3.0 HYDROLOGIC AND HYDRAULIC CONDITIONS

This chapter describes the existing hydrological resources within the project area, including the regional hydrology, project hydrology, and flood control benefits of the existing salt production pond levees. It describes hydraulic modeling conducted for the proposed pond management alternatives and identifies hydraulic impacts, including flooding impacts, which could result from implementing the various alternatives.

3.1 Affected Environment

The San Francisco Bay estuary is the largest estuary on the west coast of North and South America and is typically divided into three distinct areas: San Pablo Bay, the Central San Francisco Bay, and the South San Francisco Bay. The Cargill South Bay Salt Ponds encompass 15,100 acres located in South San Francisco Bay. This area of the Bay is shallow and hydrodynamic processes are highly variable and are greatly influenced by tides, wind and wave activity, and freshwater inflows.

South San Francisco Bay (SSFB) is defined as the portion of San Francisco Bay south of the Oakland Bay Bridge. The length of SSFB from the Oakland Bay Bridge to the southern end at Coyote Creek is approximately 50 kilometers. The width of SSFB varies from less than 2 kilometers (km) near the Dumbarton Bridge to approximately 20 km north of the San Mateo Bridge. SSFB consists of broad shoals and a deep relict river channel (Walters, 1982). The mean depth of SSFB is less than 4 meters (m), while the channel is typically 10-15 m deep. Intertidal areas typically contain a system of small branching channels that effectively drain these areas at low water.

3.1.1 SSFB Tides and Tidal Currents

Tidal flows contribute to erosion and sedimentation which affect the formation and shape of channels and inlets in SSFB. The hydrodynamics of SSFB are fairly well understood due to extensive data collection by the USGS and others (e.g., Cheng & Gartner, 1984) as well as modeling of the areas (e.g., Cheng et. al., 1993 and Gross et. al., 1999a). Currents in SSFB are predominantly tidally driven (e.g., Walters et. al., 1985). Tidal amplitude increases with distance from Central Bay SSFB. The mean tidal range at the Golden Gate Bridge is 1.25 meters, the tidal range at Alameda is 1.45 meters and the tidal range at the Dumbarton Bridge is 2.00 meters (NOAA, 2003). The tides in SSFB are “mixed semidiurnal” meaning that high tides occur twice daily and one of the high tides is significantly higher than the other. Tidal currents are stronger in the channel than in the shoals (Walters et. al., 1985) and slack water generally occurs in the shoal regions before the channel. Additional tidal data for SSFB are presented in Section 2.5 (*Hydraulic Setting*) of the ISP.

3.1.2 Freshwater Inflows to SSFB

Most freshwater inflow enters SSFB during the winter and spring. During summer, there is little freshwater inflow to SSFB and most of this freshwater inflow is effluent from municipal wastewater treatment plants. The largest tributaries to SSFB are:

- Alameda Creek, which flows into the Alameda Flood Control Channel (AFCC)
- Guadalupe River, which flows into Alviso Slough
- Coyote Creek, which becomes a tidal slough and connects to SSFB

Streamflow varies greatly from season to season and year to year. As an example of variability within a given year at a single station, the average gauged flow at USGS station #11179000 (Alameda Creek near Niles) during February is 12.5 centimeters per second (cms), while the average gauged flow during October is 0.4 cms. As an example of variability at a single station between years, during February of 1994 the average gauged flow at this location was 3.7 cms, while during February of 1998 the average was 105.2 cms (USGS, 2003).

3.1.3 SSFB Tidal Sloughs

SSFB has several tidal sloughs that provide important habitat for various species. Sloughs also impact the tidal and freshwater flows into and out of the Bay. Descriptions of the tidal sloughs within or near each of the three pond complexes (Alviso, Baumberg, and West Bay) are provided below.

Alviso Complex Tidal Sloughs. The Alviso Complex is located in the Lower South Bay, defined as the portion of SSFB south of the Dumbarton Bridge. The Lower South Bay is a relatively shallow subembayment with an average depth of 2.6 m at mean tide. Tides in this region are particularly strong due to amplification of tidal energy with distance south in SSFB. Because of the strong tides and small depths, “the area covered by water in the Lower South Bay at mean lower low water (MLLW) is less than half the surface area at mean higher high water (MHHW), indicating that over half of Lower South Bay consists of shallow mudflats that are exposed at low tides” (Schemel, 1998). Furthermore, the volume of water in the Lower South Bay at MLLW is less than half of the volume of water at MHHW, indicating that more than half of the water volume present in Lower South Bay at high water can pass through the Dumbarton Bridge during a single ebb tide (Schemel, 1998). The following tidal sloughs border the Alviso salt ponds:

- Coyote Creek
- Mud Slough
- Artesian Slough
- Alviso Slough
- Guadalupe Slough
- Stevens Creek
- Mountain View Slough
- Charleston Slough

The largest of these is Coyote Creek, which meets SSFB at Calaveras Point. Coyote Creek is a substantial source of fresh water during winter and spring. Salt marsh regions are present in several parts of Coyote Creek, particularly bordering salt ponds. The bottom elevation of the main channel of Coyote Creek ranges from -1 to -4 m National Geodetic Vertical Datum 1929 (NGVD). The tidal range in Coyote Creek, reported as 2.2 m at NOAA Station 9414575 (NOAA, 2003), is particularly large.

At the western end of Alviso Pond A21, Mud Slough splits off from Coyote Creek and, bordering Alviso Ponds A21, A20 and A19 (the Island Ponds), continues landward to connect with the Warm Springs marsh restoration area. Mud Slough is a shallow tidal slough, which receives minimal freshwater input during all seasons.

Artesian Slough borders Alviso Ponds A16 and A17 and is a tributary to Coyote Creek. The discharge from the City of San Jose municipal wastewater treatment plant enters the upstream end of Artesian Slough with a RWQCB-permitted dry season flow of 120 million gallons per day (mgd) though flows in recent years have been less.).

Alviso Slough borders ponds Alviso A7, A8, A9, A10, A11 and A12. The Guadalupe River, the second largest tributary to SSFB (after Alameda Creek) in terms of drainage area and flow, discharges to Alviso Slough. The bottom elevation of Alviso Slough ranges from -1 to -3 m NGVD. The tidal range in Alviso Slough is particularly large, with measured high water approximately a factor of 1.6 higher (relative to mean tide) than high water at the Golden Gate Bridge (NOAA, 2003). Given the combination of strong tides and shallow depths, most of the volume present in Alviso Slough at high water drains to Coyote Creek (and subsequently SSFB) during ebb tide. Therefore this slough, as well as Coyote Creek and Guadalupe Slough, actively exchanges water with SSFB due to tidal motions.

Guadalupe Slough borders Alviso Ponds A3W, A4 and A5. Guadalupe Slough receives flow from Calabazas Creek and San Tomas Creek. The Sunnyvale municipal wastewater treatment plant also discharges to Guadalupe Slough (approximately 18 mgd) and is the primary source of freshwater to Guadalupe Slough during summer and fall. The bottom elevation of Guadalupe Slough ranges from -1 to -4 m NGVD. The tidal range in Guadalupe Slough is similar to the tidal range in Alviso Slough (NOAA, 2003).

Stevens Creek, Mountain View Slough and Charleston Slough are relatively shallow and narrow tidal sloughs that contribute little freshwater flow to SSFB and drain relatively small areas.

Baumberg Complex Tidal Sloughs. The Baumberg Complex borders the eastern shore of SSFB and extends from AFCC on the south to San Mateo Bridge on the north. The region near the eastern shore of SSFB is a large mudflat. Relevant tidal sloughs flanking the Baumberg salt ponds are:

- Alameda Flood Control Channel (AFCC; also known as Coyote Hills Slough)
- Old Alameda Creek
- Mount Eden Creek
- North Creek

The largest and most ecologically important slough in this region is the AFCC. Alameda Creek flows into the AFCC. Alameda Creek, which drains an area of 633 square miles upstream of Niles (USGS, 2003), is the largest tributary to SSFB. The U.S. Army Corps of Engineers (Corps) designed and constructed the AFCC. The deepest part of the channel has bottom elevation of approximately -1.5 m NGVD near the mouth of the AFCC and slopes gently up with distance upstream. The portion of the AFCC that adjoins the salt ponds is tidal, with high tide elevation slightly lower than the high tide elevation at San Mateo Bridge, and low tide elevation considerably higher than low tide elevation at San Mateo Bridge (NOAA, 1933). Therefore, the tidal range in the AFCC is quite substantial, but less than the tidal range in nearby areas. Depths in the channel of the AFCC typically range from 2 to 3 m at high water and less than 1 m at low water in the deepest part of the AFCC. In addition, the AFCC contains a large intertidal area, which is only covered with water near high water and is drained during ebb tides. Therefore, a large portion of the water volume present in the AFCC at high water drains into SSFB during ebb tides.

