M E M O R A N D U M

TO: South Bay Salt Pond Restoration Project Management Team

FROM: Philip Williams & Associates, Ltd. and H. T. Harvey & Associates

DATE: May 18, 2005

RE: **Landscape-Scale Assessment Progress Update**

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1. EXECUTIVE SUMMARY

This document provides a progress update of the landscape-scale assessment. This update summarizes results to date in advance of the 25 May Joint Work Group meeting. Complete documentation of the landscape-scale assessment is expected by late summer.

The landscape-scale assessment consists of two parts: a geomorphic assessment and a bird use assessment. The landscape-scale geomorphic assessment, for which preliminary results are available, provides predictions of changes in mudflat and tidal marsh habitat in response to implementation of the South Bay Salt Pond (SBSP) Restoration Project. The landscape-scale bird use assessment, in progress, provides predictions of bird use associated with the habitat evolution projections. Together, the assessments inform the alternatives evaluation by providing metrics for how well a given alternative meets the project objectives.

The preliminary results of landscape-scale geomorphic evolution suggest that sufficient sediment is available for tidal restoration and that even the most subsided ponds within the Alviso complex will support marsh vegetation within the 50-year planning horizon. The primary changes to existing bay habitats as a result of tidal restoration occur in the intertidal mudflat habitats. Under the No Action Alternative, there is a small net conversion of open water to mudflat and tidal marsh habitats in the far South Bay (below the Dumbarton Bridge), and a net conversion of 1500 acres of intertidal mudflat to shallow-subtidal habitat between the San Mateo and Dumbarton Bridges. Under Alternative 3, with 90% of the former salt ponds restored to tidal action, there is a smaller net conversion of open water to bay mudflat in the far South Bay, and a substantial creation of salt marsh within the restored ponds. Between the bridges, a net conversion of 2700 acres of intertidal mudflat to shallow-subtidal habitat is predicted. Overall, there is a decrease in approximately 800 acres of mudflat habitat with Alternative 3 compared to the No Action Alternative within the South Bay. However, this loss will be mitigated by the creation of mudflat habitat within the restored ponds.

The No Action Alternative and Alternative 3 represent the bookends with respect to tidal restoration. Alternatives 1 and 2 have intermediate levels of tidal restoration, therefore their associated habitat projections fall in between the bookends. These preliminary results are being tested for sensitivity to the input assumptions.

2. INTRODUCTION

South San Francisco Bay (South Bay) hydrodynamics, morphology, and habitats have changed substantially over the previous 150 years under the influence of natural and anthropogenic processes. The largest perturbation to the system was the conversion of 90% of the tidal marsh areas to salt ponds, agriculture, and urban areas. During the same time period, there was a 40% decline in the extent of intertidal mudflats (Foxgrover and others 2004), however the correlation between the two losses is unclear. Although it is nearly impossible to separate out the impact to the system attributable to the original conversion to salt ponds, it is reasonable to assume that an action of comparable magnitude, such as restoring the salt ponds back to tidal marsh, could produce a system-wide response as dramatic as that observed over the past century. Therefore, it is essential to develop an understanding of the potential long-term system response before performing restoration actions.

The South Bay will continue to evolve over the 50-year planning horizon even without a restoration project due to ongoing changes in land use, sediment dynamics and sea level rise. For example, if the rate of mudflat loss observed between 1956 – 1983 of 0.67 km^2/year (Foxgrover and others 2004) continues unabated, more than 80% of South Bay mudflats could be lost over the next 50 years. Implementation of a restoration project as large as the South Bay Salt Pond (SBSP) Restoration Project has the potential to significantly alter this rate and change the net trends over time. Given the importance of the South Bay to large numbers of waterbird species (as well as fish, salt marsh harvest mice, harbor seals, and other wildlife), the potential effects of the SBSP Restoration Project on the habitats used by these species must be predicted to help inform the restoration alternatives (e.g., the mix of tidal habitat and managed ponds necessary to support these species).

The geomorphic assessment analyzes the rate at which salt ponds planned for tidal restoration may evolve from tidal mudflat to marsh, and how changes in sediment dynamics and sea level rise will impact the morphology, and the extent of tidal flat and shallow water habitat, of the South Bay. In this progress-update memorandum, a summary of the methodology and primary analysis tools is presented, along with preliminary habitat projections for the No Action Alternative and Alternative 3: Maximum Tidal Emphasis. These two alternatives represent the bookends with respect to tidal restoration, with the No Action Alternative restoring only the Island Ponds (ponds A19 – 21) in the Alviso Complex, and Alternative 3 restoring 90% of the former salt ponds within the project area to tidal action. Alternatives 1 and 2 have intermediate levels of tidal restoration, therefore their associated habitat projections fall in between the bookends. The final Landscape-Scale Geomorphic Memorandum will include a more comprehensive presentation of the methodology, the results of the No Action Alternative and the three preliminary restoration alternatives, and the associated sensitivity analyses, later this summer (PWA in progress).

The bird-use assessment analyzes potential changes in abundance of individual bird species and guilds based on the habitats projections from the geomorphic assessment, and empirical relationships between bird abundance and habitat availability and quality from local South Bay studies. A summary of the methodology is presented in this progress-update memorandum. The bird modeling is currently in progress for the No Action Alternative and Alternative 3. The final Landscape-Scale Bird-Use Assessment will include the modeling results and a more detailed presentation of the methodology later this summer (H. T. Harvey & Associates in progress).

3. GEOMORPHIC ASSESSMENT METHODOLOGY

The geomorphic assessment can be considered a sensitivity analysis that's primary purpose is to bound the sediment budget and establish projections of mudflat and tidal marsh habitat for the three restoration alternatives and the No Action Alternative (assuming ongoing maintenance of existing pond levees) over the 50-year planning horizon. The first step in understanding the morphology of this complex system is to examine historical morphologic change. Foxgrover and others (2004) analyzed deposition, erosion, and bathymetric change between 1858 and 1983, and will assess current trends between 1983 and 2004 after the full set of 2004 bathymetric data becomes available in early 2006. Due to the unavailability of this data set at the time of the geomorphic assessment, the 1983 bathymetric survey, along with the erosion and deposition trends depicted by Foxgrover and others (2004) between 1956 and 1983, are used as the baseline.

