5.0 SEDIMENTS

This chapter describes existing sources and levels of contamination in pond sediments within the project area. Available sediment data from past sampling efforts are compared to various sediment screening criteria. The available sampling data are most abundant for the Alviso ponds and are more scant for the Baumberg and West Bay ponds.

The project is not anticipated to generate additional contaminants that could impact sediments; however, the proposed changes in pond hydrology could impact the mobility and bioavailability of sediments. These and other sediment-related impacts are addressed in this section. Since organic chemicals were either not detected in pond sediments, or were detected at very low concentrations and are not likely to pose any additional risk to human health or the environment, the analysis of impacts focuses on impacts related to inorganic chemical contamination. Sediments will also be impacted by and will cause impacts to water quality in the project area. Water quality impacts are addressed in Chapter 4. Biological impacts related to sediment contamination are also addressed in the Biological Resources section, Chapter 6.

5.1 Affected Environment

5.1.1 Sources of Sediment Contamination

The Cargill ponds were constructed for salt making purposes starting in the early 1900s by building levees around existing marshes, mudflats, and open water areas. Some of the Alviso ponds (A1 through A7) were constructed in the late 1940s. The sediments in the Alviso area have historically been subject to significant sources of contamination from historical mining activities (especially for mercury) in the Coastal Range and Guadalupe River watershed. These mining activities resulted in the mobilization of large amounts of mercury-rich sediment into these downstream, wetland areas. Since diking the areas into ponds for salt-making operations, the source of contaminant input into these areas has generally been restricted to what comes in with the intake water, including some suspended sediment. Some contamination may also originate from the large wastewater treatment plant located upstream from the salt ponds and from urban runoff from the heavily populated and industrialized watershed. Ponds A5, A7 and A8 are not fully isolated during flooding events in the Guadalupe River, and can receive suspended sediment in floodwaters. Suspended sediment in the ponds can then be transferred between ponds by an array of weirs and culverts.

5.1.2 Description of Available Pond Sediment Contamination

Assessment of sediment quality in the ISP ponds was based on available sediment analytical data. Sediment samples were collected from 19 of the 57 ponds that are included in the ISP. These ponds are generally representative of all the ponds addressed by the ISP because they reflect the range of water depths and salinities present throughout the ISP ponds. Sampled ponds ranged in average water depth between 0.7 feet and 4.1 feet; historic salinities in sampled ponds have ranged between 11 and 340 parts per thousand.

More specifically, the ISP pond sediments data set consists of:

- 18 samples collected by the U.S. Fish and Wildlife Service ("USFWS data") from Alviso ponds A1, B1, A5, A9, A10, and A16.

- 12 samples collected by Cargill in 2002 ("Hydroscience data") from Alviso ponds A2W, A3W, A5, A9, A15, A16, and A17; Baumberg ponds 2C, 8A, and 10; and West Bay Pond 1. This data set also includes two samples collected from the Bay adjacent to the Alviso and Baumberg pond complexes.
- 59 samples from Pond A18 collected by the City of San Jose prior to purchase of that pond from Cargill ("A18 data").
- 20 samples from Ponds A4 and A8 collected by the Santa Clara Valley Water District in 1997 and 2000 as part of Phase I and Phase II hazardous substance liability assessments ("A4 and A8 data").
- 6 samples from Ponds A19, A20, and A21 collected by Cargill in 2002 ("Island Pond data").

Pond A4 is owned by the Santa Clara Valley Water District and Pond A18 is proposed to be purchased by the City of San Jose. Although these ponds are not part of the ISP, they are part of the South Bay salt pond system and are illustrative of general sediment quality in the area. Therefore, the A4 and A18 data were included in this evaluation to maximize available data and facilitate evaluation of ISP pond sediments.

As noted above, most of the available data are from the Alviso ponds. The Alviso ponds are located near the mouths of Alviso Slough, Guadalupe Slough, and Coyote Creek. This area is more directly affected than other ISP pond complexes by contaminants associated with historic mercury mining in the Guadalupe River drainage, municipal and industrial wastewater discharge, and the outflow of contaminants from an urban watershed. The weighting of the data toward the ponds closer to contamination sources is environmentally conservative.

5.1.3 Sediment Criteria

Available sediment data were compared with a variety of screening criteria that are commonly used to assess the quality of San Francisco Bay Area sediment. Those screening criteria comprised the San Francisco Bay ambient values, the San Francisco Bay Regional Water Quality Control Board (RWQCB) cover and noncover criteria, Effects Range-Low and Effects Range-Median criteria (ER-Ls and ER-Ms), and local ambient data from the Guadalupe River and other areas in the vicinity of the ISP ponds. These screening criteria are described below.

San Francisco Bay Ambient Values The RWQCB developed the San Francisco Bay ambient values (SFBRWQCB 1998) to represent the typical range of concentrations currently found in Bay sediments located away from sources of contamination. These values are listed in Table 5-1.

Typical "ambient" concentrations in Bay sediments are distinguished from "background" values that are defined as pre-industrialization (i.e., before about 1850) or naturally occurring levels of chemicals. Sediment chemistry data were obtained from the 1991 Pilot Study, Regional Monitoring Program Data from 1992 through 1995, and the RWQCB Bay Protection and Toxic Cleanup Program's 1995 Reference Site Study (as cited in RWQCB 1998). Sediment samples were collected from the spine (i.e., deep portions) of the Bay away from known sources of constituents of concern (COC) or "hot spots" and were compiled into a database representative of ambient conditions in open water areas of the Bay. Because these Bay sediment samples were collected from the deepest portions of the Bay away from contaminant sources, these values are widely used as “clean” background standards in place of other nationally based criteria, such as ER-Ls.

The data set was screened for statistical outliers, and the 85th percentile of the remaining data distribution for each chemical was selected to represent the upper bound or threshold value for ambient sediments. Increasing COC concentrations were found to be associated with increasing percentage of fine-grained sediments (fines; i.e., clays and silts). For some COCs, the distribution of the data indicated two subgroups (bi-modal) associated with sediment samples: a group above and a group below 40 percent fines. To take the two subgroups (bi-modal distribution) into account, the RWQCB calculated two upper-bound numbers: one for sediments containing less than 40 percent fines, and one for sediments containing 40 to 100 percent fines. Sediments at the project site are predominantly fine-grained (versus coarse-grained, sandy sediments); ambient values for 100 percent fines were used for comparison with ISP pond sediment data.

Table 5-1
San Francisco Bay Ambient Values

Constituent	San Francisco Bay Ambient Values (mg/kg)
Arsenic	15.3
Cadmium	0.33
Chromium, total	112
Copper	68.1
Lead	43.2
Nickel	112
Mercury	0.43
Selenium	0.64
Silver	0.58
Zinc	158
PAHs, total	3.39
DDT	0.007
PCBs, total	0.0148

Notes: mg/kg = milligrams per kilogram; PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenols

ER-Ls and ER-Ms ER-Ls and ER-Ms are toxicity-based thresholds for sediment that were developed by the National Oceanic and Atmospheric Administration (Long et al. 1995). Although NOAA did not develop these values for use as regulatory criteria, they are commonly used by state and federal regulatory and resource agencies as screening guidelines for assessing the potential for biological effects associated with contaminants in San Francisco Bay sediments. ER-L and ER-M values for inorganics and organics are listed in Table 5-2.