North of the AFCC is Old Alameda Creek. Before Alameda Creek was diverted into the AFCC, it drained into what is now known as Old Alameda Creek. Currently, Old Alameda Creek receives minimal freshwater input. It comprises two distinct channels: a narrow northern channel and a wider southern channel, divided by a vegetated bar that is only submerged at higher high water during strong (spring) tides. Limited water elevation data for Old Alameda Creek indicate that high water elevations, measured about 2 km from the mouth of Old Alameda Creek, are as high as 1.8 m NGVD, and low water elevations are typically near the bed elevation of -0.5 m NGVD (ISP September 2003).

Additional tidal channels and marsh areas are currently under construction in the Baumberg Complex. These sloughs are part of an ongoing tidal restoration project. When this restoration project is complete, Mount Eden Creek and North Creek will connect the Eden Landing Ecological Preserve to San Francisco Bay. North Creek will connect directly to Old Alameda Creek, approximately 2 km from SSFB, and Mount Eden Creek will enter the Bay, approximately 2 km north of the mouth of Old Alameda Creek.

West Bay Complex Tidal Sloughs. The West Bay Complex is located on the western side of the Dumbarton Bridge. The Dumbarton Strait, with a width of approximately 2 km, is the narrowest part of SSFB. The mean tidal range in the Bay at this location is 2.0 m (NOAA, 2003). Observed velocities in this region, for example currents measured at USGS/NOAA station C14, are relatively large due to the strong tides and narrow cross-section of the Dumbarton Strait.

The largest tidal slough located near the West Bay System is Ravenswood Slough. Local freshwater input to this slough is relatively low.

3.1.4 Flood Protection

Previous studies (USACE 1988) identified approximately 80 miles of of salt pond levees that are boundaries to other private and public properties. Many of these levees were not designed to provide flood protection and do not meet Corps of Engineers design standards. The salt pond levees have been raised periodically to compensate for past land subsidence and have been maintained by Cargill (and previously the Leslie Salt Company) for erosion. The majority of the levees in the project area were not designed or maintained as flood control measures. Furthermore, the levees were not designed to Corps standards for flood control. Therefore the levees do not provide for flood control as they are currently designed and maintained.

According to the USACE 1988 shoreline study, there have been few failures of the salt pond levees. However, the crest of some levees may not be high enough to prevent overtopping during extreme high tide and wind wave events. The USACE report identified the following as salt pond levees that were selected for additional tidal flooding analysis.

- Reach 17- Alviso
- Reach 19 – Sunnyvale
- Reach 21/22 – Mountain View/South Palo Alto
- Reach 23 – North Palo Alto

This list may not include all salt pond levees that may provide incidental flood control benefits. The Coastal Conservancy has recently retained a flood control specialist to review and update the list of critical flood control levees as part of final design efforts.

The work on this review is under way at this writing and there are no results that are suitable for reporting here.

3.2 Criteria for Determining Significance of Effects

Criteria for determining significance of hydrological effects are based upon professional judgment, review of previous studies, and CEQA Guidelines. Criteria pertaining to water quality issues are presented in Chapter 4 (Water Quality). A project would have a significant hydrologic impact if it would:

- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site.
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in flooding on- or off-site.
- Place within a 100-year flood hazard area structures that would impede or redirect flood flows.
- Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam, inundation by seiche, tsunami, or mudflow.
- Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff.
- Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map.

For NEPA purposes, Executive Order 11988, Floodplain Management, applies to the project. In addition, DOT Order 5650.2, Floodplain Management and Protection, requires that federal agencies take actions that will "preserve the natural and beneficial values served by floodplains."

3.3 Environmental Impacts and Mitigation Measures

Schaaf and Wheeler (S&W) used several hydraulic models to evaluate the hydrologic impacts of various pond management alternatives. These models and their results are discussed below under Alternative 2: Simultaneous March/April Initial Release. The No Project/No Action Alternative and Alternative 1: Seasonal Ponds were not specifically modeled, but the results of modeling for the pond management alternatives serves as the benchmark against which impacts from the other alternatives can be compared.

3.3.1 No Project/No Action Alternative

Under the No Action alternative waters would be allowed to evaporate in the ponds. The ponds would then fill seasonally with rainwater each winter and dry through the evaporation process each summer. No action would be conducted by the agencies, including levee maintenance, and some levees would likely fail during this period. Existing public access would be lost in areas of levee failure

HYDROLOGY IMPACT-1: Increased flooding of adjacent properties may result from erosion of salt pond levees that offer some flood control benefit.

