and 0.04 acre of tidal salt marsh that could potentially support low densities of California clapper rails and salt marsh harvest mice. It is possible that the salt and brackish marsh provides suitable nesting and foraging habitat for California clapper rail. However, given the paucity of California clapper rail occurrences along Artesian Slough and the extreme eastern end of South Coyote Slough in recent years, it is likely that very few rails use this habitat, and then only occasionally (and likely only during the non-breeding season).

FRM Levee Construction

Construction of the FRM levee will result in the loss of non-tidal salt and brackish marsh habitat and adjacent upland habitat along the edges of Ponds A16 and A18 and New Chicago Marsh that are suitable habitat for the salt marsh harvest mouse but not the California clapper rail. Areas with vegetation that potentially supports the salt marsh harvest mouse, and that will be disturbed by fill placed for the levee, include non-tidal and muted tidal/diked salt marsh along the southern, western, and northern edges of the Alviso impoundment; the northern edge of New Chicago Marsh, adjacent to the southern levee of Pond A16; and both the northern and southern sides of the existing Pond A18 levee. The loss of suitable salt marsh harvest mouse habitat will result from the widening of the levee, relative to its existing footprint, and will affect a total of about 13.65 acres of vegetation dominated by pickleweed, alkali heath, grasses, and non-native weedy species that provide at least marginal-quality habitat for salt marsh harvest mice. No suitable California clapper rail habitat will be disturbed by the widening of the levee footprint because the marshes along the existing levee are non-tidal and thus not likely to support the rail.

No high-quality salt marsh harvest mouse habitat will be impacted by widening of the levee. The habitat that will be disturbed consists of narrow strips of vegetation located between the existing bare levee and either bare salt panne/mud (along the Alviso impoundment), the waters of Ponds A16 and A18, or a borrow ditch (on the south side of the levee at Ponds A16 and A18). The impacted habitat is very narrow, which increases the risk of predation on any salt marsh harvest mice that might be present in those strips of vegetation, and is separated by unsuitable habitat (*e.g.*, open ground without vegetation or open water) from more extensive, higher-quality expanses of habitat, such as that in New Chicago Marsh and in the wetlands south of Pond A18 and east of Artesian Slough. Even along the southern edge of the Pond A16 levee, the strip of pickleweed and other vegetation between the levee and New Chicago Marsh is narrow, includes much dead and sparse vegetation, and supports only a patchy distribution of dense, tall, high-quality pickleweed. As a result, the quality of habitat, and the expected density of salt marsh harvest mice within the habitat to be impacted, is low, and the effects on salt marsh harvest mouse populations from the loss of these narrow strips of vegetation will be low.

Furthermore, these narrow strips of vegetation do not provide high-quality dispersal habitat for the salt marsh harvest mouse. The strips on the outboard (northern) side of the Pond A18 levee are separated by the bare levee itself from potential source populations of salt marsh harvest mice in New Chicago Marsh, the wetlands east of Artesian Slough, or the Coyote Creek Bypass. Open, unvegetated areas may act as barriers to movement of salt marsh harvest mice (Shellhammer 1978, Geissel *et al.* 1988), and thus salt marsh harvest mice likely cross the levee to and from this habitat very infrequently. In order for this vegetation to serve an important dispersal function, salt marsh harvest mice would have to cross bare levees from one source population, move long distances through the narrow strip of vegetation (or survive over generations within that narrow strip so that progeny eventually disperse long distances over time), and cross the bare levee again to reach

another high-quality habitat area. Such occurrences are unlikely, or happen very infrequently. The narrow strip of vegetation along the western edge of the Alviso impoundment is even further removed from high-quality habitat, being separated from New Chicago Marsh by a broad salt panne and the railroad tracks.

Following levee construction, unimpacted pickleweed-vegetated areas between the Zanker Landfills/WPCP and the new levee will continue to provide suitable dispersal and residence habitat for salt marsh harvest mice. More importantly, a broad ecotone along the southern and eastern sides of A18 will be constructed. This ecotone will provide much higher-quality residence and dispersal habitat than what will be impacted. This 345-foot-wide ecotone will extend from the levee top downslope to Pond A18. The native plants that will be seeded or planted on this ecotone area will provide suitable dispersal habitat for salt marsh harvest mice, and wetland vegetation and peripheral halophytes near the lower edge of the ecotone area will provide residence habitat for the salt marsh harvest mouse that is at least as suitable (or of much higher quality) as what will be impacted. This ecotone will thus compensate (and more) for any loss of habitat along Pond A18, both in terms of the acreage of habitat impacted and linearly, replacing low-quality habitat with higher-quality habitat in the same areas linearly along the levee. Although no broad ecotone habitat is proposed at Pond A16 to replace the narrow strips of vegetation lost due to levee widening, the lower slopes of the levee will be allowed to be vegetated, and pickleweed of similar quality and extent to that currently present is expected to colonize these lower slopes. This pickleweed will not be mowed, as mowing would occur only on the higher portions of the levee. Along the eastern edge of Pond A12, the vegetation to be lost (*i.e.*, between the A12 levee and the Alviso impoundment) is so narrow that it likely serves little function, either as residence or dispersal habitat, for salt marsh harvest mice. As a result, the loss of this habitat to FRM levee construction does not warrant immediate compensation in situ by the Corps. Rather, the broad ecotone to be constructed by the Service and local sponsors on the west side of the FRM levee at Pond A12 will more than compensate for any lost salt marsh harvest mouse habitat in the A12 vicinity. Although the construction of the Pond A12 ecotone is a Service-led activity, it would not be feasible but for the construction of the FRM levee by the Corps, and thus the Corps' levee construction is enabling that important habitat restoration component.

Construction of the FRM levee on the existing Pond A18 levee footprint will modify the structures that convey water in and out of the non-tidal wetlands east of Artesian Slough and south of Pond A18. These wetlands contain extensive pickleweed and are thus expected to support resident salt marsh harvest mice. The proposed project will replace any modified or removed water control structures so that flow in and out of these wetlands can continue and existing conditions within the wetlands will be maintained.

Scour of Tidal Marsh Habitat

Following breaching of Pond A18, the increased tidal prism will result in the scour of sediment, and some vegetated marsh, from channels leading between the Bay and the breach locations. As a result, some loss of existing fringe marsh for the California clapper rail and salt marsh harvest mouse will occur along Artesian and Coyote sloughs. This marsh will consist primarily of brackish and freshwater marsh, but some salt marsh along lower Coyote Slough will be lost to scour as well. The acreage of marsh expected to be lost due to scour resulting from the breaching of Pond A18 is unknown. The SBSPRP predicted that 220-250 acres of marsh loss to scour would occur over a 50-year period resulting from restoration of tidal action to as much as 11,500 acres for the entire

SBSPRP (*i.e.*, scour of about 2 percent of the marsh restored). Given the 736 acres of tidal restoration proposed at Pond A18, the extent of marsh loss for the California clapper rail and salt marsh harvest mouse due to scour might be roughly estimated at 17 acres. Such marsh loss would be gradual, and this total represents the total loss due to scour over the 50-year proposed project period.

The fringe marshes of the South Bay, which will be the marshes adversely affected by this scour, often provide the only habitat connecting the larger patches of marsh habitat that contain the "core" populations of salt marsh harvest mice. The loss of these marshes in the short term, before the restored marshes have matured to vegetated high marsh, could temporarily reduce the connectivity between the salt marsh harvest mouse populations of the South Bay. However, the short-term loss of salt marsh harvest mouse habitat and connectivity from fringe marsh scour will be offset by an order of magnitude when the restored marsh matures to a point that it can support salt marsh harvest mice. In the meantime, the marsh loss due to scour will be far less than the expected extent of marsh-type conversion (*i.e.*, from fresh or brackish marsh to salt marsh) due to increased salinization related to increased tidal prism. As a result, the enhancement of California clapper rail and salt marsh harvest mouse habitat from increased salinization will outpace any adverse effects of marsh loss due to levee construction, breaching, and localized scour while new tidal salt marsh is developing within restored Pond A18. The short-term nature of any reduction in connectivity from construction and scour suggests that it will not adversely affect the metapopulation dynamics or genetic diversity of the salt marsh harvest mouse in the South Bay.

To put the loss of marsh from excavation of pilot channels and downstream scour of fringing marsh into perspective, this 17 acres of marsh loss is far less than the expected extent of marsh-type conversion (*i.e.*, fresh or brackish marsh to salt marsh) due to increased salinization related to increased tidal prism. As a result, the beneficial effects on California clapper rail and salt marsh harvest mouse populations due to enhancement of habitat resulting from increased salinization will outpace any adverse effects of marsh loss due to breaching and localized scour in the near term while the much more extensive tidal salt and brackish marsh is developing within restored Pond A18.

During any construction or excavation activities that may result in impacts to tidal marsh habitat, the limits of work will be clearly delineated to limit effects to existing California clapper rail and salt marsh harvest mouse habitat. Side-casting of dredged materials into tidal marsh habitat (*e.g.*, during excavation) will be limited so that a minimum amount of marsh is filled. Conservation measures incorporated into the proposed project will minimize effects of human activity within marshes on California clapper rail and salt marsh harvest mouse habitat.

Effects of Service-led Actions

The only Service-led activities that could result in the loss of existing California clapper rail and salt marsh harvest mouse habitat will occur as a result of tidal restoration at Ponds A9-A15. Excavation of pilot channels in the outboard tidal marsh around these ponds will disturb about 0.03 acre of salt marsh, 0.03 acre of brackish marsh, and <0.01 acre of freshwater marsh at five breach locations along Alviso Slough and one breach location along Coyote Slough. Because recent surveys for California clapper rails conducted for the Invasive *Spartina* Project along Alviso Slough have only detected California clapper rails at the mouth of the slough, pilot channel construction and breaching at the four breach locations on Ponds A10 and A12 are likely to have little effect on

habitat that is used by nesting California clapper rails; rather, this habitat is likely used only by occasional, foraging, non-breeding individuals. The breach in the northwest corner of Pond A9 is closer to areas where California clapper rails have been recently detected, but it is located at an existing tide gate where the marsh along Alviso Slough is extremely narrow, too narrow to provide suitable nesting habitat or high-quality foraging habitat for California clapper rails. The only location where pilot channel excavation could affect habitat that has any likelihood of being used by breeding California clapper rails is in the northeastern corner of Pond A9, where the pilot channel will be excavated out to Coyote Slough. It is likely that salt marsh harvest mouse abundance in most of the breach locations is low owing to the brackish and/or very narrow nature of the marshes at these locations. However, the breach in the northeast corner of Pond A9 is located in tidal salt marsh that is more suitable for this species. Vegetation is almost completely absent from the internal berms within the Ponds A9-A15 system, and thus within-pond preparation activities for tidal breaching will not disturb any suitable salt marsh harvest mouse habitat.

Prior to or concurrent with restoration of tidal action in Ponds A9, A10, and A11, the berm between Ponds A11 and A12 will be breached. If California clapper rail and salt marsh harvest mouse habitat has developed within Pond A12 by that time, there may be a temporary loss of habitat due to breaching. However, that habitat will be quickly offset by continued marsh development. Similarly, berms between A14 and A9/A11, and between A13 and A12, will be breached prior to or concurrent with restoration of tidal action in Ponds A13-A15, potentially resulting in temporary losses of California clapper rail and salt marsh harvest mouse habitat. Again, any such losses will quickly self-restore.

As mentioned above, the increased tidal prism resulting from restoration of tidal action to Ponds A9-A15 will cause the scour of sediment, and some vegetated marsh, from channels leading between the Bay and the breach locations. As a result, some loss of fringe marsh along Alviso Slough and Coyote Slough will occur. Such scour will reduce habitat for the California clapper rail and salt marsh harvest mouse and may limit dispersal of salt marsh harvest mice along these sloughs to some extent in the short term. Assuming that the loss of marsh to scour might comprise approximately 2 percent of that restored, up to 40 acres of tidal marsh might be lost to scour over the 50-year proposed project period. This marsh would be limited to Alviso Slough downstream from Pond A12 and a small area of Coyote Slough from the northwest corner of Pond A9 downstream. Such marsh loss will occur gradually due to the phasing of breaching at these ponds (Pond A12 in 2020, A9-11 in 2025, and A13-15 in 2030). However, the beneficial effects on California clapper rail and salt marsh harvest mouse populations due to enhancement of habitat resulting from increased salinization are expected to outpace any adverse effects of marsh loss due to breaching and localized scour while new tidal salt and brackish marsh is developing within the restored marshes in Ponds A9-A15. Once cordgrass and pickleweed-dominated habitat colonizes the restored marsh within these former ponds, California clapper rail and salt marsh harvest mouse habitat will be expanded by orders of magnitude.

Small-scale, localized disturbance of habitat for the California clapper rail and salt marsh harvest mouse may also occur from walking through marshes or grounding boats in marshes during monitoring, research, or predator management efforts. Such disturbance would be very limited, particularly with implementation of proposed conservation measures (*e.g.*, for perennial pepperweed control). Effects to California clapper rails and salt marsh harvest mice resulting from monitoring, research, and predator management on the Refuge will be covered by the existing biological opinion for the SBSPRP and a future biological opinion for the Refuge's Comprehensive Conservation Plan.

Effects to California clapper rails and salt marsh harvest mice resulting from perennial pepperweed control are discussed below under the "Perennial Pepperweed Control" section."

Direct Effects to Individuals

Effects of Corps-led Actions

California Clapper Rail

Construction of the FRM levee, Artesian Slough tide gate, and Artesian Slough pedestrian bridge has the potential to disturb areas where California clapper rails are occurring only at Artesian Slough. Due to the low quality of this freshwater marsh for use by California clapper rails, there is a very low probability that a rail would be anywhere in the vicinity of the tide gate/pedestrian bridge construction area when activities are occurring in the tidal marsh. Furthermore, because the freshwater habitat in that location is not suitable for use by breeding California clapper rails, no nests, eggs, or young would be affected by activities at that location, and any California clapper rail present in the vicinity would move away from construction activities long before it could be physically injured or killed. Therefore, no loss of individuals, nests, eggs, or young will occur from construction of the FRM levee, Artesian Slough tide gate, and Artesian Slough pedestrian bridge.

Excavation of pilot channels in the outboard marsh around Pond A18 is also unlikely to result in the loss of any California clapper rails. The brackish marsh habitat at three of the pilot channel locations does not provide high-quality nesting habitat, due both to its brackish nature and the narrow nature of the marsh at those locations, and there is a low probability that California clapper rails would be breeding in those areas. Further, if pilot channel excavation in brackish or salt marsh habitat is conducted during the breeding season (February 1 – August 31), surveys for California clapper rails will be conducted prior to proposed project activities to determine whether nesting California clapper rails are present in the vicinity. If California clapper rails are detected, buffers between rail activity centers and construction will be followed. During any construction or excavation activities that may result in effects to California clapper rails, the limits of work will be clearly delineated to limit effects to this species. These conservation measures will minimize effects of human activity within marshes on California clapper rails.

Disturbance such as loud noise or the presence and movement of people and heavy equipment in or near California clapper rail habitat may alter bird behavior in ways that result in altered foraging or sheltering behavior and reduced nesting success. Such disturbance could result in temporary or permanent habitat loss due to California clapper rail avoidance of areas that have suitable habitat but intolerable levels of disturbance; abandonment of nests, eggs, or young by nesting pairs; a reduction in foraging efficiency if high-quality foraging areas are impacted; and increased movement or flushing from cover, or altered activity patterns, that reduce energy reserves and increase predation risk. The potential for disturbing breeding California clapper rails will be avoided by delaying construction activities within suitable California clapper rail breeding habitat until after the breeding season unless protocol-level surveys determine California clapper rails are absent from a 700-foot-buffer around the proposed work area. The level of disturbance of California clapper rails will also be minimized by having a Service-approved biological monitor supervise the work.

Loss of individual California clapper rails due to predation could be exacerbated by the proposed project. The restoration of tidal marsh habitat will increase habitat for northern harriers, which may

prey on California clapper rails (especially chicks). However, because habitat for northern harriers is suitable for California clapper rails as well, the increase in California clapper rail populations due to habitat restoration in a given area is expected to outpace any adverse effects of predation by northern harriers. Local increases in predation on California clapper rails may occur due to marsh restoration in close proximity to areas frequented by California gulls, such as the Newby Island Landfill, Pond A16, and New Chicago Marsh; electrical towers within Pond A18 that provide known nesting sites for common ravens and red-tailed hawks, and perches for peregrine falcons; and upland areas providing sources of predators such as cats, rats, foxes, raccoons, white-tailed kites, and American crows. Although terrestrial pathways used by mammalian predators to access marshes will be reduced through the breaching of levees in some areas, marshes that abut upland areas will be subject to predation by land-based predators. In addition, rock at the bridge abutments and surrounding electrical towers in Pond A18 may provide refugia for rats that may prey on California clapper rail eggs. The risk of predation on California clapper rails will be reduced by the implementation of a Service-approved long-term predator management and litter cleanup program under a cooperative agreement among the SCVWD, the Refuge, and the City of San Jose that will be funded by the SCVWD.

Maintenance activities along the FRM levee have the potential to disturb California clapper rails in Ponds A12, A13, and A18 after tidal restoration has occurred and rail habitat has developed within those former ponds. Recreational use of the Bay Trail segment atop the levee will affect California clapper rails in adjacent areas to the point that rails present in those restored marshes during levee maintenance activities will already be habituated to some level of human activity on the levee. In addition, the 345-foot wide ecotones will limit the potential for levee maintenance activities to adversely affect California clapper rails. As a result, routine inspections and minor maintenance activities are not expected to result in an increase in California clapper rail disturbance, relative to other types of levee use. Even mowing along the levee tops is unlikely to cause substantial disturbance of California clapper rails given the very narrow swaths to be mown, the brevity of mowing operations, and the distance (330 feet or more) between mowing and California clapper rail habitat. However, maintenance activities involving heavy equipment would be conducted outside of the California clapper rail's nesting season to the extent practicable, and if seasonal avoidance is not possible, pre-construction surveys would be conducted for nesting California clapper rails, and appropriate buffers would be implemented between proposed project activities and nesting rails as necessary.

Salt Marsh Harvest Mouse

Construction of the FRM levee, Artesian Slough tide gate, and Artesian Slough pedestrian bridge will result in fill of vegetated areas that could potentially support small numbers of salt marsh harvest mice. Excavation of pilot channels in the outboard marsh around Pond A18 will also result in removal of brackish marsh that could potentially support low densities of salt marsh harvest mice. Although the number of individual salt marsh harvest mice that may be present in habitat to be impacted by levee construction and pilot channel excavation is low, individual salt marsh harvest mice could potentially be injured or killed by crushing or smothering during the placement of sediment or other materials in suitable habitat, or by excavation of habitat. Conservation measures such as hand-removal of vegetation in potential salt marsh harvest mouse habitat under the supervision of a Service-approved biologist, measures to ensure that salt marsh harvest mice leave

areas prior to impacts, and salt marsh harvest mouse exclusion fencing will be implemented to minimize the potential for injury and mortality of individual salt marsh harvest mice.

Disturbance such as loud noise or the presence and movement of people and heavy equipment in or near salt marsh harvest mouse habitat may alter mouse behavior in ways that result in alteration of foraging and sheltering activities or reduced breeding success. Disturbance may result in displacement of salt marsh harvest mice from protective cover and their territories/home ranges (through noise and vibrations) and/or direct injury or mortality (through crushing). These disturbances are likely to disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and are likely to result in the displacement of salt marsh harvest mice from their territory/home range in the areas where their habitat is destroyed. Displaced salt marsh harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predators. Disturbance of female salt marsh harvest mice, particularly during the period of March through November, may cause abandonment or failure of the current litter. Thus, displaced salt marsh harvest mice may suffer from increased predation, competition, mortality, and reduced reproductive success.

Noise from construction activities associated with the FRM levee, Artesian Slough tide gate, and Artesian Slough pedestrian bridge close to suitable salt marsh harvest mouse habitat may alter mouse breeding, foraging, and sheltering behavior. Salt marsh harvest mice may be similarly disturbed during excavation of pilot channels, preparation of ponds for breaching (*e.g.*, construction of ditch blocks), and access of construction areas by heavy equipment along existing levee roads.

Loss of individual salt marsh harvest mice due to predation could be exacerbated by the proposed project, at least in localized areas, as described for California clapper rail. Predator management and MAM performed by the Refuge and the SBSPRP will help to minimize the risk of predation.

Vegetation management along the levees has some potential to result in the injury or mortality of individual salt marsh harvest mice and the disturbance of foraging, sheltering, and dispersal activities. However, the potential for take and number of individuals that could be taken is very low, for several reasons. First, the strip of vegetation that will be mowed along the levee top will be very narrow (expected to be 15 feet or less). Only ruderal grassland foraging/dispersal habitat and no suitable pickleweed breeding habitat will be mowed; therefore, the potential for disturbing breeding salt marsh harvest mice or a salt marsh harvest mouse nest will be avoided because breeding mice will not be present in these areas. Mowing from the levee top downslope will result in slight disturbance of downslope areas that might encourage salt marsh harvest mice to move downslope, away from the mowing activity. In addition, vegetation along the levee top is not expected to be particularly dense, especially in comparison to vegetation lower on the levee/ecotone slopes. As a result, it is possible that salt marsh harvest mice will make little use, if any, of the vegetation that needs to be mown. Maintenance such as mowing in or adjacent to salt marsh harvest mouse habitat will also be avoided during extreme high tides when salt marsh harvest mouse are most likely to approach the levee top to escape the flooding marsh. If trapping of California ground squirrels is necessary to control burrows within the levees, live traps with openings large enough to allow salt marsh harvest mice to exit the traps will be used.

Disturbance of salt marsh harvest mice from recreational trail use may occur, due to the expected occurrence of salt marsh harvest mice in ecotones and vegetated lower levee slopes and in the salt marsh harvest mouse habitat adjacent to lower Coyote Creek, where the levee trail connection to the

existing Bay Trail segment will be provided. However, such disturbance will be minimized by the physical separation of the bare-topped trail and the vegetated slopes where salt marsh harvest mice may occur. Trail use may also result in indirect effects, such as increased trash (which may attract predators) and increased invasive plants, which may adversely affect habitat quality. Predator management and invasive plant species control implemented along the trails will minimize these adverse effects.

Effects of Service-led Actions

California Clapper Rail

Excavation of pilot channels in the outboard marsh around Ponds A9-A15 has the potential to affect individual California clapper rails, including nests, eggs, and young, directly. Such effects are most likely along the pilot channel excavation area near the northeast corner of Pond A9, which provides suitable nesting habitat for California clapper rails. As noted above, the probability of nesting California clapper rails is low in the brackish marsh and narrow areas of salt marsh where breaches and pilot channels are proposed along Alviso Slough.

As mentioned previously, prior to or concurrent with restoration of tidal action in Ponds A9, A10, and A11, the berm between Ponds A11 and A12 will be breached. If California clapper rail habitat has developed within Pond A12 by that time, there is some potential for effects to individuals or nests due to breaching. Similarly, berms between A14 and A9/A11, and between A13 and A12, will be breached prior to or concurrent with restoration of tidal action in Ponds A13-A15, potentially resulting in effects to individual California clapper rails.

If pilot channel excavation in brackish or salt marsh habitat, or breaching of berms for Phases 2 and 3 near suitable California clapper rail habitat, is conducted during the breeding season, protocol-level surveys for California clapper rails will be conducted prior to proposed project activities to determine whether nesting rails are present in the vicinity. If any California clapper rails are detected, 700-foot buffers between rail activity centers and construction will be followed. During any construction or excavation activities that may result in effects to California clapper rails, the limits of work will be clearly delineated to limit effects to this species. These conservation measures will minimize effects of human activity within marshes on California clapper rails.

As noted previously, tidal restoration will result in an increase in the abundance of marsh-associated predators such as northern harriers. However, mammalian predators will have less access to these restored marshes due to the breaching of levees and the presence of Alviso and Coyote sloughs on two sides of the A9-A15 complex. Further, because no high-tension powerlines run through these ponds, perch sites for most predatory raptors will be limited.

A large colony of California gulls nests on the interior berms separating Ponds A9, A10, and A14. Tidal restoration would result in the intentional lowering of these berms or eventual erosion of these berms through tidal action, thus causing these gulls to move elsewhere to nest. These displaced gulls may select nesting sites in close proximity to California clapper rail habitat elsewhere. The displacement of gulls from areas of lower quality California clapper rail habitat to areas of higher quality habitat could result in increased predation pressure by gulls on the rail. Predator management and MAM performed by the Refuge and the SBSPRP will help to minimize the risk of predation.

Monitoring, research, and predator management efforts involving people walking through tidal marshes or boats grounding on marshes could result in effects to individual California clapper rails. Adult California clapper rails are unlikely to be injured or killed during such activities, as they are expected to flee an area subject to such activities before injury or mortality occurs. However, these activities could destroy or damage California clapper rail nests or eggs, or result in the injury or mortality of less mobile young California clapper rails. Such activities are expected to be very localized, and implementation of conservation measures (such as minimizing such activities during the California clapper rail's breeding season) will minimize the potential for such effects.

Following complete restoration of Ponds A9-A15, the extent of trails at these ponds will be limited to a trail along the eastern edges of Ponds A12, A13, and A15, with shorter spurs in three areas. Observation platforms would be constructed at the ends of these spurs. Human activity use may increase in areas where trails and observation platforms are to be opened or improved. Use of the trail along the new FRM levee is likely to increase once this levee is connected to other Bay Trail segments at its northeast end, but the removal of a loop trail in the A9-A15 complex may tend to reduce trail use. Management of potential disturbances in adjacent habitat areas from recreational human activity may not be effectively regulated or controlled, even with the proposed conservation measures to maintain public use and activities along the developed trails.

Increased recreational trail use in areas where existing trails occur adjacent to California clapper rail habitat could result in the flushing of California clapper rails at high tides, increasing predation risk. No new trails are proposed to be opened adjacent to existing California clapper rail habitat, but rails that colonize the restored tidal marshes in Ponds A12, A13, A15, and A18 would be subjected to human disturbance from trail users. The breadth of the ecotone (345 feet) will limit disturbance of California clapper rails by people using the new FRM levee along eastern Pond A12 and southern Pond A18, as humans on the top of the levee will be far removed from suitable rail habitat. People using the spur trails and the levee trail along the southern Pond A12 levee, the Pond A12/A13 levee, and the northern Pond A15 levee will be closer to California clapper rail habitat, however, due to the absence of a constructed ecotone.

Interpretive signage will be installed at the edges of sensitive California clapper rail habitat areas discouraging human entry into those areas. If monitoring indicates that disturbance of California clapper rails by humans is adversely affecting rail populations, seasonal closures of portions of these trails would be considered as an adaptive management measure.

Salt Marsh Harvest Mouse

Excavation of pilot channels in the outboard marsh around Ponds A9-A15 has the potential to injure or kill salt marsh harvest mice by crushing or smothering them during the placement of sediment or other materials in suitable habitat, or by excavation of habitat. Such effects are most likely along the pilot channel excavation area near the northeast corner of Pond A9, which provides the highest-quality habitat for this species of all the breach locations. Abundance of salt marsh harvest mice is low in the brackish marsh and narrow areas of salt marsh where breaches and pilot channels are proposed along Alviso Slough. As mentioned previously, prior to or concurrent with restoration of tidal action in Ponds A9, A10, and A11, the berm between Ponds A11 and A12 will be breached. If salt marsh harvest mouse habitat has developed within Pond A12 by that time, there is some potential for effects to individuals due to breaching. Similarly, berms between A14 and A9/A11, and between A13 and A12, will be breached prior to or concurrent with restoration of tidal

action in Ponds A13-A15, potentially resulting in effects to salt marsh harvest mice. Conservation measures will be implemented to minimize the potential for impacts to individual salt marsh harvest mice.

Disturbance of salt marsh harvest mice from pilot channel excavation, ditch block construction, breaching of berms prior to second or third phase breaching, and equipment access for these restoration-related activities would be similar to that described above. Disturbance of salt marsh harvest mice from recreational trail use would be similar to that described for California clapper rail above.

As described for California clapper rail, loss of individual salt marsh harvest mice due to predation could be exacerbated by the proposed project, at least in localized areas, and displacement of the California gull colony from the interior berms separating Ponds A9, A10, and A14 could cause these gulls to relocate in areas where they may be more likely to prey on salt marsh harvest mice.

Monitoring, research, and predator management efforts involving people walking through tidal marshes or boats grounding on marshes could also result in injury or mortality of salt marsh harvest mice or disturbance of breeding, foraging, and sheltering activities. Such activities are expected to be very localized. Effects to salt marsh harvest mice resulting from monitoring, research, and predator management on the Refuge will be covered by the existing biological opinion for the SBSPRP and a future biological opinion for the Refuge's Comprehensive Conservation Plan. Effects to salt marsh harvest mice resulting from perennial pepperweed control are discussed below under the "Perennial Pepperweed Control" section.

Effects Due to an Increase in Mercury Exposure

Effects of Corps-led Actions

It is well known that the Guadalupe River system, including Alviso Slough, has a relatively high concentration of mercury resulting from sediments washed from historical mercury mines in the upper watershed. Recent testing in Artesian Slough has revealed high mercury concentrations there as well, with total mercury being lower but methylmercury, the bioavailable form, being higher in Artesian Slough than Alviso Slough (City of San Jose 2013). Such mercury may be mobilized when pilot channels are excavated in outboard marshes along Artesian Slough prior to breaching, and the tidal action through those channels, as well as the increase in tidal prism and associated scour of sediments in Artesian Slough, could mobilize mercury-laden sediment from the slough.

Although the abundance of California clapper rails in the immediate vicinity of Artesian Slough is currently very low, mercury could be mobilized downstream into and along Coyote Slough. Mercury accumulation in eggs is known to affect California clapper rails in the Bay Estuary, with the South Bay containing the highest mercury levels. Although intake is generally not acute enough to result in lethal toxosis of adults or young, mercury is extremely toxic to embryos and thus results in low levels of egg viability, and reduced California clapper rail fecundity. Schwarzbach *et al.* (2006) found high mercury levels and low hatching success (due both to predation and, presumably, mercury) in California clapper rail eggs throughout the Bay. They also suggested that mercury exposure could slow or stunt development of young, possibly increasing predation risk. Mercury exposure has been also linked to reduced body condition in California clapper rails (Ackerman *et al.* 2011), suggesting there are potential detrimental effects on survivorship of adult birds as well. Mean

mercury concentrations in captured California clapper rail blood samples were 0.56 micrograms/ gram (µg/g; or parts per million), 9.87 µg/g in head feathers, and 9.04 µg/g in breast feathers (Ackerman *et al.* 2011). Birds with mercury concentrations in blood over 1.0 µg/g and 9.0 µg/g in feathers are considered at risk for impaired reproduction (Evers *et al.* 2004, Burger and Gochfeld 1997), and several individuals captured in that study had mercury levels above those thresholds. The mercury concentrations in both head and breast feathers in the Ackerman study suggest that rails were exposed to mercury over long periods of time, as those two feather tracts are grown in different stages of molt. This suggests that mercury exposure was chronic and accumulated over time.

Mercury is taken in by California clapper rails primarily through contaminated prey in the form of methylmercury. Methylmercury, unlike elemental mercury, is bioavailable in that it readily binds to living tissue and accumulates in aquatic food webs. For instance, in failed-to-hatch California clapper rail eggs in the Schwarzbach *et al.* (2006) study, methylmercury accounted for 95 percent of total mercury in those eggs, and this ratio of elemental to methylmercury has been found in previous studies as well (see Ackerman *et al.* 2011). In addition to reproductive failure, studies have shown that captive egrets fed doses of 0.5 milligrams of methylmercury were less motivated to hunt food, and had a reduced appetite (Bouton *et al.* 1999, Spalding *et al.* 2000). These effects may be related to reduced body condition, which could ultimately lower survivorship.

Inorganic mercury tends to be converted to methylmercury, primarily under somewhat anoxic conditions (Marvin-DiPasquale *et al.* 2003). California clapper rails are currently exposed to methylmercury when foraging on mudflats and in sloughs with high levels of mercury contamination. The proposed project has the potential to increase the exposure of California clapper rails to mercury by stirring up sediments during vegetation removal and dredging activities. Methylmercury may also be mobilized by the frequent wetting and drying of mercury-contaminated sediments during construction activities. Mercury-contaminated sediments that are currently buried too deep to adversely affect California clapper rails and other species could be mobilized by these activities, thus entering the food chain. The extent to which excavation of pilot channels and scour of sediments in Artesian Slough will release mercury such that it may be more bioavailable to California clapper rails, and to which any increased level of bioavailable mercury affects California clapper rails, is difficult to quantify.

Compared to a managed pond environment, mercury deposited in well-oxygenated marsh plains is not expected to methylate as readily (Grenier *et al.* 2010). Also, it is likely that there will be a relatively low temporal exposure after breaching occurs for mercury to circulate in the slough or restored ponds, methylate, and be incorporated into the food web. Therefore, if there is an increase in methylmercury, it will likely occur for only a short duration. Preliminary data collected for SBSPRP mercury monitoring suggest this is the case. Mercury levels in fish collected in Alviso Slough increased after the Pond A8 notch was opened in June 2011 but had already decreased by October 2011 (SBSPRP 2013). The increase in mercury levels was more pronounced around the notch than at downstream sampling locations, suggesting the effect was localized. Therefore, the loss of individual California clapper rails or reduction in reproductive success of rails is not expected to occur as a result of increased mercury exposure associated with the proposed project.

The effects of mercury on salt marsh harvest mice are largely unknown. However, this species is likely exposed to methylmercury through the tidal marsh food web and mercury concentrations in tidal marshes. Although Artesian Slough methylmercury concentrations are high, tidal marshes

show no evidence of increased bioaccumulation of mercury compared to other South Bay tidal marshes, possibly due to a paucity of organic material in the sediment (Grenier *et al.* 2010). For example, resident songbirds captured in tidal marshes in Alviso Slough showed similar bioaccumulation of mercury as other South Bay marshes (Grenier *et al.* 2010). Because increases in mercury availability are expected to be short-term, as described for the California clapper rail, the potential for increased salt marsh harvest mouse exposure to mercury is relatively low. Therefore, salt marsh harvest mice are not expected to be affected by an increase in mercury exposure related to pilot channel excavation and sediment scour.

Effects of Service-led Actions

Because of the mercury contamination of the Guadalupe River from the New Almaden mine, some of the sediment in Alviso Slough may contain high concentrations of mercury. Such mercury may be mobilized when pilot channels are excavated in outboard marshes along Alviso Slough prior to breaching, and the tidal action through those channels, as well as the increase in tidal prism and associated scour of sediments in Alviso Slough, could mobilize mercury-laden sediment from Alviso Slough and Ponds A9-A15. Effects of this mercury mobilization on California clapper rails would be as described above for Corps-led activities. The effects of mercury mobilization on salt marsh harvest mice from Service-led activities are expected to be relatively low similar to those described above for Corps-led activities.

Perennial Pepperweed Control

Effects of Corps-led and Service-led Actions

Potential effects on California clapper rail and salt marsh harvest mouse foraging and nesting due to perennial pepperweed control could result from habitat alterations (*e.g.*, native plant mortality) and marsh access through California clapper rail and salt marsh harvest mouse habitat for treatment/ eradication, monitoring, or re-vegetation activities. Ground based spraying via foot or ARGOs and post-treatment monitoring requires access through the marsh and may result in vegetation trampling or salt marsh harvest mouse nest disturbance. Use of ARGOs for control will cause temporary disturbance of marsh vegetation. All treatment crew members will be supervised by a qualified biologist and will be trained to follow the guidelines presented in the "Walking In the Marsh: Methods to Increase Safety and Reduce Impacts to Wildlife & Plants" protocol (Appendix A), thereby minimizing disturbance of California clapper rails, salt marsh harvest mice, and their habitats.

Disturbance of the marsh by field crews on-foot will be minimal because crews will be traversing through the marsh only once or twice per year to conduct treatment and monitoring, trails will not be established through the marsh, and no residual effects on marsh habitat quality are anticipated. Field crews will not crush any salt marsh harvest mice or their nests because they will be supervised by a qualified biologist and will avoid walking on high pickleweed vegetation and on wrack, where salt marsh harvest mice are likely to forage or nest. In addition, since crews will be walking slowly, any salt marsh harvest mice present will be able to move out of the immediate area. Due to the minimal amount of habitat disturbance caused by field crews and avoidance of direct impacts to salt marsh harvest mice, access of marshes by field crews on-foot for perennial pepperweed control will avoid the injury and mortality of salt marsh harvest mice and minimize the level of disturbance.

Field crews accessing the marsh via ARGOs for perennial pepperweed control may result in the temporary disturbance of marsh vegetation (habitat degradation) or crushing of individual salt marsh harvest mice or their nests beneath the ARGOs. These vehicles are designed to operate with low ground pressure (about 0.67 pounds per square inch) and distribute weight on specialized tracks. ARGOs exert a ground pressure approximately five times less than that of humans; however, a greater area of marsh vegetation would be disturbed by fields crews on ARGOs than on-foot.

ARGOs may crush and cause dieback of marsh vegetation, particularly sub-shrubby vegetation with brittle stems, such as pickleweed, the primary habitat of the salt marsh harvest mouse. Due to this identified impact, the quantity of suitable California clapper rail and salt marsh harvest mouse habitat directly affected by ARGOs is calculated by the distance within tidal marsh they will be driven to access and treat perennial pepperweed patches. There is a five-foot wide "track impact" from an ARGO traveling through the marsh. This impact would consist of temporary compaction or crushing of pickleweed and other marsh plants, with the vegetation expected to recover fully within a few months of impact. The travel path of ARGOs will be planned to minimize the amount of impact to California clapper rail and salt marsh harvest mouse habitat by traveling in mudflats whenever feasible.

The only perennial pepperweed control action that may temporarily disturb nesting California clapper rails is a portion of the marsh access for eradication activities. Backpack spraying will be used to treat perennial pepperweed within "700-ft Buffer Areas", and disturbance will be localized and very temporary (usually less than 30 minutes). California clapper rails may be harassed by treatment access within "700-ft Buffer Areas" where there is greater than one acre of infested perennial pepperweed and where treatment is likely to exceed 30 minutes. Boat-mounted spraying will be used to treat relatively larger clones along slough edges and may result in a larger scale disturbance (noise), but little immediate habitat destruction. ARGOs will not be used in "700-ft Buffer Areas" for California clapper rails. It is expected that control activities in areas with large acreages targeted for control will result in relatively more disturbance than in those areas with small acreages, given similar California clapper rail densities.

Any ARGOs used in control activities will stay 700 feet from known California clapper rail calling centers and will stay at least 50 feet from channel edges, thereby avoiding rail nest destruction or rail disturbance. However, if the intervening distance across a major slough channel or across a substantial physical barrier between the California clapper rail calling center and the proposed access area is greater than 200 feet, then access may proceed within the breeding season.

Areas where California clapper rails have been detected contain channels and low marsh vegetation used for mating, foraging, and nesting. The majority of perennial pepperweed patches occur in the transition zone and along channel edges dominated by gumplant. Perennial pepperweed patches also occur adjacent to *Spartina foliosa* patches of low marsh tidal deposition areas (wrack lines). Sensitive eradication areas include channel edges and areas where low marsh (*S. foliosa*-dominated) interfaces the pickleweed plain. Herbicide applications are not expected to cause direct mortality of *S. foliosa* and other native plant species if conservation measures are implemented to reduce herbicide spray drift and subsequent mortality of non-target plants. The eradication of perennial pepperweed is not likely to harm California clapper rails as a result of habitat loss because: (1) California clapper rails are not known to use perennial pepperweed as a habitat component, and (2) conservation measures will be implemented that avoid non-target plant eradication.

The herbicides, adjuvants, and dyes proposed for eradication of perennial pepperweed within the action area are also being used to eradicate invasive *Spartina* species in other parts of the Bay Estuary. The herbicides proposed were determined not to have any direct toxic effects to California clapper rails (California State Coastal Conservancy and Service 2003, California State Coastal Conservancy 2005). Direct toxicity of herbicide, surfactant, and colorant applications is unlikely to have significant toxic effects to California clapper rails since herbicides are directed to the upper portion of the plant and dry quickly on the plant leaf surface (usually within a few minutes of application), and exposure of rails to spray solutions would be very temporary. Even if California clapper rails are exposed to small amounts of spray solutions, they will not be injured since these chemicals are considered practically non-toxic to birds (California State Coastal Conservancy and Service 2003). The chemical treatment of perennial pepperweed will reduce expansion and formation of perennial pepperweed monocultures which alter soil conditions and crowd out native plant species used by California clapper rails for nesting and sheltering.

Salt marsh harvest mice are unlikely to come into contact with spray solutions applied to perennial pepperweed since the mice primarily inhabit pickleweed and other high marsh vegetation not targeted for control. Even if salt marsh harvest mice are exposed to small amounts of imazapyr, glyphosate, surfactants, or colorants used in the spray solutions, they would not likely be harmed since these chemicals are considered non-toxic to mammals (California State Coastal Conservancy and Service 2003, California State Coastal Conservancy 2005).