It should be noted that some inorganics, including arsenic, chromium, copper, mercury, nickel, and zinc, are commonly detected in ambient Bay sediments at concentrations higher than ER-Ls. Therefore, while ER-L values are useful as a measure of predicted biological effects, they are not commonly used by the agencies for regulating sediment quality in and around the Bay.

These values were calculated by examining the range of chemical concentrations associated with observed adverse biological effects data from a nationwide database that included co-located samples of freshwater, estuarine, and marine sediments. Because the data set includes only data for which biological effects occur (i.e., no-effects data were not included), it is considered to be a relatively conservative approach for predicting biological effects. For each chemical, the ranges of chemical concentrations associated with observed biological effects were determined and sorted in ascending order, and two values were calculated for each chemical: an ER-L and an ER-M. The ER-L values represent the lower 10th percentile concentration of the data, which is considered to be concentrations where adverse biological effects are rarely expected to occur (less than 10 percent of the time). The ER-M values represent the 50th percentile of the data, which is considered to be concentrations below which biological effects may be expected to occur less than 50 percent of the time and above which adverse biological effects are expected to occur more than 50 percent of the time.

Table 5-2
NOAA ER-Ls and ER-Ms

Constituent	Effects Range-Low (ER-L) Criteria (mg/kg)	Effects Range-Median (ER-M) Criteria (mg/kg)
Arsenic	8.2	70
Cadmium	1.2	9.6
Chromium, total	81	370
Copper	34	270
Lead	46.7	218
Nickel	20.9	51.6
Mercury	0.15	0.71
Selenium	N/A	N/A
Silver	1.0	3.7
Zinc	150	410
PAHs, total	4.022	44.792
DDT	0.0016	0.046
PCBs, total	0.0227	0.18

Notes: mg/kg = milligrams per kilogram; PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenols

RWQCB Wetland Cover and Noncover Criteria The San Francisco Bay RWQCB has promulgated sediment screening guidelines for use in evaluating the beneficial reuse of dredged sediment for wetland creation, levee repair, and landfill cover (SFBRWQCB 1992). The criteria are intended to facilitate the creation, enhancement, and restoration of wetlands in marine and estuarine environments. The criteria were developed in part based on NOAA's ER-L and ER-M criteria.

The RWQCB criteria specify the allowable use based on two categories: use for wetland noncover where exposure to the aquatic environment would be limited and wetland cover or levee construction where sediments would be exposed to the water. RWQCB has also begun to refer to noncover sediment as "foundation" sediment, since it essentially serves as the foundation of the marsh. Cover sediment contains lower chemical concentrations and must pass chronic and acute bioassay tests. Cover material is deemed suitable for placement in the surface of a wetland environment. Because noncover sediment is characterized by higher concentrations, it must be covered with 3 feet of cover sediment, and must not leach chemicals that could harm aquatic resources.

The RWQCB guidelines require evaluation of sediment chemical concentrations, leachability data, and bioassay results in comparison to reference data and applicable water quality criteria. Cover and noncover criteria have been commonly used over the past ten years by interagency task forces (including the Dredged Material Management Office) for making sediment disposal/reuse suitability determinations. The RWQCB has circulated a draft revision of the guidelines (SFBRWQCB 2000) that proposes use of "background" values for cover criteria, and Effects Range-Median (ER-M) values for noncover criteria. Unlike the 1992 guidelines, the recently proposed changes have not been formally adopted by the RWQCB; therefore, the 1992 values were used for comparison with ISP pond sediments. Table 5-3 shows the applicable (1992) criteria for trace metals and organic compounds.

Table 5-3
RWQCB Sediment Screening Criteria

Constituent	Wetlands Creation Noncover (mg/kg, dry weight)	Wetlands Creation Cover and Levee Restoration (mg/kg, dry weight)
Arsenic	33-85	<33
Cadmium	5-9	<5
Chromium, total	220-300	<220
Copper	90-390	<90
Lead	50-110	<50
Nickel	140-200	<140
Mercury	0.35-1.3	<0.35
Selenium	0.7-1.4	<0.7
Silver	1.0-2.2	<1.0
Zinc	160-270	<160
PAHs, total	4-35	<4
DDT	0.003-0.1	<0.003
PCBs, total	0.05-0.4	<0.05

Notes: mg/kg = milligrams per kilogram; PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenols

Local Ambient Data, including Guadalupe River Data Available data from the Guadalupe River and other areas in the vicinity of the ISP ponds were compiled for the ISP in order to allow comparison of pond data with local ambient conditions. These values include mercury data obtained from USFWS and RWQCB. In addition, a large amount of data from inorganic analyses was obtained for Guadalupe River sediments.

These data include a number of values that appear to be “outliers” based on either unrealistically high detected concentrations (e.g. 600,000 mg/kg copper) or notably high concentrations that are more than an order of magnitude higher than ambient sediment concentrations normally encountered in the South Bay. Means and ranges for Guadalupe River sediments were calculated without these outliers. Additionally, calculation of mean concentrations did not include the non-detects for which detection limits were not available. While the determination of “outliers” was qualitative and no quality control/quality assurance information is currently available for these data, the means and ranges calculated without these apparent outliers are consistent with available means and ranges calculated for Guadalupe watershed sediment by other parties, including the RWQCB and USFWS. Local Guadalupe River data from upstream and near the mouth of Alviso Slough are provided in Table 5-4. The apparent outliers are indicated in the ISP tables.

Table 5-4
Local Ambient Data, Guadalupe River

Constituent	Guadalupe River Low (mg/kg)	Guadalupe River High (mg/kg)	Guadalupe River Mean (mg/kg)
Upstream of Alviso Slough			
Cadmium	0.25	4.5	0.88
Mercury	0.05	9.2	2.09
Selenium	0.16	3	0.52
Near the Mouth of Alviso Slough			
Mercury	0.8	1.2	

Notes: mg/kg = milligrams per kilogram; PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenols

5.1.4 Pond Sediment Sampling Results

Available sediment data were compared with the screening values described above. These comparisons are useful because sediments contain a wide array of inorganic chemicals from natural geologic sources, as well as from anthropogenic activities like mining. The results of this evaluation are summarized below. Section 2.3 (Sediment Quality) in the ISP (Appendix A of this EIR/EIS) contains inorganic contaminant data for the ponds and a detailed discussion of these data. Appendix B in the ISP (Appendix A of this EIR/EIS) contains tables with organic contaminant data for the ponds.

Sediment in the ponds would be expected to have similar characteristics to ambient conditions in the vicinity of each pond system, including elevated concentrations of some inorganics (e.g mercury). Available sediment data from the ponds generally support this premise. The concentrations of contaminants in the ponds taken as a whole are similar to San Francisco Bay ambient concentrations and within the range of concentrations found within the Guadalupe River. In the Alviso ponds, the concentrations of some inorganics (notably arsenic, mercury, and selenium) are elevated over some reported San Francisco Bay ambient concentrations, but are within the range of ambient concentrations found within the South Bay and associated watersheds.

Organic chemicals (i.e., petroleum-based chemicals, including PAHs, PCBs and pesticides) were either not detected in pond sediments, or were detected at very low concentrations similar to ambient concentrations found in the cleanest parts of the Bay. Therefore, organic chemicals in the ponds do not likely pose any additional risk to human health or the environment beyond that found in the cleanest parts of the Bay.