The majority of the salt pond levees in the project area were never designed to provide flood protection for adjacent properties. However, these levees have been providing some flood control protection as an incidental benefit. Under the No Project/No Action Alternative, the existing levees would be allowed to degrade over time, which may lead to an increased risk of flooding of adjacent properties from those levees that do provide this incidental flood control benefit.

Significance:	Potentially significant. Since this alternative will result in the project not being implemented, no mitigation measures are proposed.

HYDROLOGY IMPACT-2: Increased tidal prism and associated velocities within the ponds due to uncontrolled levee breaches may re-suspend sediments, resulting in erosion of pond sediments and subsequent deposition in receiving waters.

As the existing salt pond levees degrade over time, the individual levees may fail in an uncontrolled manner, allowing tidal circulation into the ponds. Tidal circulation would result in an increase in velocities and shear forces within the ponds. The increased velocity may result in erosion of sediments and input of additional suspended sediments to receiving waters. In ponds with known or potential contaminated sediments at depth, this increased velocity may result in erosion of contaminated sediments and transport and deposition into receiving water bodies. Impacts pertaining to suspended sediments and contaminated sediments and their transport are also addressed in Chapters 4 (Water Quality) and 5 (Sediments).

Significance:	Potentially significant. Since this alternative will result in the project not being implemented, no mitigation measures are proposed.

3.3.2 Alternative 1: Seasonal Ponds

In Alternative 1 waters would be allowed to evaporate in the ponds. The ponds would then fill seasonally with rainwater each winter and dry through the evaporation process each summer. The only action taken by the agencies would be to maintain the levees at their current standard of maintenance (i.e., salt pond maintenance, not for flood control).

The flood protection benefit provided by pond levees to adjacent properties would be maintained and the potential flooding impacts considered under the No Project/No Action Alternative would not apply. Maintenance of the levees would also reduce potential impacts from increased erosion of pond sediments and transport into receiving waters.

3.3.3 Alternative 2: Simultaneous March-April Initial Release

In Alternative 2, the contents of most of the Alviso and Baumberg Ponds would be released simultaneously in March and April. The ponds would then be managed as a mix of continuous circulation ponds, seasonal ponds and batch ponds, though management of some ponds could be altered through adaptive management during the continuous circulation period. Higher salinity ponds in Alviso and in the West Bay would be discharged in March and April in later years when salinities in the ponds have been reduced to appropriate levels. The Island Ponds (A19-A21) would be breached and open to tidal waters.

Schaaf and Wheeler (S&W) conducted extensive hydraulic and salinity modeling of various project alternatives considered in the ISP (LSI 2003 (ISP). S&W did not study or model sediment transport. Impacts considered in this section are limited to hydrology and sedimentation. Chapter 4 (Water Quality) addresses salinity impacts. The ISP (Appendix A) and other technical reports (Appendix D) describe modeling methods and results in detail. This section summarizes information contained in these documents and provides specific references to the relevant documents.

Description of Hydrologic Models Used. The key feature of the water management plan for the project is the circulation of Bay water through the ponds and release of this water to the receiving sloughs and channels in the South Bay. During the first period of circulation through the ponds, referred to as the initial release period, the water currently in the ponds will be discharged to the Bay and replaced with Bay water brought into the ponds at the intakes. This circulation is different than the existing salt making operations because the pond systems will circulate water back to the Bay and because the flow rate through the ponds will be increased relative to existing flows.

Computer models were applied to estimate the water surface elevations and velocities within the ponds and receiving water bodies during the Initial Stewardship period. S&W used two types of models:

1. Pond Model. The Pond Model was used to estimate inflows to the ponds from the Bay, flows between ponds, volume of water evaporated from the ponds, volume of water added to the ponds by precipitation and flow rates from the ponds to the Bay and sloughs. Section 3.3.1 of the ISP (Appendix A) contains a description of the Pond Model. Results of the Pond Model are presented in the ISP (LSI, 2003) and are summarized below.
2. South San Francisco Bay Model. A three-dimensional hydrodynamic model was used to estimate physical conditions (flows, tides, currents etc.) in the Bay and sloughs. Section 3.3.2 of the ISP (Appendix A) contains a description of the South San Francisco Bay Model. Model results are presented in Appendix D.

S&W modeled both the simultaneous March/April initial release and the phased release alternatives. Results of the Pond Model were used as an input to the hydrodynamic models to evaluate potential project impacts on receiving waters.