The second step in furthering our understanding of landscape-scale sediment processes relies on calibrating a sediment budget accounting tool to past geomorphic change (*e.g.*, 1956 to 1983) in order to create a predictive tool for assessing future changes to the sediment budget (Lionberger and Schoellhamer, pers. comm.). This predictive accounting tool is used to track the change over time (*e.g.*, using decadal time steps) in the various morphologic units of interest, namely the deep subtidal channel, the shallow subtidal regions, the intertidal mudflats, and the salt ponds restored to tidal action. A second suite of tools is then used to evaluate the projected change within each component, such as examining the evolution of tidal habitat within the restored salt ponds. Information from this analysis is then used to revise the bathymetry within the South Bay and the restored ponds at decadal intervals.

This work was performed in coordination with David Schoellhamer and Megan Lionberger at the United States Geological Survey.

3.1 Tools

The primary tools for assessing geomorphic evolution of the South Bay include:

- Uncles – Peterson Salinity Model (UP Model) (Uncles and Peterson 1995) adapted and calibrated as a sediment budget tool for San Francisco Bay (Lionberger and Schoellhamer, pers. comm.)
- MARSH98 – zero-dimensional sedimentation model to predict long-term changes in bed elevation of breached ponds (Krone 1987; Philip Williams & Associates 2002)

3.1.1 SUP Model

The SUP model is a box model that represents the Bay as fifty boxes, with each box divided into an upper layer representing the shallow subtidal and intertidal mudflats and a lower layer representing the deep sub-tidal channel. The model was originally developed to simulate tidally-averaged currents and salinities in San Francisco Bay, and was referred to as the UP model (Uncles-Peterson). A sediment transport subroutine was more recently incorporated into the model for use as a sediment budget tool (Lionberger and Schoellhamer, in prep.), and the enhanced model is herein referred to as the SUP Model. The model has been used to accurately simulate variability in suspended sediment concentrations (SSC) associated with tidal fluctuations, residual velocity, and wind stress (Lionberger and Schoellhamer 2003), and to assess the potential effects of restoration on SSC and phytoplankton blooms (Shellenbarger and others 2004).

Although the SUP Model was not originally developed for use as a geomorphic modeling tool, the model was chosen for use in this assessment because it accounts for the landscape-scale responses to tidal restoration at a resolution appropriate for program-level planning. All SUP Model simulations span the 50-year planning horizon, with the breached ponds represented as sediment sinks from the upper layer of the adjacent model segment. Therefore, all pond breaches are approximated as Bay front breaches rather than tributary breaches due to the nature of the box modeling approach. Opening up the ponds for tidal restoration will change the hydrodynamics of South Bay by increasing the tidal prism, resulting in increased velocities and an increase in the total bed shear stress. This dynamic is accounted for in the model simulations.

The resulting model output includes SSC, South Bay deep subtidal and shallow subtidal bed change, accretion within the ponds, and the flux between the various morphologic units over time. The output is aggregated across the four South Bay regions utilized by Foxgrover and others (2004), where Region 1 includes the area between the Oakland-Bay Bridge and the San Bruno Shoal, Region 2 includes the area between the San Bruno Shoal and the San Mateo Bridge, Region 3 includes the area between San Mateo and Dumbarton Bridges, and Region 4 encompasses the far South Bay below the Dumbarton Bridge. The geomorphic assessment presented here focuses only on Regions 3 and 4, which have direct connections to the three pond complexes.

3.1.2 MARSH98

The primary tool for assessing geomorphic evolution of breached ponds is a simple vertical sedimentation model (MARSH98) used to predict long-term changes in bed elevation of breached ponds. This model is based on methods derived by Krone (1987), which are centered on the mass balance of suspended sediment, the frequency and duration of tidal inundation, and accumulation of deposited material.

The primary input for MARSH98 is the SSC near the pond breaches. The SUP Model predicts a depth- and width-averaged SSC for each region. SSCs in the South Bay are typically higher in the shallower areas due to wind-induced sediment resuspension, therefore the SUP Model SSCs likely under predicts SSCs near the pond breaches. Representative existing restoration sites within the South Bay near each pond complex were chosen in order to empirically scale the SUP Model SSCs to appropriate values for use within MARSH98 (Figure 1).

At the beginning of each decadal interval, the SUP Model SSC output is scaled based on an appropriate reference site for each complex. MARSH98 is then used to predict sedimentation within the tidally restored ponds. The sedimentation rates vary within the ponds depending on the starting bed elevations. The calculated elevation changes are added to the GIS coverage in order to determine the spatial distribution of marsh and mudflat within the restored areas.

3.2 Assumptions

The simulations contain a series of assumptions with respect to future conditions. For example, the analyses assume a constant rate of sea level rise of 0.003 m/year (0.01 ft/year) (IPCC 2001), assume all restored ponds are opened to tidal action at year 0 (*i.e.,* no phasing), assume vegetation colonization for cordgrass-dominated salt marsh occurs at mean tide level (MTL) + 0.3 m and pickleweed-dominated salt marsh occurs at mean high water (MHW) (H. T. Harvey & Associates and PWA 2005), , and assume tributary sediment inputs remain constant over the 50-year simulation. Tributary sediment inputs do vary temporally with Delta outflow over the 50-year simulations, with dryer years associated with lower tributary sediment inputs. However, the relationships between Delta outflow and tributary sediment loads are based on current information and do not take into account potential decreases in tributary sediment inputs that may or may not occur in the future.

3.3 Accuracy and Sensitivity

As with any predictive modeling, the results are associated with a degree of uncertainty. A series of sensitivity analyses was performed to quantify the level of uncertainty in the proposed methods and assumptions. Following is a partial list of the sensitivity runs performed.

- Vary the trapping efficiency of the ponds (*e.g.,* 100%, 75%, 50%)
- Vary the Delta Outflow (*e.g.,* wettest ten years on record, driest ten years on record, average ten-year period), which affects local watershed inflows and sediment supply, and therefore the sediment budget
- Assume all tributary sediment inputs are captured directly by the ponds (approximating maximum trapping by tributary breaches)
- Assume tributary sediment inputs are zero

3.4 Results

A summary of the major results is presented here for the No Action Alternative and Alternative 3. A more detailed report containing the complete results, including Alternatives 1 and 2, is in progress and will be released later this summer (PWA in progress).