Alviso Complex Sediment Sampling Results Sampling has been most extensive in the Alviso Complex ponds, including the Island Ponds. Available sediment quality data indicate that concentrations of contaminants in the Island Ponds (Ponds A19, A20, and A21) are similar to ambient conditions in the cleaner portions of San Francisco Bay. Data is not available for Alviso Ponds A22 and A23.

In general, concentrations of inorganics were detected in Alviso pond sediments at levels similar to San Francisco Bay ambient concentrations. Arsenic, cadmium, mercury and selenium were detected in some ponds at concentrations elevated above Bay ambient concentrations, but within the concentration ranges observed within the Guadalupe River watershed. Detected concentrations of these chemicals in the Alviso Complex sediments are discussed further below.

Chromium, copper, lead, nickel, silver and zinc were detected in the Alviso ponds at relatively lower concentrations, very similar to Bay ambient conditions. Mean concentrations of these chemicals were approximately half San Francisco Bay ambient concentrations. Maximum detected concentrations of these chemicals were only about 20% to 30% higher than San Francisco Bay ambient values.

Arsenic—Arsenic was detected at low concentrations in all but one of the Alviso ponds sampled. Detected concentrations ranged from <5 mg/kg to 19 mg/kg. The mean detected concentration of arsenic in the USFWS and Hydroscience data sets (10.74 mg/kg and 11.21 mg/kg, respectively) were lower than the San Francisco Bay ambient concentration (15.3 mg/kg). The maximum detected concentrations in those data sets (19 mg/kg and 17.5 mg/kg, respectively) were slightly above the San Francisco Bay ambient concentration. Arsenic was detected at higher concentrations in Pond A4, but the Pond A4 arsenic data appear to be of questionable quality, and the Santa Clara Valley Water District, the owner of this pond, has indicated its intention to collect additional sampling for this data. With the exception of Pond A4, detected arsenic concentrations are similar to background values and are unlikely to adversely affect water quality or wildlife.

Cadmium—Cadmium concentrations detected in the Alviso ponds were generally low. The highest concentrations were detected in the USFWS samples; concentrations in that data set ranged from non-detectable (<0.2 mg/kg) to 1.5 mg/kg, with a mean concentration of 0.96 mg/kg. This mean concentration in that data set was somewhat elevated over San Francisco Bay ambient conditions (0.3 mg/kg), but was below the RWQCB 1992 wetland cover criterion (5 mg/kg) and the ER-L (1.2 mg/kg). The maximum detected concentration detected by USFWS (1.5 mg/kg) was below the RWQCB 1992 wetland cover criterion, only slightly higher than the ER-L, and significantly below the ER-M (9.6 mg/kg).

Available Guadalupe River background data indicate that cadmium is present at similar concentrations (0.25 to 4.5 mg/kg, with a mean of 0.88 mg/kg) to those detected in the Alviso Ponds, but higher maximum concentrations were detected in the Guadalupe River. These data indicate that concentrations of cadmium in the Alviso Ponds are slightly elevated over San Francisco Bay ambient conditions, but are very similar to local ambient conditions, and are below concentrations that are likely to cause adverse effects to aquatic organisms.

Mercury—The highest concentrations of mercury were detected in the Hydroscience and USFWS samples. Hydroscience detected concentrations of mercury ranging from 0.3 mg/kg to 1.92 mg/kg, with a mean of 0.55 mg/kg. USFWS detected concentrations ranging from 0.3 mg/kg to 1.2 mg/kg, with a mean concentration of 0.84 mg/kg. Those mean concentrations are elevated in comparison with the San Francisco Bay ambient value (0.43 mg/kg). The maximum detected concentrations are similar to the RWQCB noncover criterion and significantly above the ER-L (0.15 mg/kg), the ambient value (0.43 mg/kg), the wetland cover criterion (0.35 mg/kg), and the ER-M (0.71 mg/kg).

Concentrations of mercury appear to be mostly within the range of San Francisco Bay ambient values, but there are localized areas of elevated concentrations. The highest concentrations of mercury were detected in Ponds A5, A9, A10, A15, A16, and A17.

These ponds are all located adjacent to either Alviso Slough, Guadalupe Slough, or Coyote Creek, and are within the historic Guadalupe River delta. This area is characterized by elevated background concentrations of mercury as a result of mercury mining in the watershed. Based on available data, concentrations of mercury in the Guadalupe River upstream of Alviso Slough range from about 0.05 to 9.2 mg/kg with a mean of 2.09 mg/kg. Concentrations near the mouth of Alviso Slough are about 0.8 to 1.2 mg/kg. The concentrations of mercury detected in the ISP ponds are similar to current ambient sediment concentrations and consistent with the distribution of historically high levels of mercury in the watershed.

Selenium—The highest concentrations of selenium were detected in the USFWS and Hydroscience data sets. USFWS detected selenium at concentrations ranging from 0.5 mg/kg to 2.1 mg/kg, with a mean concentration of 0.77 mg/kg. Hydroscience detected selenium at concentrations ranging from 0.71 mg/kg to 1.17 mg/kg, with a mean concentration of 0.97 mg/kg. Those mean concentrations are similar to or slightly elevated in comparison with the San Francisco Bay ambient concentration (0.64 mg/kg) and the RWQCB wetland cover criterion (0.7 mg/kg), but significantly below the RWQCB noncover criterion (1.4 mg/kg). The maximum detected concentrations are somewhat higher than background values and the cover and noncover criteria. There are no ER-L or ER-M values for selenium.

The elevated selenium concentrations (i.e., 1.03 to 2.1 mg/kg) were detected in ponds A2W, A3W, A9, A10, and A17, all of which are within or very close to the historic delta of the Guadalupe River. Based on available data, selenium concentrations in the Guadalupe River range from 0.16 to 3 mg/kg, with a mean of 0.52 mg/kg. These data indicate that selenium concentrations in the Alviso ponds are within the range of concentrations observed in ambient sediments.

Alviso Complex Island Pond Sediment Sampling Results—Two composite samples are available for each of the three Island Ponds (A19, A20, and A21). One composite sample per pond represented surface sediments and one composite sample represented sediments at depth. Each composite sample comprised three discrete samples. Mean concentrations of detected inorganics were well below San Francisco Bay ambient conditions. Maximum concentrations were also below ambient concentrations for all inorganics, except mercury and selenium. The maximum detected concentration of mercury (0.48 mg/kg) was similar to the San Francisco Bay ambient concentration and RWQCB cover criterion (0.43 and 0.35 mg/kg, respectively), but above the ER-L (0.15 mg/kg). The maximum detected concentration of selenium (0.88 mg/kg) slightly exceeded the San Francisco Bay ambient concentration and RWQCB cover criterion. No ER-L or ER-M is available for selenium. With the exception of nickel, which exists naturally in the Bay at concentrations above its ER-L and ER-M, detected concentrations of inorganics were well below RWQCB noncover values and ER-Ms.

While available data are limited, they indicate that the Island Pond sediments are similar to San Francisco Bay ambient concentrations and are unlikely to pose a risk to water quality or wildlife above that found in background sediment.

Baumberg Complex Sediment Sampling Results Available sediment quality data indicate that concentrations of contaminants in the Baumberg Ponds are similar to ambient conditions in the cleaner portions of San Francisco Bay; however, extensive sediment sampling of these ponds has not been conducted. Assessment of sediment quality in the Baumberg ponds is constrained by the small amount of data available. Available data consist of four samples collected by Hydroscience. These samples represent three of the 23 ponds in the Baumberg system. However, the ponds for which data are available are generally representative of the range of water depths and salinities that characterize the Baumberg ponds. In the sampled ponds, average existing water depths range from 0.7 to 1.3 feet, and average salinities range from 16 to 265 parts per thousand (ppt). In comparison, average existing water depths for all the Baumberg ponds range from 0.6 to 2.7 feet; average salinities for all the Baumberg ponds range from 16 to 334 ppt. In general, lower concentrations of contaminants are expected in the Baumberg ponds based on their greater distance from known sources such as the Guadalupe River drainage.