California clapper rails and salt marsh harvest mice will not lose habitat when perennial pepperweed is removed, since the rail and the mouse are not known to utilize perennial pepperweed. Removal of invasive perennial pepperweed and revegetation of the marsh-upland transition zone will provide high quality high tide refugia, a critical component of the habitat for the California clapper rail and salt marsh harvest mouse. Non-native perennial pepperweed threatens the transition zone refugia and tidal marsh habitat for the California clapper rail and salt marsh harvest mouse. Perennial pepperweed displaces higher quality tidal marsh vegetation including marsh gumplant and pickleweed. Perennial pepperweed also provides poor quality high tide refugia cover for the California clapper rail and salt marsh harvest mouse because it is leafless in the winter when the rail and the mouse are in most need of suitable upland cover during the frequent winter extreme high tide and storm events. Without suitable cover, the California clapper rail and salt marsh harvest mouse are vulnerable to predation during extreme high tide events. Therefore, perennial pepperweed control will provide a long-term benefit to the California clapper rail and salt marsh harvest mouse.

Revegetation will occur within the transition zone. Revegetation is not expected to disturb breeding California clapper rails because this activity will occur outside of the rail's breeding season. The transition zone is used by California clapper rails and salt marsh harvest mice primarily during extreme high tide events; therefore, restricting revegetation of the transition zone to low tides will minimize the potential for disturbing any California clapper rails and salt marsh harvest mice. The restoration of native plants within the transition zone will provide California clapper rails and salt marsh harvest mice with high quality high tide refugia, a critical component of population recovery for the rails and the mice.

Pacific Coast Population of the Western Snowy Plover

Loss of Habitat

Effects of Corps-led Actions

Western snowy plovers are not known or expected to nest or forage along the WPCP segment of the FRM levee or in or around Pond A18 under current conditions. As a result, construction and restoration east of Artesian Slough will not result in a net loss of western snowy plover habitat. However, prior to breaching, Pond A18 may be drawn down to facilitate within-pond preparations such as construction of ditch blocks. When Ponds A16 and A17 were drawn down prior to SBSPRP Phase I activities, western snowy plovers used the dried-out pond bottoms for nesting. If Pond A18 is drawn down prior to breaching, then the dried-out pond bottom is likely to attract nesting western snowy plovers. As a result, breaching will flood this temporarily created western snowy plover habitat.

Aside from impacts to temporarily created habitat if Pond A18 is drawn down, construction of the FRM levee will not directly affect any suitable nesting habitat for the western snowy plover. Although this species has nested in the Alviso impoundment, in Ponds A12, A13, and A16, and in New Chicago Marsh, portions of which will be directly impacted by levee construction, the western snowy plover does not nest near the existing non-engineered levees that occur within the proposed construction footprint. Rather, western snowy plovers nest farther from levees, apparently due to the disturbance associated with human use of the levees, use of levees by predatory mammals, and the species' inability to see over levees (and thus detect approaching predators) if the nest is placed too close to the levee. Thus, even under existing conditions, there is a zone close to the levees that has not been used for nesting by western snowy plovers.

However, for these same reasons, FRM levee construction could result in indirect effects to western snowy plovers by causing plovers to avoid using habitat that is otherwise suitable. The ultimate height of the FRM levee is expected to be approximately 10 feet higher than the existing levee on the south side of Pond A16, and the very low levee along the eastern side of A12 is likely to be raised even more, relative to its existing height. The levees may initially be built even higher, as some subsidence is expected over time as materials settle. As a result, the FRM levee will be substantially taller and wider than the existing levees. Western snowy plovers are unlikely to nest very close to the levee for the reasons discussed above, especially when the Bay Trail is developed atop the levee and human activity is even greater than it currently is. As a result, the zone near levees that western snowy plovers avoid for nesting would shift farther from the levee.

The extent of this indirect effect (*i.e.*, the amount of otherwise suitable nesting habitat that will no longer be used by nesting western snowy plovers) is unknown. Western snowy plovers nesting in New Chicago Marsh, on islands in Pond A16, and in Ponds A12 and A13 tend to nest well away from the Pond A16 levee. As a result, it is possible that they nest so far from the levee already that an increase in height of, and human activity along, the levee would have no effect on the plovers' perception of suitable habitat availability. In addition, tidal restoration in Ponds A12 and A13 would make those ponds completely unsuitable for use by nesting western snowy plovers. However, it is possible that increasing the height of the levee would cause plovers to retreat even farther from the levee. It is unknown whether western snowy plovers would continue to nest in the Alviso impoundment after FRM levee construction, and it is possible that plovers might view the entire

impoundment as being no longer suitable due to the taller, wider levee. Use of this impoundment by nesting western snowy plovers has been sporadic (*i.e.*, less than annual), and usually by only a single pair when it is used at all.

Although the number of pairs of western snowy plovers that may no longer nest in the vicinity of the action area as a result of raising the height of the levee is unknown, it is likely that no more than one or two pairs would be affected because areas near the action area levees have been inconsistently used by few plovers in the past. The proposed project will implement compensatory conservation measures by distributing pea gravel or other appropriate substrate on an island in Pond A16, maintaining this island for use by nesting western snowy plovers, and increasing the intensity of predator management in the vicinity. Gravel may make it more difficult for predators such as California gulls and northern harriers to detect western snowy plovers due to camouflage (*e.g.*, plovers may be difficult to distinguish within the gravel from a distance) and increased topographic relief associated with the gravel and footprints left by people distributing the gravel. As a result, predation rates on both western snowy plover eggs and chicks are likely to be lower in areas with such gravel, and more plovers may be attracted to nest in areas with gravel. Providing gravel on an island in Pond A16 is expected to increase western snowy plover nesting abundance, and possibly nesting success, thus compensating for the adverse effects of other proposed project activities on nesting western snowy plovers. These measures are expected to minimize any adverse effects of Corps-led actions on the availability of suitable western snowy plover habitat, or western snowy plover abundance or productivity.

Expansion of the FRM levee into pond, seasonal wetland, and muted tidal/diked marsh habitat will result in filling of ostensibly suitable foraging habitat and, as discussed above, the possible avoidance of foraging habitat that is otherwise suitable but would be too close to the levee following construction. However, western snowy plovers are very rarely seen foraging close to the eastern edges of Ponds A12 and A13, the southern edge of Pond A16, or the northern edge of New Chicago Marsh. As a result, effects of levee construction on western snowy plover foraging habitat are likely limited to reduced use of the Alviso impoundment. As foraging habitat in the vicinity is not likely limiting western snowy plover populations (based on the expanses of suitable foraging habitat present in managed ponds and New Chicago Marsh that is unoccupied at any given time, as well as the abundance of prey in these area), the effects of Corps-led actions on western snowy plover foraging habitat are unlikely to have a substantive effect on western snowy plover populations.

Effects of Service-led Actions

Service-led tidal restoration will result in the loss of all western snowy plover nesting habitat in Ponds A9-A15, as western snowy plovers do not nest in tidal habitats. Further, because this species forages infrequently on tidal mudflats, western snowy plovers are expected to make little use of Ponds A9-A15, even for foraging, once they are restored to tidal action. Based on data from 2012, when five of 13 nests in the proposed project vicinity were in Pond A13 (Donehower *et al.* 2012), and 2013, when two of 10 nests in the proposed project vicinity were in Pond A9 (Robinson-Nilsen *et al.* 2013), up to five pairs of western snowy plovers may be displaced by tidal restoration. Because restoration will be phased, some western snowy plover nesting habitat is expected to be present in Ponds A9-A15 until 2030, when the last of these ponds may be breached.

As discussed previously, the MAM for the SBSPRP will help to achieve the goal of supporting at least 250 individual breeding western snowy plovers in the SBSPRP area, which is half of the number of breeding western snowy plovers required within the San Francisco Bay Recovery Unit for delisting (Service 2007). The SBSPRP will implement adaptive management measures, such as more intensive management of certain ponds for western snowy plovers, as necessary to achieve that goal. The MAM associated with the SBSPRP would therefore assist in compensating for impacts to western snowy plovers from loss of nesting habitat in Ponds A9-A15 by helping to manage for plovers in other SBSPRP ponds. Because some western snowy plover nesting habitat will remain in the Ponds A9-A15 complex until 2030, there is ample time for the MAM associated with the SBSPRP to determine how to increase western snowy plover densities elsewhere prior to complete loss of plover nesting habitat from Ponds A9-A15. As described in previous sections, if the MAM indicates impacts to waterbirds (including western snowy plovers) are too severe, then fewer ponds will be restored to tidal action.

Development of a Bay Trail segment on the FRM levee, which is a Service-led activity, will increase recreational use of the levee top. This will contribute to disturbance of western snowy plovers nesting in adjacent areas, leading to an effective loss of habitat use. Research shows that nesting western snowy plovers within the South Bay are very sensitive to disturbance by recreational trail users and construction activities within 600 feet of their nests (Robinson 2008, San Francisco Bay Bird Observatory and Service 2010).

Direct Effects to Individuals

Effects of Corps-led Actions

As described for California clapper rail above, disturbance such as loud noise or the presence and movement of people, and heavy equipment near western snowy plover habitat may alter bird behavior in ways that result in injury, mortality, or reduced nesting success. Such disturbance could result in temporary or permanent habitat loss due to western snowy plover avoidance of areas that have suitable habitat but intolerable levels of disturbance; abandonment of nests, eggs, or young by nesting pairs; a reduction in foraging efficiency if high-quality foraging areas are impacted; and increased movement or flushing, or altered activity patterns, that reduce energy reserves and increase predation risk. Construction of the Alviso Segment of the FRM levee near western snowy plover habitat in Ponds A12 and A13, the Alviso impoundment, New Chicago Marsh, and A16 could result in disturbance of nesting and foraging plovers in those areas. However, moderate to fairly heavy human use already exists along the levees adjacent to western snowy plover habitat in the proposed project area. Numerous pedestrians and cyclists use the levees around the Ponds A9-A15 complex, between Ponds A15 and A13/A14, and between A16 and New Chicago Marsh on a daily basis. As a result, the western snowy plovers that use habitat adjacent to these levees (a) tend to avoid areas close to the levees used by humans, and (b) are already habituated to the use of humans along those levees. This reduces the extent to which western snowy plovers will be disturbed by levee construction and use of the levees by humans following levee completion.

Nevertheless, to minimize such impacts, work in and adjacent to potential western snowy plover nesting habitat would be conducted outside of the nesting season to the extent practicable. If seasonal avoidance is not possible, surveys before and during construction would be conducted for nesting western snowy plovers, and appropriate buffers (*i.e.*, 600 feet during construction activities) would be implemented between proposed project activities and nesting western snowy plovers.

Because western snowy plovers are not known or expected to nest very close to the existing levees, no western snowy plover nests or eggs would be located within the footprint of FRM levee construction. If nesting has occurred in areas adjacent to the levees, such as the Alviso impoundment, it is possible that young western snowy plovers could move into the construction footprint. However, if nesting occurs in the construction zone, then a Service-approved biologist will need to clear the area before construction can continue.

If Pond A18 is drawn down prior to breaching, as described previously, then breeding western snowy plovers could be nesting in the pond when construction of ditch blocks and breaching occurs. While adult breeding western snowy plovers would not be injured or killed by restoration-related construction activities or breaching, as they would flee the vicinity of any such activities, their nests, eggs, or young could be crushed, trampled, buried, or lost to flooding as a result of displacement of sediment into nesting habitat during construction of ditch blocks, or levee breaching and flooding of occupied habitat. For example, in 2010, two western snowy plovers nests at Ravenswood Pond SF2 were depredated when construction crews for the SBSPRP were working within 600 feet of the nests (San Francisco Bay Bird Observatory and Service 2010). Therefore, there is the potential for construction activities within 600 feet of a western snowy plover nest to flush the western snowy plover from its nest exposing the nest to depredation. To minimize such impacts, work in and adjacent to potential breeding western snowy plover nesting habitat would be conducted outside of the nesting season to the extent practicable. If seasonal avoidance is not possible, surveys prior to and during construction would be conducted for nesting breeding western snowy plovers, and appropriate buffers (*i.e.*, 600 feet during construction activities) would be implemented between proposed project activities and nesting western snowy plovers.

Loss of individual western snowy plovers (including eggs and chicks) due to predation could be exacerbated by the proposed project, at least in localized areas. The restoration of tidal marsh habitat will increase habitat for northern harriers, which are known to prey on western snowy plovers. Compensatory mitigation involving an increase in predator management in the New Chicago Marsh/A16 vicinity will reduce any increase in predation resulting from increased northern harrier populations from Corps-led activities.

Maintenance activities along the FRM levee have the potential to disturb nesting and foraging western snowy plovers as well. Recreational use of the Bay Trail segment atop the levee will affect western snowy plovers in adjacent areas to the point that plovers present in areas such as Pond A16 or New Chicago Marsh during levee maintenance activities will already be habituated to some level of human activity on the levee. As a result, routine inspections and minor maintenance activities are not expected to result in an increase in western snowy plover disturbance, relative to other types of levee use. Even mowing along the levee tops is unlikely to cause substantial disturbance of western snowy plovers given the very narrow swaths to be mowed, the brevity of mowing operations, and the distance (330 feet or more) between mowing and western snowy plover habitat. Other maintenance activities involving heavy equipment would be conducted outside of the nesting season to the extent practicable, and if seasonal avoidance is not possible, pre-construction surveys would be conducted for nesting western snowy plovers, and appropriate buffers would be implemented between proposed project activities and nesting western snowy plovers as necessary.
Even with the implementation of conservation measures to minimize disturbance of nesting western snowy plovers, snowy plovers that disperse away from disturbance may not successfully establish new breeding territories and breed. Plovers forced to disperse would need to either maintain existing pair bonds or develop new pair bonds and establish new breeding territories in other

suitable habitat areas. Disturbance that occurs during the non-breeding season could also result in injury, mortality, or the disturbance of western snowy plover foraging and sheltering activities. Displaced individuals could be subjected to injury or mortality from starvation, physiological stress, and increased predation.

Effects of Service-led Actions

Disturbance of western snowy plovers using Ponds A9-A15 may occur due to pilot channel excavation, ditch block construction, and equipment access for these restoration-related activities. The effects of such disturbance would be similar to that described above.

If drawdown of Ponds A9-A15 occurs to facilitate within-pond preparations, western snowy plovers are expected to nest in at least some of these ponds. While adult western snowy plovers would not be injured or killed by restoration-related construction activities, as they would flee the vicinity of any such activities, their nests, eggs, or young could be crushed, trampled, buried, or lost to flooding as a result of displacement of sediment into nesting habitat during berm lowering or construction of ditch blocks, or levee breaching and flooding of occupied habitat. To minimize such impacts, work in and adjacent to potential western snowy plover nesting habitat would be conducted outside of the nesting season to the extent practicable. If seasonal avoidance is not possible, pre-and during construction surveys would be conducted for nesting western snowy plovers, and appropriate buffers would be implemented between proposed project activities and nesting western snowy plovers.

As described for California clapper rail above, loss of individual western snowy plovers, eggs, and young may increase as a result of predation. An increase in tidal marsh habitat will result in an increase in northern harrier populations, and displacement of the California gull colony on the interior berms separating Ponds A9, A10, and A14 may cause gulls to relocate to areas closer to high densities of nesting western snowy plovers. Both the northern harrier and California gull are important predators of western snowy plovers in the South Bay. Predator management and MAM performed by the Refuge and the SBSPRP will help to minimize the risk of predation on western snowy plovers.

Service-led activities include the provision of recreational trails. Human activity may increase in areas where trails and observation platforms are to be opened or improved. Studies of the effects of recreational trail use in the South Bay on western snowy plovers showed that trail users caused western snowy plovers to flush from their nests when walkers approached on average within 538 feet when approached directly or 478 feet when passed tangentially (Robinson 2008). Use of the trail along the new FRM levee is likely to increase once this levee is connected to other Bay Trail segments at its northeast end, but the removal of a loop trail in the A9-A15 complex may tend to reduce trail use. Management of potential disturbances in adjacent habitat areas (such as Ponds A9-A15 that have not yet been converted to tidal habitats) from recreational human activity may not be effectively regulated or controlled, even with the proposed conservation measures to maintain public use and activities along the developed trails. Increased recreational trail use adjacent to western snowy plover habitat could have the same disturbance effects as described above.
Interpretive signage will be installed at the edges of sensitive habitat areas discouraging human entry into those areas. If monitoring indicates that disturbance of western snowy plovers by humans is adversely affecting plover populations, seasonal closures of portions of these trails would be considered as an adaptive management measure.

Effects Due to an Increase in Mercury Exposure

Effects of Corps-led Actions

Studies in San Diego County (Hothem and Powell 2000), at Point Reyes (Schwarzbach *et al.* 2005), and in the South Bay (Schwarzbach and Adelsbach 2003) have found elevated mercury levels in western snowy plover eggs. At Point Reyes, high levels of mercury in unhatched eggs were thought to be a possible reason for the inviability of these eggs. In the San Diego County and South Bay studies, however, concentrations of mercury in western snowy plover eggs were below known embyrotoxic thresholds established for other species.

Western snowy plovers are currently exposed to mercury in ponds containing mercury-contaminated water or sediment. Proposed tidal restoration activities that stir up contaminated sediments, such as pilot channel excavation, construction of ditch blocks, and scour due to increased tidal prism would all occur just prior to, or as a result of, tidal restoration. Although western snowy plovers foraging on intertidal mudflats may be affected by increased mercury mobilization resulting from these activities, activities that stir up mercury-laden sediments in tidal habitats are expected to have little effect on snowy plovers due to the infrequency with which snowy plovers forage in intertidal habitats in the proposed project area. Furthermore, western snowy plovers are not known to use the Pond A18 area under existing conditions, and proposed project activities are not expected to enhance conditions for western snowy plovers in A18 after proposed project completion.

Effects of Service-led Actions

Potential effects of mercury mobilization and exposure on western snowy plovers, resulting from Service-led activities, are expected to be similar to those described above for the Corps-led activities.

California Least Tern

California least terns do not nest in the action area, and thus the proposed project is not expected to result in in any effects to nesting California least terns. California least terns have been observed foraging in the action area's ponds (A9, A11, and A14) only rarely, and they have not been observed foraging in Pond A18. Although they could potentially forage in any of these ponds that contain fish, survey data collected for the SBSPRP and incidental observations by birders indicate that California least terns visit the action area (as a post-breeding forager) only irregularly and in low numbers.

Habitat Modification

Effects of Corps-led Actions

Construction of the FRM levee and the tide gate and pedestrian bridge in Artesian Slough will not affect California least tern foraging or roosting habitat. Although California least terns have not been recorded foraging in Pond A18, they could potentially forage there (albeit irregularly and in low numbers, given the lack of records). Drawing down Pond A18 prior to breaching would eliminate California least tern foraging habitat in the pond in the short term, and restoration of Pond A18 to tidal habitats would reduce the extent of suitable foraging habitat available to California least terns in the longer term. However, tidal marsh restoration is expected to benefit fish populations

considerably by providing nursery habitat in the extensive channel networks that will be restored and by exporting organic material to aquatic habitats outside the restored habitat. As a result, tidal restoration is expected to increase fish abundance (through improved water quality, food resources, and spawning and rearing habitat) in the open waters of the Bay where California least terns also forage (in addition to foraging in managed ponds), thus increasing prey availability in the South Bay for California least terns. Due to the low level of California least tern use of Pond A18 and the benefits of tidal restoration to prey fish populations, Corps-led actions will not have a substantive adverse effect on California least tern habitat and prey, and they may have a beneficial effect.

Effects of Service-led Actions

Service-led tidal restoration will result in the conversion of managed pond habitat in Ponds A9-A15 to tidal habitats. Drawing down these ponds prior to breaching would eliminate California least tern foraging habitat in the ponds in the short term, and in the longer term, there would be a net reduction in potential foraging habitat for the California least tern due to the conversion of aquatic habitat within these ponds to mostly vegetated habitats. However, California least terns have only been recorded foraging in Ponds A9-A15 infrequently and in low numbers. Also, as noted previously, tidal restoration is expected to have substantial beneficial effects on South Bay fish populations. Due to the low level of California least tern use of Ponds A9-A15 and the benefits of tidal restoration to prey fish populations, Service-led restoration activities will not have a substantive adverse effect on California least tern habitat and prey, and they may have a beneficial effect.

Disturbance of Foraging Individuals

Effects of Corps-led Actions

Because California least terns have not been recorded using Pond A18 or any of the other ponds near the FRM levee (*i.e.*, A12, A13, or A16), there is little potential for disturbance of foraging California least terns from Corps-led actions. If individuals were to forage in these ponds during FRM levee construction and they were disturbed by construction activities, they would simply move away to other, more traditionally used foraging areas.

Effects of Service-led Actions

Disturbance such as loud noise or the presence and movement of people and heavy equipment near California least tern foraging habitat may alter the tern's foraging behavior. Such disturbance could result in temporary or permanent habitat loss due to California least tern avoidance of areas that have suitable habitat but intolerable levels of disturbance; a reduction in foraging efficiency if high-quality foraging areas are impacted; and increased movement or altered activity patterns that reduce energy reserves and increase predation risk.

Because California least terns have been recorded using Ponds A9-A15 for foraging infrequently and in low numbers, the number of individuals that could be disturbed by Service-led construction or recreational activities is very low. If individuals were to forage in these ponds during restoration-related construction or breaching activities, or during high levels of recreation-related activity, and they were disturbed by those activities, they would simply move away to other, more traditionally used foraging areas.

Effects Due to an Increase in Mercury Exposure

Effects of Corps-led Actions

Because fish bio-accumulate methylmercury, and California least terns eat almost exclusively small fish, there is some potential for mercury mobilized by Corps-led restoration activities (as described above for California clapper rail) to adversely affect California least terns. California least terns are currently exposed to mercury in the South Bay by foraging on fish in contaminated tidal habitats containing mercury-contaminated water or sediment during their post-breeding period. Restoration activities in Pond A18 will mobilize contaminated sediments, and therefore there is the potential to increase California least terns' exposure to mercury. Methylmercury may also be mobilized by the frequent wetting and drying of mercury-contaminated sediments during construction activities. Such exposure could potentially affect the development of juveniles that ingest mercury in food taken during the post-breeding period and may affect fecundity in adults that ingest contaminated fish.

Recent biosentinel sampling in South Bay managed ponds and marshes indicates that mercury concentrations in fish are above the Bay mercury total maximum daily load of 0.03 μg/g for small fish (San Francisco Bay Regional Water Quality Control Board 2006). Mean mercury levels of longjaw mudsuckers and threespine sticklebacks in Alviso Slough fringe marshes were 0.11 μg/g and 0.16 μg/g, respectively (Grenier *et al.* 2010). These levels were higher (but not significantly) than in other South Bay reference sites (mudsuckers: 0.08 μg/g, stickleback: 0.11 μg/g). Based on this information, California least terns foraging in the South Bay could be exposed to mercury levels that are detrimental to piscivorous birds even in the absence of the proposed project. This is evident in Forster's terns (*Sterna forsteri*), a better-studied tern species that breeds in the South Bay, and thus has higher exposure to mercury than California least terns. In a contaminants study of Forster's terns, approximately 50 percent of captured terns were considered at or above moderate risk (> 1.0 μg/g), 13 percent were at or above high risk (>3.0 μg/g), and 9 percent were at or above extra-high risk (>4.0 μg/g) for impaired reproduction based on their blood mercury concentrations (Ackerman *et al.* 2008a). Blood sampling over time (between pre-breeding and breeding stages), suggests that breeding terns were at higher risk due to mercury increasing in their blood, suggesting terns' mercury concentrations increased with the time they spent foraging while in the Bay (Ackerman *et al.* 2008a). Blood mercury concentrations were highest in terns captured in the southernmost portions of the Bay, in the Alviso salt pond complex, including Pond A8 (Ackerman *et al.* 2008a). Unexpectedly, blood mercury concentrations in Forster's terns were substantially higher approximately two months after arriving in the Bay (*i.e.*, the period between pre-breeding and breeding) than observed in Caspian terns (*Hydroprogne caspia*) during the same time period (Eagles-Smith *et al.* 2009). Caspian terns had much higher mercury levels upon arriving, but Forster's terns mercury levels were soon elevated beyond those of Caspian terns, despite the fact that Caspian terns forage on larger prey (*i.e.*, at higher trophic levels). This was likely due to differences in foraging ecology, as Caspian terns tend to forage in the open bay waters or at inland reservoirs and Forster's terns forage mainly in ponds and tidal marsh channels (Ackerman *et al.* 2008b). As noted above, open waters in the Bay are less likely to methylate mercury than tidal marsh areas (Marvin-DiPasquale *et al.* 2003), and ponds have the potential to methylate mercury due to high levels of degradable organic matter (Grenier *et al.* 2010). Therefore, terns that forage in ponds are much more likely to be exposed to mercury than those foraging in open bay waters.

Although mercury concentrations in post-breeding California least terns in the South Bay are largely unknown, it would be expected that California least terns' exposure to mercury in the South Bay is substantially less than both Caspian and Forster's terns. Because California least terns occur only in the South Bay during post-breeding periods, they would be exposed to mercury for a relatively brief period of time. Further, because they tend to forage in open bay waters or in managed ponds in the Mountain View area (where legacy contamination by mercury should be lower than in areas that receive drainage from the mercury mines in the Guadalupe River watershed or in Artesian Slough), their exposure to mercury should be less than those of Forster's terns. Also, because they eat smaller fish than Caspian terns, California least terns likely accumulate mercury slower than Caspian terns.

California least terns do appear to have some exposure to mercury from central San Francisco Bay (Central Bay) foraging areas near their colonies. Hothem and Zador (1995) analyzed contaminant levels in California least tern eggs collected at the Oakland airport and Alameda Point colonies, and from five colonies along San Diego Bay. Mercury was detected in all eggs, but concentrations were higher in eggs from the Central Bay, with an average of 1.88 μg/g in Central Bay colonies and 1.07 μg/g in San Diego colonies. In comparison, concentrations of mercury in collected Forster's tern eggs averaged 1.35 μg/g (Ackerman and Eagles-Smith 2009). Egg mercury concentrations above 1.0 μg/g is considered high enough for impaired hatchability and embryonic mortality in birds (Scheuhammer *et al.* 2007), and although eggs with concentrations above 1.0 μg/g can hatch, there may be residual effects of mercury on chick mortality after hatching (Ackerman and Eagles-Smith 2009). This suggests that Forster's terns' exposure to mercury during the pre-breeding and breeding periods in the South Bay is higher than California least terns foraging in the Central Bay during the same periods, due in part to overall higher mercury concentrations in the South Bay and their use of pond and tidal marsh foraging sites (as opposed to open bay waters). Because maternally-deposited mercury in eggs is a result of recent dietary exposure (Heinz and Hoffman 2003), mercury in California least tern eggs likely is associated with foraging sites near colonies and not associated with mercury from the South Bay that they are exposed to during post-breeding periods.

Although the potential effects of increased mercury exposure on California least terns resulting from the proposed project are difficult to determine, California least terns are unlikely to be affected substantially by an increase in mercury exposure from the proposed project. This is because California least terns tend to forage in open water habitats in the Bay or managed ponds in the Mountain View area, where their exposure to mercury is lower than if they foraged more frequently in ponds in the Alviso area and/or in marshes like Forster's terns. Also, mercury that may impair California least tern reproduction is more likely to be derived from pre-breeding and breeding foraging sites than post-breeding staging areas in the South Bay. Finally, the increase in mercury mobilization resulting from Corps-led activities is expected to be relatively brief in duration.

Effects of Service-led Actions

Potential effects of mercury mobilization and exposure on California least terns, resulting from Service-led activities in Ponds A9-A15, are expected to be similar to those described above for Corps-led activities.

San Francisco Bay-Delta DPS of the Longfin Smelt

Habitat Modification

The proposed project is expected to substantially increase and improve longfin smelt habitat in the action area. The combined tidal restoration efforts of the Corps and the Service are expected to restore and preserve 2,746 acres of longfin smelt habitat.

Effects of Corps-led Actions

The Corps-led action to restore tidal influence to Pond A18 in the long-term is projected to restore approximately 736 acres of tidal/brackish marsh within the former salt pond and improve food-web productivity by increasing potential foraging habitat for longfin smelt. Construction of the pedestrian bridge over Artesian Slough will temporarily disturb about 1.04 acres of tidal freshwater marsh habitat for the longfin smelt within the slough.

Effects of Service-led Actions

The Service-led action to restore tidal influence to Ponds A9-15 in the long-term is projected to restore approximately 2,010 acres of tidal marsh within the former salt ponds and improve food-web productivity by increasing potential foraging habitat for longfin smelt.

Effects to Individuals

Effects of Corps-led Actions

While tidal marsh restoration in Pond A18 will be beneficial to the longfin smelt in the long-term, these actions are expected to result in adverse effects to adult and juvenile longfin smelt in the short-term during the construction phase. These actions are not expected to affect longfin smelt larvae and eggs because the proposed actions will be accomplished outside of the spawning and rearing period for this species, during the Service's recommended in-water work window for longfin smelt, from June 1 through November 30.

Adverse effects to adult and juvenile longfin smelt are expected as a result of the proposed in-water construction for the proposed project. The in-water construction requires utilization of heavy equipment (*e.g.*, excavators, bulldozers, dump trucks, and vibratory pile drivers) to place and grade new material for levee construction, remove material for breaches and pilot channels, dewatering and temporary installation of sheet piling cofferdams to facilitate tidal restoration to Pond A18, along with corresponding installation of new water control structures and to install forty new 12-inch steel piles to form the pedestrian bridge. The in-water construction may result in: (1) elevated turbidity levels; (2) potentially spill contaminants; (3) increased hydroacoustics; (4) entrainment or accidental burial of longfin smelt; (5) stranding of longfin smelt; and (6) temporary habitat alteration. The effects of the proposed project detailed below will be minimized by the proposed conservation measures included in the project description.

Elevated turbidity levels from increased suspended sediments may cause short-term behavioral changes including disruption to feeding activities or result in temporary displacement from preferred habitats. These potential behavioral changes due to turbidity will be minimized by limiting soil

disturbance to the smallest footprint necessary, developing a Stormwater Management Plan focused on use of erosion-control materials and stabilizing all disturbed areas within 12 hours, if a break in work is expected longer than seven days.

Heavy equipment has the potential to spill/ leak chemical contaminants or hazardous materials (*e.g.*, gasoline, oil, grease, concrete) into the water that may cause direct injury and mortality of longfin smelt. Potential accidental hazardous spill events will be minimized by maintaining all equipment to be free of petroleum leaks, having spill prevention kits in close proximity, and developing and implementing a Hazardous Materials Management/Fuel Spill Containment Plan.

Pile diving can generate increased hydroacoustics that may cause stress, injury, or mortality of longfin smelt. Potential increased hydroacoustics resulting from pile driving will be minimized by performing all pile diving using a vibratory hammer. Based on hydroacoustic monitoring data presented in the Biological Assessment, installation of the forty 12-inch steel piles using a vibratory hammer is estimated to result in peak sound pressure levels of approximately 150 decibels (dB), below the Fisheries Hydroacoustic Working Group's criteria for injury to fish of less than 2 grams (*i.e.*, 206 dB peak and 187 dB accumulated) (Fisheries Hydroacoustic Working Group 2008). To define the extent of increased hydroacoustics produced from pile driving, the Practical Spreading Model was used, as described in Davidson (2004) and Thomsen *et al.* (2006). The Practical Spreading Model estimates the distance at which underwater sound pressure levels created during vibratory pile installation; using the expected peak sound level of 150 dB, attenuated to estimated background levels (*i.e.*, 135 dB), it is expected increased pressure levels would not likely be detected beyond 328 feet from installation. Vibratory hammers avoid the abrupt over-and-under pressure changes exhibited by impact hammers.

Operating heavy equipment in-water or adjacent to waters can potentially cause entrainment or accidental burial, and dewatering may cause stranding; both result in direct injury and mortality to longfin smelt. Potential stress, injury, or mortality resulting from entrainment or accidental burial in heavy equipment or disturbed soils along with stranding of fish related to dewatering will be minimized by conducting all construction near or in-waters at low tide and/or allowing ample amount of time for dewatering, which is expected to allow for longfin smelt escapement during desiccation of the area, to the extent practicable. Cofferdams will be utilized to preclude longfin smelt entering areas of disturbance.

Temporary habitat alteration during construction can result in a temporary loss of prey organisms. Potential stress, injury, or mortality produced by loss of prey organisms due to habitat alteration will be minimized by precluding access for fish during construction by utilizing cofferdams to the extent feasible and providing channels that are adequate for the ingress and egress of longfin smelt while restoring tidal circulation to Pond A18.

Mercury is present in the sediments of the action area and throughout the Bay. Methylmercury is produced in aquatic ecosystems by the methylation of inorganic mercury by micro-organisms. Mercury may be mobilized when pilot channels are excavated in outboard marshes along Artesian Slough prior to breaching, and the tidal action through those channels, as well as the increase in tidal prism and associated scour of sediments in Artesian Slough, could mobilize mercury-laden sediment from the slough. Mercury could be mobilized downstream into and along Coyote Slough. Longfin smelt in the action area are exposed to methylmercury through their diet, but no information is available on the effects of dietary mercury on longfin smelt. Mercury body burdens have been

documented in fish utilizing similar habitat and prey to longfin smelt. For example, Greenfield *et al.* (2013) found tissue concentrations of methylmercury in Mississippi silversides at Alivso Slough which have been documented to impair predator avoidance in golden shiner (Webber and Haines 2003). Increased mobilization could alter physical conditions favoring transformation of mercury to methylmercury, and thus increasing mercury bioavailability. Methylmercury may also be mobilized by the frequent wetting and drying of mercury-contaminated sediments during construction activities. Thus, methylmercury ingestion and accumulation by longfin smelt is expected to occur, and mobilization of mercury from Corps-led actions could elevate mercury levels in longfin smelt. A net methylmercury increase resulting from habitat restoration is not preventable, is unpredictable, and there are very few management tools available to minimize effects.

Perennial pepperweed may be present in the action area and may require spraying of glyphosate or imazapyr near aquatic habitats for control purposes following tidal restoration, as fully described in the project description. The NMFS's programmatic conference and biological opinion on aquatic restoration actions in the States of Oregon and Washington (NMFS 2013) documented that spraying of aquatic-formulated glyphosate or imazapyr following aquatic restoration could result in adverse effects to fish. They determined that herbicide applications can result in herbicide drift or transportation into aquatic habitat that will harm listed species by chemically impairing normal fish behavioral patterns related to feeding, rearing, and migration. Effects resulting from the application of glyphosate or imazapyr following development of Ponds A12 and A18 ecotones or restoration of tidal influence to Pond A18 will be minimized by applying herbicides in accordance with the methods described in the Service's San Pablo Bay National Wildlife Refuge *Lepidium latifolium* Control Plan by Hogle *et al.* (2007).

Effects of Service-led Actions

While tidal marsh restoration in Ponds A9-A15 will be beneficial to the longfin smelt in the long-term, these actions are expected to result in adverse effects to adult and juvenile longfin smelt in the short-term during the construction phase. These effects are not expected to affect longfin smelt larvae and eggs because the proposed actions will be accomplished outside of the spawning and rearing period for the species, during the Service's recommended in-water work window for longfin smelt, from June 1 through November 30.

Adverse effects to adult and juveniles longfin smelt are expected as a result of in-water or near-water construction required to accomplish tidal restoration of Ponds A9-15. The in-water construction may result in: (1) elevated turbidity levels; (2) potentially spill contaminants; (3) entrainment or accidental burial of longfin smelt; (4) stranding of longfin smelt; and (5) temporary habitat alteration. The effects of the proposed project are detailed below and will be minimized by the proposed conservation measures included in the project description.

Elevated turbidity levels from increased suspended sediments may cause short-term behavioral changes including disruption to feeding activities or result in temporary displacement from preferred habitats. These potential behavioral changes due to turbidity will be minimized by limiting soil disturbance to the smallest footprint necessary, developing a Stormwater Management Plan focused on use of erosion-control materials, and all disturbed areas will be stabilized within 12 hours, if a break in work is expected longer than seven days.

Heavy equipment has the potential to spill/ leak chemical contaminants or hazardous materials (*e.g.*, gasoline, oil, grease, concrete) into the water that may cause direct injury and mortality of longfin smelt. Potential accidental hazardous spill events will be minimized by maintaining all equipment to be free of petroleum leaks, spill prevention kits in close proximity, and developing and implementing a Hazardous Materials Management/Fuel Spill Containment Plan.

Operating heavy equipment in-water or adjacent to waters can potentially cause entrainment or accidental burial of longfin smelt, and dewatering may cause stranding; both would result in direct injury and mortality to longfin smelt. Potential stress, injury, or mortality resulting from entrainment or accidental burial in heavy equipment or disturbed soils along with stranding of fish related to dewatering will be minimized by conducting all construction near or in-waters at low tide and/or allowing ample amount of time for dewatering, which is expected to allow for longfin smelt escapement during desiccation of the area, to the extent practicable. Cofferdams will be utilized to preclude fish entering area of disturbance.

Temporary habitat alteration during construction can result in a temporary loss of prey organisms. Potential stress, injury, or mortality produced by loss of prey organisms due to habitat alteration will be minimized by precluding access during construction by utilizing cofferdams to the extent feasible and providing channels that are adequate for the ingress and egress of longfin smelt while restoring tidal circulation to Ponds A9-15.

Potential effects of mercury mobilization and exposure on longfin smelt, resulting from Service-led activities, are expected to be similar to those described above for Corps-led activities. Because of the mercury contamination of the Guadalupe River from the New Almaden mine, some of the sediment in Alviso Slough may contain high concentrations of mercury. Such mercury may be mobilized when pilot channels are excavated in outboard marshes along Alviso Slough prior to breaching, and the tidal action through those channels, as well as the increase in tidal prism and associated scour of sediments in Alviso Slough, could mobilize mercury-laden sediment from Alviso Slough and Ponds A9-A15.

Potential effects on the longfin smelt of herbicide use during perennial pepperweed control within Ponds A9-A15 resulting from Service-led activities are expected to be similar to those described above for Corps-led activities.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion and conference opinion. Future Federal actions unrelated to the proposed project are not considered in this section, because they require separate consultation pursuant to section 7 of the Act.

Climate Change

The global average temperature has risen by approximately 0.6 degree Centigrade during the 20th Century (International Panel on Climate Change [IPCC] 2001, 2007a, 2007b; Adger *et al.* 2007). There is an international scientific consensus that most of the warming observed has been caused by human activities (IPCC 2001, 2007a, 2007b; Adger *et al.* 2007), and that it is "very likely" that it is largely due to man-made emissions of carbon dioxide and other greenhouse gases (Adger *et al.* 2007).

Ongoing climate change (Inkley *et al.* 2004, Adger *et al.* 2007, Kanter 2007) likely imperils the California clapper rail, salt marsh harvest mouse, Pacific Coast population of the western snowy plover, California least tern, and San Francisco Bay-Delta DPS of the longfin smelt and the resources necessary for their survival, since climate change threatens to disrupt annual weather patterns, it may result in a loss of their habitats and/or prey, and/or increased numbers of their predators, parasites, diseases, and non-native competitors. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat. Rising sea levels are likely to inundate much of the remaining salt marsh habitat available for the California clapper rail and salt marsh harvest mouse. Without upland habitat buffers available for the landward transgression of the marsh, the amount of suitable salt marsh habitat is likely to decrease with rising sea levels. The proposed project will reduce the cumulative effects of the loss of suitable salt marsh habitat within the action area from sea level rise by construction of the 345-foot-wide ecotone berms along Ponds A12 and A18 which will create an upland habitat buffer that will allow for the landward transgression of the marsh.

Conclusion

After reviewing the current status of the California clapper rail and salt marsh harvest mouse, the environmental baseline for these species within the action area, the effects of the proposed project and the cumulative effects, it is the Service's biological opinion that the proposed project is not likely to jeopardize the continued existence of these species. We based this determination on the following: (1) successful implementation of the conservation measures described in this biological opinion will minimize the adverse effects on individual California clapper rails and salt marsh harvest mice; (2) the avoidance of disturbing any breeding California clapper rails; (3) the restoration of at least 517 acres of tidal salt marsh/brackish marsh habitat and creation of 67 acres of ecotone habitat for the California clapper rail and salt marsh harvest mouse within Pond A18; (4) the restoration of at least 300 acres of tidal salt marsh habitat and creation of 30 acres of ecotone for the California clapper rail and salt marsh harvest mouse within Pond A12; (5) the restoration of additional tidal marsh habitat for the California clapper rail and salt marsh harvest mouse within some of the Ponds A9-A15 under an adaptive management plan; (6) the enhancement of tidal marsh habitat for the California clapper rail and salt marsh harvest mouse along Artestian, Coyote, and Alviso sloughs through salinization of freshwater and brackish marsh habitat from increased tidal prism; and (7) the implementation of a long-term predator management plan and invasive plant species control plan.

After reviewing the current status of the Pacific coast population of the western snowy plover, the environmental baseline for this species within the action area, the effects of the proposed project and the cumulative effects, it is the Service's biological opinion that the proposed project is not likely to jeopardize the continued existence of this species. We based this determination on the following: (1) successful implementation of the conservation measures described in this biological opinion will minimize the adverse effects on individual western snowy plovers; (2) the avoidance of disturbing any breeding western snowy plovers during construction of the proposed project; (3) the implementation of a long-term predator management plan; (4) the enhancement of nesting habitat for western snowy plovers within Pond A16; and (5) the proposed project will enable the SBSPRP to fulfill their commitment to maintaining at least 250 breeding individual western snowy plovers within the SBSPRP area through adaptive management of suitable nesting habitat.