3.4.1 No Action Alternative

Under the No Action Alternative with ongoing Initial Stewardship Program (ISP) management and pond levee maintenance, the largest perturbation to the system is sea level rise. Figure 2a depicts the habitat evolution predictions for the far South Bay and the three pond complexes. The SUP Model predicts that Region 4 (the far South Bay) experiences 0.7 m of net sedimentation over 50 years, outpacing sea level rise and resulting in a conversion of approximately 900 acres of existing intertidal mudflat to tidal marsh, and a conversion of approximately 800 acres of shallow- and deep-subtidal habitat to intertidal mudflat, resulting in a net loss of approximately 100 acres of intertidal-mudflat habitat. The total amount of sediment deposited and in suspension in Region 4 exceeds the tributary sediment load; therefore the far South Bay effectively operates as a sediment trap, trapping both tributary inputs and a net flux of sediment through the Dumbarton Narrows. Region 3 (between the San Mateo Bridge and the Dumbarton Bridge) experiences net erosion of approximately 0.3 m over 50 years. This results in a conversion of approximately 1500 acres of intertidal mudflat to shallow-subtidal habitat, with little change occurring to the deep-subtidal channel.

Only the Island Ponds (A19 – 21) in the Alviso Complex are restored to tidal action under this alternative, and the remaining ponds within the project area continue to operate as managed ponds. The starting bed elevations of the Island Ponds are near MTL and sedimentation raises them to cordgrass colonization elevations (0.3 m above MTL) in less than 10 years, and pickleweed colonization elevations (MHW) within 20 to 30 years.

3.4.2 Alternative 3: Tidal Habitat Emphasis

Under Alternative 3, 90% of the salt ponds within the project area are restored to tidal action as shown in the Preliminary Program Alternatives Memorandum (PWA and others 2005). This includes 1300 acres in the Ravenswood complex, 4000 acres in the Eden Landing complex, and 6850 acres in the Alviso Complex. Figure 2b depicts the habitat evolution predictions for the far South Bay and the three pond complexes.

The ponds in the Eden Landing Complex begin at the highest initial elevations, with an average initial bed elevation near MHW, 0.6 m above cordgrass colonization elevations and near the elevation where pickleweed can establish. The model predicts that vegetation will begin to establish immediately after the ponds are breached, with tidal salt marsh vegetation establishing within 10 years. The deepest ponds in the Eden Landing complex, ponds E6A and E6B, will develop tidal salt marsh habitat within 20 to 30 years. The ponds with gypsum layers (E8 and E8A) may take longer for vegetation to establish.

Figure 3 depicts the spatial and temporal change in the distribution of habitats. The areas that start out with pond bottom elevations below vegetation colonization elevations (MTL + 0.3 m) are shaded brown and considered intertidal mudflat, requiring sedimentation to occur before vegetation can establish. When pond bottoms reach cordgrass colonization elevations (shaded pink on Figure 3), vegetation can begin to establish. Vegetation may take between 0 and 10 years to establish once the appropriate elevation is reached (not represented in Figure 3). When pond bottom elevations reach pickleweed colonization elevations (shaded purple on Figure 3), more fully-developed tidal salt marsh habitat can establish.

The ponds in the Ravenswood Complex also begin at high initial elevations approximately 0.3 m above the cordgrass colonization elevations (Figure 4). In the absence of gypsum, cordgrass is predicted to establish within the 10 years. However, all of the ponds in the Ravenswood Complex, with the exception of R1, contain gypsum layers, therefore tidal salt marsh habitat may take longer to develop. Based on empirical evidence from existing restoration sites (Figure 1), sedimentation rates near the Ravenswood Complex are slower than on the eastern shore near Eden Landing, therefore the Ravenswood ponds may take slightly longer to reach pickleweed colonization elevations. Figure 4 predicts that the majority of the complex reaches this elevation within 30 years.

The Alviso Complex contains the most subsided ponds within the project area; therefore marsh establishment occurs at a slower pace (Figure 5). The Island Ponds (A19, A20, A21) and ponds A22 and 23 begin with average bottom elevations about 0.2 m above cordgrass colonization elevations. These ponds are predicted to develop vegetation within 10 years, however, the presence of gypsum layers may delay vegetation establishment. The remaining ponds in the Alviso Complex require at least 0.5 m of sedimentation to reach cordgrass colonization elevations. The analysis predicts that sufficient sediment is available to allow the ponds to reach cordgrass colonization elevation within 20 to 30 years, and pickleweed colonization elevations within 40 years. Vegetation establishment is therefore predicted to occur within the 30 to 50 year time frame.

In the far South Bay, the intertidal mudflats are predicted to continue to accumulate sediment, although at a slower rate than the No Action Alternative. Over the fifty-year planning horizon, the mudflats in Region 4 (the far South Bay) are predicted to accrete 0.3 m of sediment, with no significant long-term change in the main channel bottom bed elevation. The local tributaries and sloughs will scour and provide a source of sediment for restoration in the first decade. Region 4 experiences 0.4 m less sedimentation than the No Action Alternative, resulting in a conversion of approximately 50 acres of intertidal-mudflat habitat to salt marsh, and a conversion of approximately 450 acres of shallow-subtidal habitat to intertidal mudflat, resulting in a net increase in intertidal mudflat area of approximately 400 acres within the far South Bay over the 50-year planning horizon.

The model predicts that Region 3 (between the San Mateo Bridge and the Dumbarton Bridge) will continue to be net erosional, eroding approximately 0.15 m more sediment than under the No Action Alternative. This results in a net conversion of approximately 2700 acres of intertidal mudflat to shallow-subtidal habitat, with no significant change to the deep-subtidal channel.

4. BIRD USE ASSESSMENT METHODOLOGY

The landscape-scale assessment of bird populations will use empirical relationships between bird abundance and habitat availability and quality from local South Bay studies, along with the habitat projections from the geomorphic assessment, to predict changes in the abundance of individual bird species and guilds in the South Bay. This assessment will focus on two landscape scenarios bounding the range of restoration alternatives: the No Action Alternative, in which changes occur over time primarily as a result of sediment dynamics and sea-level rise in the tidal areas outside the existing ponds, and

Alternative 3: Tidal Habitat Emphasis. The bird populations associated with Alternatives 1 and 2 are expected to fall in between the two bookends.

The assemblage of bird species using the South Bay is comprised of a large number of taxonomically and ecologically diverse species. These species differ considerably from one another in their habitat use and requirements. Many species use multiple habitats, and their use of any given habitat may vary depending on the tide cycle, time of day, season, and population density. Thus, the relationship between the population size of a given bird species in the South Bay and the distribution and quality of habitat types varies widely among the different species. Predicting the response of various bird species to changes in the availability and quality of habitats in the South Bay will assist in appraising how well the preliminary alternatives meet the project objectives by providing metrics for alternatives evaluation. This requires the selection of focal or indicator species that represent the array of species occurring in the study area, and the use of modeling techniques that can assess these species' use of multiple habitats and responses to changes in multiple variables associated with habitat quality.