With the exception of selenium, inorganics were detected in the Baumberg ponds at concentrations below San Francisco Bay ambient concentrations. Mean and maximum detected concentrations of arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc were below ambient values and wetland cover criteria. Mean concentrations of arsenic, cadmium, chromium, copper, lead, silver, and zinc were below ER-Ls. Maximum concentrations of silver and zinc were also below ER-Ls. With the exception of nickel, which exceeded the ER-M (51.6 mg/kg), detected concentrations of inorganics were well below the ER-M and wetland noncover values. It should be noted that the nickel ER-M is lower than the San Francisco Bay ambient concentration (112 mg/kg).

Selenium was detected at a mean concentration of 0.76 mg/kg and a maximum concentration of 0.87 mg/kg. These concentrations are slightly elevated compared to the San Francisco Bay ambient concentration of 0.64 mg/kg and the RWQCB wetland cover criterion of 0.7 mg/kg, but well below the wetland noncover criterion of 1.4 mg/kg. These minor exceedences are near the range of laboratory error (typically 10 to 20%, depending on analytical method). No ER-L or ER-M is available for selenium. One sample ("Bay") was collected from Bay sediments immediately adjacent to Pond 10 to characterize local background conditions. Selenium was detected in that sample at 0.68 mg/kg, which is similar to San Francisco Bay ambient and wetland cover criteria. The mean concentration of selenium in the sampled ponds is within 11% of the Bay sample, indicating that pond conditions are very similar to ambient conditions.

The number of samples makes it difficult to confirm that these exceedences are localized; but it appears that exceedences are slight, and that selenium in Baumberg sediments is unlikely to pose a higher risk to water quality or wildlife than Bay ambient conditions.

West Bay Complex Sediment Sampling Results Assessment of sediment quality in the West Bay Ponds has a high degree of uncertainty due to the fact that only one sample is available. However, concentrations of all inorganics in that sample were well below San Francisco Bay ambient conditions, RWQCB cover criteria, and RWQCB noncover criteria. With the exception of nickel, which exists naturally in the Bay at concentrations above its ER-L and ER-M, detected concentrations of inorganics were also below ER-Ls and ER-Ms. While it is not possible to characterize sediment definitively on the basis of a single sample, the available data for this single sample indicate that inorganics are present at concentrations below background conditions and are unlikely to pose risks to water quality or wildlife.

5.1.5 Fate/Transport and Toxicity of Inorganic Contaminants in Pond Sediments

Fate/Transport and Toxicity of Mercury— Mercury contamination is widespread in sediments and waters of the San Francisco Bay area (San Francisco Estuary Institute 2000, SFBRWQCB 2000). Mercury is a constituent of particular concern to wetland restoration projects because of its ability to convert to the methylated form of the metal, which is relatively more mobile in the aquatic environment than other forms. Data for total mercury in water and sediment from long-term monitoring data under the USGS and San Francisco Estuary Institute Regional Monitoring Program (RMP) has consistently shown elevated concentrations, primarily in the north and south bay areas and river tributaries. There is also a strong correlation between total mercury and suspended sediment transport in the water (SFEI, 2000).

Elevated mercury levels are in large part a legacy of the California gold mining era, when mercury was used in the gold refining process. Mines such as south San Francisco Bay's New Almaden Mine, which operated for many years in the upper Guadalupe River watershed extracting the mercury ore cinnabar, are known to be a source of mercury in the bay system. Over time, leaching of mine tailings and overland transport of mercury-bearing sediments have resulted in the downstream accumulation of mercury in the watershed.

In aquatic environments, most mercury is chemically bound to suspended particles of soil or sediment; a smaller fraction is bound to dissolved organic carbon. Sediment-bound mercury may be available to aquatic organisms and is thus a pollutant of concern; the potential for adverse environmental effects from sediment-bound mercury depends primarily on transport and depositional characteristics (e.g., particle size) and on the physical and chemical properties of the sediment.

Additionally, sediment-bound mercury may be converted through both biotic and abiotic processes to its more bioavailable methylated form. Factors conducive to methylation of mercury include low-flow or stagnant waters, hypoxic or anoxic conditions in the water or sediment column, low pH (pH<6), and high concentrations of dissolved carbon. Most of these factors are in turn affected by biological processes such as metabolism, growth, and decay; for example, mercury methylation has been linked to the activity of sulfate-reducing bacteria in the shallow anoxic sediment column.

Aquatic plants, fish, and wildlife readily adsorb methylmercury. It can then accumulate in their tissues, creating contaminated food sources (plant or animal tissues) that transfer through the food web (Santa Clara Valley Water District and U.S. Army Corps of Engineers 2001). It is a mutagen, teratogen, and carcinogen, and has embryotoxicological, cytochemical, and histopathological effects. In aquatic organisms, concentrations of 0.1–200 micrograms per liter (µg/l) have been shown to produce adverse effects. Toxicity increases with age of the organism, exposure time, temperature, lowered salinities, and the presence of other metals.

Fate/Transport and Toxicity of Selenium—Concerns about the potential impacts of selenium in the San Francisco Estuary were raised in the mid-1980s when elevated selenium concentrations were detected in water and biota in the northern reaches of the Estuary, and in Kesterson Reservoir where the most dramatic evidence of selenium poisoning in waterfowl was observed (CDFG 1988, 1989; Ohlendorf et al. 1990).

A review of available South San Francisco Bay selenium data, collected primarily between 1995 and 2000, has shown the dominance of riverine sources in the overall selenium mass loading to the South Bay (LFR Levine-Fricke 2002). Estimates based on flow and dissolved selenium data indicated that the Guadalupe River is responsible for about 1/3 of the total selenium flow into the South Bay. The San Francisco Estuary Institute (SFEI 2000) also identified the Guadalupe River as a significant contributor of selenium to the South Bay. The LFR report estimated that all the creeks and rivers (including Guadalupe River, Alameda and Coyote Creeks) contributed more than 60% to the South Bay. Publicly-owned treatment works (POTWs) were estimated to contribute about 20% of the total selenium load, while stormwater runoff was estimated to contribute about 15%. Although the average daily water flow from the Guadalupe River is relatively low compared with Alameda Creek and the San Jose/Santa Clara POTW, it contained by far the highest selenium concentrations of any water body in the area, with an average selenium concentration of 4.7 μg/l.

The ultimate source of selenium in the South Bay watersheds is geologic. Although geologic formations containing naturally elevated selenium may be present, historical mining activities in the Santa Cruz Mountains have likely increased selenium concentrations in tributaries to the Guadalupe River that ultimately flow into the South Bay. Selenium is often associated with the types of geologic formations and mineral deposits found in the Santa Cruz Mountains, from which tributaries of both the Guadalupe River and Coyote Creek emerge.