After reviewing the current status of the California least tern, the environmental baseline for this species within the action area, the effects of the proposed project and the cumulative effects, it is the Service's biological opinion that the proposed project is not likely to jeopardize the continued existence of this species. We based this determination on the following: (1) successful implementation of the conservation measures described in this biological opinion will minimize the adverse effects on individual California least terns; (2) the avoidance of disturbing any breeding California least terns; and (3) the increase in the abundance of prey fish populations for the California least tern in the South Bay through tidal marsh restoration.

After reviewing the current status of the San Francisco Bay-Delta DPS of the longfin smelt, the environmental baseline for this species within the action area, the effects of the proposed project and the cumulative effects, it is the Service's conference opinion that the proposed project is not likely to jeopardize the continued existence of this species. We based this determination on the expected long-term habitat benefits resulting from tidal restoration and the proposed minimization measures utilized during construction.

INCIDENTAL TAKE STATEMENT

Section 9 of the Endangered Species Act and Federal regulations pursuant to section 4(d) of the Act, prohibit take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. The Service defines harassment as an intentional or negligent act or omission that creates the likelihood of injury to listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. The Service defines harm to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), take that is incidental to and not intended as part of the agency action is not considered to be prohibited, provided such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below for the California clapper rail, salt marsh harvest mouse, Pacific coast population of the western snowy plover, and California least tern are nondiscretionary, and must be implemented by the Corps and the Refuge so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption under section 7(o)(2) to apply. The Corps and the Refuge have a continuing duty to regulate the activity that is covered by this incidental take statement. If the Corps or the Refuge: (1) fail to require the applicant or any of its contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms, and/or (2) fail to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps or the Refuge must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

The prohibitions found in section 9 of the Act against taking of species do not apply until the species is listed. Therefore, the incidental take statement for the San Francisco Bay-Delta DPS of the longfin smelt does not become effective until such time as the species is listed and the conference opinion is adopted as a biological opinion issued through formal consultation. However,

the Service advises the Corps and the Refuge to consider implementing the following reasonable and prudent measures as they apply to the longfin smelt. If this conference opinion is adopted as a biological opinion following a listing or designation, these measures, with their implementing terms and conditions, will be non-discretionary.

Amount or Extent of Take

California Clapper Rail

The Service anticipates incidental take of individual California clapper rails will be difficult to detect or quantify because of the variable, unknown size of any resident population over time, their elusive and cryptic behavior, and the difficulty of finding killed or injured animals. Due to the difficulty in quantifying the number of California clapper rails that will be taken as a result of the proposed project, the Service is quantifying take incidental to the proposed project as the following:

Corps-led Actions

1. The harassment of all California clapper rails within the 1.04 acres of tidal freshwater marsh foraging/dispersal habitat disturbed along Artesian Slough during tide gate and pedestrian bridge construction.

2. The harassment of all California clapper rails within the 0.11 acre of tidal/brackish marsh foraging/dispersal habitat disturbed along the outboard Pond A18 levee during breaching and excavating the pilot channels.

3. The harassment and non-lethal harm of all California clapper rails within 17 acres of tidal marsh habitat lost due to scour along Artesian and Coyote sloughs.

4. The annual harassment of all California clapper rails within perennial pepperweed treatment areas in Pond A18.

5. The ongoing harassment by trail users of all California clapper rails within 50 feet of the pedestrian bridge constructed over Artesian Slough.

Service-led Actions

1. The harassment of all California clapper rails within the 0.06 acre of tidal/brackish marsh foraging/dispersal habitat disturbed along the outboard levees of Ponds A9-A15 during breaching and excavating the pilot channels.

2. The harassment and non-lethal harm of all California clapper rails within 40 acres of tidal marsh habitat lost due to scour along Alviso and Coyote sloughs.

3. The ongoing harassment by trail users of all California clapper rails within 50 feet of the segments of the trails constructed without a wide ecotone berm along the southern Pond A12 levee, the Pond A12/A13 levee, and the northern Pond A15 levee once tidal marsh is restored to these ponds.

4. The ongoing harassment of all California clapper rails within 50 feet of the Ponds A9-A15 levees during levee operation and maintenance activities.

5. The annual harassment of all California clapper rails within perennial pepperweed treatment areas in Ponds A9-A15.

Salt Marsh Harvest Mouse

The Service anticipates incidental take of individual salt marsh harvest mice will be difficult to detect or quantify because of the variable, unknown size of any resident population over time, their elusive and cryptic behavior, and the difficulty of finding killed or injured animals. Due to the difficulty in quantifying the number of salt marsh harvest mice that will be taken as a result of the proposed project, the Service is quantifying take incidental to the proposed project as the following:

Corps-led Actions

1. The harassment and harm of all salt marsh harvest mice within the 13.65 acres of low quality salt marsh habitat disturbed along the edges of the Alviso impoundment, the northern edge of New Chicago Marsh, adjacent to the southern levee of Pond A16, and along both northern and southern sides of the existing Pond A18 levee during construction of the FRM levee and the Artesian Slough tide gate and pedestrian bridge.

2. The harassment and harm of all salt marsh harvest mice within the 0.11 acre of salt/brackish marsh habitat disturbed on the outboard Pond A18 levee along Artesian and South Coyote sloughs during breaching and excavation of the pilot channels.

3. The harassment and non-lethal harm of all salt marsh harvest mice within 17 acres of tidal marsh habitat lost due to scour along Artesian and Coyote sloughs.

4. The ongoing harassment and harm of all salt marsh harvest mice within 25 feet of the FRM levee top during levee operation and maintenance activities (*e.g.*, mowing a 15-foot wide strip of ruderal grassland habitat adjacent to the levee crown once per year).

5. The ongoing harassment by trail users of all salt marsh harvest mice within 25 feet of the pedestrian bridge constructed over Artesian Slough.

6. The annual harassment of all salt marsh harvest mice within perennial pepperweed treatment areas in Pond A18.

Service-led Actions

1. The harassment and harm of all salt marsh harvest mice within the 0.06 acre of tidal/brackish marsh habitat disturbed along the outboard levees of Ponds A9-A15 during breaching and excavating the pilot channels.

2. The harassment and non-lethal harm of all salt marsh harvest mice within 40 acres of tidal marsh habitat lost due to scour along Alviso and Coyote sloughs.

3. The capture of all salt marsh harvest mice on Refuge lands within the construction footprint in the action area during construction of the proposed project.

4. The ongoing harassment by trail users of all salt marsh harvest mice within 25 feet of the trails constructed along New Chicago Marsh and Ponds A12, A13, A15, and A18 once tidal marsh is restored to these ponds and ecotone habitat is created along Ponds A12 and A18.

5. The ongoing harassment of all salt marsh harvest mice within 25 feet of the Ponds A9-A15 levees during levee operation and maintenance activities.

6. The annual harassment of all salt marsh harvest mice within perennial pepperweed treatment areas in Ponds A9-A15.

Pacific Coast Population of the Western Snowy Plover

The Service is quantifying take incidental to the proposed project as the following:

Corps-led Actions

1. The harassment of all western snowy plovers within 600 feet of the Alviso Segment of the FRM levee in Ponds A12 and A13, the Alviso impoundment, New Chicago Marsh, and Pond A16 during construction of the proposed project.

2. The harassment and harm of two (2) breeding pairs of western snowy plovers due to the loss of breeding habitat in the Alviso impoundment and northern New Chicago Marsh due to the raising and widening of the FRM levee.

3. The annual harassment of all of western snowy plovers within 600 feet of the FRM levee during levee operation and maintenance activities adjacent to Pond A16, New Chicago Marsh, and the Alviso impoundment.

Service-led Actions

1. The harassment and harm of five (5) breeding pairs of western snowy plovers after the permanent loss of 2,010 acres of potential salt pond nesting habitat within Ponds A9-A15.

2. The ongoing harassment by trail users of all western snowy plovers within 600 feet of the Bay Trail along the FRM levee adjacent to Pond A16, New Chicago Marsh, and the Alviso impoundment.

California Least Tern

The Service is quantifying take incidental to the proposed project as the following:

Corps-led Actions

1. The harassment of all foraging and roosting California least terns within 300 feet of construction activities at Pond A18 and the FRM levee.

2. The harassment and harm of two (2) individual California least terns after the permanent loss of 736 acres of salt pond foraging habitat within Pond A18.

Service-led Actions

1. The harassment of all foraging and roosting California least terns within 300 feet of construction activities at Ponds A9-A15.

2. The harassment and harm of four (4) individual California least terns after the permanent loss of 2,010 acres of salt pond foraging habitat within Ponds A9-A15.

3. The ongoing harassment of all foraging and roosting California least terns by trail users within 300 feet of the trails along Ponds A18, A12, A13, and A15 until these ponds are restored to tidal marsh.

San Francisco Bay-Delta DPS of the Longfin Smelt

The Service anticipates that incidental take of longfin smelt in adult or juvenile life-stages will occur due to project-related activities, however, it is difficult to determine the number of individual longfin smelt that could be subject to incidental take in the action area because of the species' cryptic and elusive nature, and the lack of abundance information from scientific surveys within the action area itself. Therefore, the Service is quantifying take incidental to the proposed project as the following:

Service-led Actions

The Service anticipates that all individual longfin smelt adults and juveniles within 2,010 acre-feet of water in Ponds A9-A15 will be subject to incidental take in the form of harm, harassment, injury, and mortality during the tidal restoration.

Effect of the Take

In the accompanying biological opinion and conference opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the California clapper rail, salt marsh harvest mouse, Pacific coast population of western snowy plover, California least tern, and San Francisco Bay-Delta DPS of the longfin smelt.

Reasonable and Prudent Measures

The Service has determined that the following reasonable and prudent measures are necessary and appropriate to minimize the effects of the proposed project on the California clapper rail, salt marsh harvest mouse, Pacific coast population of western snowy plover, California least tern, and San Francisco Bay-Delta DPS of the longfin smelt:

1. The Corps through the CSCC, City of San Jose, and SCVWD will minimize adverse effects to the California clapper rail, salt marsh harvest mouse, Pacific coast population of western snowy plover, and California least tern in the action area for the Corps-led actions by following the project description as modified by the terms and conditions.

2. The Refuge through the CSCC, City of San Jose, and SCVWD will minimize adverse effects to the California clapper rail, salt marsh harvest mouse, Pacific coast population of western snowy plover, California least tern, and San Francisco Bay-Delta DPS of the longfin smelt in the action area for the Service-led actions by following the project description as modified by the terms and conditions.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps and the Refuge shall ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These Terms and Conditions are nondiscretionary.

The following Term and Condition implements Reasonable and Prudent Measure Number One (1):

1. The Corps shall ensure that the CSCC, City of San Jose, and SCVWD minimize proposed project related effects of mobilization of methylmercury by minimizing the frequency and duration of methylization by minimizing the number of times mercury-contaminated soils are wetted and dried during construction of the proposed project (this measure does not apply to imported soils that meet contaminants screening criteria for mercury).

The following Term and Condition implements Reasonable and Prudent Measure Number Two (2):

1. The Refuge shall ensure that the CSCC, City of San Jose, and SCVWD minimize proposed project related effects of mobilization of methylmercury by minimizing the frequency and duration of methylization by minimizing the number of times mercury-contaminated soils are wetted and dried during construction of the proposed project (this measure does not apply to imported soils that meet contaminants screening criteria for mercury).

Reporting Requirements

In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, the Corps and the Refuge shall adhere to the following reporting requirements. Should this anticipated amount or extent of incidental take be exceeded, the Corps or the Refuge must reinitiate formal consultation as per 50 CFR 402.16.

1. The Service must be notified within one (1) working day of the finding of any injured or dead listed species or any unanticipated damage to its habitat associated with the proposed project. Notification will be made to the Coast/Bay Division Chief of the Endangered Species Program at the Sacramento Fish and Wildlife Office at (916) 414-6600, and must include the date, time, and precise location of the individual/incident clearly indicated on a U.S. Geological Survey 7.5 minute quadrangle or other maps at a finer scale, as requested by the Service, and any other pertinent information. When an injured or dead individual of the listed species is found, the Corps or the Refuge shall follow the steps outlined in the Disposition of Individuals Taken section below.

2. The Corps and/or the Refuge shall provide annual updates and interim progress reports to the Service on the status of the implementation of the proposed project, avoidance and

minimization measures, predator management, monitoring of the tidal marsh restoration areas, monitoring of the Pond A16 western snowy plover nesting habitat enhancements, and adaptive management.

Disposition of Individuals Taken

Injured listed species must be cared for by a licensed veterinarian or other qualified person(s), such as the Service-approved biologist. Dead individuals must be sealed in a resealable plastic bag containing a paper with the date and time when the animal was found, the location where it was found, avoidance and minimization measures implemented, and the name of the person who found it, and the bag containing the specimen frozen in a freezer located in a secure site, until instructions are received from the Service regarding the disposition of the dead specimen. The Service contact person is the Coast/Bay Division Chief of the Endangered Species Program at the Sacramento Fish and Wildlife Office at (916) 414-6600.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following actions:

1. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should develop, fund, and annually implement an avian and mammalian predator monitoring and management program within suitable habitat for the salt marsh harvest mouse, California clapper rail, western snowy plover, and California least tern around the Bay.

2. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should remove raptor nest and perch sites or install raptor perching deterrents within suitable habitat for the salt marsh harvest mouse, California clapper rail, western snowy plover, and California least tern around the Bay.

3. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should control invasive plant species (*e.g.*, perennial pepperweed) within suitable habitat for the salt marsh harvest mouse and California clapper rail.

4. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should import clean fill to raise the elevations of subsided salt ponds to accelerate the timeline of tidal marsh restoration.

5. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should install high-tide refugia islands planted with marsh gumplant for salt marsh harvest mice and California clapper rails within tidal marshes that lack sufficient high-tide refugia.

6. The Corps, the Refuge, CSCC, the City of San Jose, and SCVWD should minimize the effects of atmospheric nitrogen deposition from nitrogen oxides emissions in construction vehicle traffic exhaust in facilitating the spread of invasive plant species into naturally

nutrient-poor serpentine grassland habitat for the threatened Bay checkerspot butterfly and listed serpentine plants in the Santa Clara Valley by contributing funding to the management of invasive plant species in serpentine grassland habitat that supports these listed species.

7. The Corps and the Refuge should report sightings of any listed or sensitive animal species to the CNDDB of the CDFW. A copy of the reporting form and a topographic map clearly marked with the location the animals were observed also should be provided to the Service.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the proposed South Bay Shoreline Phase 1 Study in Santa Clara County, California. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any additional take will not be exempt from the prohibitions of section 9 of the Act, pending reinitiation.

If you have any questions regarding this biological opinion and conference opinion on the effects of the proposed South Bay Shoreline Phase 1 Study, please contact Joseph Terry, Senior Biologist, or Ryan Olah, Coast/Bay Division Chief, at the Sacramento Fish Wildlife Office at the letterhead address, telephone at (916) 414-6600, or via email (Joseph_Terry@fws.gov or Ryan_Olah@fws.gov). The contacts at the San Francisco Bay-Delta Fish and Wildlife Office are Armin Halston, Fish and Wildlife Biologist, or Kim Squires, Section 7 Coordinator, by telephone at (916) 930-5670 or via email (Armin_Halston@fws.gov or Kim_Squires@fws.gov).

cc:
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Johnathon Bishop, National Oceanic and Atmospheric Administration/National Marine Fisheries Service, Santa Rosa, California

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Appendix A: Walking In the Marsh: Methods to Increase Safety and Reduce Impacts to Wildlife & Plants

December 15, 2004

I. Safety

A. *Before heading out into the marsh check the tides*: tides can affect your ability to move through the marsh. Be aware of how long you plan to be in the marsh, what channels you may have to cross, and how the tides will change while you are in the field.

B. *Plan your route through the marsh*: use existing aerial imagery and maps to identify channels and sloughs that may impede access. When available, use high points such as boardwalks or levees to scope out a route. Scoping a route can be especially important in scenarios where visibility across the marsh is low (*e.g.,* South Bay, Suisun). It may be necessary to flag stations and/or access corridors through the marsh prior to surveys. If more than one person is accessing the marsh, travel together along major access routes to avoid the development of multiple paths. At the end of the sampling period, persons furthest out should walk out first, meeting up with others along the major access route… this minimizes the potential of people getting lost and ensures that anyone who is injured will be found in a timely manner (before everyone else has left the marsh). The goal should be to plan a safe route into and out of the marsh while minimizing travel and pathways.

C. *Channels and sloughs*: Avoid jumping channels in locations where you cannot see through vegetation on the opposite bank. Thick vegetation (*e.g.*, pickleweed, gumplant) can obscure the edge of the bank. Considerations before jumping: depth of water/channel, steepness of the channel edges, tide levels. If you are not confident that you can make the jump and the edges have high dense vegetation that you cannot see through… DO NOT JUMP.

D. *Getting stuck in the mud*: If you are sinking into mud, try to keep moving to avoid getting stuck further. If a leg gets stuck, try to twist your leg to break the suction while leaning your weight on your other leg or knee. Use whatever material you have available (e.g., clipboard, backpack) for leverage (*e.g.*, lean on those items).

E. *Other*: Besides general items such as water and food, it's a good idea to bring a flashlight and a phone (+GPS) in cases of an emergency. Let someone know what marsh area you will be in and when you plan to complete work for the day. Designate an end time and final meeting place when more than one person is out in the marsh at the same time.

II. Avoiding Impacts to Wildlife and Plants

A. *Movement through the Marsh.* While walking through the marsh, keep noise to a minimum. Avoid using multiple pathways through the marsh. Use trails if they exist. Plan and map your route to minimize environmental impacts and decrease running into hazards/barriers such as large channels. When looking for a suitable place to jump a channel, do not walk along the edge of the channel/slough because these areas provide nesting habitat for many species including the endangered California clapper rail. To find an alternate jump site, walk parallel to the channel at a distance where vegetation is lower in height and where visibility

of the ground surface is greater. At all times, observe the environment you are walking through to avoid disturbance. Choose channel jump sites where vegetation is lower or you can clearly discern what you are jumping onto. In general, avoid walking adjacent and parallel to channels/sloughs.

B. *Avoiding nests and nest substrates.* Tidal marsh species have nests that are well concealed and therefore easy to disturb when walking through the marsh. To avoid stepping on a nest, do not walk through thick vegetation or areas where you cannot see through to the ground. Avoid walking on vegetation whenever possible since plants serve as nesting substrate for many species in the marsh. In general, be aware of the area you are walking through.

C. *Bird Behavior.* If a bird vocalizes or flushes within close range of where you are standing or walking (*e.g.*, < 10-m), it is possible that a nest or young are nearby. When these circumstances arise, stop whatever you are doing and leave the immediate area (be sure to watch where and what you are walking on). Choose an alternate route through the marsh, identify the new route and location of the sighting/occurrence on a map, and record coordinates of the location if possible. Be sure to pass this information on to others that may use the same route or are conducting surveys in the same area. Be very observant of where you walk as you leave the area. There exists the possibility that you could step on a nest or young, both of which can be concealed by vegetation and are cryptic. When alarmed, individuals may freeze in place (especially juveniles).

D. *Tidal lagoons/ponds.* Avoid walking along tidal lagoons and ponds in marsh interiors that support foraging, roosting, or nesting shorebirds and waterfowl. Be observant of the distance at which birds flush or become alarmed.

E. *Tides.* Avoid conducting surveys during high tides as much as possible. These are periods when many wildlife species are at greatest risk (*e.g.*, predation). If your surveys require a high tide, be aware of the increased risk you may cause for wildlife and take all precautions to reduce that risk (*e.g.*, avoiding areas where sensitive species are known to occur).

Appendix B9

Pertinent Correspondence

Revised NOTICE OF PREPARATION

From: Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118

Subject: **Revised Notice of Preparation of a Draft Environmental Impact Report**

Project Title: South San Francisco Bay Shoreline Phase I Study

State Clearinghouse Number: 2006012020

Project Location: South San Francisco Bay Shoreline between the Guadalupe River and Coyote Creek, San Jose, California.

This NOP updates the previously released joint NOP/NOI dated January 6, 2006 for the South San Francisco Bay Shoreline Study. The revisions are related to changing the CEQA Lead Agency and adding detail to the proposed project description for the Alviso Ponds and Santa Clara County Interim Feasibility Study.

The Santa Clara Valley Water District will be the Lead Agency under CEQA and will prepare an environmental impact report for the above project. The District needs to know the views of your agency as to the scope and content of the environmental information which is germane to your agency's statutory responsibilities in connection with the proposed project. Your agency will need to use the EIR prepared by our agency when considering your permit or other approval for the project.

The project description, location, and the potential environmental effects are contained in the attached materials.

Due to the time limits mandated by State law, your response must be sent at the earliest possible date but **not later than 30 days after receipt of this notice**.

Please send your response to:

Michael Martin
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118
(408) 630-3095
michaelmartin@valleywater.org

Please provide the name of a contact person in your agency.

FOR Beau Goldie
Chief Executive Officer

18 August 2014
Date

Revised Notice of Preparation
Draft Environmental Impact Report/Statement
South San Francisco Bay Shoreline Phase I Study
Santa Clara County, California
August 2014

Introduction

A joint NOP/NOI was circulated and a public meeting held in 2006 for the entire South San Francisco Bay Shoreline Project, which encompasses all of the bay shoreline in Santa Clara County and the southern portions of San Mateo and Alameda Counties and includes the Alviso, Ravenswood, and Eden Landing pond complexes. The project proponents have decided to move forward with a segment of the overall Shoreline Project for the area between the Guadalupe River and Coyote Creek in San Jose. This NOP is released to obtain comments on a project for the Phase I Study which is focused on this area.

A joint Environmental Impact Statement (EIS) and Environmental Impact Report (EIR) (hereafter referred to as the "EIR/S") will be prepared for the South San Francisco Bay Shoreline Phase I Study (Project). The document will identify and evaluate possible environmental impacts of Project alternatives, and develop strategies to avoid, reduce, or compensate for any significant impacts.

As the lead agency responsible for compliance with the California Environmental Quality Act (CEQA), the Santa Clara Valley Water District (District) has determined that the Project may have a significant impact on the physical environment, and has decided to prepare an EIR/S to provide ample opportunity for public disclosure and participation in the planning and decision making process. The purpose of the draft EIR/S process is to develop and assess a recommended plan and alternatives for the Project and to avoid and mitigate significant adverse effects on environmental resources, while aiming to achieve the primary project objectives.

This document, which serves as the Notice of Preparation (NOP) required by CEQA and the state's CEQA Guidelines (CCR §15082), contains a brief description of the Project, including its goals and objectives, the Project alternatives identified to date, possible environmental impacts, and the resulting need for an EIR/S. It also discusses the process that will be used to determine the scope of analysis in the EIR/S, and provides an overview of the opportunities for participation in review of the EIR/S, along with contact information.

Project Overview

The District, as a local sponsor of the Project, is undertaking the environmental review process in conjunction with the U.S. Army Corps of Engineers (Corps), the federal sponsor, and the U.S. Fish and Wildlife Service, the landowner. Pending the outcome of the environmental review process and any subsequent design revisions to improve the project, the proposed Project will be submitted to the District Board of Directors for their review and potential approval. This process is aimed to provide the public with a clear understanding of the activities, elements, and methods involved with the proposed Project. However, this project description does not presume that the proposed Project is considered approved, or will necessarily be approved until

the complete environmental and planning process occurs according to CEQA guidelines and internal District Project review and approval process. The State Coastal Conservancy is an additional local sponsor and will also need to approve the Project before it will proceed as a responsible agency under CEQA.

Background

The Project area has considerable risk for tidal flooding due to low-lying terrain that is bordered by pond levees originally designed and constructed for commercial salt pond purposes rather than for flood risk management. The levees protecting these areas are mostly dikes that were created as early as the 1920s. The area south of the ponds is now nearly all urbanized with high-value development and includes transportation corridors, a wastewater plant, and other critical infrastructure. In addition, substantial sea level rise expected during the period of analysis for this study (2017–2067) will exacerbate risks from tidal flooding.

A second challenge is that the historic creation of extensive managed salt ponds in the South Bay, as well as filling of marshes and mudflats for landfills and development has resulted in the loss of most tidal salt marsh habitat in the area. In addition, degradation of remaining tidal marsh habitat from water pollution (now mostly abated), habitat fragmentation, and invasive plants has resulted in severe losses of habitat quantity and quality for salt marsh plants and wildlife leading to the listing of several species under the Endangered Species Act (both Federal and State) and severe losses of the ecosystem functions and services associated with tidal marshes and estuaries.

The Project proponents propose to reduce tidal flood risk in the area, which will also facilitate the tidal marsh restoration activity. Both flood risk management and ecosystem restoration are important to the local community and the larger South Bay area.

Goals and Objectives

The investigation of the problems and opportunities in the study area led to the establishment of the following planning objectives:

- Reduce the risk to public health, human safety, and the environment due to tidal flooding along the South Bay shoreline in Santa Clara County.
- Reduce potential economic damages due to tidal flooding in areas near the South Bay shoreline in Santa Clara County.
- Increase contiguous tidal marsh to restore ecological function and habitat quantity, quality, and connectivity in the Study Area for native, resident plant and animal species, including special-status species such as steelhead trout, California clapper rail, and salt marsh harvest mouse.
- Provide opportunities for public access, education, and recreation in the Study Area.

Alternatives Being Considered

A range of project element alternatives have been developed, including a No Project alternative, all of which will be discussed in the EIR/S. The project elements include:

Levee Segment
Three levee alignments are considered between the Guadalupe River (at the Alviso Marina) and Artesian Slough. This levee would address flood risk to the community of Alviso and State Route 237, which is an important commuter corridor for Silicon Valley. The community of Alviso has a history of fluvial flooding from Guadalupe River, which is east of the community. As a result, many of the residential structures have been rebuilt or raised substantially so that the finished floor elevation is as much as 6 feet or more above the ground. Fluvial flood risk has been reduced through local and Federal projects. However, flood risk in the Alviso area is the highest of any area along San Francisco Bay because of subsidence from historical groundwater withdrawal to support the historical agricultural industry.

The three potential alignments include Alviso North, Alviso Railroad Spur; and Alviso South. The Alviso North alignment, which is located entirely on Refuge lands, would roughly follow the western and northern outer levees of the New Chicago Marsh along the existing margins of Ponds A12, A13, and A16. It would be the farthest from the community of Alviso, and extend flood risk management to the Marsh. The Alviso South alignment would follow the southwest outer levee of New Chicago Marsh and would be the closest to the community of Alviso. The Alviso Railroad Spur alignment would coincide with the Alviso North alignment on the western portion, follow the alignment of the existing railroad spur levee through the Marsh, and coincide with the Alviso South alignment at the eastern portion. This alignment would be located between the North and South alignments and be intermediate in distance from the community of Alviso.

A railroad gate would be constructed across the Union Pacific Railroad tracks where they cross the proposed levee. A tide gate is proposed across Artesian Slough to prevent water from overtopping existing levees along the slough during future high-tide events. From Artesian Slough to Coyote Creek the levee would follow the Water Pollution Control Plant (WPCP) South alignment that runs west to east in a stair-step pattern along the north border of the existing WPCP infrastructure to the existing levee along the eastern side of Pond A18. A separate WPCP North alignment that partially bisects Pond A18 was determined to be infeasible.

Ecosystem Restoration
The habitat restoration strategy is to convert the former salt ponds in front of the proposed levee into tidal wetlands through a phased restoration process guided by adaptive management. Currently, the managed ponds provide habitat for migratory birds and waterfowl, and the project proponents are committed to maintaining these populations. However, there is also a bay-wide goal to increase the acreage of tidal marsh and associated habitats. Without a project, the ponds would continue to be managed as ponds, potentially with some limited enhancement to support the species that currently use the ponds. Restoring the ponds without a flood control element would put inland areas at flood risk.

Restoration actions seek to establish vegetated tidal wetlands with goals of maximizing long-term habitat benefits, particularly in consideration of potential sea level rise. Two levels of restoration are considered; “basic,” which represents a baseline of actions needed to restore the ponds, and “accelerated,” which involves more direct intervention and additional actions above the basic level to speed up the restoration process.

Transitional Habitat
Transitional habitat is defined as a transition area between two distinct habitats (in this case, tidal wetland and upland habitat on the levee). Transitional habitat can provide large expanses of habitat that have been missing from the Bay, attenuate waves and reduce wave run-up, and

increase habitat resiliency by providing space for marshes to retreat inland in the face of sea level rise. Three levels of transitional habitat are considered: 100:1 slopes, which would provide the most expansive habitat; 30:1 slopes; and a 50-foot-wide flat bench to provide a minimal amount of refugia immediately following construction.

Recreation Measures
Recreation measures are included to provide additional recreation benefits associated with proposed ecosystem restoration features and to compensate for the loss of public access as the ponds in the Refuge are breached and restored to tidal marsh. The recreation measures include multi-use trails on top of the new proposed flood risk management levee with connection to the Bay Trail network, viewing platforms and benches, and trail upgrades to be made to an existing segment of the Bay Trail system along State Route 237.

Preferred Alternative

The District preferred alternative would include engineered levees along the Alviso North and WPCP South alignments following existing levees built to protect against the 1-percent tidal event with anticipated sea level rise; a tide gate across Artesian Slough; "basic" restoration of Ponds A9, A10, A11, A12, A13, A14, A15, and A18; a transition habitat slope of 30:1; and the recreation measures. The flood protection components would be constructed between 2017 and 2020. Restoration of the ponds and recreation elements would take place between 2020 and 2031 with monitoring and adaptive management occurring throughout the period. See Figure 3.

Other alternatives to be evaluated in the EIR/S are shown below. The District preferred alternative is listed as "Alternative 3".

Alternatives To Be Evaluated in the EIR/S

Alternatives		Flood Risk Management		Ecosystem Restoration	
Alt #	**Summary**	**Alignment**	**LOP**	**In-pond Preparation**	**Transitional Habitat**
1	No Action	None	Existing	None	None
2	Alviso North with 4% ACE and Bench	North	25-year	Basic	50-foot-wide bench
3	Alviso North with 1% ACE and 30:1 Ecotone	North	100 year	Basic	Ecotone with 30:1 side slopes
4	Alviso Railroad with 1% ACE and Bench	Railroad Spur	100 year	Basic	50-foot-wide bench
5	Alviso South with 1% ACE and Bench	South	100 year	Basic	50-foot-wide bench

ACE= Annual Chance of Exceedance; LOP = Level of Protection;

Topics to be Analyzed in the Draft EIR

Based on the proposed project's potential for significant impacts on the environment, the District with the Corps will prepare a joint EIR/S. The EIR/S will serve to further assess the proposed project's effects on the environment, to identify significant impacts, and to identify feasible mitigation measures to reduce or eliminate potentially significant environmental impacts. An

analysis of alternatives to the proposed project will also be included in the document. Topics to be analyzed in the EIR/S, include but are necessarily limited to the following: aesthetics, air quality, biological resources, cultural and paleontological resources, soils, greenhouse gas emissions, hazards and hazardous materials, hydrology and water quality, land use, noise, recreation, transportation and traffic, and utilities. Responses received to this NOP may modify or add to the preliminary assessment of potential issues addressed in the EIR/S.

Environmental Procedures

This NOP initiates the CEQA process through which the District in conjunction with the Corps and the USFWS will refine the range of issues and project alternatives to be addressed in the EIR/S. Comments are invited on the proposal to prepare the EIR/S and on the scope of issues to be included.

Please submit any comments within 30 days of receipt of this notice to Michael Martin, the District's environmental planner for the South San Francisco Bay Shoreline Phase I Study, at the Santa Clara Valley Water District (see *Contact Information* below). After the 30-day review period for the NOP is complete, a draft EIR/S will be prepared in accordance with CEQA, as amended (Public Resources Code §21000 et seq.), the State Guidelines for Implementation of CEQA (CCR §15000 et seq.), and NEPA.

Once the draft EIR/S is completed, it will be made available for a minimum 45-day public review and comment period. Copies of the draft EIR/S will be sent directly to those agencies commenting on the NOP, and will also be made available to the public at a number of locations, including the District headquarters and public libraries in the area. Information about availability of the draft EIR/S will also be posted on the District's website (http://www.valleywater.org) and at the Shoreline Study's website (http://www.southbayshoreline.org).

Contact Information

For further information, contact the following:

Michael Martin
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 630-3095
Michaelmartin@valleywater.org

Additional information relevant to the project and the EIR/S can also be found at http://www.valleywater.org and http://www.southbayshoreline.org

Figure 1: Location Map

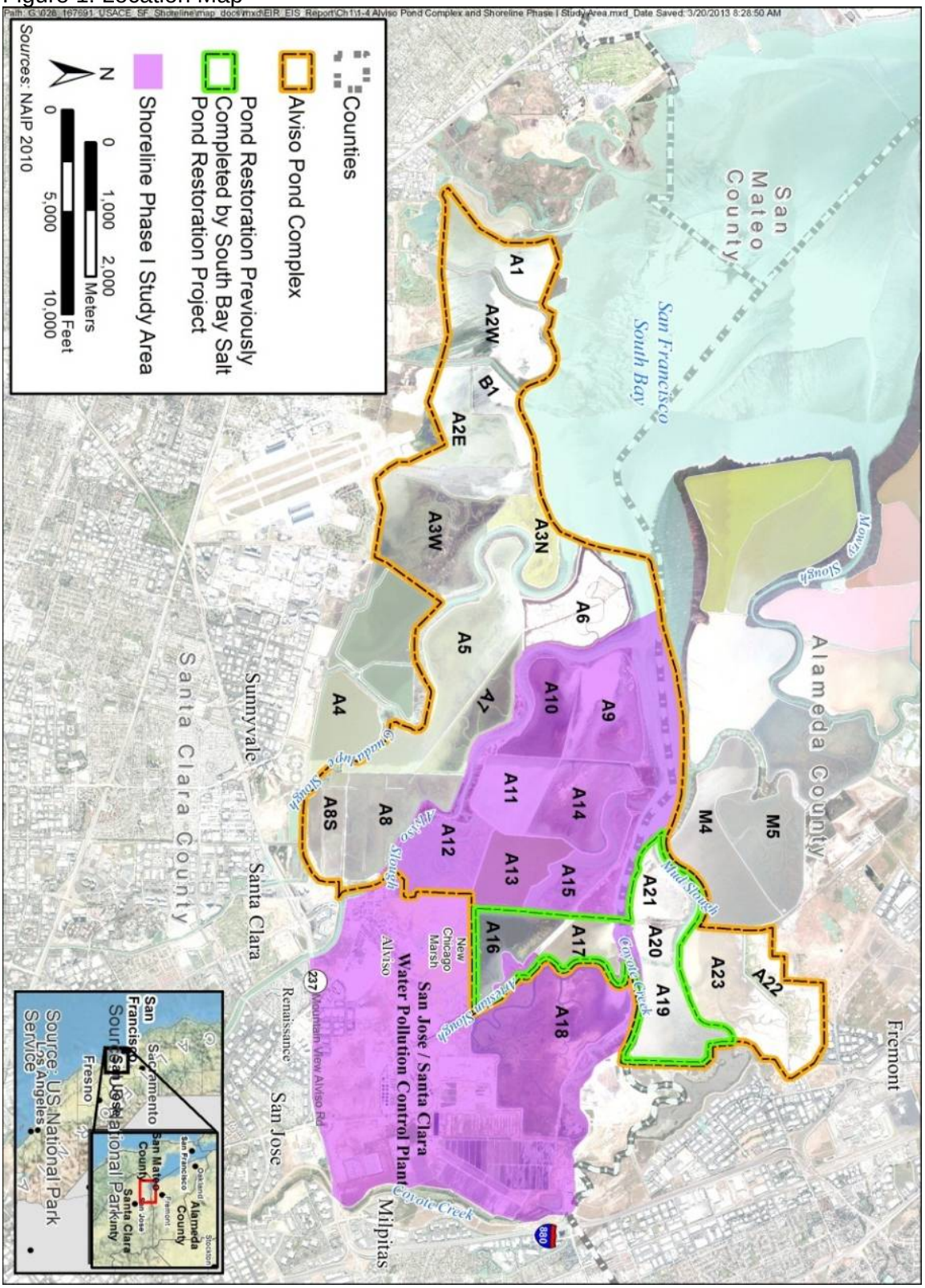


Figure 2: Alviso Levee Segment Alternatives

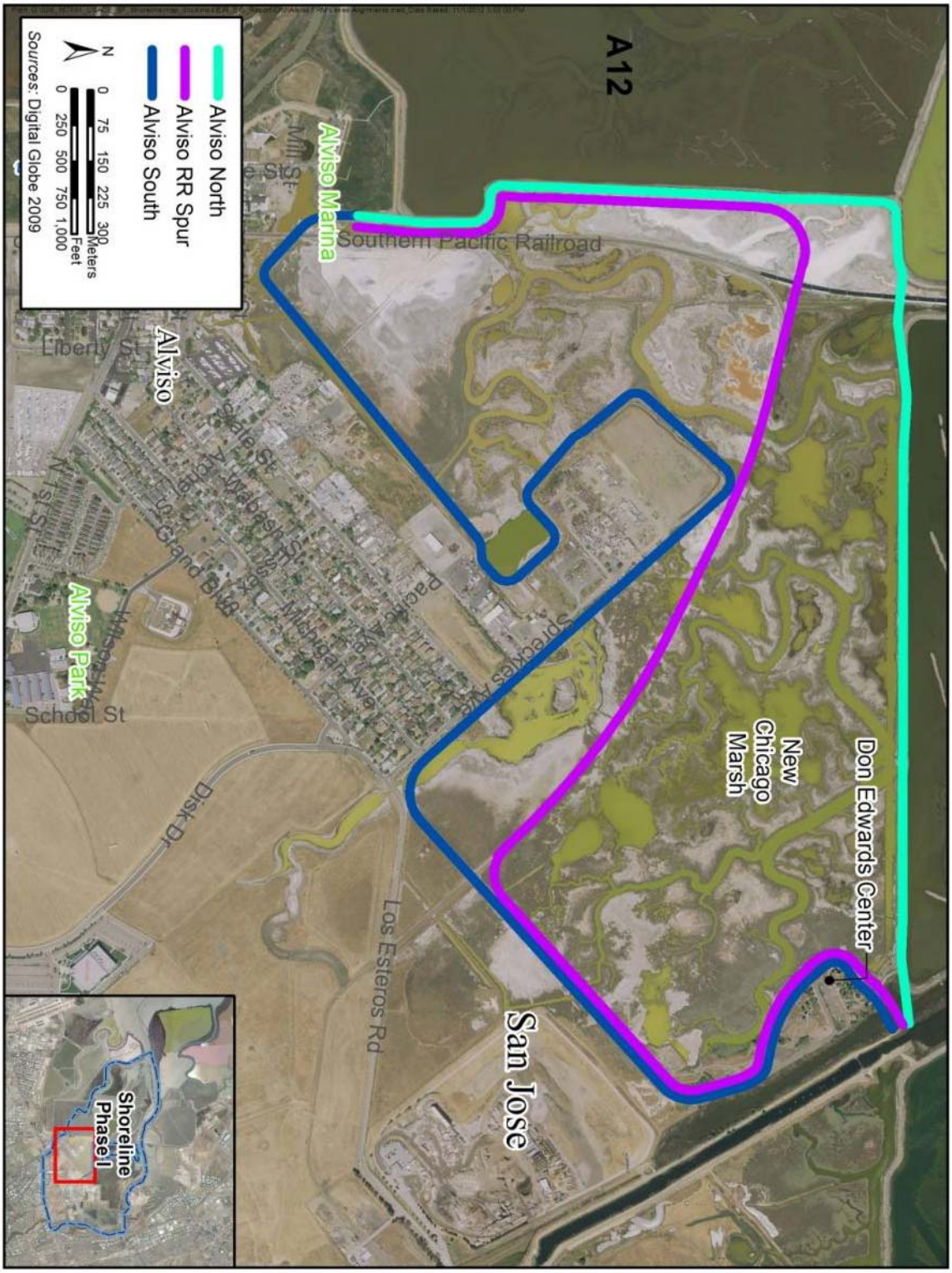
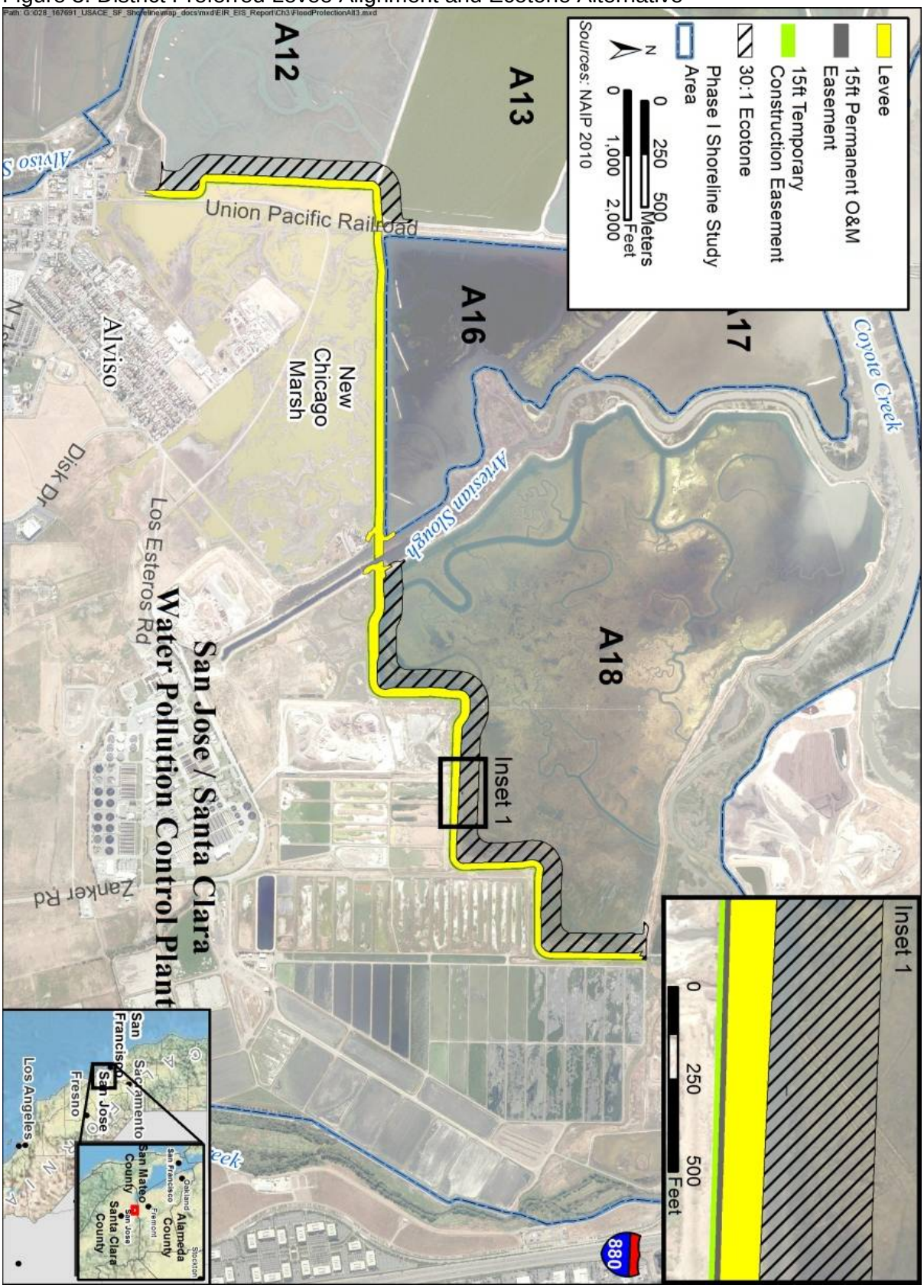


Figure 3: District Preferred Levee Alignment and Ecotone Alternative



NOTICE OF PREPARATION/NOTICE OF INTENT

Subject: Notice of Preparation/Notice of Intent of a Draft Environmental Impact Statement/ Environmental Impact Report/Feasibility Report for the South San Francisco Bay Shoreline Study: Alviso Ponds and Santa Clara County Interim Feasibility Study

The U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service, Lead Agencies under NEPA, and the California Coastal Conservancy, Lead Agency under CEQA, will prepare a joint project-level Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)/Feasibility Report, hereafter called the Report, for the first Interim Feasibility Study component of the South San Francisco Bay Shoreline Study. We need to know the views of your agency as to the scope and content of the environmental information which is germane to your agency's statutory responsibilities in connection with the proposed project. Your agency may need to use the Report when considering your permit or other approval for the project.