4.1 Tools

The landscape-scale assessment of bird populations will be based primarily on bird-habitat relationship models and a revised Habitat Conversion Model (HCM) developed by PRBO Conservation Science. PRBO developed a HCM[1] in 2003 to predict bird densities and total numbers for several hypothetical South Bay restoration scenarios. The purpose was to compare the effects of different marsh restoration endpoints (with respect to channel and pond density) and different mixes of tidal marsh and salt pond habitat configurations. The model was based on data PRBO collected on bird abundance on a subset of South Bay salt ponds (which, at the time, were being used by Cargill for salt production) and in existing South Bay tidal marshes. These datasets were used to develop multivariate models relating bird density to salt pond and tidal marsh habitat characteristics, including surrounding land use.

The HCM model was used to generate static representations of habitat value across a wide range of bird species that depend on South Bay salt ponds and/or tidal marshes. Species were grouped by guilds; predicted population dynamics of individual species were not addressed. Since the Preliminary Program Alternatives had not yet been developed, the HCM modeling used early assumed restoration scenarios and did not attempt to examine changes in tidal habitats over time. Salt pond conditions were assumed to remain as they had been under Cargill's management for salt production, rather than reflecting conditions under pond management specifically for bird use. Tidal mudflats, a critical habitat for migratory shorebirds, were not considered in the HCM scenario evaluations.

The landscape-scale bird use assessment will address many of these and other issues that were not addressed in the HCM modeling. PRBO and H. T. Harvey & Associates have collaborated to revise the model. While the modeling approach remains similar, the models have been improved in several ways:

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[1] The Habitat Conversion Model is also known as the "Phase 1" model. The name has been changed for this assessment to avoid confusion with the Phase 1 Project.

1. Identification of tidal marsh and/or salt pond-dependent focal species, limiting factors, and seasons of greatest importance to these species.
2. Refinement of estimates of foraging habitat for shorebirds and diving ducks in existing ponds using new salt pond bathymetry data collected by USGS.
3. Explicit consideration of uncertainties.
4. Incorporation of a comprehensive evaluation of South Bay-wide habitat values, including intertidal mudflats and the remaining Cargill ponds.
5. Explicit consideration of marsh microhabitats (pond, channel, vegetation) and the development of separate density predictions for each.
6. Consideration of overall waterbird biomass (by guild) and approximation of potential carrying capacities in overall predictions.
7. Consideration of changes in tidal marsh and mudflat habitats as predicted by the geomorphic assessment.
8. Consideration of different types of managed ponds, including management for birds, not just for salt production.
9. Application to the Preliminary Program Alternatives

4.2 Model Approach and Assumptions

The revised Habitat Conversion Model (HCM) is habitat-based, and is predicated on the general assumption that habitat is the primary limiting factor for the bird species evaluated. The HCM does not incorporate population dynamics, but does estimate a South Bay population index for each focal species. These population indices, standardized by their baseline values, may be compared across different restoration scenarios, but should not be interpreted as actual population numbers.

The HCM includes the pond, tidal marsh, and intertidal mudflat habitats of the South Bay, south of the San Mateo Bridge, but does not consider other parts of San Francisco Bay, nor any other geographic areas that may be used by the focal species. Existing tidal/muted marsh habitat and Cargill-owned salt ponds are included as static habitats with fixed bird densities and overall numbers (based on means from PRBO data).

After selecting focal species, seasons, metrics, and appropriate predictor variables, pond-level habitat relationship models were developed for each species-season-habitat combination. The results of the geomorphic assessment were used to calculate values for the tidal habitat predictor variables. Vegetated tidal marsh evolution, and the type of dominant tidal marsh vegetation expected to develop (i.e., cordgrass vs. pickleweed in salt marshes, or bulrush in brackish marshes), was predicted based on empirical data relating dominant marsh vegetation type to tide height and salinity in the South Bay (H. T. Harvey & Associates and PWA 2005, Figure 6). Predicted values for managed pond habitat variables were estimated based on refinements to the Preliminary Program Alternatives for the configuration and management of managed ponds. For example, under Alternative 3, approximately 10% (1500 acres) of the ponds within the project area will remain as managed ponds and will be managed as reconfigured ponds to maximize bird use (Gordus and others 1996; H. T. Harvey & Associates 1996; PWA and others 2005).

To develop site-level predictions of bird density (managed pond or tidal marsh), PRBO developed a GIS-based tool that reads in spatially-explicit restoration scenarios, incorporates those values into the models, and produces a pond-level density estimate for each focal species-season combination. These density estimates may then be compared across pond units or combined to produce an overall South Bay population index.

For shorebirds, which make use of multiple habitats in the South Bay, PRBO developed a method to combine mudflat, managed pond, and tidal marsh population indices, weighting each by habitat availability (tidal exposure) and assumed prey value (based on low tide habitat use) to develop an overall index of habitat value. In the absence of bioenergetic data, these empirically-derived parameters should provide a reasonable proxy for overall energetic value. Their importance will be evaluated with a sensitivity analysis.

Because many of the salt ponds surveyed by PRBO were not utilized to their full capacity because they were managed for salt production rather than bird use, a potential carrying capacity for each pond was estimated by identifying the maximum observed bird density from PRBO's data. The ratio of mean to maximum pond-level densities will be used to generate upper-end predictions of bird use for managed ponds under the No Action Alternative. Changes in bird use associated with pond management strategies under Alternative 3 are addressed separately using habitat relationship models which cover a fairly broad range of depths and salinities.

The landscape scale assessment of bird use under the No Action and Tidal Emphasis alternatives is expected to be completed by June 2005. Subsequently, a more detailed report will be prepared presenting and discussing the results (H. T. Harvey & Associates in progress).