The New Almaden region within the Santa Cruz Mountains contains well-known mercury ore deposits. The geologic processes responsible for the formation of mercury-rich deposits (cinnabar, a mercury sulfide) in this area are unrelated to the processes resulting in selenium enrichment; however, cinnabar is associated with pyrite and other sulfides (Bailey and Everhart 1964), which commonly contain selenium impurities. The high pyritic content of shales in the Coast Ranges is considered a major reason for their high selenium content (Martens and Suarez 1997). Therefore, it is quite likely that exposed and/or oxidized sulfide deposits in the New Almaden region are an important source of selenium to the Guadalupe River. In addition, Upper Cretaceous marine shales, often enriched with selenium, are also found near the headwaters of Alamitos Creek, a tributary to the Guadalupe River.

Concentrations of selenium in biota in the South Bay have been reported to be elevated relative to average levels in the North and Central Bays (SWRCB 1988; CDFG 1989). However, there are no major industrial sources of selenium known in the South Bay, in contrast to the North Bay where oil refineries have historically discharged significant amounts of selenium in their wastewater.

POTWs have been identified as a potential source of selenium to the South Bay (SFBRWQCB 1997). Selenium in POTW effluent has been assumed to be “strongly influenced by selenium levels in groundwater,” which are in turn a result of “naturally-high (Se) concentrations in local geology and evaporative concentration” (SFBRWQCB 1997). Cutter and San Diego-McGlone (1990) reported that selenium concentrations in South Bay POTW discharges in March 1988 were as high as 1.43 μg/l, and generally higher than those from San Francisco or East Bay POTWs. However, according to a review conducted by LFR in 2002, most reported POTW discharge data revealed less than 1 μg/l selenium in samples. Based on 27 measurements collected between December

1987 and March 1988, Cutter and San Diego-McGlone (1990) estimated that the total selenium flux from South Bay, East Bay, and San Francisco POTWs was approximately 400 kilograms per year (kg/yr). This estimated flux is five times smaller than the total selenium flux from North Bay refineries prior to selenium reduction efforts carried out by the refineries in the 1990s.

The hydrology of the South Bay differs from the other Bay regions in that it is enclosed on three sides, is much shallower, and has a longer water residence time than other parts of the Bay (San Francisco Estuary Project [SFEP] 1992). As such, the South Bay, and in particular the South Bay south of the Dumbarton Bridge, is relatively stagnant and subject to a higher evaporation rate, as manifested in the relatively higher concentrations of numerous constituents of South Bay water compared to other parts of the Bay (SFEI 1999).

Selenium mobility, bioavailability, and toxicity depend on the selenium species (i.e., its form) in the environment. Selenium chemistry is complex and the element exists in several different forms and oxidation states, including: the oxyanions selenate (Se [VI]) and selenite ([Se[IV]); and the more reduced forms of elemental selenium and inorganic and organic selenides.

Selenite is generally considered more harmful to biota than selenate because of its potential to bioaccumulate more readily (Ogle et al. 1988; Zhang et al. 1990), and tendency to adsorb to particulate matter, which can be ingested by bivalves (Luoma et al. 1992). Selenite is strongly adsorbed by soil surfaces (especially iron hydroxides) at acid to near-neutral pHs; alkaline conditions can release selenite from soil surfaces. Selenate, the most oxidized and most common form in natural waters, is not adsorbed strongly by soil and is consequently the selenium form most readily taken up by plants. Selenate is readily reduced to selenite under common wetland conditions, which can then be adsorbed and/or precipitated by a number of soil solid phases, including iron hydroxides, carbonates, and organic materials. Alternatively, selenite can be oxidized under drying conditions to selenate, thus becoming more mobile in the environment. Under anaerobic conditions, which can readily occur in wetland environments, selenite can be further reduced to elemental selenium and into selenides (e.g., FeSe). Although these reduced forms of selenium are typically less bioavailable than the oxyanionic forms (e.g., selenate and selenite), microbial transformations and uptake of these reduced forms are known to occur (Oremland 1994).

Like mercury, selenium can be methylated by a variety of microorganisms, generally producing dimethyl-selenides (DMSe). Unlike mercury, however, methylated selenium is believed to be less toxic than the oxyanions, and because of its high volatility, has received a lot of attention for its potential use as a remediation technique to lower selenium concentrations in contaminated soil and sediment. Addition of carbonaceous materials to soil has been reported to enhance formation of DMSe, especially under aerobic conditions.

5.2 Criteria for Determining Significance of Effects

Potential effects of the various project alternatives (including No Project/No Action and Alternatives 1, 2, and 3) on sediments were assessed qualitatively and quantitatively based on a comparison between existing conditions and projected post-implementation conditions with regard to contaminant mobility, exposure, and bioavailability. Criteria based on CEQA and NEPA guidelines were used to determine the significance of potential impacts of sediment-associated contaminants on biota or water quality. Under NEPA, analysis of significance requires considerations of both the context and intensity of an impact. Consideration of context means the significance of an action must be analyzed within the appropriate temporal, geographic, and ecological scale, while intensity refers to the severity of the impact. Impact intensity and context were fundamental to the development of RWQCB screening criteria for wetlands cover materials, which are included in the significance thresholds for sediment impacts (below). As discussed above (see Section 5.1.3), these criteria are based partly on NOAA ER-Ls and ER-Ms, which are themselves based on observed toxicity responses in organisms (intensity). The RWQCB criteria take into consideration the particular situation of the San Francisco Bay region (context).

Sediment impacts were considered significant if they would reasonably be expected to:

- Result in substantial changes in the mobility or bioavailability of sediment-associated contaminants
- Increase exposure of wildlife to contaminants in excess of relevant regulatory criteria and guidelines (RWQCB screening criteria for wetlands cover materials)
- Increase exposure of listed species to bioaccumulatable contaminants
- Result in indirect impacts to water quality that could cause exceedances of water quality criteria (see Chapter 4 for water quality criteria)
- Result in impacts to potential future restoration of the project ponds

Since the process of freshening saline water bodies with sediments containing various levels of metals has never before been monitored, the actual potential for impacts is not known. Consistent with NEPA guidelines, impacts were considered significant if available information indicates potential adverse effects, but insufficient information is available to determine the severity of those effects.

5.3 Impacts

The discussion of impacts from sediments focuses on those ISP ponds that contain levels of inorganic contaminants that exceed RWQCB screening criteria for wetland cover materials, based on available sediment sample data (see Section 5.1). A total of 11 ponds, all located in the Alviso Complex, contain levels of mercury or selenium that exceed the screening criteria. These ponds include A1 (mercury), A2W (selenium), B1 (mercury), A3W (selenium), A3N (mercury), A5 (mercury), A9 (mercury and selenium), A10 (mercury and selenium), A15 (mercury), A17 (mercury and selenium) and A16 (mercury). The elevated concentrations of selenium and mercury detected in sediment and/or tissue samples from these Alviso ponds indicate that potential oxidation or wetting/drying cycles in these ponds would be of particular concern.

As discussed in Section 5.1.4.1, sampling has been most extensive in the Alviso Complex ponds, including the Island Ponds. Available sediment quality data indicate that concentrations of contaminants in the Island Ponds (Ponds A19, A20, and A21) are similar to ambient conditions in the cleaner portions of San Francisco Bay. Data is not available for Alviso Ponds A22 and A23. Available sediment quality data indicate that concentrations of contaminants in the Baumberg Ponds are similar to ambient conditions in the cleaner portions of San Francisco Bay (see Section 5.1.4.2); however, extensive sediment sampling of these ponds has not been conducted. Only one sediment quality sample is available to assess sediment quality in the West Bay Ponds (see Section 5.1.4.3). Concentrations of all inorganics in that sample were well below ambient conditions in the cleaner portions of San Francisco Bay.