The project description, location, and the potential environmental effects are contained in the attached materials.

Due to the time limits mandated by State law, your response must be sent at the earliest possible date but not later than 30 days after receipt of this notice. A public scoping meeting is scheduled. It will be held on Wednesday, January 25, 2006, from 5:30-8:30 p.m, at 40 North Milpitas Blvd., Milpitas, CA 95035.

Please send your response, and the name of a contact person in your agency, to:

Brenda Buxton
California Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, California, 94612

Date: 1/06/06 Signature: Brenda Buxton

Title: Project Manager

Telephone: (510) 286-1015

SUMMARY

Pursuant to the National Environmental Policy Act of 1969, as amended (NEPA), and the California Environmental Quality Act of 1970, as amended (CEQA), the U.S. Army Corps of Engineers (Corps), the U.S. Fish and Wildlife Service (USFWS), and the California Coastal Conservancy (CCC) intend to prepare a joint project level Environmental Impact Statement / Environmental Impact Report / Feasibility Report (Report) to address the potential impacts of the first Interim Feasibility Study component of the South San Francisco Bay Shoreline Study, San Francisco Bay, California. This study is closely interrelated with the ongoing South Bay Salt Ponds Restoration Project, discussed in the Notice of Intent dated November 9, 2004. It will function as a project-level EIS/EIR tiered under that programmatic EIS/EIR and will be issued subsequently to the programmatic document. The Corps and the USFWS will serve as Joint Lead Agencies under NEPA, and CCC will be the Lead Agency under CEQA.

Lead Agencies Proposed and Connected Actions

The Corps, in cooperation with the USFWS, and the CCC are proposing to study flood protection and ecosystem restoration for the Alviso portion of the South San Francisco Bay (South Bay) Salt Ponds and adjacent areas to determine whether there is a federal interest in constructing a project with flood protection and/or ecosystem restoration components in this area, and if so, to determine the optimum project to recommend to Congress for authorization. The Report will recommend a plan which will provide for long-term restoration for these salt ponds and adjacent areas as well as flood protection and recreation components, if these actions are justified under Federal criteria. The Report and its alternatives will be tiered to the programmatic EIS/EIR for the South Bay Salt Ponds Restoration Project.

SCOPING PROCESS

Public participation in the environmental scoping process is an important step in determining the full scope of issues to be addressed in the Report. The Corps, the USFWS, and the CCC request your comments on the scope and content of the draft joint Report.

A public scoping meeting will be held to solicit comments on the environmental effects of the range of potential projects and the appropriate scope of the Report. The public is invited to comment on environmental issues to be addressed in the Report during this meeting.

Dates

Written comments from all interested parties are encouraged and must be received no later than 30 days after receipt of this notice. A public scoping meeting will be held on Wednesday, January 25, 2006, from 5:30-8:30 p.m. at 40 North Milpitas Blvd., Milpitas, California, 95035. Persons needing reasonable accommodations in order to attend and participate in the public scoping meetings should contact Bill DeJager at (415) 977-8670 at least a week in advance of the meeting to allow time to process the request.

Addresses

Written comments should be sent to Yvonne LeTellier, Project Manager, U.S. Army Corps of Engineers, 333 Market Street, 8th Floor, San Francisco, California, 94105-2197, or Brenda Buxton, Project Manager, California Coastal Conservancy, 1330 Broadway, 11th Floor, Oakland, CA, 94612. Written comments may also be sent by facsimile to (415) 977-8695, or via email through the public comments link on the South Bay Salt Ponds Restoration Project website, at

www.southbayrestoration.org/Question_Comment.html. All comments received, including names and addresses, will become part of the administrative record and available to the public.

SUPPLEMENTARY INFORMATION

On November 9, 2004, the USFWS and the Corps issued a Notice of Intent for the proposed South Bay Salt Ponds Restoration Project programmatic EIS/EIR. The Corps and the USFWS propose to integrate the planning process for the Alviso Pond and Santa Clara County Interim Feasibility Study component of the South San Francisco Bay Shoreline Study with the planning process for the South Bay Salt Ponds Restoration Project. The two projects include ecosystem restoration, flood protection, and public access components. However, the current Interim Feasibility Study is a project-level component of the South Bay Salt Pond Restoration Study and it will be tiered to the above-mentioned programmatic EIS/EIR. This Interim Feasibility Study and the Report to be prepared will only cover a portion of the larger geographic area addressed in the South Bay Salt Ponds programmatic EIS/EIR.

Project Description.
South Bay Salt Ponds Restoration Project.
Project Location: The South Bay Salt Ponds Restoration Project area comprises 15,100 acres of salt ponds and adjacent habitats in South San Francisco Bay that USFWS and California Department of Fish and Game (CDFG) acquired from the Cargill Salt Company in 2003. USFWS owns and manages the 8,000-acre Alviso pond complex and the 1,600-acre Ravenswood pond complex. CDFG owns and manages the 5,500-acre Eden Landing pond complex.

The overarching goal of the South Bay Salt Ponds Restoration Project is to restore and enhance wetlands in the South San Francisco Bay while providing for flood protection and wildlife-oriented public access and recreation. The following project objectives were adopted by the South Bay Salt Ponds Restoration Project's Stakeholder Forum which includes representatives of local governments, environmental organizations, neighboring landowners, businesses, and community organizations:

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.
2. Maintain or improve existing levels of flood protection in the South Bay area.
3. Provide public access and recreational opportunities compatible with wildlife and habitat goals.
4. Protect or improve existing levels of water and sediment quality in the South Bay, and fully evaluate ecological risks that could be caused by restoration.
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 species.
6. Protect the services provided by existing infrastructure (e.g., power lines, railroads).

USFWS and CDFG reviewed the proposed project objectives to ensure compliance with legal mandates, such as compatibility of wildlife with public access. Two additional evaluation factors were identified in the Alternatives Development Framework for comparative analysis:

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7. Cost Effectiveness: Consider costs of implementation, management, and monitoring so that planned activities can be effectively executed with available funding.
8. Environmental Impact: Promote environmental benefit and reduce impacts to the human environment.

The South Bay salt ponds are now being managed by the U.S. Fish and Wildlife Service and the California Department of Fish and Game under an Initial Stewardship Plan which was evaluated in a March 2004 Final EIS/EIR. The long-term restoration plan currently under evaluation in the ongoing programmatic NEPA/CEQA process may include general plans for the entire project area as well as detailed design plans for a specific Phase I project.

South San Francisco Bay Shoreline Study.
The Corps plans to prepare a Feasibility Report integrated with an EIS/EIR for the South San Francisco Bay Shoreline Study: Alviso Ponds and Santa Clara County Interim Feasibility Study, pursuant to the following resolution by the U.S. House of Representatives Transportation and Infrastructure Committee, adopted July 24, 2002:

> "Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that the Secretary of the Army is requested to review the Final Letter Report for the San Francisco Bay Shoreline Study, California, dated July 1992, and all related interims and other pertinent reports to determine whether modifications to the recommendations contained therein are advisable at the present time in the interest of tidal and fluvial flood damage reduction, environmental restoration and protection and related purposes along the South San Francisco Bay shoreline for the counties of San Mateo, Santa Clara and Alameda, California."

Project Location: The South San Francisco Bay Shoreline Study area extends along South San Francisco Bay and includes the Alviso, Ravenswood, and Eden Landing pond complexes which are described above, as well as additional shoreline and floodplain areas in the counties of Alameda, San Mateo, and Santa Clara. The Report referenced in this Notice of Intent would propose implementation of the findings of the first Interim Feasibility Study component of the Shoreline Study. The area to be examined in the first Interim Study consists of 25 ponds in the Alviso pond complex on the shores of the South Bay in Fremont, San Jose, Sunnyvale and Mountain View, located in Santa Clara and Alameda counties, plus substantial adjacent areas which may need flood protection or which may be affected by flood protection or ecosystem restoration measures. The study area is bordered by San Francisco Bay and the operational salt ponds of Alameda County to the north and San Francisquito Creek on the west. To the south and east, the study area extends beyond the salt ponds to include all lands subject to inundation from a 100-year tidal flooding event. These additional lands are primarily urbanized areas in Palo Alto, Mountain View, Sunnyvale, and San Jose to the south, and urbanized lands in Milpitas and Fremont to the east. These lands are generally delineated on maps which are on file with the Corps of Engineers, San Francisco District. During the course of the study the exact delineation of which lands are subject to tidal inundation may be modified based on technical studies.

The Corps proposes to conduct the South San Francisco Bay Shoreline Study: Alviso Ponds and Santa Clara County Interim Feasibility Study in coordination with the South Bay Salt Ponds Restoration Project and in partnership with the USFWS, the CCC, CDFG, and the Santa Clara Valley Water District (SCVWD). It is expected that the Corps's Report for the first Interim Feasibility Study component of the Shoreline Study will be released after the completion of the South Bay Salt Ponds Restoration Project programmatic EIS/EIR, so the EIS/EIR components of the Report for the Shoreline Study will tier off from the joint programmatic South Bay Salt Ponds EIS/EIR.

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Alternatives

The Report will consider a range of alternatives and their impacts, including the No Action Alternative. Scoping will be an early and open process designed to determine the issues and alternatives to be addressed in the Report. For example, the range of alternatives may include varying mixes of managed ponds and tidal marsh habitat as well as varying levels and means of flood management and recreation and public access components which respond to the project objectives.

Content of the Report

The Report will identify the anticipated effects of the project alternatives (negative and beneficial) and describe and analyze direct, indirect, and cumulative potential environmental impacts of the project alternatives, including the No Action Alternative, in accordance with NEPA(40 CFR 1500-1508) and CEQA. For each issue listed below, the Report will include a discussion of the parameters used in evaluating the impacts as well as recommended mitigation, indicating the effectiveness of mitigation measures proposed to be implemented and what, if any, additional measures would be required to reduce the impacts to a less-than-significant level. The list of issues presented below is preliminary both in scope and number. These issues are presented to facilitate public comment on the scope of the Report, and are not intended to be all-inclusive or to be a predetermination of impact topics to be considered.

Biological Resources.
The Report will address the following issues and potential detrimental and beneficial impacts related to biological resources:

- effects on population sizes of endangered species and other species of concern, including California clapper rail, snowy plover, California least tern, salt marsh harvest mouse, Chinook salmon and steelhead trout.
- shifts in populations and effects on population sizes of migratory waterfowl and shorebirds
- increased habitat connectivity for all organisms that use multiple marsh and/or aquatic habitats, including birds, mammals, and fish
- potential for improved habitat connectivity with adjacent upland habitats
- potential loss of hypersaline wetlands and their unique communities
- reduction in predation for species of concern with larger habitat blocks
- increased nursery habitat in wetlands for fish
- potential for salmonid entrainment into managed ponds
- effects of *Spartina alterniflora* and the hybrids of this species, and other invasive species
- effects of flood control structures on existing ecosystem attributes and functions including aquatic and terrestrial species.
- effects of public access and recreation on aquatic and terrestrial species.

Hydrology and Flood Protection.
The Report will address the following issues and potential detrimental and beneficial impacts related to hydrology and flood protection:

- existing and future without-project tidal flood hazards as affected by fluvial inputs
- effects on the tidal regime and tidal mixing from project components, and related effects on salinity of Bay waters
- effects on high-tide water levels and resulting effects on flood hazards
- changes in tidal hydrodynamics, including tidal prism and tidal range in tidal sloughs, resulting changes in channel geometry and changes in tidal flood risks (including during project implementation)

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- effects on flood flow conveyance as a result of converting salt ponds to tidal marsh
- potential decrease in wave energy associated with tidal marsh restoration and reduced erosion of flood protection levees
- Impacts on tidal flooding frequency and extent, and flood protection due to breaches in salt pond levees, improvement of existing levees, and construction of new levees
- Impacts on groundwater quality

Water and Sediment Quality.
The Report will address the following issues and potential detrimental and beneficial impacts related to water and sediment quality:

- effects of salt pond levee breaches, including changes in salinity, turbidity, dissolved oxygen, biochemical and biological oxygen demand, metals, polychlorinated biphenyls (PCBs), and other pollutants of concern.
- changes in residence time of water in the South Bay and related effects on water quality.
- changes in mercury and/or methyl mercury concentrations, and other pollutants of concern, in Bay and slough waters.
- potential to mobilize existing sediment contaminants, including mercury, PCBs, and other pollutants of concern.
- potential contamination from outside sources, including urban runoff, wastewater discharges, imported sediment and atmospheric deposition.

Recreation and Public Access.
The Report will address the project's effects on existing recreation facilities and their use as well as the potential effects of expansion or creation of new facilities. The benefits and impacts of increased or decreased public access on biological resources and achievement of other project objectives will also be addressed.

Economics.
The Report will evaluate the economic effects of the alternatives, including costs and benefits of flood protection, recreation, and effects on commercial fishing.

Cumulative Impacts.
The Report will examine the cumulative impacts of past, ongoing, and reasonably foreseeable future projects affecting tidal marsh and estuarine habitats in the South Bay, as well as effects on adjacent urban and rural lands and communities.

Environmental Analysis Process

The Report will be prepared in compliance with NEPA and Council on Environmental Quality Regulations, contained in 40 CFR parts 1500 - 1508; and with CEQA, Public Resources Code Sec 21000 et seq., and the CEQA Guidelines as amended. Because requirements for NEPA and CEQA are somewhat different, the document must be prepared to comply with whichever requirements are more stringent. The Corps and the USFWS will be Joint Lead Agencies for the NEPA process and the CCC will be the Lead Agency for the CEQA process. In accordance with both CEQA and NEPA, these Lead Agencies are responsible for the scope, content, and legal adequacy of the document. The SCVWD will be a Responsible Agency under the provisions of CEQA. Therefore, all aspects of the Report scope and process will be fully coordinated between these four agencies.

The scoping process will include the opportunity for public input during a public meeting and by written comments submitted during the 30-day scoping period.

The draft Report will incorporate public concerns associated with the project alternatives identified in the scoping process and will be distributed for at least a 45-day public review and comment period. During this time, both written and verbal comments will be solicited on the adequacy of the document. The final Report will address the comments received on the draft during public review and will be made available to all commenters on the draft Report. Copies of the draft and final reports will be posted on the Internet as part of the public review process.

The final step in the Federal EIS process is the preparation of a Record of Decision (ROD), a concise summary of the decisions made by the Corps and the USFWS. The ROD will identify the alternative selected by the agencies and other alternatives that were considered. It also will discuss the mitigation measures that were adopted. Because there are two lead agencies, it is possible that each agency will prepare its own ROD. The Record, or Records, of Decision may be published no earlier than 30 days after publication of the Notice of Availability of the final EIS. The final step in the State EIR process is certification of the EIR, which includes preparation of a Mitigation Monitoring and Reporting Plan and adoption of its findings, should the project be approved.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, California 94555

May 28, 2015

Caleb Conn
Project Manager
U.S. Army Corps of Engineers
San Francisco District
1455 Market Street
San Francisco, CA 94103

Re: South San Francisco Bay Shoreline Study Phase 1 Project – Refuge coordination in the study's planning process

Dear Mr. Conn,

This letter serves as documentation of the United States Fish and Wildlife Service's (USFWS) Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) participation in the South San Francisco Bay Shoreline Study Phase 1 Project (South Bay Project), in response to comments from the USACE headquarters on the Draft Interim Environmental Impact Statement/ Environmental Impact Report/Feasibility Report (Integrated Document), specifically: "*Lastly, there does not appear to be any correspondence or affirmation from the USFWS' Don Edwards National Wildlife Refuge acknowledging or providing input into the planning process. Has nothing been received from the Refuge or was it just not included in the draft report?*"

The USFWS has been engaged in the Shoreline Study at least since 2003 with the acquisition of the large complex of former commercial salt ponds from Cargill and its addition to the Refuge to be managed for wildlife and habitat conservation. Following the acquisition, the Corps concluded that there was a Federal interest in a South Bay Project, given that USFWS would not be able to provide flood risk management, and that the public benefits of a large scale multipurpose flood protection/ ecosystem restoration project could only be realized with the Corps assistance.

The Refuge Manager, with technical assistance from Refuge staff and the Department of the Interior San Francisco Field Office of the Solicitor's legal counsel, actively participated in crafting early supporting documents such as Issue Resolution Conference White Papers on future-without project assumptions and land access policy. Pursuant to NEPA, the USFWS joined the Corps as a Federal Co-Lead and jointly issued a Notice of Intent to Prepare an Integrated Environmental Impact Statement/Environmental Impact Report/Feasibility Report for the South San Francisco Bay Shoreline Study: Alviso Ponds and Santa Clara County Interim Feasibility Study, published on January 6, 2006 (Federal Register Vol. 71, No. 4). Further, the USFWS is an integral partner in the multi-agency collaborative South Bay Salt Pond Restoration Project, which is closely interrelated with the South Bay Project.

The Project Leader for the San Francisco Bay National Wildlife Refuge Complex (of which the Don Edwards Refuge is one of seven units) has participated as a Principal on the South Bay Project Executive Team for the past several years (both I and my predecessor, Mendel Stewart). Additionally, the Refuge Manager and /or his staff have participated on the Shoreline Management Team for at least the past few

years. Several Refuge staff reviewed and provided edits as well as supporting references to the Draft Integrated Document; however, the Refuge was inadvertently left off of the List of Preparers in Chapter 7.0. A list of names is enclosed for incorporation into the Final Integrated Document.

I and my staff will continue to provide technical assistance to completing the Final Integrated Document and its associated responses to comments, as necessary, as well as the Implementation Guidance submittal package and other supporting materials necessary for reaching a final Chief's Report and ultimately project authorization and implementation. Please let me know if you have any further questions.

Sincerely,

Anne E. Morkill
Project Leader
San Francisco Bay National Wildlife Refuge Complex
Pacific Southwest Region
U.S. Fish and Wildlife Service

Addendum to List of Preparers (Chapter 7.0), Integrated Environmental Impact Statement/Environmental Impact Report/Feasibility Report for the South San Francisco Bay Shoreline Study

USFWS Don Edwards San Francisco Bay National Wildlife Refuge (USFWS)

Name	Discipline	Role in Preparing Report
Anne Morkill	Refuge Complex Manager	Exec Team representative for Refuge; general document QC
Eric Mruz	Refuge Manager	PDT representative for Refuge; general document QC
Melisa Amato	Wildlife Refuge Specialist	PDT representative for Refuge; general document QC
Cheryl Strong	Wildlife Biologist	General review and updates of text in Integrated Document
Rachel Tertes	Wildlife Biologist	General review and updates of text in Integrated Document
Jennifer Heroux	Visitor Services Specialist	General review and updates of text in Integrated Document
Patricia Roberson	Planner/NEPA Coordinator	General review and updates of text in Integrated Document; environmental NEPA support

Rev 5/28/2015

Draft Integrated Document Distribution (copy of document)

United States Environmental Protection Agency, Region IX

U.S. Fish and Wildlife Service, California Fish and Wildlife Office

Union Pacific Railroad Company

Draft Integrated Document Notice of Availability

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Acterra
Advance Soil Technology Inc.
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Aerial Archives
Agilent Laboratories
Alameda County
Alameda County Board of Supervisors
Alameda County Clean Water Program
Alameda County Flood Control District
Alameda County Mosquito Abatement District
Alameda County Public Works Agency
Alameda County Water District
Alameda Creek Alliance
Alcalde & Fay
Alviso Water Task Force
ALZA Corporation
AMEC Earth and Environmental
American Canyon Eagle/Napa Valley Register
American River College
American Rivers
A-N West, Inc.
ANG Newspapers
Applied Marine Sciences
Applied Materials Inc.

Aquarium of the Bay
Aquarium of the Pacific
Archibald & Wallberg Consultants
Art Anderson Associates
Asian Week
Aspen Environmental Group
Assoc. General Contractors of California
Association of Bay Area Governments (ABAG)
Audubon Society (Sequoia Chapter)
Avian Research Associates
Avocet Research Associates
AWTF
BART-Capitol Corridor Planning Group
Bay Area Air Quality Management District
Bay Area Open Space Council
Bay Area Ridge Trail
Bay Area Sea Kayakers
Bay Institute
Bay Nature
Bay Nature Magazine
Bay Planning Coalition
BayCrossings
Baykeeper
Beyond Searsville Dam
Biggs Cardosa Associates
Biodiversity Resources Center
Bio-Integral Resource Center
Boston University, Marine Biological Program
Boy Scouts
Brown & Caldwell
California Air National Guard
California Coastal Commission
California Department of Conservation
California Department of Fish and Wildlife
California Department of Health Services

California Department of Pesticide Regulation
California Department of Toxic Substances Control
California Department of Transportation, District 4
California Department of Water Resources
California Department of Water Resources, Bay Delta Office
California Emergency Management Agency
California Marine Affairs Navigation Conference (CMANC)
California Native Plant Society - SC Chapter
California Native Plant Society- Marin Chapter
California Natural Resources Agency
California Office of Historic Preservation
California Recreational Boaters of California
California Resources Agency
California State Coastal Conservancy
California State Governor's Office
California State Lands Commission
California State Parks Division of Boating and Waterways
California State University, Stanislaus
California Trout Inc.
California Waterfowl Association
California Wildlife Conservation Board
California Wildlife Foundation
Cardinal Photo
Cargill Salt
Carollo Engineers
Castro Valley Sanitary District
CCCR/Ohlone Audubon
CDFG
Center for Collaborative Policy
Center for Development of Recycling
Center for Ecosystem Management and Restoration
Center for Public Oversight
CH2M Hill
Children's Discovery Museum BioSITE
Citizens Committee to Complete the Refuge
City of Alameda Health Care District

City of Berkeley Shorebird Nature Center

City of Concord

City of Cupertino

City of East Palo Alto

City of Foster City

City of Fremont

City of Hayward

City of Los Altos, Public Works Dept.

City of Menlo Park

City of Milpitas

City of Monte Sereno

City of Mountain View

City of Newark

City of Oakland, Environmental Service Division

City of Palo Alto

City of Petaluma

City of Redwood City

City of San Francisco, PUC

City of San Jose

City of San Jose, City Facilities Architectural Services Public Works

City of San Jose, Dept. of Parks, Recreation & Neighborhood Services

City of San Jose, Environmental Services

City of San Jose, Planning Department

City of San Mateo

City of Santa Clara

City of Saratoga

City of Sunnyvale

City of Union City

CLEAN South Bay

Clean Water Fund

Coast & Harbor Engineering, LLC

Coastal Conservancy

College of the Redwoods Honors Program

Committee for Green Foothills

Concept Marine Associates

Contra Costa County Community Development

Contra Costa Flood Control District -Public Works Dept.

Contra Costa Times

Contra Costa Vector and Mosquito Control District

Cooper Crane

Crissy Field Wetlands Project

CSU Hayward

CSU-East Bay

CWA

Dall & Associates

Danish Hydraulic Institute

De Anza College

Defenders of Wildlife

Department of Fish and Game

Department of the Interior

DFG

DFG -Project Wild

Diane Renshaw Consulting Ecologist

Dinwiddie & Associates

DIO/OEPC

DOE Joint Genome Institute

Don Edwards SF Bay National Wildlife Refuge

DTSC

Dublin-San Ramon Services District

Ducks Unlimited

Earth, Air, & Space Educational Foundation

Earthwatch Institute

East Bay Bicycle Coalition

East Bay Conservation Corps

East Bay Dischargers Authority

East Bay Regional Park District

EBMUD

EBRPD

ECORP Consulting, Inc.

EDAW, Inc.

Eden Shores Community

EIP Associates

Eisenberg, Olivieri & Associates Inc. (EOA)

Empirical Education

ENTRIX, Inc.

Environmental Data Solutions

EnvrioSystems Group

EOA, Inc.

EPA Can Do/Jane Leach MFAC/Raven Works Field Sports Ministry

Erler & Kalinowski, Inc.

ERS Inc.

ESA

Estuarine Engineering Branch

EVEREST INTERNATIONAL CONSULTANTS, INC

Exponent Inc.

FarWest Restoration Engineering

Federal Highway Administration

Fishing in the City

Floating Islands West

Foothill College

Fresno Audubon Society

Friend of Alameda NWR

Friends of Adobe Creek

Friends of Bayfront Park

Friends of Calabazas Creek

Friends of Corte Madera Creek Watershed

Friends of Five Creeks

Friends of Novato Creek

Friends of Sausal Creek

Friends of Stevens Creek Trail

Fugro West, Inc.

Gahagan & Bryant Associates, Inc.

GAIA Consulting, Inc.

Geomatrix Consultants

Ginger Bryant & Associates

Golden Gate Audubon

Great Eastern Ecologyy, Inc.

Guadalupe Coyote RCD

House of Representatives - 13th District

House of Representatives - 7th District

H.A.R.D.

H.T. Harvey & Associates

Hanan & Associates, Inc.

HAN-PADRON ASSOCIATES, LLP

Hanson Environmental, Inc.

HASPA Citizens Advisory Committee

Hayward Area Recreation and Park District

HDR Engineering Inc.

Hidden Villa

High School Programs/Leadership Corp.

Hispanic Chamber of Commerce

HMH Inc.

Home Builders Association, South Bay

Huffman-Broadway Group, Inc

Humboldt State University

Hydro Science

Hydroikos Associates

Hydroscience Engineers, Inc.

Jasper Ridge Biological Preserve

Jensen Corp./Jensen Landscape Services Inc.

Johnson & Johnson

Jones & Stokes

K&AES, INC.

Kamman Hydrology & Engineering

KGO-TV

Kinnetic Laboratories, Inc.

Kleinfelder

KQED

KTEH

Lake Merritt Breakfast Club

Laurel Marcus and Associates
Lawrence Livermore National Laboratory
Leafybranch.org
League of Women Voters
LifeScan, Inc.
Lipton Environmental Group
Livermore Area Recreation and Park District
Lockheed Martin Space Systems Company
Loma Prieta Chapter of the Sierra Club
Los Angeles Times
Lowney Associates
Loyola Marymount University
LSA Associates, Inc.
LSS
LWV for Fremont/Newark/Union City & LWVBay Area Nat.Res/Water Board Chair
Malcolm Pirnie, Inc.
Marin Audubon
Marin County Public Works Dept.
Marin Independent Journal
Marine Mammal Center
Marine Science Institute
Math Science Nucleus
Mayne Elementary School
McGuire and Hester Construction
McNeese State University
MEC Analytical Systems Inc.
Menlo High School
Menlo Park Environmental Commission
Menlo Park Planning Commission
Metropolitan Transportation Commission
Midpeninsula Regional Open Space District
Moffatt & Nichol Engineers
More Fishing
Morgan Hill Chamber of Commerce
MPBTA

Mt. Pleasant High School

Murray Engineering & Consulting

Museum of Local History

MWH

Napa County Flood Control Dist.

Napa County Mosquito Abatement District

Napa County RCD

NASA

NASA Ames Research Center

NASA-JPL

National Fish & Wildlife Foundation

National Park Service

Native American Heritage Commission

Natural Heritage Institute

Newscolor, LLC

NOAA

NOAA

NOAA -National Marine Fisheries Service

NOAA -National Marine Fisheries Service, Habitat Conservation Branch

NOAA -National Ocean Service

NOAA Restoration Center

North Salinas Valley Mosquito Abatement District

Northwest Hydraulics

Novo Nordisk

NRDC

Ocean Sciences

Office of Supervisor Rose Jacobs Gibson

Ohlone Audubon Society

Oklawaha Farms, Inc.

One-to-One Tutoring Service

Our City Forest

Pacific EcoRisk

Pacific Gas & Electric Co.

Pacific Inter-Club Yacht Association

Pacific Sun

Palo Alto Baylands Nature Center

Palo Alto Daily News

Palo Verde Residents Association

Pelican Media

Peninsula Open Space Trust

People for Livable and Affordable Neighborhoods (P.L.A.N.)

PM Strauss & Associates

Point Reyes Bird Observatory

Point Reyes National Seashore

Port of Oakland

Port of Redwood City

Port of San Francisco

Presidio Trust

PWA

QEA, LLC

Questa Engineering Corporation

RanaResources

Refuge EEC

Regional Water Quality Control Board

Rep. Mike Honda's office

Resources Law Group

Resources Legacy Fund

Restore Coyote Creek

RHAA

Riparian Habitat Joint Venture

River of Words

Romberg Tiburon Center

Royston Hanamoto Alley & Abey Landcsape Architects

S.S. Papadopulos & Associates

Sacramento Bee

Salmon & Trout Enhancement Program

Salt River Construction

San Francisco Bay Area Water Transit Authority

San Francisco Bay Bird Observatory

San Francisco Bay Brands

San Francisco Bay Conservation and Development Commission
San Francisco Bay Joint Venture
San Francisco Bay National Wildlife Refuge
San Francisco Bay Regional Water Quality Control Board
San Francisco Baylands Ecosystem Habitat Goals
San Francisco Boardsailing Association
San Francisco Conservation Corps
San Francisco Invasive Spartina Project
San Francisco Planning Department
San Francisco Public Utilities Commission
San Francisco State University
San Francisco State University, Biology Dept.
San Joaquin Regional Rail Commission
San Jose Conservation Corps & Charter School
San Jose Mercury News
San Jose Public Library- Alviso Branch
San Jose Public Library- Calabazas Branch
San Jose Public Library- Evergreen Branch
San Jose Public Library- Hillview Branch
San Jose Public Library- Joyce Ellington Branch
San Jose Public Library- Pearl Avenue Branch
San Jose Public Library- Rosegarden Branch
San Jose Public Library- Santa Teresa Branch
San Jose Public Library- Seventrees Branch
San Jose Public Library- Willow Glen Branch
San Jose State University
San Jose State University, Dept. of Biological Sciences
San Mateo County
San Mateo County Board of Supervisors
San Mateo County Bridge Trails Committee
San Mateo County Clerk-Recorder's Office
San Mateo County Env. Health
San Mateo County Harbor District
San Mateo County Mosquito Abatement District
San Mateo County MVCD

San Mateo County Planning Commission
San Mateo County Resource Conservation District
San Mateo County Trails Committee
San Mateo County Transit District
San Mateo County, Department of Public Works
Santa Clara Building and Construction Trades Council
Santa Clara County
Santa Clara County Airports
Santa Clara County Black Chamber of Commerce
Santa Clara County Clerk-Recorder
Santa Clara County Farm Bureau
Santa Clara County Open Space Authority
Santa Clara County Parks & Recreation Department
Santa Clara County Planning Office
Santa Clara County Vector Control District
Santa Clara County, Office of Supervisor Dave Cortese
Santa Clara Open Space Authority
Santa Clara University
Santa Clara Valley Audubon Society
Santa Clara Valley Urban Runoff PPP
Santa Clara Valley Water District
Santa Cruz County Mosquito Abatement District
Santa Monica Bay Restoration Commission
Save Bayfront Park
Save Our South Bay Wetlands
Save The Bay
Save the Wetlands in Mayhews
SBYC/ANG
Schaaf & Wheeler
SCVAS
SEEDS
Semiconductor Industry Association
Senator Dianne Fienstein's Office
Sequoia Analytical Laboratory
SF Bay Trail

SFEI

SFO

SFPUC

SFSU Recreation and Leisure Studies

Shaw Environmental & Infrastructure

Shaw Environmental, Inc.

Shoreline Park in Mountain View

Sierra Club, Loma Prieta Chapter

Sierra Club, SF Bay Chapter

Silicon Valley Association of Realtors

Silicon Valley Bicycle Coalition

Silicon Valley Engineering Council

Silicon Valley Land Conservancy

Silicon Valley Leadership Group

SLR International

Solano County Mosquito Abatement District

Sonoma County Water Agency

Sonoma Ecology Center

Sonoma Land Trust

Sound Watershed

Southbrook Homeowners Association

Southern California Coastal Water Research Project

Southern Illinois University in Carbondale

Southern Sonoma RCD

SRI International

Stanford University

State Assemblyman, 22th District

State Coastal Conservancy

State Lands Commission

Student Conservation Association

SVLG

Sycamore Associates

Tahoe Research Group

TDC Environmental

Teal Ltd.

Tetra Tech, Inc.

The Conservation Fund

The Nature Conservancy

The Regional Water Quality Control Plant

The Trail Center

The Watershed Project

Tim Hilleary Construction

Towill, Inc.

Town of Los Gatos

TranSystems

Treadwell & Rollo, Inc.

Triton Marine Construction

U College London

UC Berkeley

UC Berkeley, Dept. of Civil & Environmental Engineering

UC Berkeley/ESPM

UC Bodega Marine Lab

UC Davis

UC Santa Barbara

UC Santa Cruz

UCLA

Union City

Union Sanitary District

University of Idaho

University of Nevada

University of New Orleans

University of San Francisco, Biology Department

University of Twente

University of Virginia

University of Washington, School of Aquatic and Fishery Sciences

University of Western Australia

Urban Creeks Council

URS Corporation

U.S. Army Corps of Engineers

U.S. Army Corps of Engineers HQ

U.S. Army Corps of Engineers S. Pacific Div.

U.S. Army Corps of Engineers Sacramento District

U.S. Army Corps of Engineers SF District

U.S. Coast Guard

U.S. Department of Agriculture Natural Resources Conservation Service

U.S. Department of the Interior, Office of Environmental Policy and Compliance

U.S. Environmental Protection Agency, Office of Clean Water Act Compliance

U.S. Environmental Protection Agency, Region 9

U.S. Fish & Wildlife Service

U.S. Fish & Wildlife Service - Don Edwards SF Bay National Wildlife Refuge

U.S. Senator Diane Feinstein

U.S. Geological Survey

U.S. Geological Survey, Pacific Science Center

U.S. Geological Survey, Western Ecological Research Center

U.S. Geological Survey, Western Fisheries Research Center

U.S. Geological Survey /Humboldt State

U.S. Geological Survey /WERC

Vali Cooper & Associates, Inc.

Vallejo Times-Herald (A)

Valley & Mountain Consulting

Vietnamese Chamber of Commerce

VIMS

Walk San Jose

Wall Street Journal

Wallis Engineering

Watershed Sciences

Weber

WEST CONSULTANTS, INC.

West Point Marina

West Valley Clean Water Program

West Valley Sanitation District

West Yost & Associates

Weston Solutions Inc

Wetlands and Water Resources

Wetlands Research Associates, Inc.

Wetlands Wildlife Associates

Wildlands, Inc.

Wildlife Education & Rehabilitation Center (WERC)

Wildlife Stewards

William Lettis & Associates

Winzler & Kelly Consulting Engineers

Wolfe Mason Associates

WRA, Inc.