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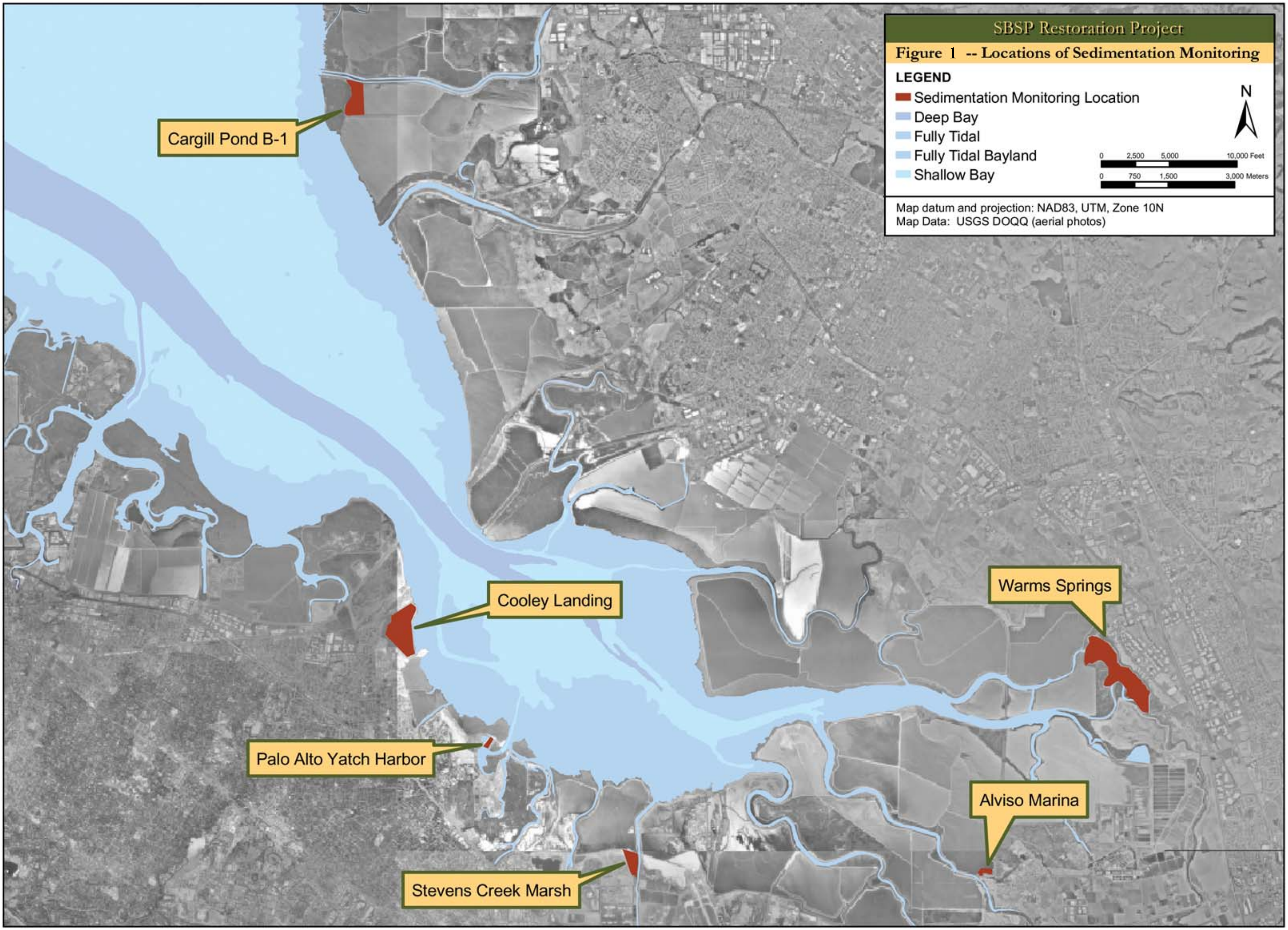
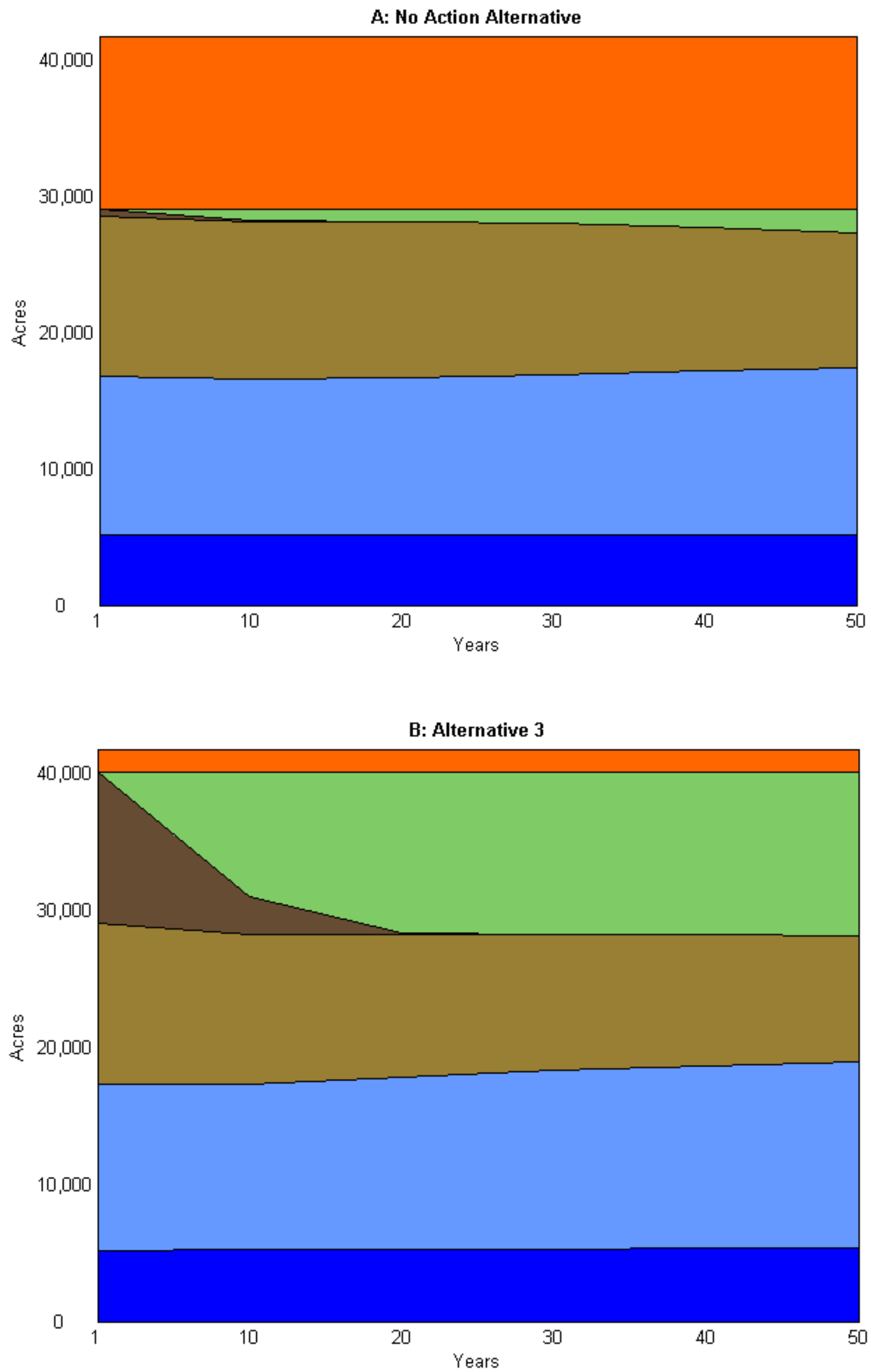
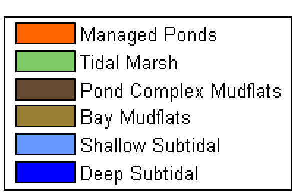
Source files for this report are located at PWA:
\\orca\pwa\Projects\1720_SouthBay-Stage1\Task03d_SedimentBudget\TechMemo\Landscape_Scale_Summary_v1.1.doc