Changing the depths of water levels in the ponds in the project area could cause impacts to water quality and biota, particularly in those ponds that contain elevated levels of inorganic contaminants by: 1) creating acidic conditions in sediments and soils; 2) increasing the mobility, availability, and concentration of contaminants (through oxidation, acidification, freshening and methylation of mercury); 3) increasing the opportunities for wildlife contact with contaminants in exposed sediments; and 4) impacting vegetation growth in gypsum/salt-affected soils. These types of impacts are discussed generally first and then in relationship to each of the proposed project alternatives below.

Impacts from Oxidation—Oxidation of exposed sediments can increase the mobility and bioavailability of inorganic contaminants. Drying of ponds can expose sediments to air and can result in oxidation of sulfides and organic matter that are known to bind inorganic contaminants strongly, making the inorganic contaminants more mobile and bioavailable. Oxidation can also generate acid conditions in sediment and levee soil which can further increase the mobility of inorganic contaminants, especially the cationic heavy metals (e.g., copper, lead, mercury). Impacts to water quality and biota could occur indirectly from the increased mobility of inorganic contaminants following oxidation reaction.

Impacts from Acidification— Oxidation of exposed sediments can generate low pH (acidic) conditions in sediments and levee soil, which can further increase the mobility and bioavailability of inorganic contaminants. If the pH should drop into the acid range (e.g., below pH 6), adsorption of inorganics by clays and iron hydroxides would be depressed and inorganics could be released from the sediment. The cationic heavy metals (e.g., copper, lead, mercury) are especially subject to this type of impact. Arsenic and selenium are exceptions to the rule. In their common anionic forms, selenite and arsenate are typically more strongly adsorbed and immobilized under acidic conditions. Impacts to water quality and biota from mercury could occur under these conditions, both indirectly from increased mobility of contaminants and directly through contact with low pH sediment and soil.

Impacts from Freshening Effects. The introduction of fresher water into saline ponds where salt precipitates exist may increase the release of contaminants. In higher salinity ponds, salts containing inorganic contaminants may precipitate out of the water column and/or become adsorbed on sediment surfaces. Introduction of fresher water into the ponds (freshening) may dissolve the precipitated salts, providing a source of inorganic contaminants in discharge water. This could be a problem in ponds that have consistently been managed at above 150 ppt, which is the point that gypsum (calcium sulfate) precipitates (i.e., Ponds A19-23, the West Bay ponds, and some Baumberg ponds. However, levels of mercury and selenium were not found to be high in those ponds. The extent and duration of the freshening effect is unknown. The magnitude of this impact would be dependent on a number of physiochemical factors, as well as the amount and types of contaminants in pond precipitates and sediment**.**

Impacts from Mercury Methylation. Drying/wetting cycles in ponds can promote methylation of mercury, increasing the mobility and bioavailability of mercury.

Sediment-bound mercury released as a result of drying and oxidation could become available for methylation when the ponds are re-flooded by winter rains. As discussed in Section 5.1.5.1 above, the organic form of mercury, methylmercury, is more mobile and bioavailable than the inorganic form. In general, ponds with higher total mercury concentrations have greater potential for methylmercury production, although low concentrations of total mercury can also produce considerable concentrations of methylmercury under certain hydrologic and biogeochemical conditions.

Impacts from Gypsum/Salt-Affected Soils. Gypsum/salt affected soils may impede vegetation growth and impact habitat values. Long-term pond drying of sediment can result in gypsum/salt affected soils, which can impede the establishment and growth of wetland vegetation. Saline-sodic soils commonly have a pH of about 8.5, and freshening can create more alkaline sodic soils (e.g., with a pH above 9). These soils are typically very compact with poor hydraulic conductivity and tend to inhibit plant colonization and growth. These conditions may also limit restoration options in the future. Extremely saline and sodic conditions could also reduce the diversity and/or or biomass of invertebrates, thereby decreasing the value of certain ponds as foraging habitat for some other birds and fish. For some birds (e.g., snowy plover), unvegetated ponds actually provide better habitat, and in many cases can provide dense populations of certain invertebrates, such as brine flies and brine shrimp.

Impacts from Changes in Water Level. Changes in water levels can increase wildlife exposure to contaminants by introducing fish and other wildlife to ponds where they weren't previously present and increasing the contact between wildlife and contaminants in exposed sediments**.** For example, changing water depths will change foraging opportunities for birds. Diving and dabbling waterfowl are exposed to different levels of contaminants in sediments than probing birds. Exposure may be through increased bioavailability of contaminants resulting from oxidation and methylation, and potential concentration of contaminants in diminishing overlying water. In general, more forms of wildlife could be exposed to contaminants as pond levels decrease.

5.3.1 No Project/No Action Alternative

SEDIMENTS IMPACT-1: The mobility and bioavailability of inorganic contaminants may increase within project ponds.

Under the No Project/No Action Alternative, ponds would be operated as seasonal ponds and would dry down during the summer months. Drying of formerly inundated or saturated sediments under the No Project/No Action Alternative would result in oxidation of exposed sediments. As noted above, oxidation of sediments can increase the mobility and bioavailability of inorganic contaminants and can also result in acidic conditions in sediments and soils, which can further increase the mobility and bioavailability of inorganic contaminants. Drying/wetting cycles, which would occur in the ponds under the No Project/No Action Alternative, could also promote methylation of mercury, as discussed above.

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

SEDIMENTS IMPACT-2: Long-term pond drying may result in the formation and exposure of gypsum/salt-affected soils, decreasing the habitat value of ponds for some wildlife species and limiting future restoration options.

Under the No Project/No Action Alternative, some gypsum/salt-affected soils will be left or will develop on the sediment surface of some ponds. As discussed above, gypsum/salt-affected soils can impede growth of wetland vegetation and reduce the diversity and/or biomass of invertebrates, thereby decreasing the value of the ponds as foraging habitat for some species. Other species would benefit. Since there is presently little vegetation at the project ponds, the impact from the development of gypsum/salt-affected soils is primarily an impact to the potential for future restoration of ponds. That is, the presence of gypsum/salt-affected soils may limit future restoration options for certain ponds.

Significance: Potentially significant and unavoidable

Under the No Project/No Action Alternative, some gypsum/salt-affected soils will be left or will develop on the sediment surface of some ponds. As discussed above, gypsum/salt-affected soils can impede growth of wetland vegetation and reduce the diversity and/or or biomass of invertebrates, thereby decreasing the value of the ponds as foraging habitat for some species. Other species would benefit. The development of gypsum/salt-affected soils may also limit future restoration options for certain ponds.

SEDIMENTS IMPACT-3: Changes in pond water levels may alter exposure of wildlife to contaminants in sediments.

Under the No Project/No Action Alternative, the dry-down cycles that would occur in seasonal ponds could create additional foraging opportunities for birds, where currently access is limited by deeper water levels. Additional foraging access could increase exposure of foraging birds to contaminants in sediments. While diving and dabbling waterfowl may be exposed to some contaminants in sediments covered with ponded water; in general, more forms of wildlife could be exposed to contaminants as pond levels decrease. Increased access to sediments, combined with potential increased mobility and bioavailability of contaminants, could impact foraging birds.

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

SEDIMENTS IMPACT-4: Unplanned breaches of ponds could result in significant water quality and wildlife impacts from contaminants in sediments.