WRECO

www.earthandbeauty.com

Zentner and Zentner

Individuals Not Affiliated with an Agency or Group

Zach	Adamis
Seth	Adams
William	Ahern
Christina	Ahlers
Ariel	Ambruster
Sioux	Ammerman
Gavin	Archbald
Jim	Armstrong
Grant	Ballard
Robert	Bamford
Megha	Bansal
Peter	Baye
Andrew	Beahrs
Robyn	Beavers
Charles	Benton
Bruce	Bernard
Anne-Marie	Beveridge
Henry	Blankenheim
Kyle	Bloomster
Doug	Bloyd
Scott	Bourne
Bill	Bousman
John	Bowers
Carolyn	Box
Carie	Brandon
Tim	Brewer
Brian	Bruha
Vibeke	Burchard
Thomas	Butler
Cesent	Calimpong
Daniel	Campbell
Anita	Carse
Keith	Chan
Lynn	Chiapella
Vincent	Chiu
Richard	Cimino
Carl	Claras
Jackie	Cohen
Robert	Cone
Karla	Conmy
David	Cook

Katharine	Cook
Terry	Cooke
Christine	Corwin
Nyree	Cruz
Sara	Cutuli
Carol	Cyr
Trent	Dahle
Audrey	Davenport
Brian	David
Karen	Davis
Edwin	Dean
David	Demko
Sarah	Deslasuriers
Susan	DeVico
Gabriel	Dixon
Bryan	Do
Wilson	Doctor
Lance	Dohman
Laurie	Donnelly
Mike	Dooley
Tom	Driscoll
Cynthia	Drozd
Daniel	Duke
Mary Ann	Duke
Ron	Duke
Inge	Duncan
Mark	Duncan
Beth	Dyer
Melissa	Dyer
Debbi	Egter Van Wissekerke
Shama	Ejaz
Jeffrey	Englander
Rusty	Fairey
Jesse	Fairman
Helen	Farnham
Margaret	Fawcett
Gabrielle	Feldman
Melissae	Fellet
Katie	Field
Chuck	Finnie
Joan	Florsheim
Wendy	Foss

Carole	Foster
Rita	Foti
William	Frankeberger
Erica	Freeman
Bill	Frey
Brian	Fulfrost
Peterq	Gamino
Linda	Gass
Meggan	Gehring
Mandeep	Gill
Richard	Givens
Susan	Gladstone
Fred	Glover
Riley	Gordinier
Brad	Goubeaux
Michael	Graff
Andrea	Graffis
Allison	Green
Matt	Greene
Matthew	Greuel
Salena	Grewal
Marty	Grimes
Edward	Gross
Cristina	Grosso
Jon	Hallberg
Srinivas	Hanabe
Katrina	Harrison
Dennis	Haussler
John S.	Haydon
Dan	Heimann
Jerry	Heinrichs
Michael	Henderson
Mark	Hendren
Eric	Hentschke
Yolanda	Hernandez
Jennifer	Heyd
Gregory	Hoffman
Hugo	Hoffman
John	Hollingsworth
Rob	Holt
Tom	Horan
Carolyn	Hovig
Joshua	Hoyt

Joshua	Huber
Monica	Hudson
Roland	Huet
Denise	Hughes
Jamil	Ibrahim
Robert	Jakovina
Kristal	Janes
Anne	Janzer
Kanwal	Jaswal
Lance	Jensen
Frank	Jesse
Sergio	Jimenez
Travis	Johnson
Dan	Johnston
Kelly	Jost
Anne	Jurek
Erin	Justice
Zach	Katz
Jerry	Kay
Frank	Kellers
Paul	King
Fred	Krieger
Terry	Kurtz
George	Lallas
Marilyn	Latta
Jerry	Lawrence
Aaron	Lee
Therese	Lee
Bea	Leija
Don	Lepley
Bill	Lev
Joyce	Lewis
Dan	Liddell
Sally	Lieber
Mike	Linden
Cynthia	Lipford
Jane Braxton	Little
Sally	Liu
Bill	Lock
Vicki	Logan
Jeremy	Lowe
Libby	Lucas
John	Lukas

John	Luongo
Joseph	Lutzweit
Tom	Madalena
Alberta	Maged
John	Magee
Julianna	Mandler
John	Margowski
Herb	Masters
Regina	Maurantonio
Olivier	Mazeas
Tripp	McCandlish
Jim	McDermott
Theresa	McDermott
Joanne	McFarlin
Nancy	McKown
Caitlin	McLaughlin
Jim	Meyers
Michael	Millar
Mike	Miller
Gaurav	Misra
Kevan	Moffett
Karen	Monahan
Genie	Moore
Jennifer	Moore
Maritza	Mullen
Angus	Mullins
Stacia	Mumm
Dan	Murphy
Seamus	Murphy
Jim	Murray
John	Neibel
Denis	Newman
Daisy	Nguyen
Wes	Nichols
Angela	Obando
Davinna	Ohlson
Jorge	Ordonez
Mary	Pakenham-Walsh
Beth	Pardieck
Dave	Paullin
Heidi	Peirce
Alan	Pobanz
Eric	Polson

Matt	Polvorosa Kline
Roger	Potash
Brian	Potter
Roy	Powers
Paul	Prange
Jonah	Probell
Evan	Raymond
Bill	Reddy
Jeff	Reese
Paul	Reisentz
Christian	Reyes
Sarah	Richmond
Marijke	Rijsberman
John	Roselli
Susan	Rosenthal
Wayne	Roth
Pati	Rouzer
Ariel	Rowan
Homa	Rozan
Mike	Rugg
Carol	Runge
Steve	Rutledge
David	Salinero
Edgar	Salire
Noelani	Sallings
Rolane	Santos
Red	Schlichting
Ann	Schneider
Kristin	Schuster
Rob	Schusteritsch
Clysta	Seney
Drew	Seutter
	seutter
Andrea	Shea
Judy	Sheen
Danny	Shewey
Jeff	Sicklesteel
Jack	Smith
K	Smith
Kyle	Smith
Carolyn	Smyth
Kimberly	Snyder
Jana	Sokale

Jacqueline	Solomon
Joie	Spooner
Pam	Squyres
Dan	Stammerjohn
James	Stattion
Vince	Staub
Hugo	Steemers
Richard	Stovel
Carolyn	Strange
Anne	Sturm
Dennis	Sugar
Terrence	Sullins
Barbara	Sulser
Karen	Sundback
Lisa	Sy
Jan	Talbert
Joshua	Tallis
Nancy	Teater
Frank	Teng
Joe	Thomas
David	Thomson
Gabriel	Thoumi
Julie	Thrower
Ralph	Toloski
Lindsey	Tong
Rosario	Torres
Harriet	Trezevant
Ashutosh	Tripathi
Kazuya	Tsurushita
Mari	Tusten
Carol	Tyler
Claire	Tyler
Robert	Venticinque
Amber	Vierling
Josh	Wallaert
Michael	Wasmann
Jeff	Watanabe
Jennifer	Watson
Wendy	Webster
Don	Weden
Sabrina	West
Jason	Wiener
Christina	Williams

Mary	Wisnewski
J	Wood
Claire	Woolf
Katherine	Wright
Rose	Wright
Yungnane	Yang
Greg	Yarris
Jake	Young
Annie	Zacanti

San Francisco Bay Conservation and Development Commission
455 Golden Gate Avenue, Suite 10600, San Francisco, California 94102 tel 415 352 3600 fax 415 352 3606

September 4, 2015

Mr. Thomas Kendall
Chief of Planning
U.S. Army Corps of Engineers
1455 Market Street, 16th Floor
San Francisco, CA 94103

SUBJECT: BCDC Support for the South San Francisco Bay Shoreline Study, Phase 1

Dear Mr. Kendall:

Thank you for the request by the San Francisco District of the U.S. Army Corps of Engineers (USACE) that the San Francisco Bay Conservation and Development Commission (BCDC) support the flood risk management and ecosystem restoration work proposed by USACE's South San Francisco Bay Shoreline Study, Phase 1. The project is described in the draft Integrated Report released on December 19, 2014, and with additional detail provided in subsequent meetings with the project proponent.

As the proposed project would be constructed by the federal government, with some local and state funding, BCDC will require USACE to prepare and submit a Consistency Determination for review by BCDC under the federal Coastal Zone Management Act (CZMA). Based on decades of past practice and experience, we believe that it would be most prudent for USACE to submit its Consistency Determination during the project's Pre-Construction Engineering & Design phase.

In general, the BCDC staff supports the purpose of this project and looks forward to taking it before the Commission for its review and action under the CZMA when enough information is gathered and analyzed to ensure that it will both comply with the enforceable policies of the Coastal Management Program (CMP), as contained in the McAteer-Petris Act and in the San Francisco Bay Plan ("Bay Plan"), and benefit the region. Both the staff and Commissioners can better provide USACE with practical suggestions if USACE is willing to provide the Commission with an initial briefing on the project. As such, we have reserved time for a USACE presentation at our next Commission meeting on September 17, 2015.

It is worthwhile to note that the Commission previously has unanimously approved at least two horizontal levees to create transition zones, upland habitat, and areas where marsh can move inland with rising sea level rise at Sonoma Creek (Consistency Determination No. C2014.004) and Max Keech Properties (BCDC Permit No. 2007.005). That being said, the project's south bay shoreline levee would require much larger amounts of fill than either of the two above-referenced projects, although the fill is proposed to be placed within salt ponds, as opposed to within the Bay. While BCDC's criteria for evaluating fill in salt ponds are different than its criteria used to analyze fill proposed in the Bay, any fill proposed within BCDC's

jurisdiction must be justified. Also, the Commission will analyze this project in light of its efforts to make the Bay's shoreline more resilient to expected rising sea level; it has consistently supported appropriate efforts to do so in the past, and I am sure that USACE will receive many questions from the staff and Commissioners about the project's design and purpose in light of the ramifications of climate change and the need to protect the Bay's existing natural resources.

Based on the draft Integrated Report, BCDC-USACE staff-level coordination, and USACE's responses to BCDC's comment letter of February 23, 2015, the BCDC staff can indicate now that the proposed project is generally consistent with the Bay Plan's policies, or can be amended to be so, with additional documentation and a series of changes. The Bay Plan encourages converting salt ponds to tidal and subtidal habitats and designing ecosystem restoration and flood risk management features that provide for, and are adaptable to, projected rising sea level. The USACE proposal incorporates these attributes and its proposed ecotone would provide important habitat and ecosystem resilience. The Bay Plan requires that the public have access to the Bay shoreline, and the project would promote such access by filling a gap in the Bay Trail. I am happy that discussions among the Corps, BCDC, and other project-related staff indicate that the federal agencies are willing to work with Commission staff to ensure that the project design will be fully consistent with the Commission's policies as it is brought to a more detailed level.

Finally, please note that BCDC is open to the concept of phased consistency review, as authorized by section 930.36(d) of the CZMA regulations, should USACE elect to pursue this approach. Using this approach, BCDC generally requires up to 75 days to conclude our process and provide a federal agency with a phased Consistency Concurrence following the submission of a phased Consistency Determination. As stated above, however, we believe that a better process would be to expedite a Commission briefing on the overall goals of the project now, and review a USACE Consistency Determination later at the Pre-Construction Engineering & Design phase.

I hope this letter clarifies our position and please be assured that we very much look forward to working with you to complete this very important project.

If you have any further questions, please contact Bob Batha of our staff at 415-352-3612, or by email at bob.batha@bcdc.ca.gov; or me directly.

Sincerely,

LAWRENCE J. GOLDZBAND
Executive Director

References:

BCDC (1979). Management Program for San Francisco Bay. San Francisco Bay Conservation and Development Commission (prepared with financial assistance from the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, under the provisions of the Federal Coastal Zone Management Act of 1972, as amended).

BCDC (2008). San Francisco Bay Plan. San Francisco Bay Conservation and Development Commission.

U.S. Department
of Transportation
Federal Aviation Administration

Western-Pacific Region
Airports Division

San Francisco Airports District Office
1000 Marina Boulevard, Suite 220
Brisbane, CA 94005

May 21, 2015

Mr. Thomas R. Kendall
Chief, Planning Branch
Engineering and Technical Services Division
U.S. Army Corps of Engineers - San Francisco District
1455 Market St. San Francisco, CA 94103
ATTN: William DeJager
Environmental Section A -

Subject: FAA Comments on the Draft Interim Feasibility Report and Draft Environmental Impact Statement/Environmental Impact Statement/Report – South San Francisco Bay Shoreline Phase I Study, Santa Clara County, California

Dear Mr. Kendall:

Mr. Dejager of your staff contacted our office in April 2015 regarding whether we had any comments or concerns regarding aviation issues and the Draft Interim Feasibility Report and Draft Environmental Impact Statement (EIS)/Environmental Impact Statement/Report – South San Francisco Bay Shoreline Phase I Study, which is proposing a flood protection and environmental enhancement project approximately 5 miles north of Norman Y. Mineta San Jose International Airport. We appreciate that Mr. Dejager made this effort as we were not aware of the Draft EIS. We have the following comments.

Any wildlife or environmental enhancement project has the potential, if located in an inappropriate location, to increase the potential for wildlife to collide with aircraft. Our Federal Aviation Administration Advisory Circular (A/C) 150-5200-33B *Hazardous Wildlife Attractants on or Near Airports*, which is available on the www.faa.gov website, recommends a separation distance of at least 5,000 feet between potential hazardous wildlife attractants and airports serving piston-powered aircraft, and a separation distance of at least 10,000 feet between such hazards and airports serving turbine-powered (jet) aircraft. Hazardous wildlife attractants can include marsh and wetland areas, which would be enhanced as part of your proposed project. FAA AC 150-5200-33B also recommends a separation distance of 5 miles between the farthest edges of an airport's Air Operations Area (AOA) (i.e. runway) and a hazardous wildlife attractant if the attractant could cause hazardous wildlife movement into or across approach or departure airspace. The AC also identifies which types of wildlife have the greatest potential to strike and damage aircraft.

Both Norman Y. Mineta San Jose International Airport, and Moffett Federal Airfield at the National Aeronautics and Space Administration, Ames Research Center, are in the vicinity of the project alternatives described in the Draft EIS. Both airports service turbine-powered aircraft. While it appears both airports are beyond 10,000 feet from your proposed project alternatives, it also appears they may be within 5 miles of your project alternatives. We recommend that you disclose in the Final EIS the separation distances between the Air

Operations Areas (nearest point of the runway) of these airports and the proposed habitat improvements for each alternative described in the EIS.

Also, for any of your project alternatives that are within 5 miles of these airports, we recommend that the EIS evaluate whether the proposed habitat improvements could cause wildlife hazardous aircraft operations such as waterfowl, shorebirds, gulls, or raptors to move into or across approach or departure airspace (i.e. the areas beyond the ends of the runway where aircraft climb immediately after takeoff, or line up to land). We recommend that if such habitat improvements are included in your Final EIS, that you modify the habitat restoration plan in that area so it would not create any attractants that could encourage hazardous wildlife movements into or across approach or departure airspace within 5 miles of the either airport.

If your Final EIS does propose to create or enhance habitat that could attract wildlife hazardous to aircraft operations to within 10,000 feet of either airport, or cause hazardous wildlife movement into or across approach or departure airspace, this should be identified as a significant environmental impact, and that condition disclosed to the Federal official responsible for signing the Record of Decision for the EIS.

The FAA does not support the creation of new wildlife hazards to aircraft. While there are methods to discourage wildlife from areas where they represent a wildlife-aircraft strike hazard, such methods are time consuming and expensive to implement, and are not a substitute for advance planning that avoids attracting wildlife hazardous to an airport or an airport's approach or departure airspace in the first place.

Thank you for consideration of these comments. If you have questions regarding these comments you may contact me at telephone 650-827-7601 or e-mail maverick.douglas@faa.gov, or contact Mr. Douglas Pomeroy of my staff at telephone 650-827-7612 or e-mail douglas.pomeroy@faa.gov.

Sincerely,

M. Douglas

Maverick Douglas
Acting Manager

cc:
Director of Aviation, Norman Mineta San Jose International Airport
Chief Executive Officer, Santa Clara Valley Water District
Center Director, NASA Ames Research Center
Refuge Manager, Don Edwards San Francisco Bay National Wildlife Refuge

Sent via e-mail – no hard copy to follow

July 13, 2015
CIWQS Place ID 813084

U.S. Army Corps of Engineers
San Francisco District
Attn.: Thomas R. Kendall
1455 Market St.
San Francisco, CA 94103

Subject: Letter of support for the South San Francisco Bay Shoreline Project

Dear Mr. Kendall:

This letter is in response to your request for a letter supporting the flood risk management and ecosystem restoration project (Project) proposed in the December 2014 *Draft South San Francisco Bay Shoreline Phase I Study*, Integrated Document, *Draft Integrated Interim Feasibility Report and Environmental Impact Statement / Report* (Shoreline Study). Water quality certification (Certification) pursuant to section 401 of the federal Clean Water Act will be required to authorize construction of the Project. The San Francisco Bay Regional Water Quality Control Board (Water Board) usually reviews applications for Certification during the detailed, final design process that occurs after completion of a final environmental document. Therefore, we plan to consider issuing Certification for the Project following completion of Project review in compliance with the requirements of the California Environmental Quality Act (CEQA) and after review of near-final Project designs. At this time the Water Board has not been requested to take formal action on any requirements related to the Project. However, as is described below, the Project appears to be consistent with the intent of the *San Francisco Bay Basin Water Quality Control Plan* (Basin Plan), the Water Board's primary regulatory document, and, therefore, appears to be eligible for Certification. This letter provides Water Board staff's assessment of the proposed Project.

Project Description

The proposed Project is identified as Alternative 3 in the Shoreline Study. The Project's components include an Alviso North levee alignment, San José–Santa Clara Regional Wastewater Facility (WPCP) South levee alignment, a 30:1 (1 foot of elevation rise for each 30 feet of horizontal distance) ecotone adjacent to ponds A12/13 and A18, restoration of ponds A9-15 and A18, a flood gate across the Union Pacific Railroad tracks near ponds A12/13, and a tidal flood gate at Artesian Slough. The Project includes an engineered levee, approximately 15.2 feet high, along existing salt pond berms, the eastern border of Pond A12, and the southern borders of

ponds A16 and A18. The Project would allow for continued Federal Emergency Management Agency (FEMA) accreditation at the end of the study's period of analysis (2017-2067).

Water Board Comments

Water Board staff supports the Project and recognizes that it is needed both for flood protection and to enable the restoration of salt marsh and related habitats in about 2,800 acres of historically diked salt ponds in South San Francisco Bay, in the former Alviso Salt Pond Complex ponds A9 through A15 and A18. Since the current salt pond levees provide flood protection to the Alviso area, the Project will facilitate salt marsh restoration by allowing the outer salt pond levees to be breached after the Project has replaced flood protection provided by these levees. Project implementation is also part of a long-term adaptive management strategy to address the potential impacts of sea level rise in the Bay.

Reviewed in isolation, the flood control element of the Project, with adjacent ecotone fill, would place fill into about 137 acres of waters of the State, consisting of 16.8 acres of wetlands and 120.8 acres of open water. This impact is large for a single project and would require significant mitigation to be consistent with the Basin Plan, which incorporates the State of California's no net loss policy (Governor's Executive Order W-59-93 and Senate Concurrent Resolution No. 28). However, the Basin Plan also directs the Water Board to use the *Baylands Ecosystem Habitat Goals* (1999) (*Habitat Goals*), and the *Baylands Ecosystem Species and Community Profiles* (2000) (referred to collectively as the "Habitat Goals Reports") as guides for wetland restoration to protect beneficial uses of waters in San Francisco Bay. The *Habitat Goals* contains the following recommendation for the shoreline in the vicinity of Alviso Slough:

> Restore tidal marsh throughout most of the segment, providing a continuous corridor of tidal marsh along the bayshore… . Restoration should emphasize reestablishing a natural transition between tidal marsh and adjacent wetlands and upland habitats**,** as well as transitions between salt and brackish tidal marsh.

One of the significant beneficial uses that the Basin Plan assigns to waters of the State in South San Francisco Bay is the preservation of rare and endangered species. The proposed habitat enhancement activities in the Alviso Salt Pond Complex ponds will enhance this beneficial use. The Habitat Goals and the *USFWS Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (Recovery Plan) (USFWS, August 27, 2013), which include recovery actions for the California Ridgway rail (formerly California Clapper Rail) and salt marsh harvest mouse (SMHM), support both the restoration of as many acres of tidal marsh as feasible and the creation of ecotones between marsh habitats and upland high water refuges.

The ecotones will contribute to the value of the marsh and the future success of special status species using the marsh by providing an important transition zone. This type of upland transitional habitat is not well represented in the South San Francisco Bay due to the historic severe loss of habitat and the typically abrupt transitions between remaining middle marsh habitat and steep-sided levees. The ecotones will provide high tide cover and escape habitat for the California Ridgway Rail and SMHM, as well as providing some opportunity for landward migration of wetland habitat in the face of sea level change.

The Project's inclusion of tidal marsh restoration, along with the habitat enhancement provided by the ecotones in the proposed Project, supports the Water Board's ability to issue Certification for the Project.

As is noted in the Shoreline Study, South San Francisco Bay appears to be on the verge of becoming a sediment sink, rather than a sediment source. With increasing sea level and decreasing sediment supply, restoration practitioners and researchers in San Francisco Bay are encouraging all stakeholders to proceed with a sense of urgency to create sustainable marshes. Since the uncertainties related to sediment supply will increase over time, we encourage the U.S. Army Corps of Engineers to commence work on the Project as soon as possible.

Conclusion

In summary, Water Board staff is supportive of the Project, which will provide the integrated flood risk management and tidal habitat restoration that is necessary to support the preservation of rare and endangered species and to enhance habitat resilience to sea level rise. We look forward to continuing to work with the Project sponsors to complete the Certification process as further design details are provided.

If you have questions regarding the Certification process, please contact me at (510) 622-2314 or via email to bwolfe@waterboards.ca.gov.

Sincerely,

Digitally signed by Bruce H. Wolfe
DN: cn=Bruce H. Wolfe, o=SWRCB, ou=Region 2, email=bwolfe@waterboards.ca.gov, c=US
Date: 2015.07.13 12:20:27 -07'00'

Bruce H. Wolfe
Executive Officer

Cc:
John Bourgeois, California Coastal Conservancy – John.Bourgeois@scc.ca.gov
Melanie Richardson, Santa Clara Valley Water District – mrichardson@valleywater.org

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET ST.
SAN FRANCISCO, CALIFORNIA 94103-1398

July 16, 2015

Carole Roland-Nawi
State Historic Preservation Officer
Office of Historic Preservation
1725 23rd Street, Suite 100
Sacramento, California 95816

Dear Ms. Roland-Nawi:

The U.S. Army Corps of Engineers San Francisco District (USACE) has conducted a feasibility study entitled South San Francisco Bay Phase I Shoreline Study (Shoreline Study). The Shoreline Study project area comprises the industrial solar salt pond complex known as the Alviso Unit, which is situated at the southern end of San Francisco Bay near the town of Alviso (City of San Jose), Santa Clara County, California. The results of the Shoreline Study identified a dual-purpose project, which the USACE is undertaking: (1) ecosystem restoration that will convert the salt ponds into tidal salt marsh and (2) flood risk management that will involve levee construction across the salt ponds north of the town of Alviso. The Shoreline Study has incorporated a public-recreation component into the plans as well.

We initiated consultation in writing with you in December 2014, pursuant to 36 C.F.R. § 800, the implementing regulations of Section 106, National Historic Preservation Act, as amended. The USACE received a response letter in January 2015; however, you elected not to comment at that time because the submitted materials for the undertaking did not indicate that USACE had identified historic properties or assessed effects consistent with the standards of 36 C.F.R. § 800.4 through § 800.5.

Over the past two weeks, my staff and I have coordinated with Jessica Tudor through email and telephone conversations to rectify the data gaps by submitting materials (July 14th) that we believe sufficiently document USACE efforts to identify and evaluate historic properties, and to assess potential effects to identified properties. The USACE has identified two historic properties, the Alviso Historic District (in the town of Alviso) and the Alviso Salt Pond Historic Landscape per 36 C.F.R. § 800.4(b). In our opinion, implementing the ecosystem restoration would cause an adverse effect only to the Salt Pond Historic Landscape (36 C.F.R. § 800.5(a)).

In addition, we are confident that the submitted materials address other concerns in your letter, such as the delineation of the Area of Potential Effects in accordance with 36 C.F.R. § 800.4(a)(1) and clarifying the previous ecosystem restoration project in the Alviso Unit by the U.S. Fish and Wildlife Service, who satisfied the requirements of Section 106 and executed a Memorandum of Agreement (MOA). We feel that the measures contained in this MOA largely address the character of effect created by our project. We would like to reach agreement on how

best to address our project's effects to historic properties, if any, beyond those specifically addressed in the U.S. Fish and Wildlife Service agreement document.

If you have questions, please contact Kathy Ungvarsky, Archaeologist, at (415) 503-6842 or (email: kathleen.ungvarsky@usace.army.mil). I look forward to continuing the Section 106 process and receiving your comments.

Sincerely,

Thomas R. Kendall, P.E.
Chief, Planning Branch

AMENDMENT TO

MEMORANDUM OF AGREEMENT

AMONG THE U.S. FISH AND WILDLIFE SERVICE,
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER, AND
THE U.S. ARMY CORPS OF ENGINEERS
REGARDING
THE SOUTH BAY SALT POND RESTORATION PROJECT
INCLUDING RESTORATION OF FORMER INDUSTRIAL SALT PONDS TO TIDAL SALT MARSH AND OTHER WETLAND HABITATS,
INCLUDING THE FORMER SALT WORKS WITHIN THE ALVISO UNIT OF THE DON EDWARDS SAN FRANCISCO BAY NATIONAL WILDLIFE REFUGE AND THE CALIFORNIA DEPARTMENT OF FISH AND GAME'S EDEN LANDING ECOLOGICAL RESERVE, ALAMEDA AND SANTA CLARA COUNTIES, CALIFORNIA

(HEREAFTER "Agreement")

WHEREAS, the Agreement was executed in June, 2012;

WHEREAS, the U.S. Fish and Wildlife Service (USFWS) is proposing to amend this Agreement because of a beneficial and necessary activity described in "the San Francisco Bay Phase I Shoreline Survey" that recommends the U.S. Army Corps of Engineers San Francisco District (USACE) restore salt ponds to tidal salt marsh and repair levees adjacent to the U.S. Fish and Wildlife Service's (USFWS) property and encompassing a portion of the Alviso Salt Ponds within the Don Edwards National Wildlife Refuge (NWR) that are covered by the Agreement; and

WHEREAS, the Alviso Salt Ponds were determined to be eligible for the National Register of Historic Places (with SHPO concurrence dated 10/12/2010) and have been documented to Historic American Landscape Survey standards (HALS CA-92) and submitted to the Library of Congress (2013) as mitigation for the salt pond restoration activities as per this Agreement; and

WHEREAS, the USFWS is inviting the USACE to be a signatory party on the Agreement because they are proposing similar restoration activities in Alviso Ponds A9-18, along with critical levee flood control repairs bordering Alviso Ponds A18, A16, A-13, and A12 that will ensure the viability of the entire Alviso Salt Pond restoration project (undertaking); and

WHEREAS, the Area of Potential Effects (APE) for the Agreement is being expanded to include Alviso Pond A18 and the bordering levee (Expanded-APE) (Amendment Attachment-1); and

WHEREAS, the USACE will complete identification and evaluation of historic properties within the Expanded-APE prior to beginning restoration activities in Pond A18 and levee construction; and

WHEREAS, changing the function and appearance (character defining features) by restoring Pond A18 to salt marsh is a potential adverse effect, similar to the adverse effects determined in the Agreement for the other Alviso Salt Works ponds; and

WHEREAS, converting Pond A18 to tidal salt marsh is similar to the other Alviso Salt Works Historic District ponds which are the subject of the Agreement; therefore the HALS documentation for the Alviso Salt Works Historic District is sufficiently comprehensive to embrace Pond A18; and

WHEREAS, the USACE has provided written information on the Shoreline Study findings to the Native American tribes listed with the California Native American Heritage Commission, and has invited the tribes in writing to comment, but has not received any comments; and

WHEREAS, the USACE will send a copy of this executed amendment to the Advisory Council on Historic Preservation; and

NOW, THEREFORE, in accordance with Stipulation I and Stipulation II. C. of the Agreement, the USFWS, USACE, and SHPO agree to amend the Agreement as follows:

Amend Stipulation I. Area of Potential Effect by inserting the following text as paragraph C:

> "Specifically, the APE is extended to also include existing waterways (Alviso Slough to the west and Coyote Creek to the north) that could be impacted by pond restoration or levee construction (sewage treatment ponds north and east of the proposed levee). All project actions would occur within Ponds A9–A15 and A18, all south of Coyote Creek. In addition, the entire Alviso Marina (at the southernmost point of Pond A12 along Alviso Slough) has been included because the proposed levee would tie in at the existing levee just east of the marina. No other actions are proposed for the marina property.
>
> Along the southern edge, the area has been defined by applying a 100-foot buffer to the southernmost levee option. This area includes land that would be available for use during construction for activities such as materials and equipment staging and temporary roads for transporting equipment, materials, and personnel along the levee construction route. All ground-disturbing construction activities would occur within this boundary."

Amend Stipulation II. A by inserting a second paragraph with the following text:

> "The USACE will complete the identification and evaluation of historic properties within the Expanded-APE prior to beginning restoration activities. All draft historic property identifications and determinations of eligibility (DOE) will be submitted to SHPO and USFWS for a 30-day review and comment period. The USACE will address

the comments and resubmit the final DOE to the USFWS and SHPO for concurrence. The SHPO will have 30 days to respond.

If Pond A18 is found to be a contributing property, the USACE will revise the Alviso Salt Works Historic District DPR-523 form to include a description of the pond, a map(s), historical background, and photographs. A draft of the revised DPR-523 form will be transmitted to SHPO and USFWS for 30-day review and comment period. The USACE will address comments, submit a revised document, and request concurrence from SHPO on the Pond A18 DOE. The SHPO will have 30 days to review the revised document. The final revised DPR-523 form will then be transmitted to the USFWS, the SHPO, and the Northwest Information Center, prior to June 2019."

Amend Stipulation II.C. to insert the following text:

"The same procedures outlined by the USFWS in their Historic Properties Treatment Plan to manage new archaeological discoveries during restoration of the NWR ponds will apply to Pond A18 and the levee (Expanded-APE). The USACE will also be responsible for managing inadvertent discoveries in the Expanded-APE."

Amend the Signatory Block to include the USACE as follows:

SIGNATORY PARTIES

U.S. FISH and WILDLIFE SERVICE

By: _____ Date: 3 Sept 2015

Anne Morkill, Refuge Complex Manager
Don Edwards San Francisco Bay National Wildlife Refuge

CALIFORNIA STATE HISTORIC PRESERVATION OFFICER

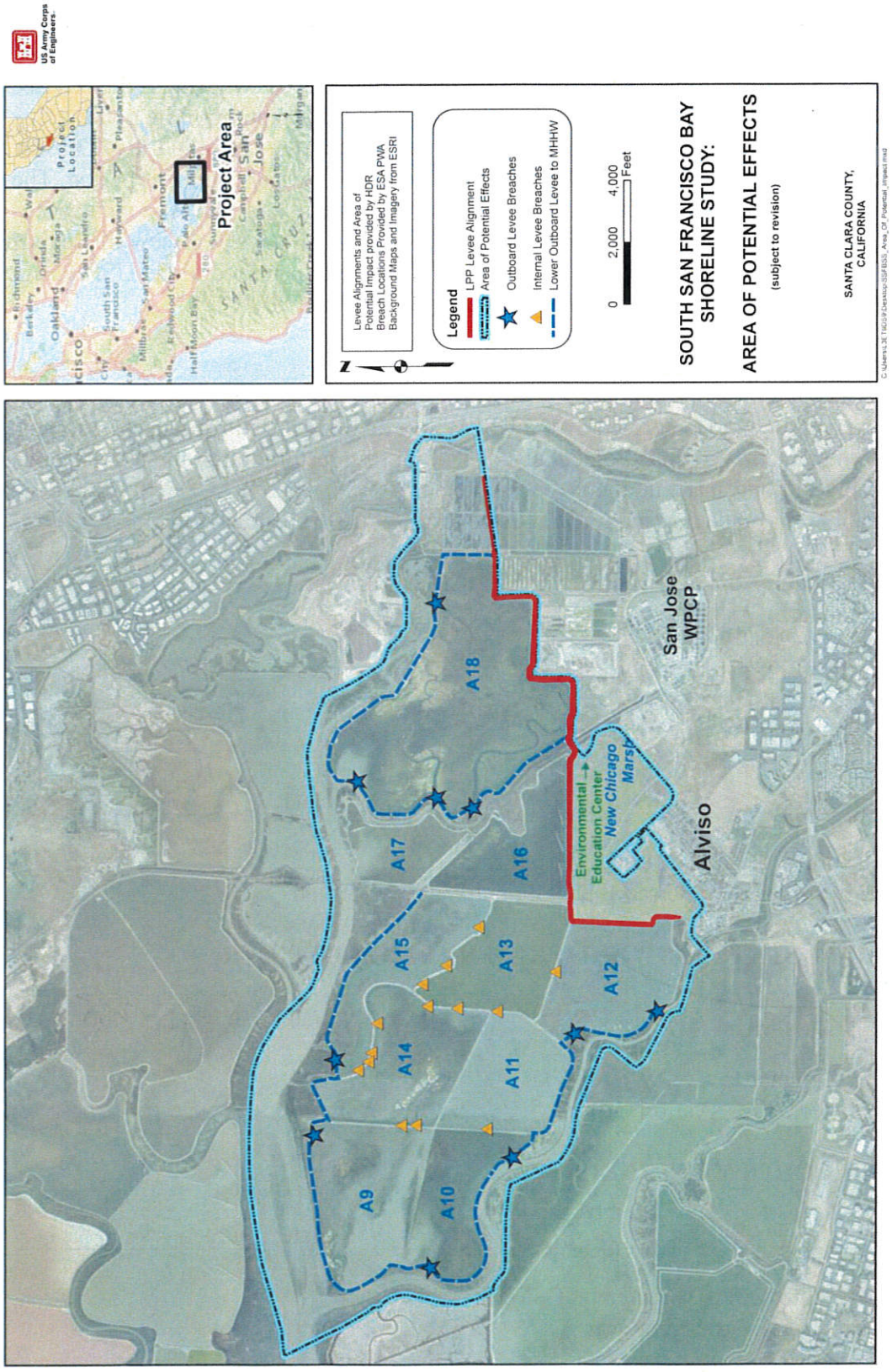
By: _____ Date: 8 Sept 2015

Julianne Polanco
State Historic Preservation Officer

U.S. ARMY CORPS of ENGINEERS

By: _____ Date: 3 Sep 15

John C. Morrow, P.E. Lieutenant Colonel
San Francisco District Engineer



Amendment Attachment-1. Expanded-APE includes A18 and levee.

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET ST.
SAN FRANCISCO, CALIFORNIA 94103-1398

July 16, 2015

Ms. Rosemary Cambra, Chairperson
Muwekma Ohlone Indian Tribe
of the San Francisco Bay Area
P. O. Box 360791
Milpitas, CA 95036

Dear Ms. Cambra,

The U.S. Army Corps of Engineers, San Francisco District (USACE) has conducted a study entitled South San Francisco Bay Shoreline (Shoreline), and is proposing a two-part project: ecosystem restoration that will convert the Alviso salt ponds into tidal salt marsh and flood risk management that will involve levee construction outside and north of the town of Alviso across the salt ponds. The project has incorporated a public recreation component into the plans as well.

The USACE has prepared a draft Environmental Impact Report/Statement (EIR/S), published December 2014. Since then, we have initiated consultation with the State Historic Preservation Officer pursuant to the Section 106 implementing regulations at 36 C.F.R. § 800. As part of that process, I request your comment on the USACE undertaking.

Please find enclosed two documents: (1) the Cultural Resources section of the USACE draft EIR/S and (2) a Memorandum for Record that summarizes the USACE Shoreline project, highlights the historic properties identified and consideration of effects, and provides background information on the previous U.S. Fish and Wildlife Service Section 106 efforts for tidal marsh restoration in south San Francisco Bay and how it relates to the USACE undertaking.

If you would like to receive the entire EIR/S or any other documents, we would provide hard copies or electronic files on a CD. Please contact Kathleen Ungvarsky, Archaeologist, at (415) 503-6842 (email: kathleen.ungvarsky@usace.army.mil) for additional information.

Sincerely,

Thomas R. Kendall
Chief, Planning Division

Enclosures

Mr. Valentin Lopez
Chairman, Amah Mutsun Tribal Band
PO Box 5272
Galt, CA. 95632

Ms. Katherine Erolinda Perez
Ohlone/Costanoan Indian Tribe
P.O. Box 717
Linden, CA 95236

Ms. Jakki Kehl
Ohlone Indian Tribe
720 North 2nd Street
Patterson, CA 94363

Ms. Michelle Zimmer
Amah Mutsun Tribal Band of Mission San Juan Bautista
789 Canada Road
Woodside, CA 94026

Representative Ramona Garibay
Ohlone/Costanoan Indian Tribe
Trina Marine Ruano Family
30940 Watkins Street
Union City, CA 94587

Ms. Ann Marie Sayers
Indian Canyon Mutsun Band of Costanoan
P. O. Box 28
Hollister, CA 95024

Irene Zwierlein
Amah Mutsun Tribal Band of Mission San Juan Bautista
789 Canada Road
Woodside, CA 94062

Mr. Andrew Galvan
The Ohlone Indian Tribe
Mission San Jose
PO Box 3152
Fremont, CA 94539

Memorandum for Record July 2015

Subject: San Francisco Bay Phase I Shoreline Study

1. This MFR includes a project description of the ecosystem restoration measures and flood risk management levee currently proposed by the U.S. Army Corps of Engineers San Francisco District (USACE) for the salt pond complex known as the Alviso Unit. It also includes background information on the U.S. Fish and Wildlife Service (USFWS) restoration program in the Alviso Unit and its relationship to the USACE project.

2. USACE Project Description and APE. The USACE proposed action, referred to as the San Francisco Bay Phase I Shoreline Study (Phase I Project), would involve an area of 13 salt ponds located in the eastern half of the Alviso Unit, which has a total of 25 salt ponds (Figure 1). All but one salt pond in the APE are situated within the USFWS Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) administered by the USFWS. The one pond added to USACE Phase I Project APE (A18) is owned by the City of San Jose. In the APE, restoration activities will focus on converting the salt ponds to naturally functioning, tidally influenced salt marsh, which will require breeching levees and opening ponds to the tides, building levees between the newly restored tidal marsh areas and local communities, and restoring habitat features.

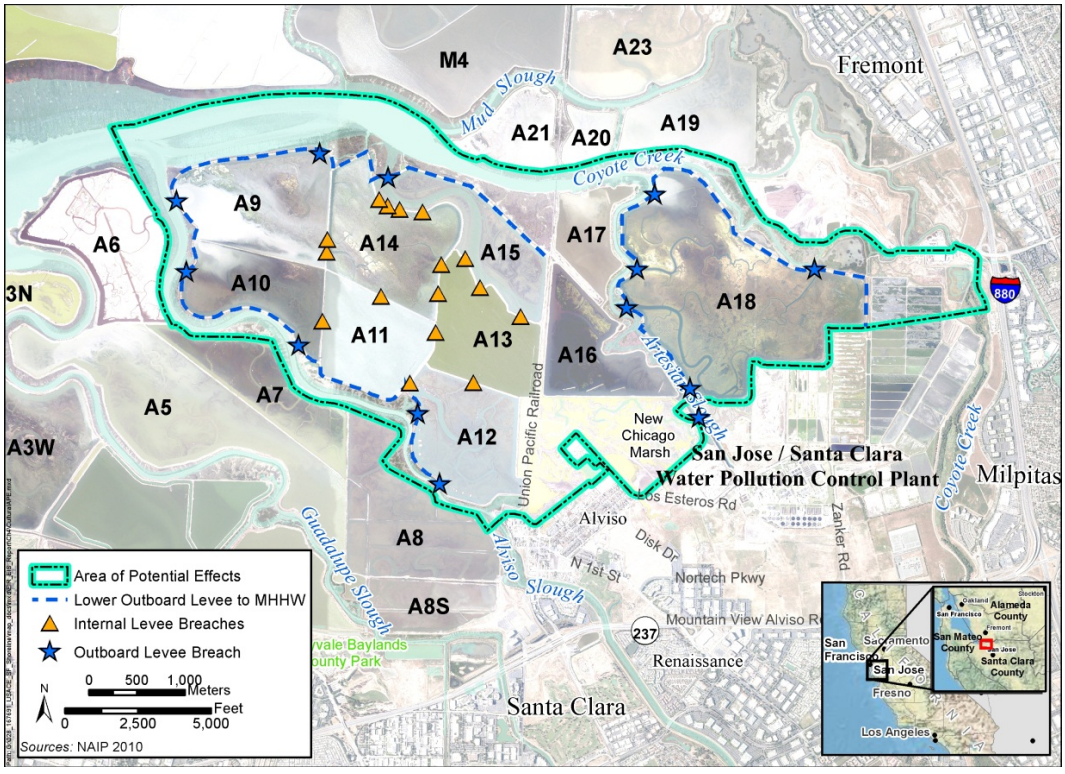


Figure 1: San Francisco Bay Phase I Shoreline Project Area of Potential Effects

3. The Phase I Project is a dual-purpose project, closely associated with the USFWS restoration program: the conversion of industrial salt ponds into tidally influenced salt marsh, and the construction of a flood risk management levee that is critical to the function of the

restoration measures. The Phase I Project is related to an extensive, multiagency program in San Francisco Bay, entitled the South Bay Salt Pond Restoration Project (SBSPRP), which has identified approximately 20,000 acres of former industrial salt-pond complexes stretching across the South Bay shoreline between Fremont and Palo Alto that would be restored to tidal salt marsh and other wetland habitats. Under the SBSPRP, the USFWS identified three major historic salt pond complexes in the South Bay and outlined restoration plans: Eden Landing Unit near Hayward, Ravenswood Unit near Palo Alto, and Alviso Unit in north San Jose.

4. USFWS Section 106. In 2012, the USFWS consulted with the California State Historic Preservation Office (SHPO) regarding the restoration program for the entire Alviso Unit, and consequently, satisfied the requirements of Section 106 of the National Historic Preservation Act (NHPA), pursuant to 36 C.F.R. § 800, by executing a Memorandum of Agreement (MOA) that included a Historic Property Treatment Plan (HPTP). Information from the USFWS Section 106 compliance is highlighted below; it has direct impact on the current USACE effort to comply with Section 106

5. Alviso Unit National Register. The USFWS evaluated the Alviso Unit, concluded that it was eligible for inclusion in the National Register of Historic Places (National Register), and received concurrence from the California State Historic Preservation Officer (SHPO) that the *Alviso Salt Pond Historic Landscape (Historic Landscape)* is a Historic Property under Criterion A of the National Register. The USFWS technical report discussing the National Register evaluation of the Alviso Unit is entitled "Appendix E: Identification and Evaluation of the South San Francisco Bay Solar Salt Industry Landscape," a copy of which is available from USACE.

The Alviso Unit APE was surveyed by the USFWS, which consisted of walking the outboard and inboard salt pond levees, recording archaeological features on and next to the levees as well as documenting features in the ponds through visual observations and GPS recording. The USACE technical report, which is entitled "Cultural Resource Assessment: South San Francisco Shoreline Interim Feasibility," presents the results of its research and survey effort; it is available from USACE.

6. USFWS Adverse Effects. The USFWS determined that restoration would cause adverse effects to the *Historic Landscape* as a result of converting salt ponds into tidal marsh, because the project will change the character-defining elements of the property by affecting their function and appearance. Under the terms of HPTP, the USFWS prepared a report on the *Historic Landscape* that meets the requirements of the *Historic American Landscape Survey*. The report was submitted to the Library of Congress through the National Park Service. The determination of adverse effect to the *Historic Landscape* is consistent with USACE finding. Even with the addition of pond A18 to the USACE undertaking, USACE suggests that additional mitigation measures beyond the USFWS report may not be needed, an issue that will be part of USACE Section 106 consultation with SHPO for the tidal marsh restoration project component.