SBSP Restoration Project
Figure 1 -- Locations of Sedimentation Monitoring
LEGEND
Sedimentation Monitoring Location
Deep Bay
Fully Tidal
Fully Tidal Bayland
Shallow Bay
N
0 2,500 5,000 10,000 Feet
0 750 1,500 3,000 Meters
Map datum and projection: NAD83, UTM, Zone 10N
Map Data: USGS DOQQ (aerial photos)
Cargill Pond B-1
Cooley Landing
Warms Springs
Palo Alto Yatch Harbor
Alviso Marina
Stevens Creek Marsh



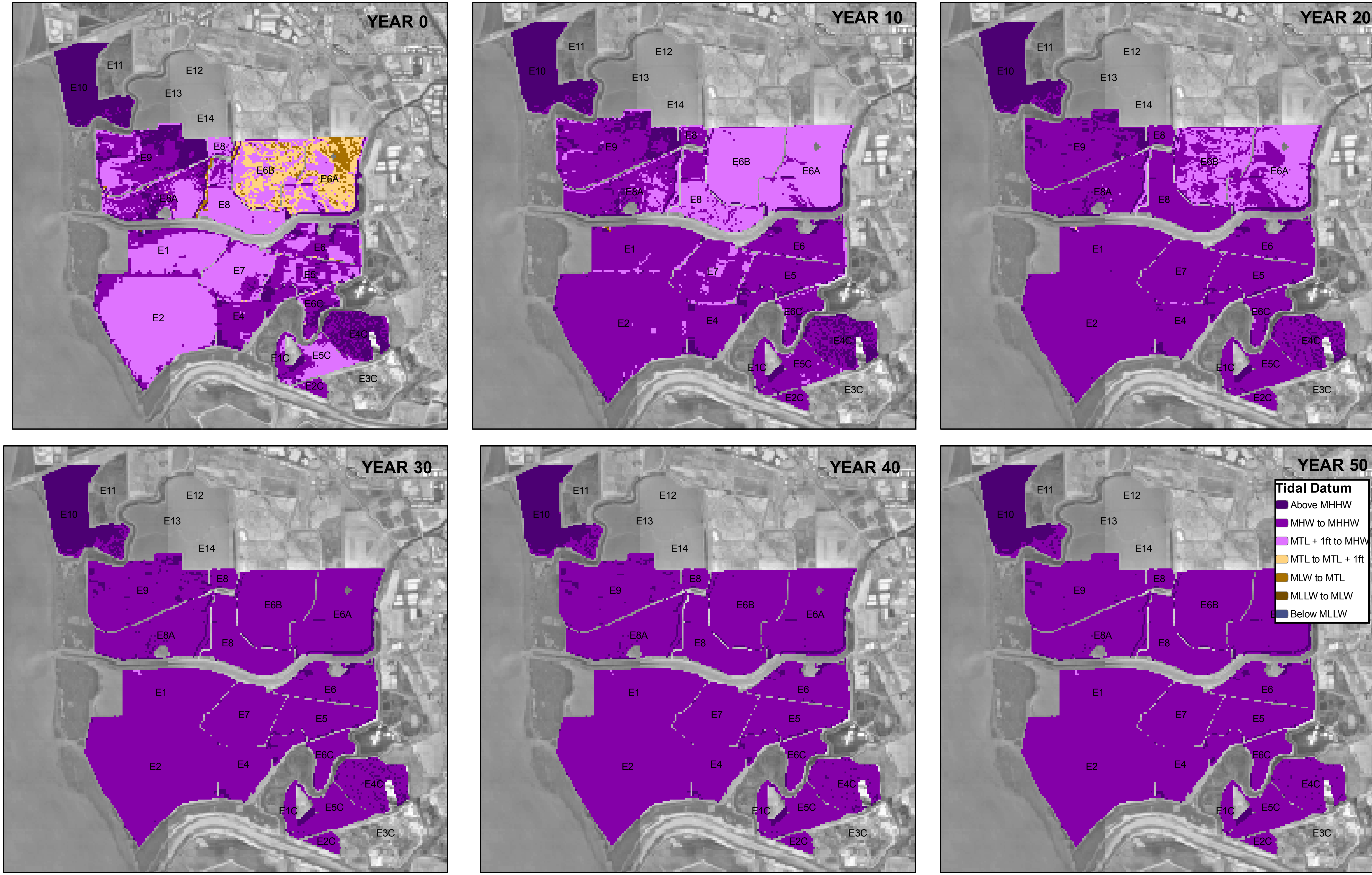


Acreage shown include the three pond complexes and the South Bay, south of the San Mateo Bridge (existing marsh areas, such as Greco Island, are not included)