In addition, S&W conducted finer resolution modeling of the impacts of breaching the Island Ponds (Alviso Ponds A19, A20, and A21) and restoring them to tidal flow.

The Pond Model and South San Francisco Bay Model require tide and weather input data. As discussed in Section 3.3.3 of the ISP (Appendix A), pond and receiving water conditions were modeled for a simulation period of 19 months (April 1994 to October 1995), which includes two summer periods and one winter period. The particular period was selected to include a relatively recent period where Bay tidal and salinity profile information was available, and to include a range of meteorological conditions. 1994 represents a relatively dry year, with above average salinity in the South Bay, while 1995 represents a relatively wet year with low average salinity in the Bay and sloughs and a higher likelihood of flood conditions that could affect the stability or erosion of the ponds.

Results of Hydrologic Modeling. This section summarizes the modeled hydrologic changes within the pond complexes. Chapter 4 of the ISP presents detailed descriptions of the water levels anticipated within each of the ponds and other modeling results.

The modeled initial release scenarios in the ISP are as follows:

- Alternative 2: Simultaneous March/April Initial Release - All systems except the island ponds (A19, A20, and A21), the A23 system, and the West Bay pond group to begin discharge in April. Initial pond salinities based on maximum salinities shown in Table 4-3.
- Alternative 3: Phased Initial Release - Selected ponds would begin initial release at the same time. These would include Alviso Systems A2W, A3W, A7 and Baumberg Systems 2, 8A and 11. The ponds were selected to represent a significant number of systems that could be included in a first phase of the project based on construction and operational constraints. The staggered release was assumed to begin in July, to allow some construction in the spring after the winter rainy season. Most of the proposed system structures would not be accessible for construction during the winter. The initial pond salinities were based on the maximum salinities from ISP Table 4.1.5. The remaining pond systems, Alviso Systems A14 and A16, and Baumberg System 2C, would start circulation in the subsequent year. The initial release for these later systems is proposed for April and would be similar to the Simultaneous Release scenario above.
- April 2002 Values – An additional modeling scenario, not directly related to an Alternative, used actual pond salinity values from April 2002 (rather than maximum values) to examine more likely results of a March/April simultaneous discharge.

Alviso Complex Ponds

Results for each pond system are complex and presented in detail in Chapter 4 of the ISP (Appendix A). Although the ISP operation would allow tidal circulation through the pond system, the flow into and out of the ponds on a daily basis would be relatively small compared to the volume in the ponds. A goal of all the pond modeling alternatives is to maintain long-term discharge salinities below 40 ppt and to maintain water levels as close to existing conditions as possible. Typical daily water surface elevations would fluctuate by less than 0.1 ft in most pond systems. The ponds are managed to reduce salinity within the ponds to an acceptable level within an initial discharge period.

Island Ponds

The Island Ponds (Alviso Ponds A19, A20, and A21) would be breached in a controlled manner to allow them to return to full tidal action. If the ponds are restored to full tidal action, available hydrologic modeling indicates that they would be inundated on the higher high tides but would be above water at other times during the tidal cycle (S&W, 2003).

S&W ran hydrodynamic simulations of existing conditions and breach conditions for the Island Ponds. The models and model results are described in the Alviso Island Pond Breach Initial Stewardship Plan Study in Appendix __ (referred to hereafter as the Island Pond Study (S&W, 2003). In the analysis, Ponds A19 and A21 contain two breaches and A20 contains a single breach. S&W analyzed flow through nine cross-sections and through each of the five breaches (see Figure 1-2 of Appendix A). The dimensions of the initial pond breaches is equal to the smallest grid spacing of the model at 25 meters and is larger than what will likely be constructed in the field. It is expected that the actual initial breaches constructed for the project would be fairly small and that they would be allowed to open up over time due to erosion. These assumptions are considered to be conservative, since they may overestimate the rate at which water is initially released from the ponds to Coyote Creek.