7. USACE Levee Contribution. Although the USFWS restoration program included the concept of new levees in the Alviso Unit, USACE has explicitly outlined the design and siting of the levee, and evaluated the visual impacts, the results of which were presented in the USACE draft Environmental Impact Report/Statement (EIS/R). The USACE considered alternatives to a new levee, including a no-action alternative, and selected the least environmentally damaging levee alternative (out of three possible alternatives) in consideration of the wishes of Alviso

residents (Figure 2). The new levee alignment follows the alignment of an existing, non-engineered levee; however, the new levee will have engineered dimensions and will be larger. The new Alviso North levee is situated far from the town to reduce the level of adverse visual effects. The EIR/S includes simulation photos that show the view of the new levee from different points around Alviso.

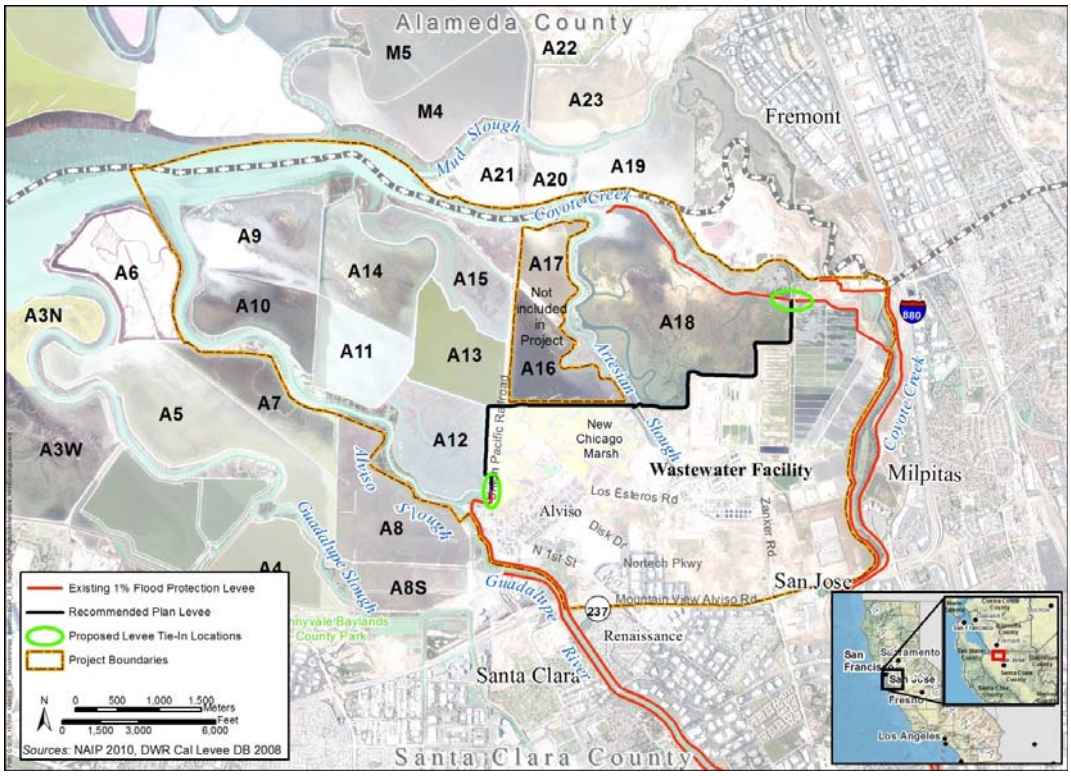


Figure 2: Study Area Map Showing Levee Location

8. USACE Levee and Alviso Historic District. In addition to the salt pond *Historic Landscape*, the other historic property of importance for the USACE Section 106 consultation is the Alviso Historic District. Alviso, known as "Port of Alviso (San José)," was listed in the National Register in 1973 as a District. The Alviso Historic District comprises eleven buildings on ninety acres. The Port of Alviso is also a State of California Point of Historical Interest (SHPI SCL-061) and listed in the California History Plan and California Inventory of Historic Resources.

Alviso is situated adjacent to, and overlooks, the vast salt pond complex. The northwest boundary of the Historic District is adjacent to the part of the APE where the western end of the flood levee will tie into to the existing levee at the Alviso Marina. This construction would require work near and possibly in the Historic District. The addition of a new levee would not cause an adverse effect to any of the contributing elements of the Historic District, or to any non-contributing buildings. The introduction of a larger levee would cause a minor change in the character and setting; however, constructing this feature would not diminish the integrity of the District's significant historic features. USACE has therefore determined that the undertaking will not cause an adverse effect to the Alviso Historic District.

9. USACE Cultural Resource Inventory. The USACE Phase I research identified several other historic sites and prehistoric cultural resources situated near but outside the USACE APE. They were nonetheless visited during archaeological surveys and updated site information recorded. One archaeological site (CA-ALA-338) is of particular interest, because it is recorded as the disturbed remnants of a shell deposit situated in the bottom of a salt pond. Archaeologists have observed ALA-338 for decades, and most recently both USACE and the USFWS have reported on this site in their cultural resource documents noted above. The site appears to be situated east of the Alviso Unit APE, i.e., east of Pond A19, but this ancillary salt pond area may be under the USFWS jurisdiction. If it is Refuge lands, the USFWS monitoring and management measures in their HPTP (attached to the MOA) would be applicable. The USACE will follow up on this matter.

10. The USACE understands that the USFWS consulted local Native American tribal representatives and invited them to comment on the SBSPRP restoration measures for the Alviso Unit. To date, the USACE has not offered the tribes an opportunity to comment. USACE will engage the tribes through written correspondence and request their comment and recommendations.

MEMORANDUM OF AGREEMENT
BETWEEN THE U.S. FISH & WILDLIFE SERVICE
AND THE
CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING
THE SOUTH BAY SALT POND RESTORATION PROJECT
INCLUDING RESTORATION OF FORMER INDUSTRIAL SALT PONDS TO TIDAL SALT MARSH AND OTHER WETLAND HABITATS, INCLUDING THE FORMER SALT WORKS SITES WITHIN THE ALVISO UNIT ON THE DON EDWARDS SAN FRANCISCO BAY NATIONAL WILDLIFE REFUGE AND CALIFORNIA DEPARTMENT OF FISH AND GAME'S, EDEN LANDING ECOLOGICAL RESERVE; ALAMEDA AND SANTA CLARA, COUNTIES, CALIFORNIA

WHEREAS, the South Bay Salt Pond Restoration Project (SBSPRP) is an extensive project that includes approximately 20,000 acres of former industrial salt pond complexes along the shoreline of the San Francisco Bay, south of the San Mateo Bridge. The salt ponds were part of a vast system of salt ponds previously operated by Cargill Salt. In 2003 the Alviso and West Bay salt pond complexes were transferred to the U.S. Fish and Wildlife Service and included in the Don Edwards San Francisco Bay National Wildlife Refuge (DESFBNWR). The Baumberg salt pond complex, now knows as the Eden Landing Ecological Reserve, is owned and managed by the California Department of Fish and Game (CDFG). The SBSPRP is partially on federal property, will require a federal permit, and will use federal funding. Restoration activities will change the salt ponds to salt marsh which alters their function and open water appearance, both of which are contributing characteristics of the historic landscape and has the potential to affect a historic property (Undertaking) (Figure 1 in Attachment 1); and

WHEREAS, the U.S. Fish and Wildlife Service (USFWS) has determined, in consultation with the California State Historic Preservation Officer (SHPO), that the former salt works and evaporative salt industry ponds associated with the Alviso Unit of the DESFBNWR and property owned and managed by the CDFG known as the Eden Landing Ecological Reserve (ELER) are eligible for inclusion in the National Register of Historic Places under Criteria A (historic property) as historic landscapes, including the six eligible archaeological sites identified within the ELER as defined in 36 CFR Part 800, the regulation implementing Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. 470f). The SHPO concurred with the evaluation on October 12, 2010; and

WHEREAS, the USFWS has determined that altering the former industrial salt ponds in the Alviso and ELER complexes by replacing the controlled flow of water with a tidally influenced marsh environment will adversely affect the character defining elements of the ponds by affecting their function and appearance and may adversely affect the archaeological sites by changing the water system (Adverse Effect); and

WHEREAS, the USFWS has consulted with the SHPO pursuant to 36 CFR Part 800 regarding the Undertaking's adverse effects on historic properties and the USFWS has notified the Advisory Council on Historic Preservation (Council) of the adverse effect pursuant to 36 CFR 800, implementing Section 106 of the National Historic Preservation Act, as amended, 16 U.S.C. 470f (NHPA). The Council has declined to participate in a letter dated December 3, 2010; and

WHEREAS, a portion of the project is on land owned by the CDFG. The USFWS and CDFG have consulted regarding this project and have executed a Memorandum of Understanding (MOU) that determines that the USFWS is the lead agency and defines the relationship and responsibilities of each agency. The CDFG is a consulting party with obligations that are associated with the resolution of the adverse effect, thus they have been invited to concur in this MOA (800.6(c)(3); and

WHEREAS, the USFWS has consulted with interested parties and tribes. The SBSPRP includes a wide variety of partners and agencies. Communication with and input from stakeholders in the community and interested organizations continues to be achieved using public meetings and workshops, a website, a newsletter, press releases, and presentations, to ensure that the public remains informed about the project status and is involved in the planning and implementation process. The USFWS consulted with tribes and tribal members provided by the California Native American Heritage Commission. Consultation was also accomplished through contacts during the public outreach efforts. The Hayward County Historical Society and parties that expressed an interest will continue to be updated as the project is implemented; and

NOW, THEREFORE, the USFWS and the SHPO agree that if the Undertaking proceeds, the Undertaking shall be implemented in accordance with the following stipulations in order to take into account the effects of the Undertaking on a historic property and to satisfy the requirements of Sections 106 and 110(b) of the NHPA, and further agree that these stipulations shall govern the Undertaking and all of its parts until this Memorandum of Agreement (MOA) expires or is terminated.

STIPULATIONS

The USFWS and by extension through the MOU, CDFG shall ensure that the following stipulations are implemented:

I. Area of Potential Effect

A. The Area of Potential Effect (APE) is depicted in Figures 2 and 3 (Attachment 1) and includes the Alviso Historic District and ELER Historic District that are located in the southern end of San Francisco Bay. The ELER encompasses 6612 acres divided into 23 ponds. The Alviso Unit encompasses 9677 acres divided into 28 ponds. Within the APE, activities will focus on restoring the salt ponds to naturally functioning, tidally influenced salt marsh which requires breeching levees and opening ponds to the tides, building levees between the newly restored

tidal marsh areas and local communities, and restoring habitat features. Additionally, archaeological resources within the ELER Historic Landscape that are contributing elements of the landscape may be affected by fluctuating water levels

B. If modifications to the Undertaking take place subsequent to the execution of this MOA that necessitate the revision of the APE, USFWS will consult with the SHPO to facilitate mutual agreement on the subject revisions. If USFWS and SHPO cannot reach an agreement, then the parties will resolve the dispute in accordance with Stipulation III.B of this document. Should the USFWS and SHPO reach mutual agreement on the proposed revisions the USFWS will submit a final map of the revision no later than 30 days following such an agreement.

II. Mitigation of Project Effects to Historic Properties

The USFWS has consulted with the SHPO and has developed a historic properties treatment plan (Attachment 2) that will be implemented, prior to and during the SBSPRP. The mitigation plan follows the *Secretary of the Interior's Standards for the Treatment of Historic Properties* and includes the following elements:

A. Recordation of Historic Properties: The Alviso and ELER salt pond complexes are considered historic landscape districts. The USFWS consulted with the Regional Coordinator for the HALS program at the National Park Service regarding the requirements for photo documentation and recordation of the landscape that is commensurate with the level of adverse effect. NPS-HALS program staff responded with guidance on the requirements for recordation, therefore all recordation and photography documentation requirements will be in accordance with this guidance. The HALS documentation will be submitted to the NPS for transmittal to the Library of Congress. Copies of the HALS documentation will also be maintained at the DESFBNWR, USFWS Cultural Resources Team office, CDFG, and the Hayward County Historical Society.

B. Interpretation of Solar Salt Industry: Interpretive materials will be developed, including at least one interpretive panel and pamphlet that describes the solar salt industry process and landscape features that were associated with the evaporative salt industry. A draft of the interpretive materials will be shared with SHPO and interested parties for review and comment. The panel will be installed within the ELER. The timeline for completing the interpretive materials is based on the pace of the restoration project but is estimated to be within 5 years of the date of this agreement

C. Archaeological Resources: Archaeological resources within the ELER that are contributing elements of the historic landscape will be treated according to the Treatment Plan (Attachment 2). Generally, sites will be protected *in situ*.

However, sites that are affected by fluctuating water levels will be documented with photography, GPS mapping, and limited subsurface testing of features and selective surface collection. The sites will then be monitored once a year at a low tide event or summer dry season for five consecutive years from the signing of this MOA. Monitoring will continue until the restoration work is completed. No additional affects are anticipated from the restoration work once the salt marsh habitat has been reestablished, at that point monitoring will cease. If any site appears to be accessible to vandals or the structure of the site changes due to vandalism, then a more substantial data collection procedure will be instituted. There is also the potential for new discoveries to occur and these will be managed by recordation and data collection procedures outlined in the Historic Properties Treatment Plan (Attachment 2).

III. Administrative Provisions

A. Standards

1. Professional Qualifications: All activities prescribed in Stipulations I and II of this MOA shall be carried out under the authority of USFWS by or under the direct supervision of a person or persons meeting at a minimum the *Secretary of the Interior's Professional Qualifications Standards* (48 FR 44738-3, September 29, 1983) in the appropriate disciplines.

B. Dispute Resolution

1. Should the SHPO object to the manner in which the terms of this MOA are implemented, to any action carried out or proposed with respect to implementation of the MOA, or to any documentation prepared in accordance with and subject to the terms of this MOA, the USFWS shall immediately consult with the SHPO for no more than 30 days to resolve the objection. If the objection is resolved through such consultation, the action subject to dispute may proceed in accordance with the terms of that resolution. If, after initiating such consultation, the USFWS determines that the objection cannot be resolved through consultation, the USFWS shall forward all documentation relevant to the objection to the Council, including the USFWS proposed response to the objection, with the expectation that the Council will within 45 days after receipt of such documentation:

    a. Advise the USFWS that the Council concurs in the proposed response to the objection, whereupon the USFWS will respond to the objection accordingly; or

b. Provide the USFWS with recommendations, which the USFWS will take into account in reaching a final decision regarding its response to the objection; or

c. Notify the USFWS that the objection will be referred for comment to the Council pursuant to 36 CFR 800.7, and proceed to refer the objection and comment. The USFWS shall take the resulting comment into account in accordance with 36 CFR 800.7(c)(4) and Section 110 (1) of the NHPA.

2. Should the Council not exercise one of the above options within 45 days after receipt of all pertinent documentation, the USFWS may assume the Council's concurrence in its proposed response to the objection.

3. The USFWS shall take into account any Council recommendation or comment provided in accordance with this stipulation with reference only to the subject of the objection. The USFWS responsibility to carry out all actions under this MOA that are not the subjects of the objection will remain unchanged.

4. At any time during implementation of the measures stipulated in this MOA should an objection pertaining to such implementation be raised by a member of the public, the USFWS shall notify the SHPO and take the objection into account, consulting with the objector and, should the objector so request, with the SHPO to address the objection. The time frame for such consultation shall be reasonably determined by the USFWS.

5. The USFWS shall provide to the SHPO, the Council when Council comments have been issued hereunder, and any parties that have objected pursuant to paragraph B.4., above, with a copy of its final written decision regarding any objection addressed pursuant to this stipulation.

6. The USFWS may authorize any action subject to objection under this stipulation to proceed after the objection has been resolved in accordance with the terms of this stipulation.

C. Amendments

Either signatory may propose that this MOA be amended, whereupon the signatories will consult for no more than 30 days to consider such amendment. The amendment process shall comply with 36 CFR 800.6(c)(1) and 800.6(c)(7). This MOA may be amended only upon the written agreement of the signatories. If it is not amended, this MOA may be terminated by either signatory in accordance with Stipulation D., below.

D. Termination

1. If this MOA is not amended as provided for in paragraph C. of this stipulation, or if

either signatory proposes termination of this MOA for other reasons, the signatory proposing termination shall in writing notify the other signatory, explain the reasons for proposing termination, and consult with the other signatory for at least 30 days to seek alternatives to termination. Should such consultation result in an agreement on an alternative to termination, then, the signatories shall proceed in accordance with the terms of that agreement.

2. Should such consultation fail, the signatory proposing termination may terminate this MOA by promptly notifying the other signatory in writing. Termination hereunder shall render this MOA null and void. If this MOA is terminated hereunder and if the USFWS determines that the Undertaking will nonetheless proceed, then the USFWS shall either consult in accordance with 36 CFR 800.6 to develop a new MOA or request the comments of the Council pursuant to 36 CFR Part 800.

E. Duration of the MOA

Unless terminated pursuant to paragraph D. of this MOA, or unless it is superseded by an amended MOA, this MOA will be in effect until the USFWS, in consultation with the SHPO, determines that all of its stipulations have been satisfactorily fulfilled. The duration of this MOA will not exceed seven (7) years, because of the restoration phases that require up to five years to complete, unless the signatory parties agree to an extension. Upon a determination by USFWS that all of the terms of this MOA have been satisfactorily fulfilled, this MOA will terminate and have no further force or effect. The USFWS will promptly provide the SHPO and CDFG with written notice of its determination and of the termination of the MOA. Following provision of such notice, this MOA will be null and void.

F. Effective Date

This MOA will take effect when it has been executed by both the USFWS and the SHPO. Execution of this MOA by the USFWS and the SHPO, its transmittal by the USFWS to the Council in accordance with 36 CFR 800.6(b)(1)(iv) and subsequent implementation of its terms, shall evince pursuant to 36 CFR 800.6(c), that this MOA is an agreement with the Council for purposes of Section 110(1) of the NHPA, and shall further evince that the USFWS has afforded the Council an opportunity to comment on the Undertaking and its effects on historic properties, and that the USFWS has taken into account the effects of the Undertaking on historic properties. The CDFG is a concurring party to the MOA as represented by their signature.

U.S. FISH and WILDLIFE SERVICE

By: D. Mendel Stewart Date: 5/25/12

Mendel Stewart, Project Leader, San Francisco Bay NWR Complex, Region 8

CALIFORNIA STATE HISTORIC PRESERVATION OFFICER

By: Milford Wayne Donaldson Date: 28 JUN 2012

Mr. Milford Wayne Donaldson, FAIA: California State Historic Preservation Officer

Concurring Party
CALIFORNIA DEPARTMENT OF FISH AND GAME

By: Scott Wilson Date: 6/12/12

Mr. Scott Wilson, Acting Regional Manager, Bay Delta Region

Attachments:
Attachment 1: Figure 1. Project Location Map.
Figure 2. Alviso Unit APE.
Figure 3. ELER APE.

Attachment 2: Historic Properties Treatment Plan

ATTACHMENT 1.

South Bay Salt Pond Restoration Project

Project Overview and APE Map

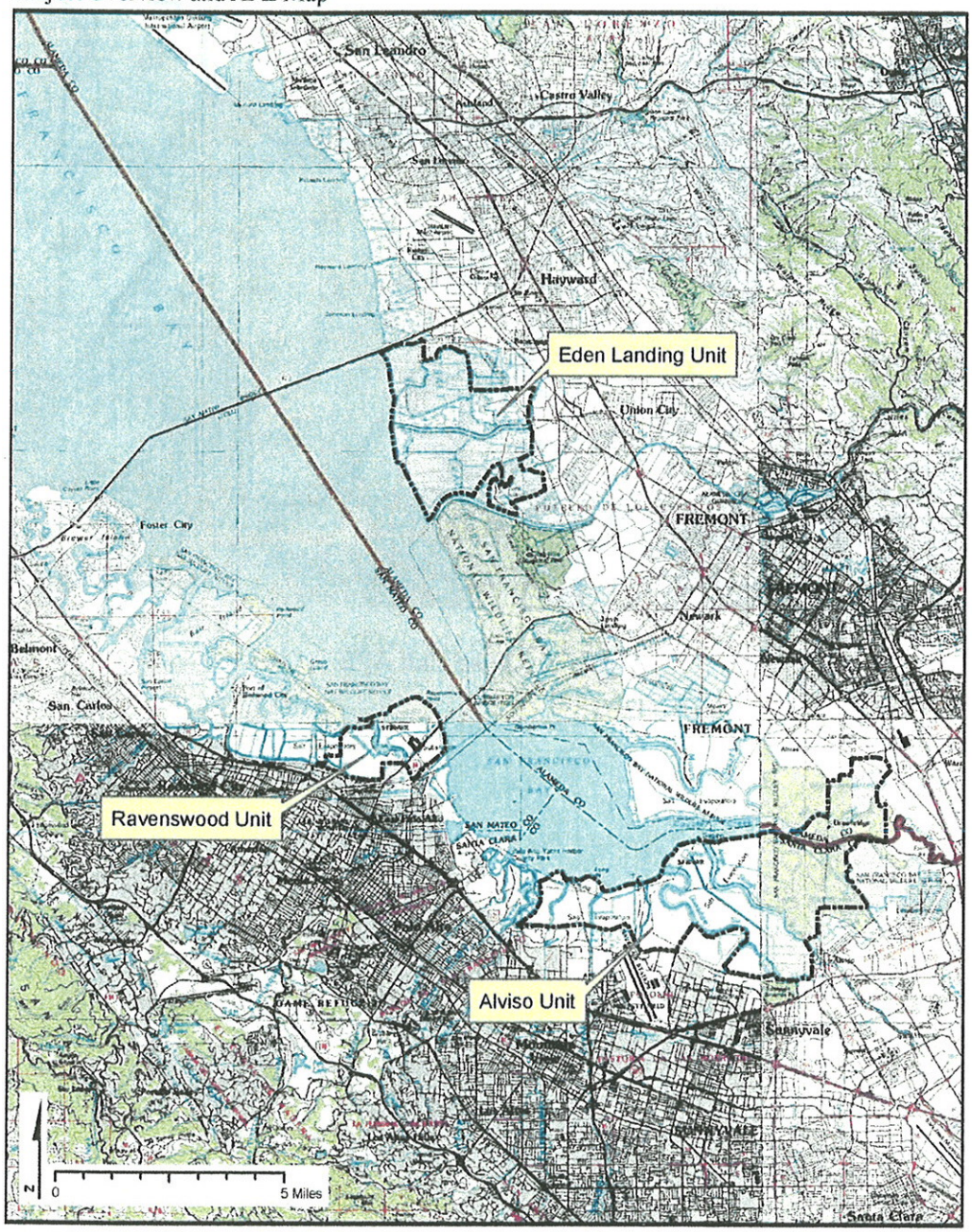


Figure 1. Project location map.

South Bay Salt Pond Restoration Project

Alviso Unit APE Map

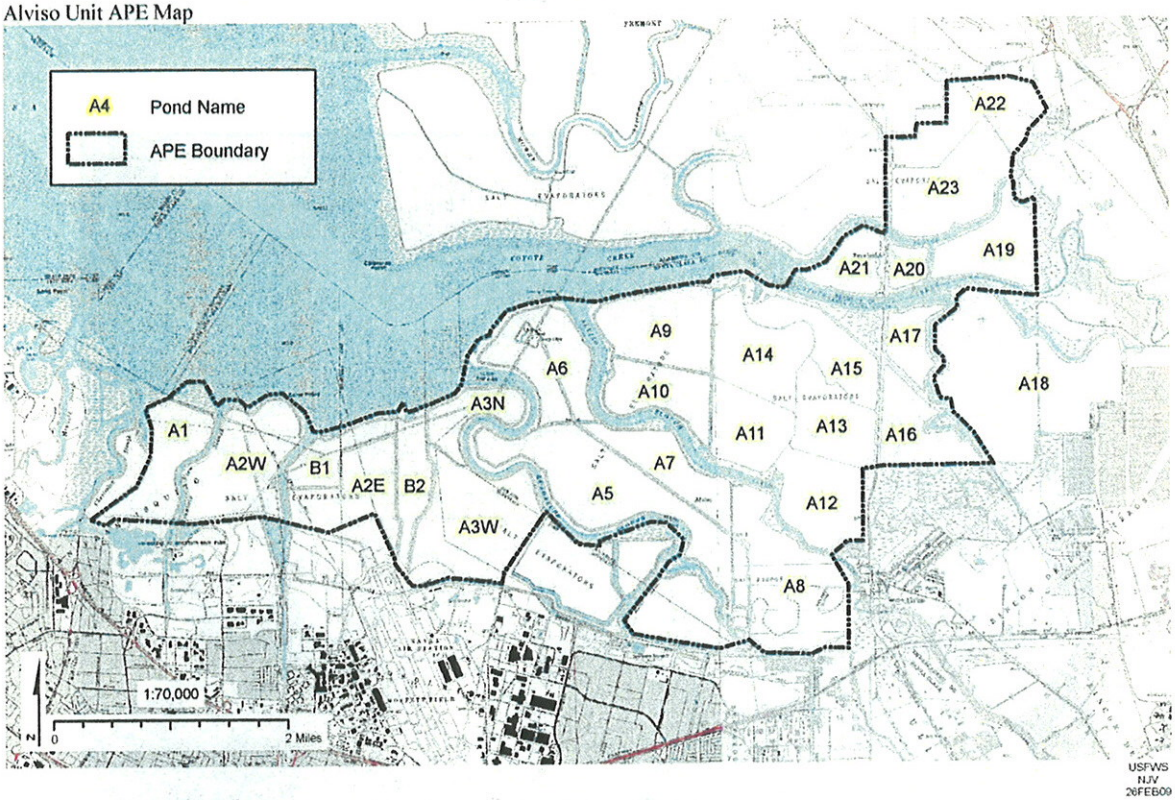


Figure 2. Alviso Unit APE.

South Bay Salt Pond Restoration Project

Eden Landing Unit APE Map

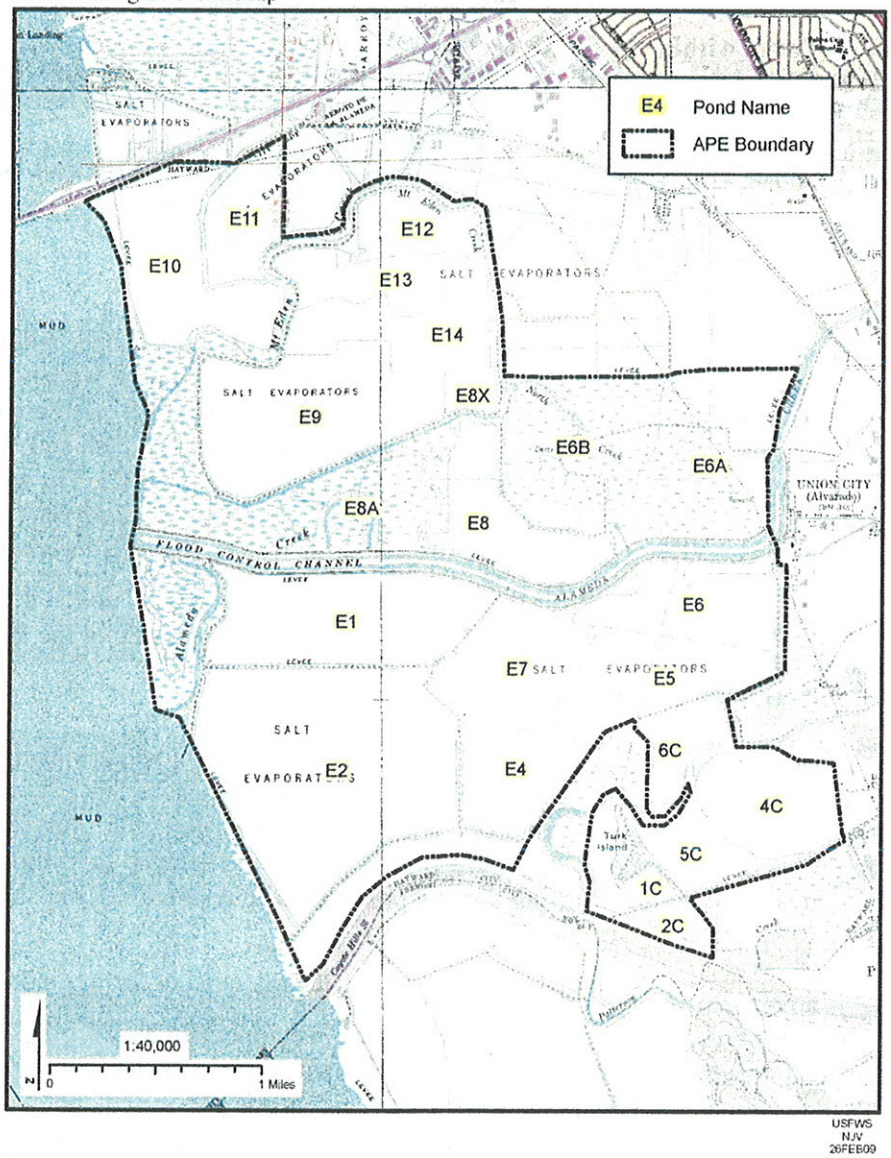


Figure 3. ELER APE.

ATTACHMENT 2.

U.S. Fish and Wildlife Service Project #FWS040721A
Historic Properties Treatment Plan
for the
Salt Works within the South Bay Salt Pond Restoration Project at the
Alviso Unit, Don Edwards San Francisco Bay National Wildlife Refuge,
and the
Eden Landing Ecological Reserve, California Department of Fish and Game
Alameda and Santa Clara counties, California
January 14, 2011/revised May 4, 2012

Introduction

The South Bay Salt Pond Restoration Project (SBSPRP) will restore the former industrial salt production ponds in South San Francisco Bay to a more natural mix of tidal wetland habitats and managed ponds. The restoration comprises former salt ponds located at the southern end of San Francisco Bay. The SBSPRP encompasses property managed by the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG). The agencies are working together along with the California State Coastal Conservancy (Conservancy) and U.S. Army Corps of Engineers (USACE) and other project partners. The SBSPRP is composed of three noncontiguous units, including the Eden Landing Ecological Reserve (ELER or Eden Landing) on the east side of the Bay near the San Mateo bridge; the Alviso unit at the southern end of the bay; and the West Bay-Ravenswood unit located on the west side of the Bay near the Dumbarton Bridge (Figure 1).

In 2010 the salt works at the Alviso Unit and ELER were evaluated and determined to be eligible to the National Register of Historic Places (NRHP) as historic landscapes that encompass a range of condensing ponds, archaeological resources, and features associated with solar salt production and processing. This historic properties treatment plan has been developed to mitigate for the adverse effects associated with converting the salt ponds back to a native salt marsh habitat.

Undertaking

The SBSPRP is an extensive project that includes nearly 20,000 acres of former industrial salt ponds that were part of a vast system of salt ponds previously operated by Cargill Salt. The USFWS is the lead agency for complying with the National Historic Preservation Act. The Alviso Unit is managed by the USFWS and the ELER salt ponds are owned and managed by the CDFG. The SBSPRP is partially on federal property, will require a federal permit, and will use federal funding. Restoration activities will change the salt ponds to salt marsh which alters their function and open water appearance, both of which are contributing characteristics of the historic landscape and has the potential to affect a historic property

South Bay Salt Pond Restoration Project

Project Overview and APE Map

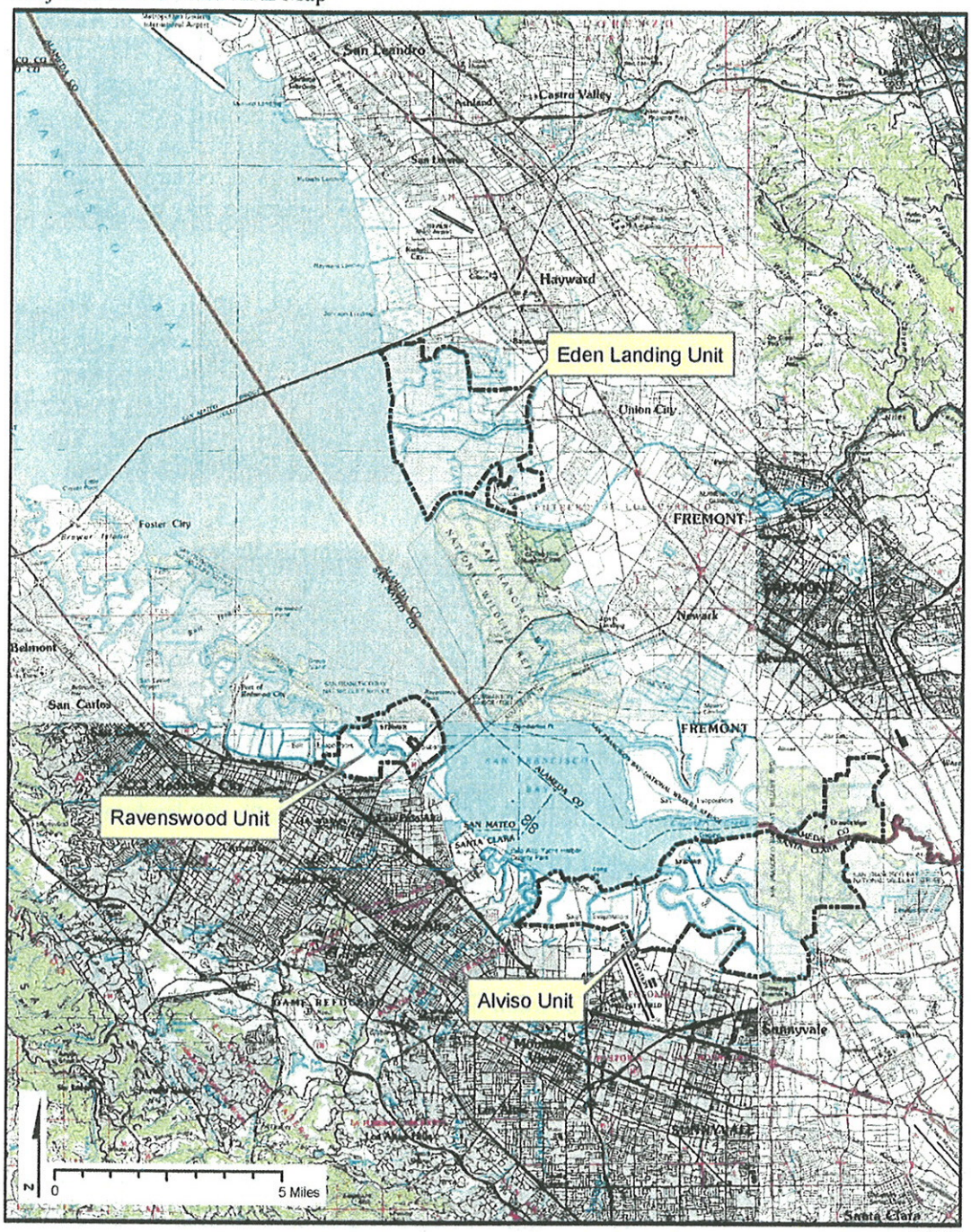


Figure 1. Project location map.

Area of Potential Effects
The Area of Potential Effect (APE) is depicted on Figure 1 and includes the Alviso Historic District and ELER Historic District that are located in the southern end of San Francisco Bay (See Figures 2 and 3). The ELER encompasses 6612 acres divided into 23 ponds, in Alameda County. The Alviso Unit encompasses 9677 acres divided into 28 ponds, within Alameda and Santa Clara counties. Within the APE, activities will focus on restoring the salt ponds to naturally functioning, tidally influenced salt marsh which requires breeching levees and opening ponds to the tides, building levees between the newly restored tidal marsh areas and local communities, and restoring habitat features. Additionally, archaeological resources within the ELER Historic Landscape that are contributing elements of the landscape may be affected by fluctuating water levels

The Alviso Unit is drained, from east to west, by Mud Slough, Coyote Creek, Alviso Slough, Guadalupe Slough, Stevens Creek, Mtn View Creek, and Charleston Slough. The boundaries of the Alviso Salt Works Historic Landscape are established by legal ownership and natural features. The Eden Landing Unit is drained by Mt. Eden, North, and Old Alameda Creeks, the Alameda Federal Flood Control Channel marks the southern boundary of the district. The boundaries of the Eden Landing Salt Works Historic Landscape are established by legal ownership and natural features.

Alviso Salt Works Eligibility to the National Register of Historic Places:
The Alviso Salt Works Historic Landscape meets eligibility standards under criterion A because it is associated with the twentieth century period of industrialization when one operator created a vast network of evaporation ponds to produce the large amount of brine necessary to meet production demands. The SHPO has concurred with the eligibility determination (Donaldson to Mruz, October 12, 2010). Interpreting the Alviso Salt Works landscape offers a different view of the salt industry than the Eden Landing area. The Alviso Salt Works clearly reflects the industrial zenith and development of huge tracks of salt marsh for salt brine production. The large exterior levees and vast ponds are the signature features of the Alviso Unit solar salt landscape.

Alviso Salt Works Historic Properties Description
The history of solar salt production in Alviso dates from the 1920s. In Alviso, the salt industry did not develop from small, family-owned salt farms, but rather, began as an industrial-level enterprise. Only two salt companies, the Alviso Salt Company (that included Continental Salt and Chemical Company) and Schilling's Arden Salt Company are associated with the Alviso unit. Both companies appear to have built levees, developed salt ponds, and harvested salt from these lands during the 1920s. Arden acquired Alviso Salt in 1929, including its plant near the town of Alviso. Leslie Salt became the sole operator after 1936, until Cargill's acquisition in 1978 (EDAW 2005:14).

The Alviso Salt Works is characterized by vast evaporation ponds, large levees, and robust water control devices. The pattern of spatial organization has changed only slightly from the 1950s when the operation was controlled by the Leslie Salt Company. The Alviso Unit was developed for brine production there were no crystallizing ponds or processing plants within the unit.

One archaeological site, one townsite, and a bridge have been recorded within the Alviso Salt Works, none of which are related to salt production (Table 1). Only two of the three resources within the Alviso Salt Works are potentially eligible properties but they do not contribute to the Alviso Salt Works Historic Landscape. The town of Drawbridge (P-01-003291) and site CA-ALA-338 (P-01-002057) have been reviewed but no formal determination of eligibility has been completed. Site CA-ALA-338 was originally noted in 1909 by Nels C. Nelson as a shell-midden mound site. The site location has been re-visited, but no evidence of the site was identified (Busby 2008; Valentine 2009). Site CA-ALA-338 appears to have been completely destroyed by salt pond development.

The town of Drawbridge (P-01-003291) was a small community of cabins that were used for duck hunting and weekend retreats. The isolated location also attracted bootleggers, gamblers, and prostitution in the 1920s and 1930s. Leslie's salt plant diked off parts of the east and west marshes at the southern end of San Francisco Bay, leaving Drawbridge in isolation and causing the ground to subside (Morrow 1984; EIS/EIR 2007 Report). Environmental conditions for the island have not improved since the 1940s and most of the cabins are in serious decline, are threatened by vandalism, or are sinking into the marsh. The community was essentially abandoned by the 1950s with the last resident staying until 1978 when the Don Edwards San Francisco Bay NWR was established. Drawbridge is within the refuge boundaries but a corridor through the center of the island and town is on land owned by the Southern Pacific Railroad and private entities. Access to the island requires permission from the Southern Pacific Railroad to cross on their tracks. Because the Service does not own or manage the primary corridor of the town which is within 50 ft of the tracks along with safety concerns with the access on an active railroad track, the deteriorated condition of the buildings, and the problem of continued subsidence of the island have sidelined a proactive preservation approach and implementation of a 1980s plan to open the site to visitors (Morrow 1984:136-137).

The Coyote Slough bridge was constructed in 2001 as a replacement of an earlier bridge and is ineligible to the NRHP.

Table 1. Recorded cultural resources within the Alviso Salt Works Historic Landscape.

Trinomial Site No.	Primary Site No.	Treatment	Eligibility To the NRHP	Description
CA-ALA-338	P-01-002057	N/A	Unevaluated	Disturbed remnants of shell midden; no surface evidence.
	P-01-003291	Monitor	Unevaluated	Drawbridge townsite
	P-01-010205/P-43-001578	N/A	No	Coyote Slough Bridge-installed in 2001.