figure **2**

Long-term Habitat Evolution Predictions

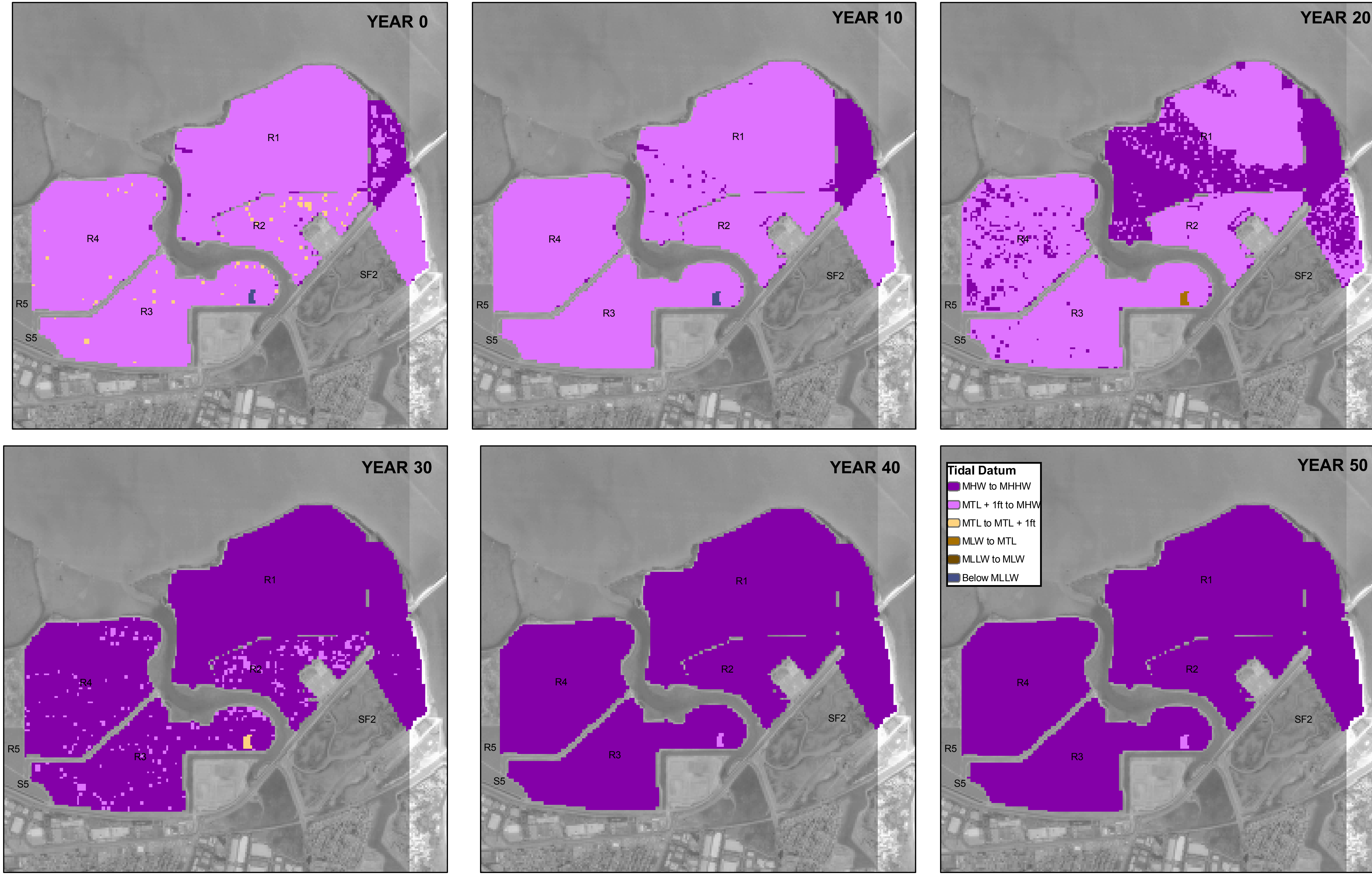
PWA



Datum and projection: NAD83, UTM, Zone 10N; NAVD 88, meters
Map Data: USGS Bathymetry Survey (pond elevations)
USGS DOQQ (aerial photos)

South Bay Salt Pond Restoration Project - Eden Landing Pond Complex Alternative 3

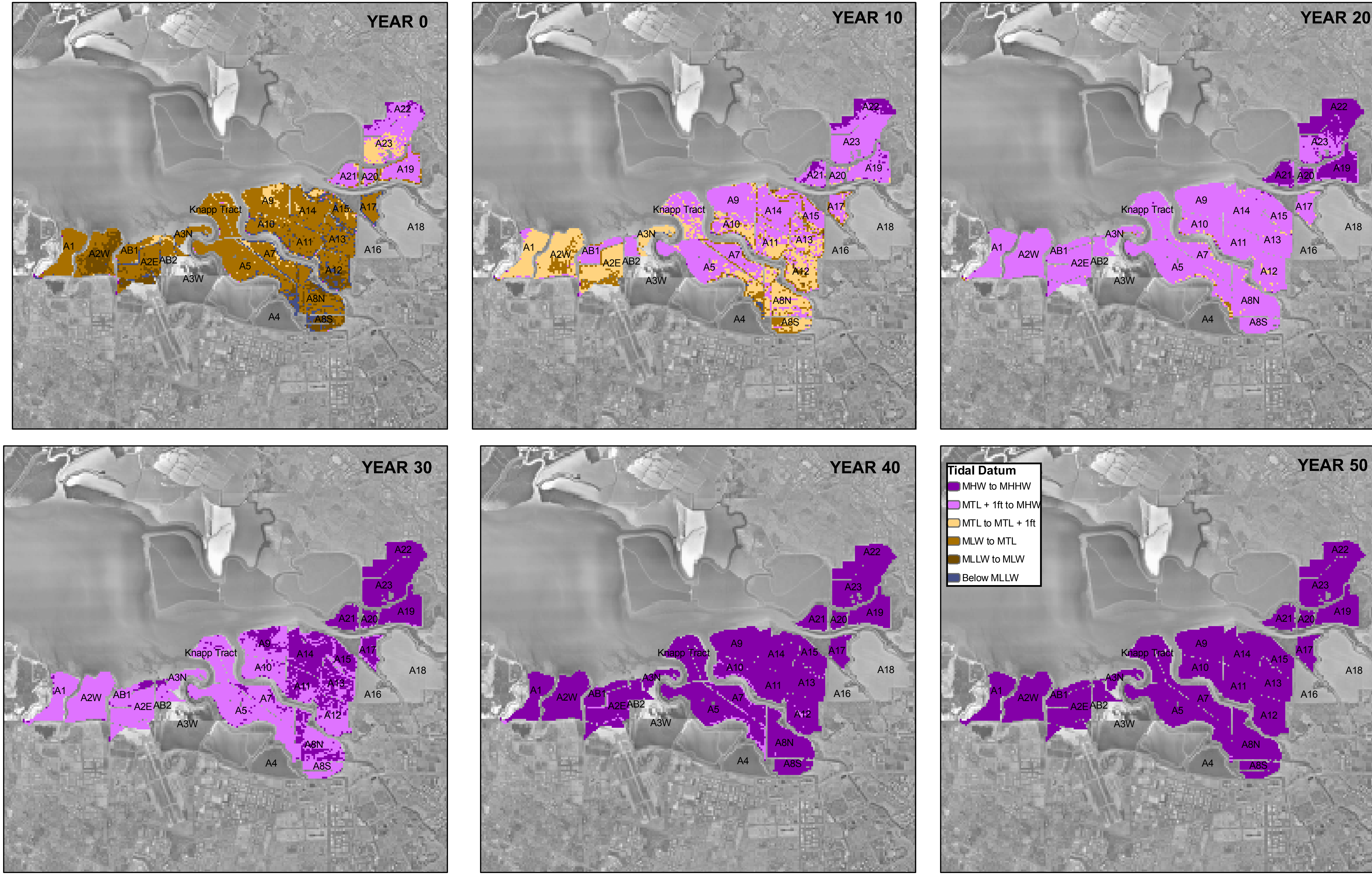
Sedimentation forcasts assume sea level rise by 0.01ft/yr.
Tidal datum increases 0.1ft every 10 year.