Two different initial breach scenarios were evaluated for the ISP. The first scenario assumes that the elevation in each breach is near the elevation of the pond bottom, and is referred to as the Breach at Pond Bottom Elevation scenario. The breach width in this scenario is 25 m. This scenario provides a conservative estimate of the initial release of the pond water because, though it is expected that the initial breach elevation may be near the pond bottom elevation, it is likely that the initial breach width will be less than 25 m. This scenario is discussed further in Section 5.1 of the Island Pond Study (S&W, 2003)

The second scenario assumes that each breach elevation is at 0 ft NGVD, and is therefore referred to as the Breach at 0 ft NGVD scenario. The breach width in this scenario is also 25 m. This scenario provides an even more conservative estimate of the initial release of the pond water and represents the maximum rate of exchange in Coyote Creek that is plausible for the initial breach of Ponds A19, A20, and A21. This scenario is discussed further in Section 5.2 of the Island Pond Study (S&W, 2003)

The model report uses conservative assumptions that result in the maximum possible tidal prism in the ponds. However, as a result of other various model assumptions and limitations, the S&W analysis should not be considered a worst-case or overly conservative estimate. The velocities and velocity differences could be greater than predicted by the simulations, although this is not considered likely.

A comparison of simulation results for existing conditions and the two breach scenarios is summarized below and presented in detail in the Island Pond Study (S&W, 2003). These results give an indication of the potential effect that breaching the Island Ponds would have on the tidal range, tidal prism, local velocities, and local bed shear stresses in the Alviso region.

Tidal Elevation Impacts of Island Pond Breaching—The breaches would affect the tides in Coyote Creek, with effects varying by location. Adjacent to the Island Ponds, the predicted tidal range decreases and both low water and high water elevations are affected. At the Island Ponds, the tidal range is reduced by approximately 6 inches. The existing tidal range is approximately 7 feet. Downstream of the Island Ponds, the predicted tidal range changes only slightly by increasing the elevation at low water. Upstream of the Island Ponds, the predicted tidal range decreases slightly, due to decreased high water elevations.

Tidal Prism Impacts of Island Pond Breaching—Breaching the Island Pond levees would increase the tidal prism in the Alviso region; in particular, it would influence the tidal prism of Coyote Creek. An increase in flow into and out of Coyote Creek during the tidal cycle would lead to increased velocities in Coyote Creek. Because Coyote Creek is known to be a depositional environment, increased velocities could either cause the Coyote Creek sedimentation regime to become less strongly depositional or lead to scour. Velocity simulation results are discussed further below ("Velocity Impacts of Island Pond Breaching").

Based on the S&W simulation results, it is expected that breaching the Island Pond levees will increase the tidal prism in regions of Coyote Creek located adjacent to the levee breaches and downstream of the levee breaches. For the regions adjacent to the levee breaches, the predicted increases in tidal prism are substantial, while in the regions downstream of the levee breaches, the predicted increases in tidal prism are smaller. Upstream of the levee breaches, in portions of Coyote Creek and Artesian Slough, the predicted tidal prism decreases. The analysis of cross-sectional velocities predicted maximum velocities at the Island Pond breaches ranging from 1.79 to 4.54 feet per second (ft/s). The maximum velocity magnitude for a stable inlet channel should be about 1.0 ± 0.15 m/s (3.28 ± 0.5 ft/s, Goodwin 1996). The maximum predicted velocities at the downstream breach for Pond A21 and the downstream breach for Pond

Velocity Impacts of Island Pond Breaching—The S&W analysis included simulation of cross-sectional velocities and depth-averaged velocities throughout the Alviso region under existing conditions and breach conditions. A19 exceed this range, which suggests that these breaches may scour to be wider than 25 m (the initial breach width for both breach scenarios modeled).

The analysis of depth-averaged velocity throughout the Alviso Region gives a prediction of the daily Root Mean Square (RMS) velocity and maximum velocity at each horizontal location in the model grid for a representative day (June 7, 1994) from the month-long (June 7 to July 7, 1994) simulation. The RMS velocity gives a weighted average of the velocity that occurs at each modeled grid cell.

Results of the depth-averaged velocity analysis show that the levee breaches will result in increased tidal velocities in regions of Coyote Creek located adjacent to the levee breaches and smaller increases downstream of the levee breaches. The tidal velocities are expected to decrease upstream of the levee breaches and in Artesian Slough, Mud Slough and the Warm Springs Marsh area. For the majority of the area, the breach scenario results in a less than 0.1 ft/s change in predicted maximum velocities compared to existing conditions. Maximum predicted velocity magnitude increases of 0.1 to 0.2 ft/s are seen in the channel of Coyote Creek from the open boundary to the mouth of Mud Slough. The greatest increases in predicted RMS velocities under breach conditions occur between the mouth of Mud Slough and the Pond A19 breach.