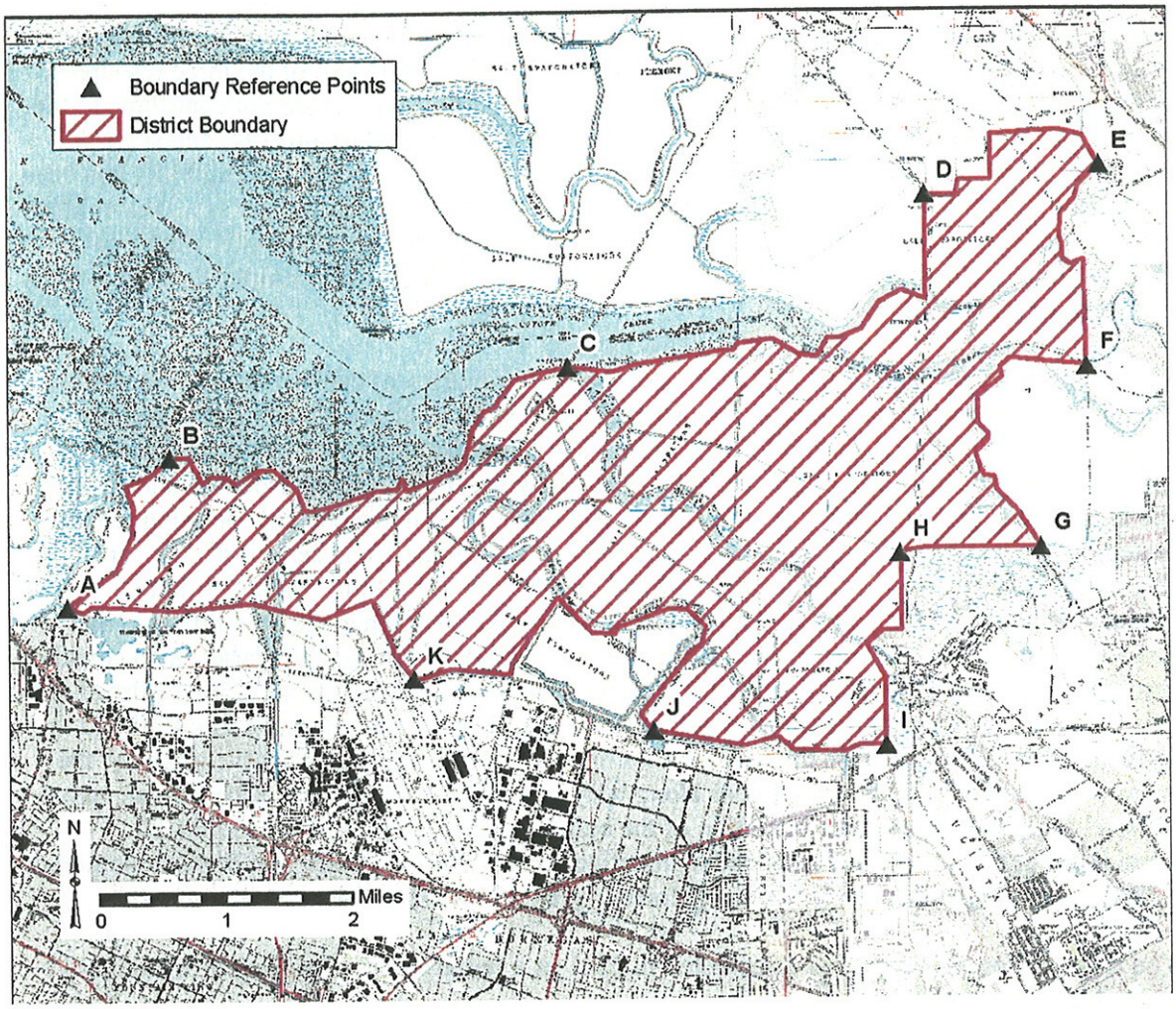


Figure 2. Alviso Salt Works Historic Landscape – Project APE.

Eden Landing Salt Works Eligibility to the National Register of Historic Places:
The Eden Landing Salt Works meets eligibility criteria A and D as defined by the National Register of Historic Places (NRHP) as a historic landscape. The SHPO has concurred with the eligibility determination (Donaldson to Mruz, October 12, 2010). Character defining elements of the historic landscape are the perimeter levees, interior pond divisions, archaeological sites associated with the family-owned processing plants and landings, and the Archimedes screw pumps. The overall Eden Landing Salt Works Historic Landscape provides an opportunity to interpret the evolution of the solar salt industry.

Eden Landing Historic Properties Description

The San Francisco Bay solar salt industry had its beginnings in the Eden Landing area. The initial salt production operations were small, family-owned parcels of less than 50 acres. There were nearly 30 different salt works located within the Eden Landing area between 1850 and 1910. One of the largest salt operations was the Union Pacific Salt Company which was in continuous production from 1872 to 1927. The Oliver Salt Company was among the few nineteenth century salt producers that continued operation into the 1920s. Between 1910 and 1930 the industry began consolidating as the market demand for salt increased beyond the capacity of the small producers. In 1930 the number of operators dropped from 28 to only five; and by the 1940s Leslie became the only major operator (EDAW 2005:14). "The Leslie-California Salt Company purchased the Oliver Salt works in 1931" (Ver Planck 1958:110). The small ponds have been altered to meet modern large-scale production needs.

Eleven cultural resources have been recorded within the Eden Landing Salt Works Historic Landscape, all of which are related to the historic period of salt manufacturing (Table 2). Four sites have been determined eligible, five sites have been determined ineligible, and one site is unevaluated. And, one architectural resource, the Archimedes Screw Windmills has been determined to be a contributing element of the Eden Landing Salt Works historic landscape.

Table 2. Recorded cultural resources within the Eden Landing Salt Pond Historic Landscape.

Trinomial Site No.	Primary Site No.	Treatment	Eligibility To the NRHP	Description
CA-ALA-489H, -501H	P-01-000217	Monitor and data collection	Yes	Eden Landing historic shipping station (warehouses, wharves, associated developments)
CA-ALA-494H	P-01-000210	Interpret, monitor	Yes	Oliver Salt Co. piling and foundations
-	P-01-010740	Interpret, monitor	Yes	Archimedes Screw Windmills
CA-ALA-495H	P-01-000211	N/AA	No	Location of former Rocky Point Saltworks – no surface remains.
CA-ALA-496H	P-01-000212	Monitor	Yes	Pilings and foundation of former Union Pacific Salt (ca. 1872-1927)
CA-ALA-497H	-	N/A	No	Peterman's Salt Works -- no surface remains
CA-ALA-498H	P-01-214	N/A	No	Salt works, not relocated
CA-ALA-499H	P-01-215	N/A	No	Modern refuse scatter
-	PF-1	Monitor	Yes	Whisby Salt Works refuse scatter
-	P-01-010834	N/A	No	Union City Alvarado Salt Ponds
-	FWS-07-12-1	Monitor, data collection	Yes	J. Quigely Alvarado Salt Works, domestic refuse scatter

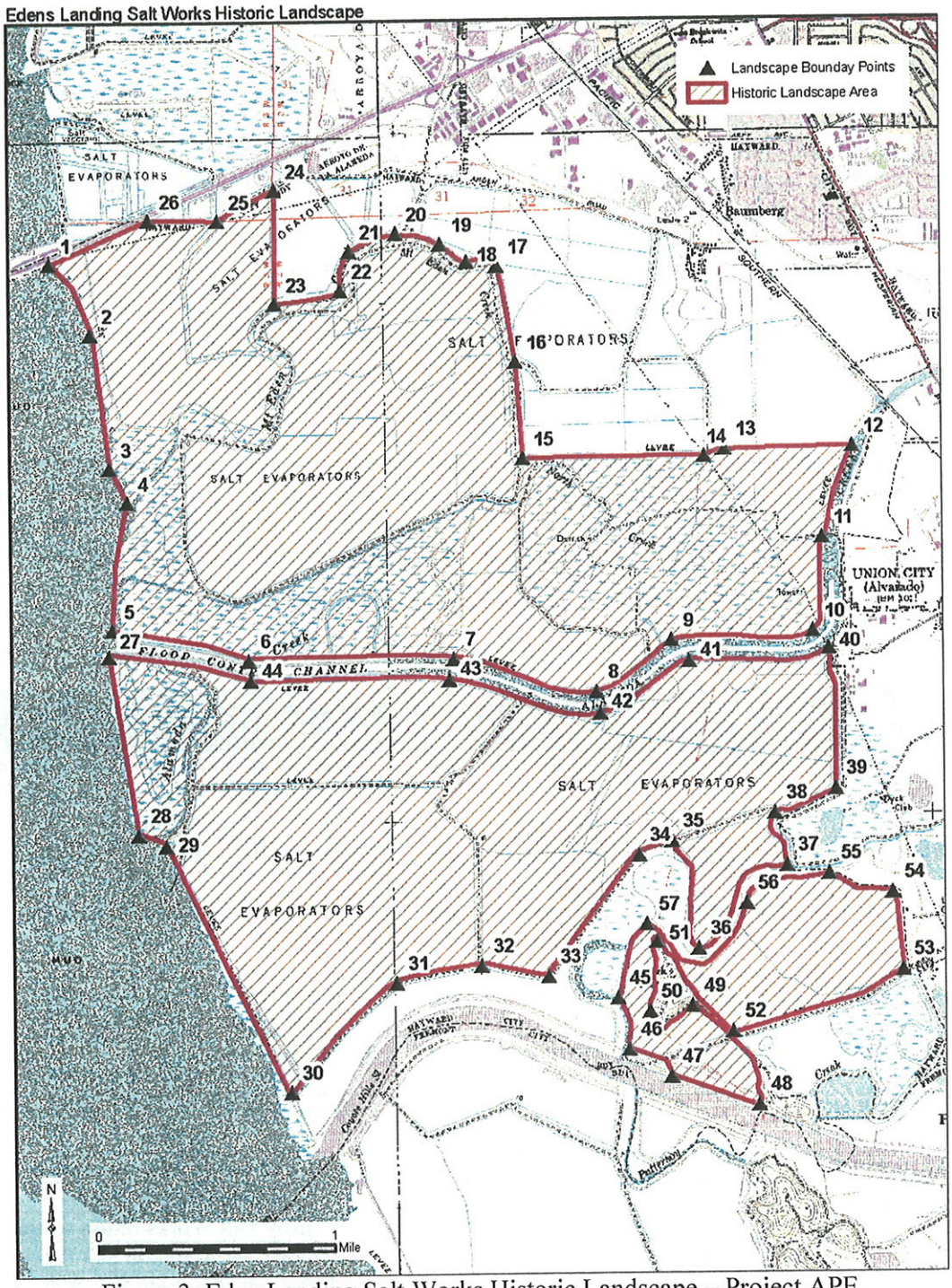


Figure 3. Eden Landing Salt Works Historic Landscape – Project APE.

Character Defining Features of the Alviso and Eden Landing Salt Works Historic Landscape

Character defining features of the Salt Works includes the landscape of levees, open-water ponds, water control structures, roads, and remnant wooden features, and archaeological sites. The initial evaporation ponds were built adjacent to the bay while secondary ponds were larger and protected from inundation from open bay water. Pickling and crystallizing ponds are relatively small and close to the salt processing plant and transportation corridor. The landscape features are engineered but lack distinctive qualities of individual workmanship or materials. The features are important because of their interrelationship and function as an evaporative salt factory. The ponds appearance of open water surrounded by earthen levees is a character defining feature.

The ELER encompasses some of the earliest salt ponds developed for salt production from the naturally suitable tidal salt marsh lands. Remnant features of the salt works of the Oliver family, the Barton family's Union Pacific Salt Works, and J. Quigley's Alvarado Salt Works are represented by archaeological sites that are historic properties. Overprinting by the modern solar salt industry has altered the nineteenth century landscape, raising levees, combining small ponds into much larger evaporation ponds, and changing the flow of water. The levees, water control structures, intakes, and pump stations have all been altered over the years to accommodate the increased production capacity, yet the distinctive pond landscape and remnant features reflect the evolving solar salt production industry.

Assessment of Effects to the Alviso and Eden Landing Salt Works Historic Landscape

The assessment of effects is determined by applying the criteria of adverse effects as provided in 36 CFR 800.5(ii).

> *Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization,. . . that is not consistent with the Secretary's standards for the treatment of historic properties and applicable guidelines.* The *Secretary's Standards* suggest that changes to historic properties should be minimal, follow the original plan, and should be compatible with existing materials or function.

The proposed modifications to remove salt works ponds from salt production will change their function and open water appearance, which are contributing characteristics of the historic landscape. The proposed restoration activities will alter these character defining features of the property which contributes to its eligibility and is an adverse effect as per 36 CFR 800.5(2)(iv). Additionally, altering the water flow from a controlled level to a tidally influenced dynamic flow may affect the six eligible sites within the Eden Landing Salt Works. Only the salt pond landscape will be affected by the restoration activities in the Alviso Salt Works.

Mitigation to resolve the adverse effects of the project activities is directed toward the salt pond landscape and six sites in the ELER.

Treatment Plan Actions
This Historic Properties Treatment Plan will affectively mitigate the effects of the SBSPRP. The USFWS and CDFG will ensure implementation of the treatment plan to include:

1) Documenting the salt works landscape based on consultation with the NPS Regional Coordinator for the Historic American Landscapes Survey (HALS);

2) Submitting the HALS documentation to NPS who will transmit it to the Library of Congress. Additionally, copies of the HALS documentation will be maintained at the DESFBNWR, USFWS Cultural Resources Team office, CDFG, and the Hayward Historical Society;

3) Protecting archaeological resources *in situ* within the ELER that are contributing elements of the historic landscape. Sites that are affected by fluctuating water levels will be documented with photography, GPS mapping, and limited subsurface testing of features and selective surface collection. The sites will then be monitored once a year at a low tide event or summer dry season for five consecutive years from the signing of this MOA. Monitoring will continue until the restoration work is completed. No additional affects are anticipated from the restoration work once the salt marsh habitat has been reestablished, at that point monitoring will cease. If any site appears to be accessible to vandals or the structure of the site changes due to vandalism, then a more substantial data collection procedure will be instituted.

4) Monitoring sites will include a site visit by a qualified archaeologist who will prepare a brief condition assessment report with photo-documentation of each site. Photographs will be taken from set photo points, each year, in order to trace any changes to the sites. Photographs will be maintained by the USFWS Cultural Resources Team (CRT). The CRT will evaluate the photographic record annually to provide site protection recommendations to the land managing agency. Reports will be archived with project materials at the CRT office.

5) Developing interpretive materials to be installed within the ELER that introduces the story of evaporative salt production in the San Francisco Bay region, including a boardwalk and interpretive panel at the Oliver Salt Works and Archimedes Screw Windmills.

Summary and Resolution of Adverse Effect
The mitigation measures presented in this Historic Properties Treatment Plan and stipulated in the Memorandum of Agreement will resolve the adverse effect of the South Bay Salt Pond Restoration Project.

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July 16, 2015

Mr. Andrew Galvan
The Ohlone Indian Tribe
Mission San Jose
PO Box 3152
Fremont, CA 94539

Dear Mr. Galvan,

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The USACE has prepared a draft Environmental Impact Report/Statement (EIR/S), published December 2014. Since then, we have initiated consultation with the State Historic Preservation Officer pursuant to the Section 106 implementing regulations at 36 C.F.R. § 800. As part of that process, I request your comment on the USACE undertaking.

Please find enclosed two documents: (1) the Cultural Resources section of the USACE draft EIR/S and (2) a Memorandum for Record that summarizes the USACE Shoreline project, highlights the historic properties identified and consideration of effects, and provides background information on the previous U.S. Fish and Wildlife Service Section 106 efforts for tidal marsh restoration in south San Francisco Bay and how it relates to the USACE undertaking.

If you would like to receive the entire EIR/S or any other documents, we would provide hard copies or electronic files on a CD. Please contact Kathleen Ungvarsky, Archaeologist, at (415) 503-6842 (email: kathleen.ungvarsky@usace.army.mil) for additional information.

Sincerely,

Thomas R. Kendall
Chief, Planning Division

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DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET ST.
SAN FRANCISCO, CALIFORNIA 94103-1398

July 16, 2015

Ms. Ann Marie Sayers
Indian Canyon Mutsun Band of Costanoan
P. O. Box 28
Hollister, CA 95024

Dear Ms. Sayers,

The U.S. Army Corps of Engineers, San Francisco District (USACE) has conducted a study entitled South San Francisco Bay Shoreline (Shoreline), and is proposing a two-part project: ecosystem restoration that will convert the Alviso salt ponds into tidal salt marsh and flood risk management that will involve levee construction outside and north of the town of Alviso across the salt ponds. The project has incorporated a public recreation component into the plans as well.

The USACE has prepared a draft Environmental Impact Report/Statement (EIR/S), published December 2014. Since then, we have initiated consultation with the State Historic Preservation Officer pursuant to the Section 106 implementing regulations at 36 C.F.R. § 800. As part of that process, I request your comment on the USACE undertaking.

Please find enclosed two documents: (1) the Cultural Resources section of the USACE draft EIR/S and (2) a Memorandum for Record that summarizes the USACE Shoreline project, highlights the historic properties identified and consideration of effects, and provides background information on the previous U.S. Fish and Wildlife Service Section 106 efforts for tidal marsh restoration in south San Francisco Bay and how it relates to the USACE undertaking.

If you would like to receive the entire EIR/S or any other documents, we would provide hard copies or electronic files on a CD. Please contact Kathleen Ungvarsky, Archaeologist, at (415) 503-6842 (email: kathleen.ungvarsky@usace.army.mil) for additional information.

Sincerely,

Thomas R. Kendall
Chief, Planning Division

Enclosures

Mr. Valentin Lopez
Chairman, Amah Mutsun Tribal Band
PO Box 5272
Galt, CA. 95632

Ms. Katherine Erolinda Perez
Ohlone/Costanoan Indian Tribe
P.O. Box 717
Linden, CA 95236

Ms. Jakki Kehl
Ohlone Indian Tribe
720 North 2nd Street
Patterson, CA 94363

Ms. Michelle Zimmer
Amah Mutsun Tribal Band of Mission San Juan Bautista
789 Canada Road
Woodside, CA 94026

Ms. Rosemary Cambra, Chairperson
Muwekma Ohlone Indian Tribe
of the San Francisco Bay Area
P. O. Box 360791
Milpitas, CA 95036

Representative Ramona Garibay
Ohlone/Costanoan Indian Tribe
Trina Marine Ruano Family
30940 Watkins Street
Union City, CA 94587

Irene Zwierlein
Amah Mutsun Tribal Band of Mission San Juan Bautista
789 Canada Road
Woodside, CA 94062

Mr. Andrew Galvan
The Ohlone Indian Tribe
Mission San Jose
PO Box 3152
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July 16, 2015

Irene Zwierlein
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789 Canada Road
Woodside, CA 94062

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Appendix B10

Clean Water Act Section 404(b)(1) Determination



Clean Water Act Section 404(b)(1) Determination

South San Francisco Bay Shoreline Phase I Study

Santa Clara County, California

July 1, 2015

CLEAN WATER ACT SECTION 404(B)(1) EVALUATION

1.0 PROJECT DESCRIPTION

The Shoreline Study Integrated Document fully analyzes alternatives and their effects to the environment within the National Environmental Policy Act Requirements. The alternative discussed in this 404(b)(1) evaluation is the Recommended Plan, which is also the Least Environmentally Damaging Practicable Alternative. This is discussed further in the "Attachment 1. LEDPA Analysis for All Alternatives" and also Chapter 3.9.3 of the Integrated Document.

1.1 PROJECT LOCATION

The study area for Shoreline Phase 1 encompasses a portion of the South Bay shoreline between Alviso Slough and Coyote Creek, along with adjacent managed ponds, tidal waters and marshes, and upland areas in the vicinity of Alviso (Figure 1). Land areas include the community of Alviso, nearby light industrial areas, and a wastewater facility. The study area covers about 7,400 acres in Santa Clara County and consists of the area between the mouth of the Guadalupe River (to the west) and the mouth of Coyote Creek (to the east) and extends south to include both the community of Alviso and the San José–Santa Clara Regional Wastewater Facility (Wastewater Facility). The Study Area includes areas where restoration and FRM action may be implemented and former Salt Ponds A9–A15 and A18.

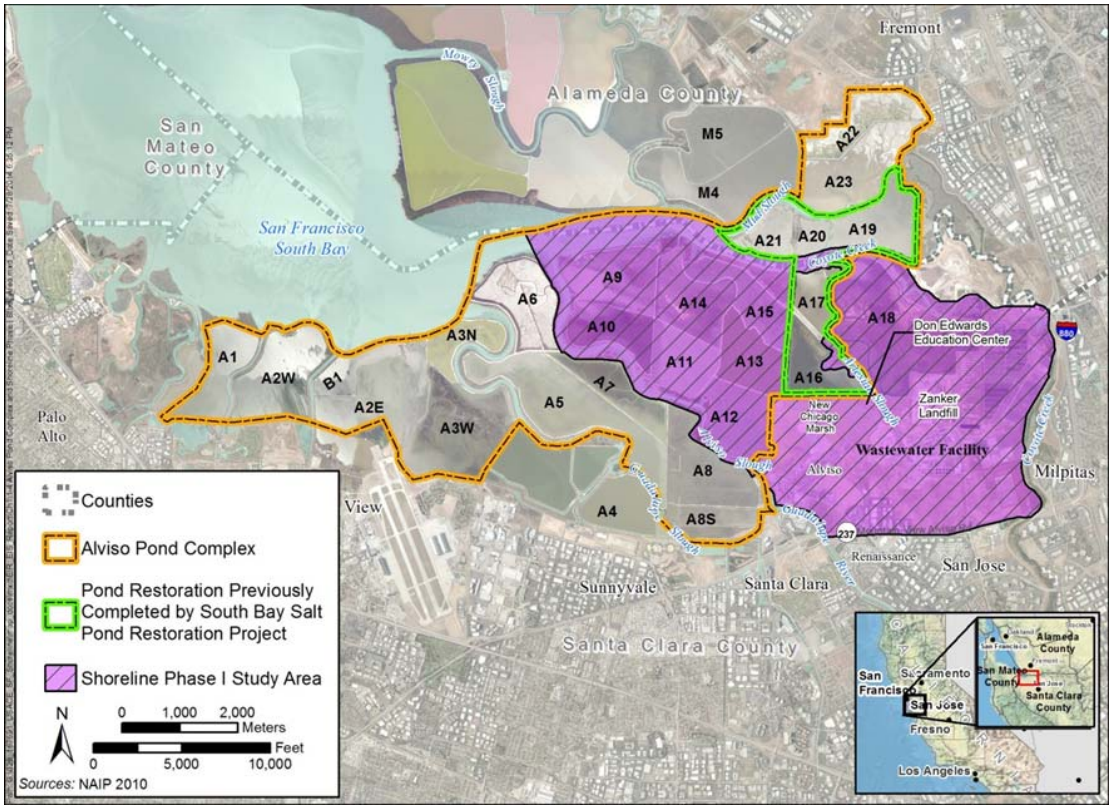

Figure 1. Alviso Pond Complex and Shoreline Phase I Study Area

1.2 GENERAL DESCRIPTION

The U.S. Army Corps of Engineers, San Francisco District, is proposing to construct levees bayward of the community of Alviso and the adjacent Wastewater Facility, restore Ponds A9-15 and A18 from existing managed ponds to allow tidal flow between adjacent sloughs and the existing ponds, allowing for restoration of tidal marsh habitat, and provide recreation features in line with the project objectives. The proposed plan includes: Basic ecosystem restoration of Ponds A9–A15 and Pond A18 with a 30:1 ecotone adjacent to Ponds A12/13 and A18. The tidal marsh restoration approach would be consistent with the approach taken by the South Bay Salt Pond (SBSP) Restoration Project, as follows: modifications would include breaching of outboard levees, modification of internal levees, construction of ditch blocks along existing levee-adjacent channels, and construction of pilot channels along historical contours. The ecotone will provide transitional habitat between the tidal marsh and the upland levee, providing refugia for wildlife during flooding and wave attenuation. The flood risk management levee will be earthen with a height of 15.2 feet NAVD 88 and would tie into existing 1-percent ACE flood risk management features in the study area. Landside areas would have a 15-foot-wide permanent easement (for operation and maintenance) and an additional 15-foot-wide temporary easement for the construction period along the full length of the levee. The new levees would be at least partially on land managed by the USFWS.

In addition to the flood risk management and ecosystem restoration, recreation features will include educational and interpretive signs, seating areas with benches, multi-use trails, wildlife viewing platforms, and a pedestrian bridge over Artesian Slough and the Union Pacific Railroad.

1.3 AUTHORITY AND PURPOSE

1.3.1 Project Authority

This report was prepared as an interim response to USACE Study Authorizations contained in multiple congressional actions, including Section 142 of the Water Resources Development Act of 1976 (WRDA), Public Law 94-94-587, a resolution adopted by the U.S. House of Representatives' Committee on Transportation and Infrastructure in 2002, and further guidance adopted through the WRDA of 2007, Section 4027:

> *".—In accordance with section 221 of the Flood Control Act of 1970 (42 U.S.C. 1962d–5b), and subject to paragraph (2), the Secretary shall credit toward the non-Federal share of the cost of any project authorized by law as a result of the South San Francisco Bay shoreline study—*
>
> *(A) the cost of work performed by the non-Federal interest in preparation of the feasibility study that is conducted before the date of the feasibility cost sharing agreement; and (B) the funds expended by the non-Federal interest for acquisition costs of land that constitutes a part of such a project and that is owned by the United States Fish and Wildlife Service. (2) CONDITIONS.—The Secretary may provide credit under paragraph (1) if— (A) the value of all or any portion of land referred to in paragraph (1)(B) that would be subject to the credit has not previously been credited to the non-Federal interest for a project; and (B) the land was not acquired to meet any mitigation requirement of the non-Federal interest."*

The most recent Water Resources Reform and Development Act (WRRDA) 2014 Section 1025 provides discretionary authority to the ASA(CW) to approve the USACE's implementation of a project on other Federal Lands (specifically in cases where the non-Federal interest originally purchased those lands). However, the "Secretary may carry out a project [on such lands] only after the non-Federal interest has entered into a memorandum of understanding (MOU) with the Federal agency that includes such terms and conditions as the Secretary determines to be necessary."

For the South San Francisco Bay Shoreline project, this provision applies to all project elements on USFWS lands. Although prior to WRRDA 2014, the USACE was proposing to ask Congress for authorization to construct FRM features on USFWS lands, WRRDA 2014 does apply to the whole project. Any project features that reside on USFWS lands will need a MOU between the non-Federal sponsor and the USFWS to be completed that includes such terms and conditions that the ASA(CW) deems necessary.

1.3.2 Project Purpose

Much of the portion of the study area that is not currently subject to tidal action historically consisted of tidal marsh and slough prior to diking efforts in the 20th century. Loss of these tidal habitats has greatly compromised biological and water quality functions in the study area. In addition, most of the study area is potentially vulnerable to sea level change over the course of the study's evaluation period of 50 years due to its topographic position at the extreme downstream end of the Santa Clara Valley where the valley adjoins San Francisco Bay.

As a result of severe subsidence in the Study Area, many areas landward of the former salt ponds became potentially vulnerable to tidal flooding. The non-engineered dikes protecting these areas were created as early as the 1920s and generally maintained to protect the ponds from tidal flooding when they were being used for salt production. These dikes were not engineered nor intended to reduce flood risk for urban areas. These lands are now substantially urbanized and have high-value development and include much of the well-known Silicon Valley as well as transportation corridors, wastewater plants, and other critical infrastructure. In addition, a substantial sea level change (SLC) is expected during the planning horizon for this study (2017–2067), exacerbating problems from tidal flooding.

The former management of the study area ponds by Cargill provided incidental flood risk reduction to the South Bay area. The transfer of pond ownership to the U.S. Fish and Wildlife Service (USFWS) and the City of San José created an opportunity to restore tidal marsh habitat by breaching these non-engineered pond dikes. However, breaching the non-engineered pond dikes would increase flood risk to inland areas that are currently separated from San Francisco Bay by these ponds. Therefore, the Shoreline Study purpose is to provide flood risk management to the Community of Alviso and the larger Silicon Valley, along with providing ecosystem restoration and maintaining recreational opportunities. Please see Chapter 2 of the Integrated Document for a more in depth discussion of the Purpose and Need of this project.

2.0 GENERAL DESCRIPTION OF DREDGED OR FILL MATERIAL

2.1 GENERAL CHARACTERISTICS OF MATERIAL

The imported fill will come primarily from the channel excavation of three other FRM projects in the county; Upper Llagas Creek (31 miles away), Upper Guadalupe River (11 miles away) and Permanente Creek (9 miles away). The materials are predominantly clays and silts with some sand. There is no gravel or bedrock at the sites indentified for borrow.

Technically, there could be fill associated with raising the inner levees to prepare for ponds being breached, leading to loss of jurisdictional waters. This would be temporary as these levees would be graded down later when remaining ponds are breached. Any islands retained on these inner levees would be only in locations where there is substantial existing levee width, such as some of the levee intersections and the Pond A14/A15 levee. Islands formed in these areas would be on solid, well-established, consolidated fill. Any temporary fill needed to widen an inner levee (should widening be needed in some areas) would be graded down at a later date and would return to being jurisdictional. Because the restoration will be occurring in phases between 2020 and 2030, additional analysis will be provided during the plans and engineering design phase of this project.

2.2 QUANTITY OF MATERIAL (CUBIC YARDS)

There will be approximately 940,000 cubic yards of fill with the Recommended Plan's FRM levee.

2.3 SOURCE OF MATERIAL

The imported fill will come primarily from the channel excavation of three other FRM projects in the county; Upper Llagas Creek (31 miles away), Upper Guadalupe River (11 miles away) and Permanente Creek (9 miles away). The materials are predominantly clays and silts with some sand. There is no gravel or bedrock at the sites indentified for borrow.

2.4 DESCRIPTION OF THE PROPOSED DISCHARGE SITE

The spoil from the existing levee (36.3 acres of non-engineered dikes) excavation will be used in the construction of the proposed FRM levee (50%) and the bench or ecotone (50%).

2.4.1 Location

The FRM levee location and footprint is described in detail in Chapter 9.2 of the Integrated Document, Plan Description.

2.4.2 Size

The Recommended Plan FRM levee includes the footprint of the existing levee, with the 15.2 foot levee being 110 feet wide, at 49.9 acres, and the ecotone being 345 feet wide, at 116.3 acres.

2.4.3 Type of site and size

The type of habitat includes the existing levee footprint and open water and wetlands within a managed pond.

2.4.4 Timing and Duration of Discharge

It is anticipated that the duration of construction would occur approximately 3 years between June 2018 and March 2021. The construction schedule for the timing and duration of the project is located in Chapter 3. 7.3 of the Integrated Document.

2.4.5 Description of Disposal Method

Fill will be mechanically placed and shaped in controlled lifts with ground based equipment. Lifts will be rolled into a stable continuum resistant to sloughing and erosion. The surface of the completed fill will be tracked walked to provide stability and a reasonably substrate for vegetation.

2.5 FACTUAL DETERMINATIONS (SECTION 230.11)

2.5.1 Physical Substrate Determinations

The South Bay is a complex system, both geographically and hydrodynamically, with freshwater tributary inflows, tidal currents, and wind interacting to create complex circulation patterns that vary over time. The most obvious hydrodynamic response to these forcing mechanisms is the daily rise and fall of the tides, although much slower residual circulation patterns also influence the mixing and flushing processes of the South Bay.

The Alviso Complex ponds are operated to maintain continuous tidal circulation by management of tidal flow through water control structures. With breaching of the internal non-engineered dikes, the tidal flow will be restored to a more natural state, without the use of water control structures.

2.5.2 Substrate Elevation and Type

Material would be placed along the existing non-engineered dikes A12/A13 and A18, and further into the bay than the current footprint with a 30:1 ecotone.

2.5.3 Sediment Type

The materials are predominantly clays and silts with some sand. There is no gravel or bedrock at the sites indentified for borrow.

2.5.4 Dredge/Fill Material Movement

Material is expected to remain within the construction footprint since the levee will be built to the appropriate flood risk management standards. The ecotone will be gently sloping down from the upland area of the FRM levee and is not expected to move further into the bay.

2.5.5 Physical Effects on Benthos

No adverse impacts to benthic organisms are anticipated other than displacement of those organisms in the construction footprint of the proposed project. The benthos in the canals being filled would be buried under the fill material; however these highly prolific organisms are expected to quickly re-establish in the natural wetlands restored through improved hydrology. It is anticipated that no long-term adverse impacts would occur.

3.0 FACTUAL DETERMINATIONS

3.1 WATER CIRCULATION, FLUCTUATION, AND SALINITY DETERMINATION

3.1.1 Water column

During construction of the levee and breaching of the internal ponds, turbidity would increase temporarily in the water column adjacent to the project. The increased turbidity would be short-term; therefore the Recommended Plan would have no long-term or significant impacts, if any, on salinity, water chemistry, clarity, color, odor, taste, dissolved gas levels, nutrients or eutrophication

3.1.2 Current Patterns and Circulation

The flow of tidal waters into the ponds is currently controlled through structures. Removal of the internal berms will increase the natural tidal flow process.

Normal Water Level Fluctuations: For tidal areas, mean higher high water (MHHW) in the study area is currently at 7.81 feet NAVD 88, and ordinary high water (OHW) is 8.47 feet NAVD 88. Pond A16 is currently managed to be around 3.1 feet NAVD 88. Other ponds may be higher or lower, but they are all managed well below MHHW. All topography that could have a change in jurisdictional status is above current average water levels for MHHW and OHW.

3.1.3 Salinity Gradients

Salinity is that of oceanic water. Dredged material placement would not affect normal tide fluctuations or salinity.

3.1.4 Actions That Will Be Taken to Minimize Impacts

BMPs and other benthic protection measures have been coordinated with the resource agencies to minimize impacts.

3.2 SUSPENDED PARTICULATE/TURBIDITY DETERMINATIONS

During project construction, a temporary short-term increase in suspended particulates may occur that are associated with levee removal and reconstruction. Best management practices would be used to minimize the suspension and transport of soils, levee materials, and roadway materials into water adjacent to or downstream of the construction area including use of sediment controls, turbidity screens, or sediment blockages for adjacent wetlands.

In general, any short-term impacts to water quality associated with construction of the project would be ameliorated by construction sequencing, best management practices for erosion and sedimentation control and monitoring during construction. Turbidity would be short-term and localized and no significant adverse impacts are expected. State water quality standards for turbidity outside an allowable mixing zone would not be exceeded.

3.2.1 Effects on Chemical and Physical Properties of the Water Column

The sea level elevation where the FRM levee will be constructed is characterized by a sandy/silt substrate. There would be little, if any, adverse effects to chemical and physical properties of the water as a result of placing sandy/silty material within the construction footprint.

3.2.1.3 Light Penetration

During construction operations there would be a temporary insignificant reduction in light penetration in the canals in the immediate vicinity of the activity. Once construction is complete, light penetration is expected to return to pre-construction levels.

3.2.1.4 Dissolved Oxygen

Dissolved oxygen levels would not be altered by this project due to the tidal energy wave environment and associated adequate reaeriation rates.

3.2.1.5 Toxic Metals, Organics, and Pathogens

No toxic metals, anthropogenic organics, or pathogens are anticipated at this time to be released by project construction. Several other ponds (A21/20/19, E8A/9/8X, Alviso: Pond A8 (includes 8S), A6 tidal restoration, A17 tidal restoration), in this area have been breached to restore managed ponds to tidal marsh habitat through the South Bay Salt Pond Restoration Project, with no releases of toxic metals, organics, or pathogens.

3.2.1.6 Aesthetics of the Water Column

During construction, visual aesthetics would be negatively impacted.

3.3 EFFECTS ON BIOTA

3.3.1 Primary Productivity and Photosynthesis

Disposal of excavated materials would adversely affect 17.4 acres of wetlands in the immediate vicinity of construction by destroying vegetation and smothering biota. However, restoration of 2,783 acres of salt ponds to tidal marsh habitat would improve the primary productivity and photosynthesis due to an increase in quantity and quality of wetland habitat within the Study Area.

3.3.2 Suspension/Filter Feeders

During construction operations there would be a temporary increase in turbidity and possibly a decrease in suspension/filter feeders due to construction activities. This temporary increase in turbidity would be short-term and should not have any long-term negative impact on these highly fecund organisms. The implantation of the project should benefit these organisms by creating a better quality wetland habitat.

3.3.2.3 Sight Feeders

During construction operations there would be a temporary increase in turbidity and possibly a decrease in sight feeders due to construction activities. No significant impacts on these

organisms are expected as the majority of sight feeders are highly mobile and can move outside the affected area. When the project is operational, sight feeders would benefit from the better quality wetland habitat.

3.4 CONTAMINATION DETERMINATIONS

The material that would be used for FRM levee construction would not introduce, relocate, or increase contaminants at the area. The fill material would consist of sandy material with some silt and is not expected to contain any hazardous materials. Construction activities will require the use of diesel powered standard and low-ground pressure equipment. All construction contracts will include basic and site specific requirements for safety and environmental protection. Typical requirements would require each Contractor to develop plans and strategies to implement best management practices (e.g. barriers, fueling locations, etc.) for preventing contamination as well as responding to accidental spills.

3.5 AQUATIC ECOSYSTEM AND ORGANISM DETERMINATIONS

No long-term adverse impacts on aquatic organisms are anticipated. Tidal marsh ecosystems are expected to greatly improve because of implementation of the Recommended Plan. The proposed project is not expected to cause or contribute to violations of State Water Quality Standards, jeopardize the existence of any federally endangered or threatened species, nor impact a marine sanctuary. No significant degradation is expected and all appropriate and practicable steps would be taken to minimize impacts. Removal of internal levees within the existing ponds is expected to restore tidal flow and re-establish tidal marsh habitat throughout the project footprint.

3.5.1 Effects on Plankton

No adverse impacts to plankton are anticipated.

3.5.2 Effects on Benthos

The extended footprint of the new FRM levee material would bury some benthic organisms. Benthic organisms found within the project area adapted for existence in an area with substrate movement, thus most would be able to burrow up through the disposed material. Recolonization is expected to occur within a year after construction activities cease. No adverse long-term impacts to non-motile or motile benthic invertebrates are anticipated.

3.5.3 Effects on Nekton

No adverse impacts to nektonic species are anticipated.

3.5.4 Effects on Aquatic Food Web

No adverse impacts to the aquatic food web are anticipated, other than minor temporary impacts within the construction footprint of the proposed spreader channels.

3.5.5 Effects on Special Aquatic Sites

There are no hardground or coral reef communities located in the immediate project area that would be impacted by the Recommended Plan.

3.5.6 Wetlands

The dominant vegetation community in the Project Area is pickleweed. There would be approximately 17.4 acres of wetland habitat loss with the construction of the FRM levee. However, this loss is considered minimal due to the increase in tidal marsh habitat to 2,783 acres and is not anticipated to have any adverse effects. The proposed project is anticipated to provide positive ecological benefits by reconnecting tidal flows to the Bay.

3.5.7 Threatened and Endangered Species

Federally listed species that are known to be present within the Study Area include the steelhead trout, salt marsh, harvest mouse, western snowy plover, California least tern, and California Ridgway rail. Appropriate measures to avoid, minimize, and reduce, and compensate for impacts to listed species have been fully coordinated with NMFS and USFWS. A Biological Opinion was received from the USFWS on April 27, 2015 and a Letter of Concurrence was received from NMFS on May 19, 2015. Please see Appendix B8 (ESA Compliance) of the FR/EIS/EIR for the Biological Assessment and Biological Opinion that detail the federally listed species within the project area.

3.5.8 Effects on Sanctuaries and Refuges

No adverse impacts to sanctuaries are anticipated as the site does not contain a sanctuary. Ponds A9-15 are located on Don Edwards San Francisco Bay National Wildlife Refuge (USFWS Refuge) land for restoration, and the USFWS owned FRM levee along Ponds A12 and A13. The refuge will gain tidal wetland habitat over managed salt ponds, which are valuable habitat and is compatible with the Tidal Marsh Recovery Plan.

3.5.9 Effects on Mud Flats

The Recommended Plan would affect 0.6 acres of mud flats due to FRM and ecotone construction. This area will be converted into a transitional habitat for use by several species in regards to sea level rise.

3.5.10 Effects on Vegetated Shallows

There are no vegetated shallows located in the immediate project area that would be impacted by the Recommended Plan.

3.5.11 Effects on Other Wildlife

No adverse impacts to small foraging mammals, reptiles, or wading birds, or wildlife in general are expected. The ecotone and restored tidal marsh habitat is expected to improve habitat for wildlife in the Project Area.

3.6 PROPOSED DISPOSAL SITE DETERMINATIONS

3.6.1 Mixing Zone Determination

Material placed with regard to the FRM levee would meet requirements outlined in the Water Quality Certificate. Placement would not cause unacceptable changes in the mixing zone water quality requirements as specified by the State of California's Water Quality Certification permit procedures. No adverse impacts related to depth, current velocity,

direction and variability, degree of turbulence, stratification, or ambient concentrations of constituents are expected from implementation of the project.

3.6.2 Determination of Compliance with Applicable Water Quality Standards

Because of the inert nature of the material to be to be disposed, Class III water quality standards would not be violated.

3.6.3 Potential Effects on Human Use Characteristics

3.6.3.3 Municipal and Private Water Supply

In the short term, water use would be limited to project construction for activity such as dust control; no long-term water use would be associated with the project, and the project would not affect the overall water supply. Water use during project construction would depend on weather conditions and would be primarily limited to earthwork operations. A project of this type and magnitude would typically use two water trucks per day during earthwork operations at 2,500 gallons per truck. Earthwork operations for this project are estimated at this feasibility level of development to be about 750 days, which equates to approximately 3.75 million gallons of construction water.

It should be noted that construction operations such as these often make use of recycled water. The Wastewater Facility is within the project boundary and produces high-quality, tertiary treated recycled water. The recycled water is distributed throughout the area for irrigation and other approved purposes as part of the discharge permit, and this would be a viable, available, conservation-minded source.

Because the project would not require any new, long-term sources of water, impacts on water supply would be less than significant.

3.6.3.4 Recreational and Commercial Fisheries

Fishing in the immediate construction area would be prohibited during construction. Otherwise, recreational and commercial fisheries would not be impacted by the implementation of the project.

3.6.3.5 Water Related Recreation

Water related recreation in the immediate vicinity of construction would be prohibited during construction activities. People are not allowed to use the current managed ponds for water activities and therefore there would be no impact on water related recreation.