Under the No Project/No Action Alternative, levees would not be maintained and unplanned breaches of the ponds would be more likely. Given the impacts of this alternative on the mobility, bioavailability, and concentration of inorganic contaminants bound in sediments, any breach of the project ponds could have significant impacts on water quality and biota.

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

5.3.2 Alternative 1 (Seasonal Pond Alternative)

Impacts under this alternative are nearly the same as those under the No Project/No Action Alternative. The primary difference would be that the potential for sediment contaminant impacts on water quality and biota as a result of levee failure (see Sediments Impact-4 under No Project/No Action above) would be reduced since the infrastructure (levees, weirs, etc.) that separates the ponds from the Bay and sloughs would be maintained. Unlike Alternatives 2 and 3, Alternative 1 does not allow for flexibility and adaptability in the management of the ponds in response to project impacts that may be observed in the field in the future. Thus, Sediments Impacts-1 and -3, which are related to the management of the ponds as seasonal ponds with wetting and drying cycles, would be potentially significant and unavoidable under this alternative.

SEDIMENTS IMPACT-1: The mobility and bioavailability of inorganic contaminants may increase within project ponds.

Under Alternative 1, ponds would be operated as seasonal ponds and would dry down during the summer months. Drying of formerly inundated or saturated sediments under this alternative would result in oxidation of exposed sediments. As noted above, oxidation of sediments can increase the mobility and bioavailability of inorganic contaminants and can also result in acidic conditions in sediments and soils, which can further increase the mobility and bioavailability of inorganic contaminants. Drying/wetting cycles, which would occur in the ponds under this alternative, could also promote methylation of mercury, as discussed above.

Significance: Potentially significant and unavoidable.

SEDIMENTS IMPACT-2: Long-term pond drying may result in the formation and exposure of gypsum/salt-affected soils, decreasing the habitat value of ponds for some wildlife species and limiting future restoration options.

Under the No Project/No Action Alternative, some gypsum/salt-affected soils will be left or will develop on the sediment surface of some ponds. As discussed above, gypsum/salt-affected soils can impede growth of wetland vegetation and reduce the diversity and/or biomass of invertebrates, thereby decreasing the value of the ponds as foraging habitat for some species. Other species would benefit. Since there is presently little vegetation at the project ponds, the impact from the development of gypsum/salt-affected soils is primarily an impact to the potential for future restoration of ponds. That is, the presence of gypsum/salt-affected soils may limit future restoration options for certain ponds.

Significance: Potentially significant and unavoidable

SEDIMENTS IMPACT-3: Changes in pond water levels may alter exposure of wildlife to contaminants in sediments.

Under Alternative 1, the dry-down cycles that would occur in seasonal ponds could create additional foraging opportunities for birds, where currently access is limited by deeper water levels. Additional foraging access could increase exposure of foraging birds to contaminants in sediments. While diving and dabbling waterfowl may be exposed to some contaminants in sediments covered with ponded water; in general, more forms of wildlife could be exposed to contaminants as pond levels decrease. Increased access to sediments, combined with potential increased mobility and bioavailability of contaminants, could impact foraging birds.

Significance: Potentially significant and unavoidable.

5.3.3 Pond Management Alternative 2: Simultaneous March/April Initial Discharge

Under Pond Management Alternative 2, potential sediment-related impacts include an increase in the mobility and bioavailability of contaminants in sediments, which could adversely impact water quality and biota; changes in hydrology that may increase wildlife exposure to contaminants in sediments; and an increase in the transport of suspended sediment, which could also adversely impact water quality and biota. Removal of brines in accordance with the terms of the Cargill Ponds Acquisition and the introduction of fresher water into highly saline ponds to dilute existing salts as proposed in the ISP would prevent the formation and exposure of gypsum/salt-affected soils that can result in adverse effects to habitat values. Mitigation measures proposed for Sediments Impact-1 (Sediments Mitigation Measures 1A, 1B, and 1C) are also proposed for Sediments Impacts-3 and -6 under this alternative.

SEDIMENTS IMPACT-1: The mobility and bioavailability of inorganic contaminants may increase within project ponds.

Hydrologic changes anticipated under Pond Management Alternative 1 may affect the mobility and bioavailability of contaminants through several mechanisms including oxidation, acidification, freshening, and wetting/drying cycles that increase production of methylmercury**.** Increases in levels of contaminants measured in pond water may be an indication of the effect of one or more of these mechanisms, which are discussed further below and were also discussed above in the summary of the types of project impacts anticipated.

Introduction of fresher bay water into the more saline ponds may release inorganic contaminants. Under Pond Management Alternative 1, initial release of all the ponds in March/April would mean that the pond systems would be released when incoming water salinities would be at their lowest (i.e., freshest). This freshening may increase dissolution of salts from sediments and cause more concentrated release of sediment-associated contaminants in comparison with Alternative 2, under which many of the pond systems with elevated concentrations of mercury and/or selenium are planned for initial release in July. However, the larger volume of water that may be present in the ponds in March/April may mitigate for the greater mass of contaminants potentially dissolving from salts. This impact would be short-term in duration, occurring only during the initial discharge period.

Oxidation Impacts. Average water depths and anticipated variation in water depths were modeled by Shaaf & Wheeler based on rainfall and tide data from 1994-1995 (see Section 4 of the ISP; Appendix A). Hydrologic changes expected under Pond Management Alternative 1 are presented in Table 2-1. As discussed above, changes in water levels in project ponds are relevant to the impacts to water quality and biota of contaminants in sediments.

Of the ponds that are known to have elevated levels of selenium and/or mercury higher than RWQCB screening criteria for wetland cover materials (Alviso Ponds A1, A2W, B1, A3W, A5, A9, A10, A15, A17, and A16), only Ponds A9, A10, A16, and A17 will be managed with water levels substantially shallower than existing conditions. The proposed hydrologic regimes for these ponds could result in periodic exposure of sediment to air. Of these, Ponds A1, A7, A8, A9 and A16 also support breeding and/or foraging populations of shorebirds, including some listed species, and are therefore considered to be sensitive habitat. Only two ponds (A9 and A16) currently have exposed "islands" that are used for nesting by shorebirds.

Variability in water levels, such as for batch ponds, will have an effect on the frequency and duration of sediment exposure as well. In batch ponds, large volumes of water are transferred from pond to pond during relatively short periods of time and water elevations can vary significantly over a number of weeks or months. In Ponds A9, A10, A16, and A17, reduced variability in water levels under this alternative may counteract the effects of the lower average water levels proposed for these ponds, and therefore the anticipated frequency and duration of sediment exposure within these ponds may be similar to or less than existing conditions. Predicted hydrologic conditions are based on tide and rain data from 1994-1995, and actual water levels will depend on future tide heights and weather patterns. Lower water levels than anticipated can result from weak tide cycles and/or prolonged dry weather.

Acidification Impacts. In ponds where average water levels will be more than 6 inches higher than existing conditions, exposure to acid levee soils could affect water pH in localized areas of the ponds. Although some North Bay levee soils have been found to be acidic, at this time, there is no indication that South Bay levee soils are the same. However, if some areas were found to have low pH levels, localized areas of acidic pond water could increase the mobility of sediment-associated contaminants. Lowered pH can also adversely affect wildlife through loss of invertebrate colonies that serve as food sources for birds. Foraging birds could experience direct toxicity if acid conditions are present. However, the impact of lowered pH is likely to be short–term. This is because saturating currently exposed levee sideslopes can restore reducing conditions that are known to decrease acidity; and saline bay waters contain carbonates that can buffer acid conditions towards more neutral conditions. Experience in the North Bay salt ponds shows that acid conditions resulting from pond drying was buffered back to neutral conditions after bay waters were introduced into ponds through levee breaches (Personal communication Mike Rugg).