Between the mouth of Mud Slough and the Alviso A19 breach (downstream of the breach), maximum predicted depth-averaged velocities also increase by approximately 0.5 fps, with the highest increases seen immediately adjacent to the levee breaches. Upstream of the Pond A19 breach, the predicted maximum velocities in Upper Coyote Creek and Artesian Slough are reduced under the Long-Term Breach scenario.

Concerns have been raised that increased velocities in Coyote Creek could cause scour at the Union Pacific railroad bridge which crosses Coyote Creek between ponds A21 and A20. S&W conducted an analysis of the potential for scour of this railroad bridge if the Island Ponds are breached. The analysis assumed that, at present, the channel cross-sectional geometry (bathymetry) at the railroad bridge is at or near equilibrium with the cross-sectional velocities. That is, it was assumed that under present conditions neither scour nor deposition occurs. This implies that, with an increase in velocity following breaching of the Island Pond levees, the cross-sectional area would increase at the railroad bridge until the cross-sectional average velocity at this location is equal to the cross-sectional average velocity under existing conditions (i.e., the geometry of the channel would return to equilibrium with cross-section velocities). Under this assumption, larger than existing tidal velocities would lead to scour. Conversely, smaller tidal velocities should lead to deposition.

The assumption that the channel geometry at the railroad bridge is presently at or near equilibrium with cross-section velocities is considered conservative and is likely to overestimate the extent of scour that would result from the levee breaches for several reasons. First, as noted above, field data suggests that Coyote Creek is not presently in equilibrium and that it is actually a depositional environment. Therefore, it is likely that tidal velocities could actually increase to some extent without leading to scour. In addition, at present, the channel of Coyote Creek may already be scoured to some extent during and following large storms when freshwater flows in Coyote Creek are large. Scour, which presently occurs due to freshwater flows, would probably not be significantly changed by the presence of the levee breaches.

Based on the modeling results, it is estimated that during both flood and ebb tides, following the breaching of the Island Pond levees, the cross-sectional area at the railroad bridge would increase by approximately 20 to 30 percent before the channel would return to a state of equilibrium with channel velocities equivalent to existing conditions.

Either a widening or a deepening of the channel could accomplish the predicted increase in cross-sectional area. During flood tide, a depth adjustment of approximately 1.5 to 3 feet would be required in the channel region. It is unknown what the impact to the existing railroad bridge will be due to the potential 3 foot deepening of the channel in this area. Therefore, a mitigation measure to inspect the bridge piers has been included as described below.

Baumberg Complex Ponds

Hydrologic modeling indicates that, in general, the ISP will result in slightly lower elevations and possibly more frequent drawdown. Under ISP modeled conditions, Baumberg System 2C (Ponds 6, 5, 6C, 4C, 3C, 5C, 1C, and 2C) would have average water depths about 0.1 to 1 foot higher than existing conditions, although some of those Ponds (1C and 5C) would still be seasonal. The remaining Baumberg ponds would have average water depths about 0.5 to 2 feet lower than existing conditions. Average water depths in the Baumberg Ponds would range from zero to about 2.5 feet in summer, and about 1.0 to 2.5 feet in winter. Water levels under the ISP are therefore likely to be at or below the sediment elevation for some portion of the year. Hydrologic modeling indicates that water levels would vary by about 0.5 feet, due to weather and tides.

West Bay Complex Ponds

Hydraulic modeling of the West Bay Ponds was included in the final ISP (Appendix A). The West Bay pond group consists of five pond systems. The complex includes seven ponds: 1, 2, 3, 4, 5, S5 and SF2. The ponds will be managed to maintain long term discharge salinity levels to below 40 ppt and to establish tidal circulation through the ponds.

> *HYDROLOGY IMPACT-1:* Increased flooding of adjacent properties may result from erosion of salt pond levees that offer some flood control benefit.

The project design allows for increased tidal flows through hydraulic structures to accelerate reduction of pond salinity. Although unlikely, this increased tidal flow could lead to the acceleration of levee erosion and a reduction in flood control benefits. As noted above under the No Project/No Action Alternative, salt pond levees were never specifically designed to provide flood protection for adjacent properties. However, these levees have been providing some flood control protection as an incidental benefit.

Except for the Island Ponds (A19, A20, and A21), the existing levees would be maintained to meet existing flood control benefits under this alternative. Therefore, for the pond levees, the existing level of flood control benefit would be maintained and impacts would be less than significant.

Significance: Less than Significant.

> *HYDROLOGY IMPACT-2:* Increased tidal prism and associated velocities within the ponds could re-suspend sediments, resulting in erosion of pond sediments and subsequent deposition in receiving waters.