3.6.3.6 Aesthetics

The Recommended Plan includes a 15.2 foot levee. This levee will impact the aesthetics of the area, however, recreational features such as pedestrian bridges, viewing platforms, and interpretive signs will be located along the trails. These impacts are not expected to adversely affect the aesthetic resources of the restored tidal marsh habitat.

3.6.3.7 Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves

No such designated sites are located within the project area.

3.7 DETERMINATION OF CUMULATIVE EFFECTS ON THE AQUATIC ECOSYSTEM

There would be no cumulative impacts that result in a major impairment in water quality of the existing aquatic ecosystem resulting from the placement of material at the project site.

3.8 DETERMINATION OF SECONDARY EFFECTS ON THE AQUATIC ECOSYSTEM

There would be no secondary impacts on the aquatic ecosystem as a result of the fill. During construction the sites would be contained with sedimentation barriers. Erosion would be controlled by appropriate erosion control techniques. Sedimentation would be controlled during construction.

4.0 FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

4.1 ADAPTATION OF SECTION 404(B)(1) GUIDELINES TO THIS EVALUATION

No significant adaptations of the guidelines were made relative to this evaluation.

4.2 EVALUATION OF AVAILABILITY OF PRACTICABLE ALTERNATIVES TO THE PROPOSED DISCHARGE SITE WHICH WOULD HAVE LESS ADVERSE IMPACT ON THE AQUATIC ECOSYSTEM

No practicable alternative exists which meets the study objectives as well as the non-Federal sponsors objectives that does not involve discharge of fill into waters of the United States. The 12.5 foot levee would require 17.2 acres of fill into existing wetlands, which is 0.02 acres less than the Recommended Plan. Impacts to Waters of the U.S. would be 57.1 acres under the 12.5 levee, and 136.6 acres under the Recommended Plan. The 136.6 acres includes the 30:1 sloping ecotone, which would provide transitional habitat for species, including listed species. Over time, the affected ponds and adjacent areas would have middle-term and long-term gains in waters of the United States as restoration areas transition. The 15.2 foot levee is requested by the non-Federal sponsor to meet FEMA requirements/accreditation at the end of the study period and provides more assurance of flood protection in the event of the USACE high SLC scenario (see Chapter 3 of the Integrated Document for a more robust discussion on SLC and levee heights. The no action alternative would not require fill of wetlands, however, the condition of the non-engineered dike would need replacement per USACE flood risk management standards in the face of sea level rise and also in order to restore tidal marsh habitat to the Bay Area.

4.3 COMPLIANCE WITH APPLICABLE STATE WATER QUALITY STANDARDS

After consideration of disposal site dilution and dispersion, the discharge of dredged materials would not cause or contribute to, violations of any applicable State water quality standards for Class III waters. In reconnecting the Bay with the tidal marsh habitat, water quality and habitat for species should improve.

4.4 COMPLIANCE WITH APPLICABLE TOXIC EFFLUENT STANDARD OR PROHIBITION UNDER SECTION 307 OF THE CLEAN WATER ACT

The discharge of fill materials is not anticipated to cause or contribute to violations of any applicable state water quality standards for Class III waters or Outstanding Florida Waters where applicable. The discharge operation is not anticipated to violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

4.5 COMPLIANCE WITH ENDANGERED SPECIES ACT OF 1973

The placement of fill materials in the project area is not anticipated to jeopardize the continued existence of any species listed as threatened and endangered or result in the likelihood of destruction or adverse modification of any critical habitat as specified by the Endangered Species Act of 1973, as amended. A Biological Opinion was received from the USFWS on April 27, 2015 and a Letter of Concurrence was received from NMFS on May 19, 2015. No adverse effects are expected to any listed species.

4.6 COMPLIANCE WITH SPECIFIED PROTECTION MEASURES FOR MARINE SANCTUARIES DESIGNATED BY THE MARINE PROTECTION. RESEARCH, AND SANCTUARIES ACT OF 1972

No marine sanctuaries are located within the project area.

4.7 EVALUATION OF EXTENT OF DEGRADATION OF THE WATERS OF THE UNITED STATES

Waters of the United States impacts that would occur as a result of flood risk management implementation would occur at the time of construction. Levee and tide gate construction at Artesian Slough would result in the fill of waters of the United States. Ecosystem restoration impacts would occur in phases as the ecosystem restoration process takes place over time. Most adverse waters of the United States impacts (discharge of fill) would be from levee construction and installing transitional habitat, but lesser amounts of fill would occur due to breaching of ponds. Ecosystem restoration activity would result in beneficial effects by restoring or creating waters of the United States as the restoration process occurs over time. Impacts to wetlands from project construction would be offset over time due to restoration of large areas of tidal marsh.

The placement of fill material would not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreational and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic species and other wildlife would not be adversely affected. Significant adverse effects on

aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values would not occur.

4.8 APPROPRIATE AND PRACTICABLE STEPS TAKEN TO MINIMIZE POTENTIAL ADVERSE IMPACTS OF THE DISCHARGE ON THE AQUATIC ECOSYSTEM

Appropriate steps have been taken to minimize the adverse environmental impact of the Recommended Plan. Turbidity would be monitored so that if levels exceed State water quality standards, the contractor would be required to cease work until conditions return to normal.

5.0 CONCLUSION

On the basis of the guidelines, the proposed dredging and disposal sites are specified as complying with the requirements of these guidelines.

Attachment 1. LEDPA Analysis for All Alternatives

Most adverse waters of the United States impacts (discharge of fill) would be from levee construction and installing transitional habitat, but lesser amounts of fill would occur due to breaching of ponds. Ecosystem restoration activity would result in beneficial effects by restoring or creating waters of the United States as the restoration process occurs over time. Impacts to wetlands from project construction would be offset over time due to restoration of large areas of tidal marsh.

Table 1 shows estimated construction-related impacts by type of waters of the United States for each of the action alternatives (see Chapter 3 in the Integrated Document for Alternatives). The table shows waters impacts associated with levee construction (including the different alignments), installing the Artesian Slough tide gate, and building transitional habitat.

Alternatives 2 and 3 would have similar wetland losses at 17.2 acres (1.13 percent of the total wetland area in the study area) and 17.4 acres (1.15 percent of wetland area in the study area), respectively. Alternative 4 would have the highest wetland loss at 37.1 acres, which is about 2.44 percent of the wetland area in the study area.

Alternative 3 would have the highest loss of other waters of the United States (120.2 acres or about 2.86 percent of the area of all non-wetland waters in the study area) because it would affect more area of circulation pond. Alternative 5 would have the smallest loss of other waters 0.82 percent of the area of all non-wetland waters in the study area.

Table 1. Flood Risk Management and Transitional Habitat Construction-Related Impacts by Type of Wetlands and Other Waters of the United States by Project Alternative

In acres and percentage of total acreage in the study area

Type of Water	Alternative 2 (NED/NER Plan)	Alternative 3 (Proposed Action and LPP)	Alternative 4	Alternative 5
Vegetated Wetland				
Salt Marsh				
Tidal	1.7 (0.53%)	1.7 (0.53%)	1.1 (0.34%)	0.0 (0.00%)
Non-tidal	8.1 (9.48%)	8.2 (9.60%)	8.3 (9.72%)	8.3 (9.72%)
Brackish Marsh	0.3 (0.07%)	0.3 (0.07%)	0.2 (0.05%)	0.2 (0.05%)
Muted Tidal/Diked Marsh [a]	1.8 (0.53%)	1.8 (0.53%)	22.0 (6.47%)	20.3 (5.97%)
Freshwater Marsh	1.0 (1.07%)	1.1 (1.18%)	0.9 (0.97%)	0.8 (0.86%)
Vegetated Wetland Subtotal	12.9 (1.0%)	13.1 (1.0%)	32.5 (2.6%)	29.6 (2.3%)
Unvegetated Wetland				
Seasonal Wetland	3.7 (14.12%)	3.7 (14.12%)	4.2 (16.03%)	0.0 (0.00%)
Mudflat	0.6 (0.27%)	0.6 (0.27%)	0.4 (0.18%)	0.4 (0.18%)
Unvegetated Wetland Subtotal	4.3 (1.7%)	4.3 (1.7%)	4.6 (1.9%)	0.4 (0.2%)
All Wetlands Total	17.2 (1.13%)	17.4 (1.15%)	37.1 (2.44%)	30.0 (1.97%)
Other Non-wetland Waters				
Open Water	9.4	9.4	9.7	9.6
Ponds				
Batch (high salinity)	7.9	32.6	9.2	7.3
Circulation	22.6	78.2	17.7	17.7
Sewage Treatment Ponds	0.0 (0.00%)	0.0 (0.00%)	0.0 (0.00%)	0.0 (0.00%)
Legacy Ponds	0.0 (0.00%)	0.0 (0.00%)	0.0 (0.00%)	0.0 (0.00%)
Other Water Subtotal	39.9 (0.95%)	120.2 (2.86%)	36.6 (0.87%)	34.6 (0.82%)
Grand Total	57.1 (1.00%)	137.6 (2.40%)	73.7 (1.29%)	64.6 (1.13%)

Note: Alternative 1 is the No Action Alternative and is therefore not included in this table or the following tables.
Key: NED/NER = National Economic Development/National Ecosystem Restoration; LPP = Locally Preferred Plan

Alternative 3 is the plan that is the least environmentally damaging practicable alternative. This LEDPA designation is based on the following considerations:

- Alternative 1, while it would have no immediate impacts to wetlands and other waters of the U.S., would not be resilient to SLC. Some existing non-tidal

wetlands would be lost in the long term. Marsh species listed under the Endangered Species Act would not recover within the study area due to needed habitat not being restored. Opportunities for increased wetland area and consequently improved water quality would be foregone. Breaching of existing managed ponds due to SLC would occur too late for sediment accumulation to form marshes in these areas.

- Alternatives 4 and 5 would have increased impacts to wetlands and other waters of the U.S. (relative to other alternatives) because of the levee alignment through New Chicago Marsh, with no offsetting improvements in aquatic resources.
- Alternative 2 would have the least short-term impacts to wetlands and other waters of the U.S. It would be less resilient to SLC, both in terms of the marsh transition zone adapting to rising sea levels and in the ability of the FRM levee to protect New Chicago Marsh from eventual drowning caused by its elevation being below mean sea level. The marsh transition zone would be much less useful for maintenance and recovery of listed marsh species.
- Alternative 3 would have slightly greater immediate impacts to wetlands and other waters of the U.S. because of the additional areas of fill for the wider levee and the ecotone. This alternative would provide tidal marsh ecotone with a much better ability to adapt to SLC and in doing so would provide additional assistance towards recovery of listed species. In addition, the increased FRM levee height would better protect New Chicago Marsh and its important population of salt marsh harvest mouse from risk of inundation due to SLC.

Appendix B11

Recovery Plan Criteria for Downlisting and Delisting for California Sea Blite, Salt Marsh Harvest Mouse, and Ridgway's Rail

Table B11-1 *Recovery Plan Criteria for Downlisting and Delisting for California Sea-Blite, Salt Marsh Harvest Mouse, and Ridgway's Rail in the Shoreline Phase I Study Area* summarizes the factors that affect recovery of and criteria that need to be met for downlisting and delisting of California sea-blite, salt marsh harvest mouse (SMHM), and California Ridgway's rail.

Table B11-1. Recovery Plan Criteria for Downlisting and Delisting for California Sea-Blite, Salt Marsh Harvest Mouse, and Ridgway's Rail in the Shoreline Phase I Study Area

Criteria by Factors Affecting Recovery	Recovery Plan Species in the Central/South San Francisco Bay Recovery Unit		
	California Sea-Blite	Salt Marsh Harvest Mouse	California Ridgway's Rail
A: Present destruction, modification or curtailment of habitat or range			
Downlisting	Habitat supporting at least three populations must exist on land in conservation ownership or under conservation management.	Protect and manage historic and restored marsh complexes in the recovery unit at: • East Palo Alto–Guadalupe Slough, 1,000 or more acres in size, with viable habitat areas (VHAs) at (1) East Palo Alto–Cooley Landing–Palo Alto Nature–Mountain View to Stevens Creek and (2) Stevens Creek to Guadalupe Slough. • Guadalupe Slough–Warm Springs, 1,000 or more acres in size, with one VHA within the marsh complex. Habitat supporting all extant SMHM occurrences must be protected via habitat management. Each marsh complex must support VHAs that are connected by suitable habitat corridors with sufficiently deep pickleweed plains and/or sufficiently deep high marsh zones (and preferably both). Unless precluded by natural features or existing hardscape, the marsh complexes themselves must be connected to one another by marsh or restored tidal marsh of sufficient depth and complexity to allow for dispersal and recolonization. Marsh complexes must be 1,000 acres or more in size. VHAs must be 150 acres or more in size. Reduction in extant *Lepidium latifolium* populations to less than 10% cover (in and downgradient of the high marsh-upland ecotone) for 5 years in each marsh complex. Implement a system for early detection and control of future invasive plant infestations.	Protection and management of habitat sufficient to support a population of 500 rails in the recovery unit at East Palo Alto–Guadalupe Slough and Guadalupe Slough–Warm Springs marsh complexes. • The habitat for each population must have a minimum area of 1,111 acres (450 ha) of contiguous high-quality tidal marsh habitat with well-developed channel systems and high-tide refugia/escape cover at the high marsh/upland transition zone and/or inner-marsh. Reduction in extant *Lepidium latifolium* populations to less than 10% cover (in and downgradient of the high marsh-upland ecotone) for 5 years in each marsh complex. Implementation of a system for early detection and control of future invasive plant infestations. Implementation of site-specific management plans on lands owned by USFWS, CDFW, and Mid-Peninsula Open Space District to reduce human-caused disturbance to rails.
Delisting	Habitat supporting at least three populations must exist on land in conservation ownership or under conservation management for 10 generations.	Meet all criteria under downlisting item A. Develop a plan for early detection and control of *Lepidium latifolium* (in and downgradient of the high marsh-upland ecotone) to be implemented following any future increase beyond 10% cover; secure a source to fund such actions in perpetuity. Implement the South Bay Salt Pond Restoration Plan (USFWS 2009).	Meet all criteria under downlisting item A. Develop a plan for early detection and control of *Lepidium latifolium* (in and downgradient of the high marsh-upland ecotone) to be implemented following any future increase beyond 10% cover; secure a source to fund such actions in perpetuity. Implement the South Bay Salt Pond Restoration Plan (USFWS 2009).

Table B11-1. Recovery Plan Criteria for Downlisting and Delisting for California Sea-Blite, Salt Marsh Harvest Mouse, and Ridgway's Rail in the Shoreline Phase I Study Area

Criteria by Factors Affecting Recovery	Recovery Plan Species in the Central/South San Francisco Bay Recovery Unit		
	California Sea-Blite	Salt Marsh Harvest Mouse	California Ridgway's Rail
B: Overutilization for commercial, scientific, or educational purposes			
Downlisting Delisting	Overutilization is not known to be a threat to this species; no downlisting or delisting criteria developed.	Overutilization is not known to be a threat to this species; no downlisting or delisting criteria developed.	Overutilization was a major factor for this species at the turn of the 20th century but is not currently known to be a threat; no downlisting or delisting criteria developed.
C: Disease or predation			
Downlisting	Disease and predation are not known to be a major threat to this species; no downlisting or delisting criteria developed.	*Disease* is not known to be a major threat; no downlisting criteria developed. An unnaturally high level of *predation* is thought to exist in some marshes where SMHM are concentrated into narrow *Sarcocornia* zones due to surrounding habitat loss. Though little is known about death rates related to the resulting predation, it is presumed that restoration of deep marshes with ample high tide refugia, both high marsh and intermarsh, will result in a reduction of predation rates. Focus is on restoration of high quality marshes; no downlisting criteria developed for predation.	*Disease* is not known to be a major threat; no downlisting criteria developed. For *predation*, develop and implement a predator management plan at sites with significant predation issues.
Delisting		Disease and predation are not known to be a major threat to this species; no delisting criteria developed.	No delisting criteria developed for disease. Meet all downlisting criteria under item C. Predator monitoring indicates that, for 5 consecutive years, predation pressure on California Ridgway's rails falls below a level at which it negatively affects long-term population persistence.

Table B11-1. Recovery Plan Criteria for Downlisting and Delisting for California Sea-Blite, Salt Marsh Harvest Mouse, and Ridgway's Rail in the Shoreline Phase I Study Area

Criteria by Factors Affecting Recovery	Recovery Plan Species in the Central/South San Francisco Bay Recovery Unit		
	California Sea-Blite	Salt Marsh Harvest Mouse	California Ridgway's Rail
D: Inadequacy of existing regulatory mechanisms			
Downlisting Delisting	Existing regulatory mechanisms not identified as inadequate; no downlisting or delisting criteria developed.	Existing regulatory mechanisms not identified as inadequate; no downlisting or delisting criteria developed.	Existing regulatory mechanisms not identified as inadequate; no downlisting or delisting criteria developed.
E: Other natural or manmade factors affecting continued existence			
Downlisting	To provide sufficient resilience to stochastic events, meet downlisting conditions under item A and have at least: • A minimum of three populations.[a] • For 5 consecutive years of monitoring, the three populations must total a minimum of 1,500 individuals.	40% of the VHAs of each large marsh complex must have SMHM present at the capture efficiency level[d] of 5.0 or better and: • An additional 50% of the VHAs of each large marsh complex must have SMHM present at the capture efficiency level of 3.0 or better. • Each marsh complex must be monitored and found to meet the above criteria at least twice, with at least 5 years between surveys. After marsh complexes meet the criteria twice, there is no need to resurvey as long as no more than 20 years have passed and there has been no obvious negative change to habitat during that time. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to SLC. • This criterion will be met when SLC modeling shows sufficient uplands have been protected to accommodate landward migration while still allowing for acreage criteria to be met (see item A criteria).	To provide sufficient resilience to stochastic events, meet downlisting conditions under items A, B, and C and have an average number of at least 1,060 rails over a 10-year period, spread over a large geographic area. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to SLC. • This criterion will be met when SLC modeling shows sufficient uplands have been protected to accommodate landward migration while still allowing for acreage criteria to be met (see item A criteria).

Table B11-1. Recovery Plan Criteria for Downlisting and Delisting for California Sea-Blite, Salt Marsh Harvest Mouse, and Ridgway's Rail in the Shoreline Phase I Study Area

Criteria by Factors Affecting Recovery	Recovery Plan Species in the Central/South San Francisco Bay Recovery Unit		
	California Sea-Blite	Salt Marsh Harvest Mouse	California Ridgway's Rail
Delisting	To provide sufficient resilience to stochastic events, meet delisting conditions under item A and have at least: • A minimum of three populations[b] • For 10 consecutive years of monitoring, the three populations must each support at least 500 individuals and the cumulative total of all San Francisco Bay populations must total a minimum of 8,000 individuals. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to SLC. • This criterion will be met when SLC modeling shows sufficient uplands have been protected to accommodate landward migration while still allowing for acreage criteria to be met. To minimize impacts sustained after oil spills occurring at or near populations of this species, the San Francisco Bay and Delta Area and Central Coast Area sections of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of this species.	75% of defined VHAs within each of the marsh complexes must have SMHM consistently present at the capture efficiency level of 5.0 or better. • Each marsh complex must be monitored and found to meet the above criteria at least twice, with at least 5 years between surveys. After marsh complexes meet the criteria twice, there is no need to resurvey as long as no more than 20 years have passed and there has been no obvious negative change to habitat during that time. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to SLC. • This criterion will be met when SLC modeling shows sufficient uplands have been protected to accommodate landward migration while still allowing for acreage criteria to be met. To minimize impacts sustained after oil spills occurring at or near rail populations, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of this species.	To provide sufficient resilience to stochastic events, meet delisting conditions under items A, B, and C and have an average number of at least 3,180 rails over a 10-year period, spread over a large geographic area. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to SLC. • This criterion will be met when SLC modeling shows sufficient uplands have been protected to accommodate landward migration while still allowing for acreage criteria to be met (see item A criteria). To minimize impacts sustained after oil spills occurring at or near rail populations, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of this species. Develop a map that identifies sources and extents of mercury exposure in rails; implement a plan to remediate the most significant point sources of mercury. Exposure of rails to mercury must be reduced such that the mean mercury concentration of all eggs sampled within a marsh complex must fall below 0.2 µg/g (fresh wet weight) for 5 consecutive years, the point above which it is believed developmental abnormalities and reproductive harm occur. • Only fail to hatch eggs will be sampled.

Source: USFWS 2013

km = kilometers; ha = hectares; USFWS = U.S. Fish and Wildlife Service; CDFW = California Department of Fish and Wildlife;

[a] For downlisting, a population is any concentration of plants separated by greater than 1.9 km (1.2 miles) from other such concentrations of plants, with no intervening locations observed over a period of 5 years.

[b] For delisting, a population is any concentration of plants separated by greater than 1.9 km (1.2 miles) from other such concentrations of plants, with no intervening locations observed over a period of 10 years.

[c] Viable habitat areas (VHAs) are defined as well-developed tidal marshes with (1) extensive *Sarcocornia* (pickleweed) on a mid to high marsh plain 200 meters (219 yards) or more deep (from shore to bay); (2) adjacent wide high marsh transition zone, wherever possible, that acts as a refugium for the mice during the highest tides with sufficient area and cover to minimize predation risks; and (3) stands of *Grindelia* or tall forms of *Sarcocornia*, interspersed among shorter forms of *Sarcocornia* to provide additional high tide refugia within the marsh and away from the upland edge.

[d] Capture level efficiency is the number of mice captured divided by effort in number of trap nights expended times 100.

Appendix B12

Environmental Justice Appendix

Environmental Justice Appendix

Regulatory Setting and Study Methodology

On February 11, 1994, President Bill Clinton issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. As the Federal sponsor of the Proposed Project, the U.S. Army Corps of Engineers (USACE) must consider how the project might affect minority and low-income populations.

Potential environmental justice populations were identified using American Community Survey 5-year estimates (2006–2010) and 2010 U.S. Census information..

In 2010, the Census blocks that make up the Alviso community supported a population of about 1,790 people (U.S. Census Bureau 2010). As of the late fall of 2012, 2010 Census data were available at the block level for race and ethnicity but not for income. For income and poverty, then, the following discussion relies on 5-year American Community Survey estimates for the census tract within which Alviso and the study area are located. This tract is much larger than the study area but is the best available information for the area.

Baseline Condition – Minority Populations

According to the Council on Environmental Quality's (CEQ) guidelines for environmental justice analyses (CEQ 1997):

> Minority populations should be identified where either (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the majority population percentage in the general population or other appropriate unit of geographic analysis. A minority population also exists if there is more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above-stated thresholds.

This study uses criterion (a) to identify minority communities. For the purpose of this study, a *minority* is a person who is Black, Asian, American Indian or Alaskan Native, or Native Hawaiian or other Pacific Islander, or is of Hispanic or Latino origin. People of Hispanic or Latino origin may be of any race and of more than one race.

Table 1 *General Racial and Ethnic Distribution of the Study Area* summarizes the racial and ethnic population distribution of cities in the study area. Table 1 *General Racial and Ethnic Distribution of the Study Area* shows that, in general, Santa Clara County and the cities in and around the study area have a higher proportion of minorities than the State as a whole. In San José, Santa Clara, and Sunnyvale, the percentage of Asian minorities is greater than the percentage of non-minorities (that is, white people who are not Hispanic). In general, the area is dominated by people who are Asian or white (both Hispanic and not Hispanic).

Table 1. General Racial and Ethnic Distribution of the Study Area

Area	Percentage of Total Population [a, b]									
	Total population	White, not Hispanic	White, Hispanic	Black or African American	AIAN[c]	Asian	HNOPI[d]	Some Other Race	Two or More Races	All Minorities
California	3,725,3956	40.1	17.4	6.2	0.9	13.0	0.3	16.9	4.9	59.6
Santa Clara County	1,781,642	35.2	11.8	2.6	0.7	32.0	0.4	12.4	4.9	64.8
San José	945,942	28.7	14.1	3.2	0.8	32.0	0.5	15.7	4.9	71.2
Santa Clara	116,468	36.1	8.9	2.7	0.5	37.7	0.5	8.3	5.3	63.9
Sunnyvale	140,081	34.5	8.5	1.9	0.5	40.9	0.4	8.7	4.6	65.5
Milpitas	66,790	14.6	5.9	2.9	0.5	62.1	0.5	8.7	4.7	85.3

Source: US Census Bureau 2010

[a] People of Hispanic or Latino origin can be one or more different races. These totals by race include people who might also be Hispanic or Latino.

[b] Percentages might not add up to 100 due to rounding.

[c] American Indian or Alaskan Native

[d] Native Hawaiian or other Pacific Islander

The study area supports two Census tracts (5046.02 and 5050.09) and several whole Census blocks. The Alviso area is made up of smaller blocks, but the study area also falls into parts of other much larger Census blocks that extend far outside of the study area boundary. Of the 54 individual blocks that are wholly or partially within the study area, 26 did not have any population in 2010 and were not considered in the analysis. These blocks include areas within the former salt pond complex and areas that support industrial/light industrial development only.

The remaining 28 blocks supported a population of 1,824 people in 2010; 88.3 percent of whom identified as minorities; only four blocks had a minority population that was less than 50 percent of the total population. See Appendix A6 *2010 Census Data – Racial and Ethnic Distribution of Study Area* for a detailed table of the racial and ethnic distribution by 2010 Census block. All but three of the blocks in the Alviso community had a 50 percent or greater proportion of minorities.

Figure 1 *Minority Distribution in the Study Area* shows the areas where minorities make up at least 50 percent of the total block population.

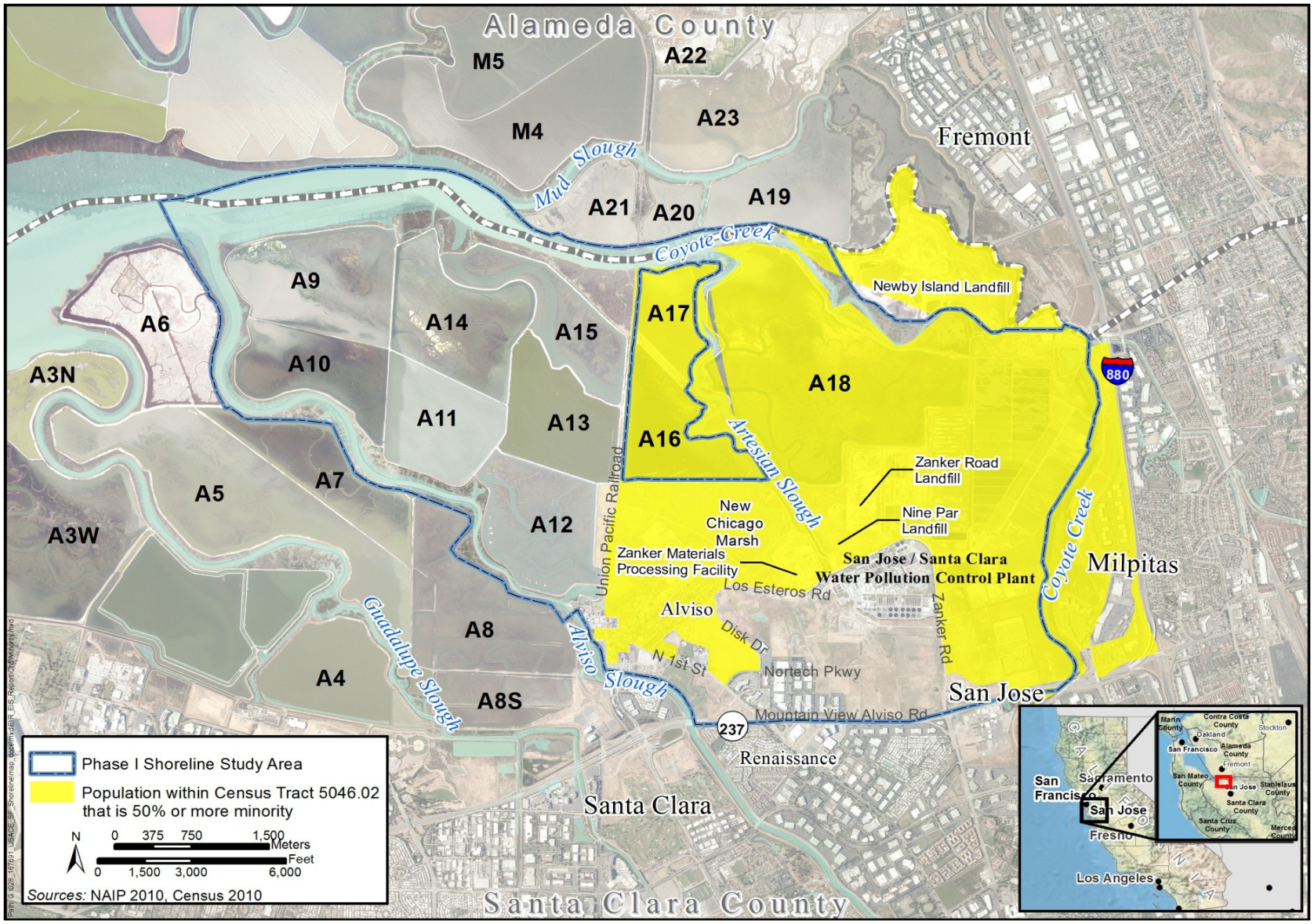

Figure 1. Minority Distribution in the Study Area

Baseline Condition – Low-Income Populations

To identify low-income populations, the CEQ's environmental justice guidance states the following (CEQ 1997):

> Low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports, Series P-60 on Income and Poverty. In identifying low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.

Note that the Census Bureau's current P-60 population report provides only general information about income trends nationwide and does not provide detailed information about the study area (DeNavas-Walt et al. 2012). Because of this, 2010 Census data are used to present more detailed information on income and poverty in the study area.

For the purpose of this study, a low-income population is persons who have a median income below the poverty thresholds defined by the U.S. Department of Health and Human Services. To identify low-income populations in the study area, this study identifies areas having a substantially higher percentage of people and households in poverty than the counties of Alameda and Santa Clara.

Table 2 *Income and Poverty Summary for Cities in the Study Area* summarizes the median income and poverty status of people living in cities in the study area.

Table 2. Income and Poverty Summary for Cities in the Study Area

Area	Median Household Income (2006–2010)	Percentage of Persons with Income below Poverty Level (2006–2010)
California	$60,883	13.7%
Santa Clara County	$86,850	8.9%
San José	$79,405	10.8%
Santa Clara	$85,294	8.6%
Sunnyvale	$90,174	6.2%
Milpitas	$92,694	5.8%

Source: U.S. Census Bureau 2012a, 2012b, 2012c, 2012d

Table 2 *Income and Poverty Summary for Cities in the Study Area* shows that, in general, people living in areas around the study area have a much higher median income than the rest of the residents of California as whole. To some degree, the higher incomes associated with each city reflect a higher cost of living in the Bay Area and are more meaningful when compared to the county incomes (and to each other) rather than to the State statistic.

The rates of people living in poverty in cities in the study area are lower than the State rate of 13.7 percent and range from a low of 5.8 percent in Milpitas to a high of 10.8 percent in San José.

Table 3 *Income and Poverty Summary for Census Tracts in the Study Area* summarizes income and poverty for the two Census tracts that include the study area. Census tract 5046.02 includes the community of Alviso but also includes large parts of the cities of Milpitas, Santa Clara, and Sunnyvale. Census tract 5050.09 is a much smaller tract that includes some developed areas south of State Route (SR) 237 between Coyote Creek and the Guadalupe River. 2010 Census data for poverty were not available at the time this report was written.

Table 3. Income and Poverty Summary for Census Tracts in the Study Area

Demographic Criterion	Census Tract	
	5046.02	5050.09
Median household Income	$52,202	$75,082
Population for whom poverty status is determined	1,471	6,026
Percentage of population below poverty level	15.6%	10.7%
Poverty Status by Race: of the population, percentage that is below poverty level		
White alone	12.9%	15.5
Black or African American alone	100%	13.2
American Indian and Alaskan Native alone	NA[a]	NA
Asian alone	0%	3.5
Native Hawaiian and Other Pacific Islander alone	NA[a]	0
Some other race alone	20.7%	5.3
Two or more races	0%	18.8
Poverty Status by Ethnicity: of the population, percentage that is below poverty level		
Hispanic or Latino (of any race)	16.6%	13.5%
White alone (not Hispanic or Latino)	17.4%	12.9%

Source: U.S. Census Bureau 2012b

Note: The data presented here are estimates based on a sample of the population. See Appendix A6 *2010 Census Data – Racial and Ethnic Distribution of Study Area* for complete information about margins of error and data reliability.

[a] Either no sample observations were available or too few sample observations were available to compute an estimate.

The populated part of the study area is centered on the community of Alviso. Alviso is in Census tract 5046.02. As shown in Table 3 *Income and Poverty Summary for Census Tracts in the Study Area*, the 2006–2010 median income of this Census tract was substantially lower than the median income for Santa Clara County as a whole (which was $86,850 for the same period; see Table 2 *Income and Poverty Summary for Cities in the Study Area*) and for the city of San José (which was $79,405 for the same period; Alviso is within the city limits). This indicates that, in 2010, the median income of households in Census tract 5406.02 was lower than that of households in the surrounding areas. The median income of households in Census tract 5050.09, which is in the southeast corner of the study area, was $75,082. This income was also lower than the county and city median incomes. Please note that, in the case of Census tract

5046.02, the margin of error is quite large (±$35,786; see Appendix A7 *2010 Census Data – 5-Year Income Estimates for Study Area*) and the data might not represent the true income status of people living there.

The 2006–2010 American Community Survey data also provide Census tract–level information about poverty. As shown in Table 3 *Income and Poverty Summary for Census Tracts in the Study Area*, the overall proportion of people living in poverty (for that part of the population for whom poverty status has been defined) was 15.6 percent in Census tract 5046.02 and 10.7 percent in Census tract 5050.09. Both of these proportions are higher than the amount for Santa Clara County as a whole (8.9 percent below poverty level; see Table 2 *Income and Poverty Summary for Cities in the Study Area*). The percentage of people living below the poverty level in Census tract 5046.02, within which Alviso is located, was substantially higher than the county and city percentages. This indicates that poverty is more prevalent in this Census tract than in surrounding areas. However, as with the income data, the margin of error for poverty is quite high in this Census tract (±10.1 percent). The percentage of people living in poverty in Census tract 5050.09 was similar to the city percentage. The margin or error for Census tract 5050.09 was ±4.1 percent.

The American Community Survey also provides information about poverty based on race and ethnicity. As shown in Table 3 *Income and Poverty Summary for Census Tracts in the Study Area*, all (100 percent) of the black and African American people (23) living in Census Tract 5046.02 were living below the poverty level, and a high percentage (20.7 percent) of people who identify themselves as some other race (581) were living below the poverty level. When considered separate from race, the poverty rate of the Hispanic or Latino origin population (16.6 percent) in Census tract 5046.02 was lower than but not statistically different from the poverty rate of people who are white and not Hispanic or Latino (17.4 percent).

Considering all three measurements (median income, overall poverty, and poverty by race and ethnicity), the data suggest that the population of Census tract 5046.02, within which the community of Alviso is located, is generally lower income than surrounding areas. However, the margins of error for the data estimates presented in the American Community Survey introduce uncertainty. Therefore, the presence of a low-income population cannot be verified with the available data.

Summary

In summary, the 2010 Census information shows that the population of that part of the study area that includes the populated parts of Alviso supports a minority population. The American Community Survey estimates indicate that the same area is probably lower income. Section 0 *Potential Effects on Environmental Justice Populations* assumes that the area shown on Figure 1 *Minority Distribution in the Study Area* represents an environmental justice population in the study area.

Potential Effects on Environmental Justice Populations

Methodology for Determining Effects

Pursuant to Executive Order 12898, this section considers whether the project alternatives would:

- Cause disproportionately high adverse effects (such as noise, air quality, and access effects) on the identified population(s) during construction
- Cause disproportionately high adverse effects on the identified population(s) during operation and maintenance of the flood risk management (FRM) levee and restored areas

As defined in the 1997 CEQ guidance, the following factors are used to measure environmental justice effects:

- For *human health effects*, agencies are to consider the following factors to the extent practicable:
  - Whether the health effects, which may be measured in risks and rates, are significant (as the term is used by the NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death; and
  - Whether the risk or rate of hazard exposure by a minority population, low-income population, or Indian tribe to an environmental hazard is significant (as the term is used by the NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group; and
  - Whether health effects occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.
- For *environmental effects*, agencies are to consider the following:
  - Whether there is or will be an impact on the natural or physical environment that significantly (as the term is used by the NEPA) and adversely affects a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment; and
  - Whether environmental effects are significant (as the term is used by the NEPA) and are or may be having an adverse impact on minority populations, low-income populations, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and
  - Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.

In general, the part of Santa Clara County that includes the study area is racially and ethnically diverse. Racial and ethnic minorities make up 88.3 percent of the total population in Census blocks that are included, either wholly or partially, in the study area.

The community of Alviso, the area that generally supports the identified environmental justice populations, has long been located adjacent to the former salt ponds, the San José–Santa Clara Regional Wastewater Facility (Wastewater Facility), and industrial uses surrounding the plant. This analysis does not evaluate how these existing uses have affected the community in the past. The following discussion focuses on how this specific project might affect the environmental justice population.

Alternatives Evaluation

In general, the Shoreline Phase I Project is expected to have positive regional economic impacts as a result of both a reduction in flood risk and the expenditure of funds to implement the projects (USACE 2012a).These positive effects would apply to all populations in the study area. The following paragraphs examine the potential environmental justice population effects associated with constructing the FRM levee and ecosystem restoration components and the long-term management of the study area.

Flood Risk Management Levee

In the long term, the greatest flood risk improvements would be experienced by those living in the community of Alviso, which supports an environmental justice population.

The community of Alviso is at an elevation at or below about 5 feet NAVD 88. Because of the low elevation of the town, a coastal flood event could result in flood depths as great as 8 feet throughout much of the floodplain. Flood events that would result in several feet of flooding in Alviso are estimated to cause more than $100 million in direct damage to structures and contents.

The existing patchwork of non-engineered salt pond dikes that keeps bay water from the developed area has, in fact, prevented tidal flooding in the study area to date. However, according to the coastal flood risk analysis there is currently a high annual risk of flooding, and this risk will increase over the period of analysis under any of the three sea-level change (SLC) scenarios considered. According to the combined coastal and geotechnical modeling, in 2017 the annual chance of flooding is approximately one in three. Under the USACE Intermediate SLC scenario the annual risk of flooding by the year 2067 is estimated to be greater than fifty percent. This increase is due to the increase in relative sea level at the study location over the period of analysis.

Because of the significant flood depths anticipated, the flood risk is high both from a property damage perspective as well as a public health and safety perspective. If a project to reduce flood risk is not constructed, the study area would likely be vacated after repeated flooding and the community of Alviso would no longer exist.

During actual construction of the levee, most of the potential adverse social effects on the community of Alviso would take place during construction. Because the community is the

closest to the proposed construction area, residents living in the community would be the most likely to be exposed to construction-related nuisances such as noise, dust, and additional traffic. As described throughout Chapter 4 *Existing and Future Conditions/Affected Environment, Environmental Consequences, and Mitigation Measures*, these construction-related effects would be short-term and minimized through applying best management practices. For example, construction-related air quality impacts would be avoided or minimized through careful material management, equipment management, and wind erosion control. The construction-related community impacts associated with FRM levee construction would be most noticeable to Alviso residents with Alternative 5 since the proposed FRM levee location would be very close to the community. Alternatives 2 and 3 would have the least effect on the community since the FRM levee would be on the north side of New Chicago Marsh (NCM; a distance of a quarter to a half mile in most places). Construction staging would be the same under all of the alternatives. For the most part, equipment and material would be staged in areas away from the community (primarily on Wastewater Facility property to the east and northeast).

In summary, applying best management practices to control dust and noise and limiting vehicle use to concentrated staging areas east of the town would prevent or minimize adverse construction-related effects on the residents of Alviso. Improving the long-term level of flood risk management would have a beneficial effect on the Alviso community. In general, then, the overall effect of the FRM element of the Shoreline Phase I Project would benefit this environmental justice population.

Ecosystem Restoration

The ecosystem restoration activities most likely to affect residents of Alviso are construction-related nuisance impacts similar to those described for FRM levee construction. In the case of ecosystem restoration, activity would begin at Pond A12, which is the pond closest to the community, starting in Year 0 with pond preparation. People living on the west end of Alviso could experience the construction-related nuisance impacts through about Year 4, when the Pond A12 breach is scheduled to occur. After that time, pond preparation work and construction activity would move to areas farther away from the community, so dust and noise impacts would lessen. Residents would probably still experience construction-related traffic, but, given the level of traffic that would probably be associated with the in-pond work, the schedule (it is spread out over several years), and the traffic maintenance plan that would be used during construction, construction-related traffic impacts are not expected to significantly affect mobility and access in, through, and around Alviso. Because the Pond A12 construction impacts would be short-term and because other construction would be physically farther away and low-intensity, construction-related nuisance impacts are not expected to cause significant effects on the residents of Alviso.

Long-term operations associated with areas restored through outboard levee breaches, such as water control and ongoing monitoring, are not expected to result in any adverse social impacts that could disproportionately affect people living in Alviso.