Datum and projection: NAD83, UTM, Zone 10N; NAVD 88, meters
Map Data: USGS Bathymetry Survey (pond elevations)
USGS DOQQ (aerial photos)

South Bay Salt Pond Restoration Project - Ravenswood Pond Complex Alternative 3

Sedimentation forcasts assume sea level rise by 0.01ft/yr.
Tidal datum increases 0.1ft every 10 year.

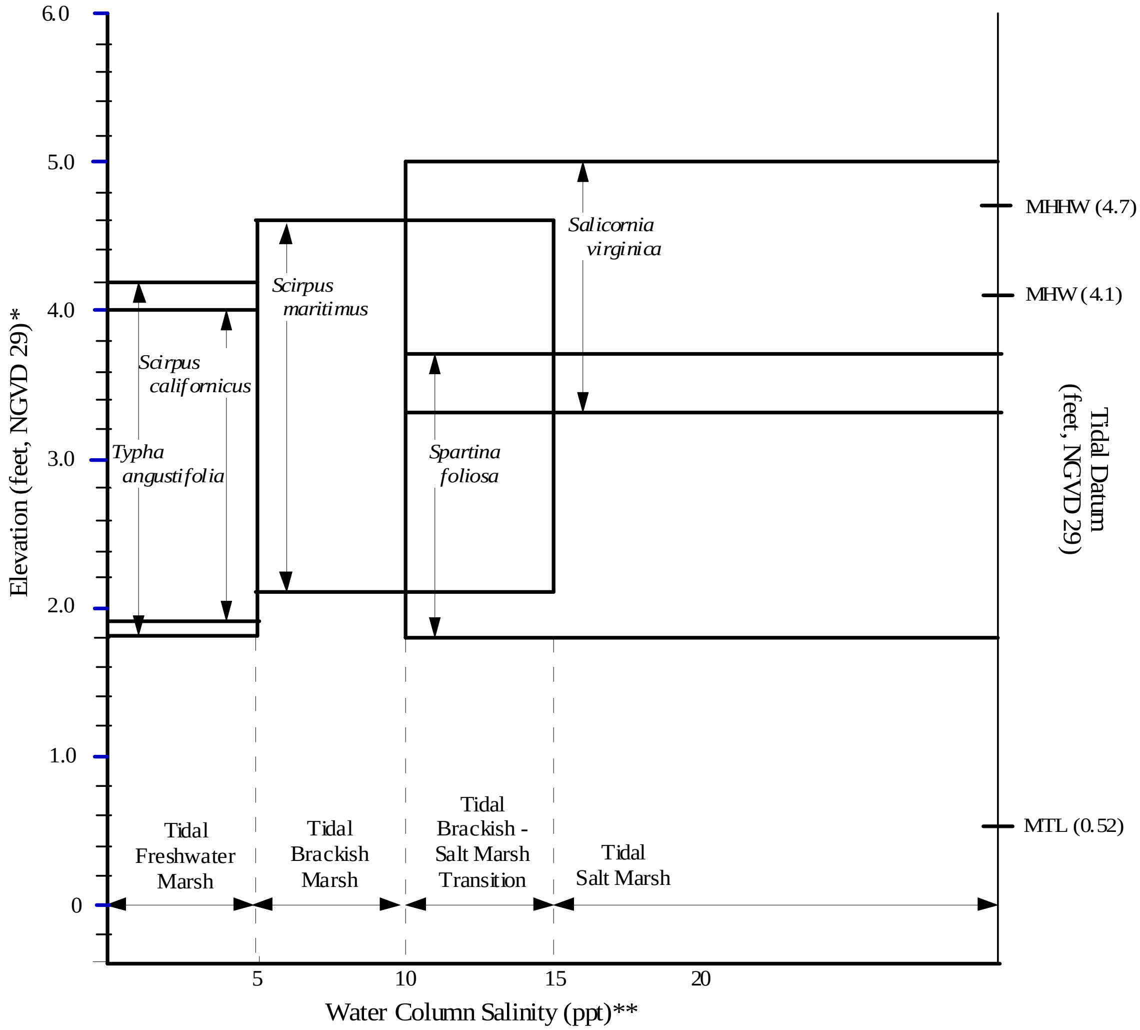


Datum and projection: NAD83, UTM, Zone 10N; NAVD 88, meters
Map Data: USGS Bathymetry Survey (pond elevations)
USGS DOQQ (aerial photos)

South Bay Salt Pond Restoration Project - Alviso Pond Complex Alternative 3

Sedimentation forcasts assume sea level rise by 0.01ft/yr.
Tidal datum increases 0.1ft every 10 year.

Figure 6 – Approximate Elevation and Water Column Salinity Range of Dominant Plant Species in Tidal Marsh Habitats along the Coyote Creek and Mud Slough (South Bay).



* Shows means of elevation limits. Island Pond Report (2456-01) Appendix B contains complete data.

** Salinity data modeled (Gross, 2003). Elevation and habitat data is empirical.