Under Alternative 2, tidal inflows would circulate through the pond systems and return to the Bay. The increased flow through the ponds may result in an increase in velocities and shear forces within the ponds. This increased velocity may result in erosion of sediments, transport of suspended sediments, and deposition of those sediments into receiving water bodies. In ponds with known or potential contaminated sediments at depth, this could result in transport of contaminants to receiving waters. The exact nature and location of scour that could result is impossible to predict.

For most of the managed pond systems, significant increases in tidal prism and in velocities and shear forces are not anticipated. Therefore, the potential for widespread scour within tidal marshes and channels adjacent to these systems is considered unlikely. Typical flow velocities in the ponds are estimated to be much smaller than existing wind and wave-generated velocities.

The Island Ponds are likely to be breached and to function as fully tidal systems. Sediments in the Island Ponds do not contain elevated levels of contaminants. The Island Pond breaches may increase scour and release sediments at the breach locations, some channel areas, and within the ponds as pond bottoms drain at low tide. At the same time, the ponds represent a major depositional area added to Coyote Creek. At high tide, water from Coyote Creek will deposit sediment within the ponds as the pond bottoms transition to high marsh. The balance between net erosion and sedimentation will depend on the rate at which the breaches expand by erosion in comparison to the deposition within the ponds

Significance: Less than Significant.

> *HYDROLOGY IMPACT-3:* Breaching of Island Ponds could result in increased velocities in the surrounding areas, resulting in erosion of mud flats and damage to the Southern Pacific railroad bridge piers.

Modeling by S&W (see discussion above) concluded that breaching of the Island Ponds is likely to cause an increase in velocities and scour potential within Coyote Creek around the railroad bridge. S&W estimated scour depths of 2-3 feet around the railroad bridge based on conservative assumptions regarding existing sedimentation conditions in Coyote Creek. It is not anticipated that this scour depth would cause damage to the railroad bridge. However, the exact nature and extent of any scour problems on adjacent mud flats or the railroad bridge piers is unknown and difficult to quantify with modeling alone. It is also possible that the current depositional environment could handle an increase in velocities without significant erosion or scour.

The potential erosion in the marsh and mudflat areas of Coyote Creek were not included in the scour analysis. However, S&W found that the potential for scour of existing mudflats is limited by several factors including the brief inundation period at high tide, low velocities near slack water, protection from existing marsh vegetation and limited water depths.

Significance: Potentially significant.

> *HYDROLOGY MITIGATION-2A:* A qualified engineer should conduct regular inspections of adjacent mudflats and the railroad bridge piers during the first 5 years following breaching to look for evidence of scour or damage to bridge pier supports. This inspection should be coordinated with regular bridge inspections conducted by Union Pacific

The engineer should prepare inspection reports documenting the results of the inspection and any recommendations for additional work.

> *HYDROLOGY MITIGATION-2B:* If bridge inspections identify excessive scour or damage to bridge piers not related to weather patterns or upstream changes, then a qualified engineer shall develop a plan for protecting the piers and USFWS work with the railroad tol implement the plan.

Post-mitigation Significance: Less than significant

> *HYDROLOGY IMPACT-4:* Flow into the ponds may result in excessive sediment deposition near inlet/outlet structures that could impact operation of water control structures.

As velocities of water carried away from the water control structures are reduced, additional sediments are deposited adjacent to water control structures and "delta" formation occurs. Excessive sediment deposition could impede operation of the water control structure and impact water management operations.

Significance: Not significant in Island Pond under full breached conditions (since no structures are used). Potentially significant in other pond systems.

HYDROLOGY MITIGATION-3A: Conduct annual inspections of all water control structures.

USFWS and DFG will conduct an annual inspection of all water control structures to look for areas of excessive sediment deposition or scour. Results of these inspections will be recorded on maintenance log sheets along with any follow-up inspections or maintenance sediment removal or regrading operations.

> *HYDROLOGY MITIGATION-3B:* Remove deposited sediment and regrade as required to avoid deposition impacts.

In areas where sediment deposition interferes with culvert function, USFWS or CDFG, as appropriate, shall implement measures to remove deposited sediment and regrade as required to avoid deposition impacts.

Post-mitigation Significance: Less than significant

3.3.4 Alternative 3: Phased Initial Release

Impacts and associated mitigation measures are as described for Alternative 2 above (Section 3.3.3). The timing of initial release will not affect hydrologic impacts. It is not anticipated that there will be different impacts beyond those described for Alternative 2.