Freshening Impacts. Introduction of fresher bay water into the more saline ponds may release inorganic contaminants. Of the ponds with elevated concentrations of inorganic contaminants (mercury and/or selenium), there are several ponds of medium salinity levels that will become substantially fresher under Alternative 1. These are Alviso Ponds A5, A8, A9, A10, A15, A17, and A16.

Significance: Potentially significant.

> *SEDIMENTS MITIGATION MEASURE-1A*: Conduct pre-project sampling of sediments from specific ponds, in accordance with the project Additional Sediment Sampling Analysis Plan (SAP).

The RWQCB, upon review of the Report of Waste Discharge (ROWD) for the ISP, recommended additional sediment sampling to further characterize the nature and extent of mercury and selenium contamination in ISP pond sediments. As a result, an Additional Sediment Sampling and Analysis Plan (SAP) was prepared (see Appendix J). The SAP describes the proposed sample locations, sample collection procedures, and chemical and physical analyses to be performed. The SAP proposes sampling 2 depths at each of 50 sampling locations distributed within 16 ponds, including ponds in the all three pond complexes. Sediment samples will be analyzed for metals, methylmercury, total organic carbon, salinity, and pH.

> *SEDIMENTS MITIGATION MEASURE-1B:* Conduct post-implementation monitoring in areas with elevated concentrations of inorganics to determine whether conditions are occurring that would increase contaminant mobility (e.g., methylation, acidification, or oxidation of sediments, or visual observation of increased drying or wetting/drying cycles).

Post-implementation monitoring would focus on ponds where available data indicate the presence in sediments of concentrations of inorganics that exceed standards and where proposed hydrologic regimes could result in exposure of contaminated sediments. To date, these ponds include Alviso Ponds A9, A10, A16, and A17. If results of the SAP indicate additional ponds with elevated inorganics and hydrologic regimes of concern, these ponds would be monitored as well**.**

> *SEDIMENTS MITIGATION MEASURE-1C*: If post-implementation monitoring during the Continuous Circulation Period (Sediments Mitigation Measure-1B) indicates the presence of conditions that would increase contaminant mobility, implement water management measures to mitigate these conditions.

The following measures would be implemented in the order presented:

1. Assess the risk posed by the increase relative to ambient conditions in the South Bay.
2. Adjust water management to raise water levels and minimize wetting/drying cycles.
3. Monitor pH levels. If levels below pH 6 are identified, restore saturated conditions to acid sediments/levee soils to promote the buffering of pH towards neutral conditions.
4. Add water management structures. Minor adjustments to water levels can be made in some ponds by decreasing or increasing pumping in ponds where pumps will be present, or adding or removing weir boards in ponds where weirs are present. Modification of water control structures/pumps in one pond will affect the hydrology of other ponds in that system, so effects of specific water level changes on all ponds in the system must be evaluated before implementing this measure.

SEDIMENTS MITIGATION MEASURE 1D: If post-implementation monitoring (Sediments Mitigation Measure 1B) during the Initial Release Period identifies elevated levels of inorganic impacts in discharge waters, potentially attributable to freshening effects, this impact may be mitigated in future releases by implementing additional water control measures designed to reduce freshening effects.

Freshening may be slowed during the Initial Release Period by introducing bay water in summer when salinities in incoming water are higher. By reducing the salinity difference between introduced bay water and existing pond water, the rate of freshening may be slowed such that dissolution of contaminants may be reduced. Although reductions in flow through the ponds could also reduce freshening effects, such reductions would result in higher salinities in discharge waters. Therefore, a better solution to freshening impacts may be to increase the volume of water prior to discharge, which would dilute the contaminants that dissolve and become re-suspended as a result of freshening and to reduce the concentrations of these contaminants in discharge water.

Post-mitigation Significance: Less than significant

> *SEDIMENTS IMPACT-3*: Changes in pond water levels may alter exposure of wildlife to contaminants in sediments.

Under Alternative 2, the dry-down cycles that would occur in ponds that would be managed as seasonal ponds could create additional foraging opportunities for birds, where currently access is limited by deeper water levels. Additional foraging access could increase exposure of foraging birds to contaminants in sediments. While diving and dabbling waterfowl may be exposed to some contaminants in sediments covered with ponded water; in general, more forms of wildlife could be exposed to contaminants as pond levels decrease. Increased access to sediments, combined with potential increased mobility and bioavailability of contaminants, could impact foraging birds.

Significance: Potentially significant

> *SEDIMENTS MITIGATION MEASURE-1A*: Conduct pre-project sampling of sediments from specific ponds, in accordance with the project Additional Sediment Sampling Analysis Plan (SAP).

See Appendix J and discussion under Sediments Impact-1.

> *SEDIMENTS MITIGATION MEASURE-1B*: Conduct post-implementation monitoring in areas with elevated concentrations of inorganics to determine whether conditions are occurring that would increase contaminant mobility (e.g., methylation, acidification, or oxidation of sediments, or visual observation of increased drying or wetting/drying cycles).

See discussion under Sediments Impact-1.

> *SEDIMENTS MITIGATION MEASURE 1C*: If post-implementation monitoring indicates the presence of conditions that would increase contaminant mobility, implement water management measures to mitigate these conditions.

See discussion under Sediments Impact-1.

Post-mitigation Significance: Less than significant

> *SEDIMENTS IMPACT-3A:* Changes in hydrology may increase wildlife exposures to contaminants.

Increasing the number of connections to receiving waters, or changing the nature of the connections (for example creation of uncontrolled openings such as gaps in the levee or installation of culverts with no water control structures) can create more opportunities for fish to enter the ponds. Introduction of fish into ponds where they are not currently present could increase the potential for biotic exposure to sediment-associated contaminants. To the extent that predators consume these fish, bioaccumulation could increase, especially for mercury and selenium.

Significance: Potentially significant.

> *SEDIMENTS MITIGATION MEASURE-1A*: Conduct pre-project sampling of sediments from specific ponds, in accordance with the project Additional Sediment Sampling Analysis Plan (SAP).

See Appendix J and discussion under Sediments Impact-1.

> *SEDIMENTS MITIGATION MEASURE-1B*: Conduct post-implementation monitoring in areas with elevated concentrations of inorganics to determine whether conditions are occurring that would increase contaminant mobility (e.g., methylation, acidification, or oxidation of sediments, or visual observation of increased drying or wetting/drying cycles).

See discussion under Sediments Impact-1.

> *SEDIMENTS MITIGATION MEASURE 1C*: If post-implementation monitoring indicates the presence of conditions that would increase contaminant mobility, implement water management measures to mitigate these conditions.

See discussion under Sediments Impact-1.

Post-mitigation Significance: Less than significant

> *BENEFICIAL SEDIMENT IMPACT-1*: Higher average water levels in some ponds could decrease the mobility and bioavailability of contaminants and the potential for wildlife exposure to contaminants in those ponds.

No mitigation is required for beneficial impacts.

> *BENEFICIAL SEDIMENT IMPACT-2:* In the long term, freshening of hypersaline sediments will produce sediment and water conditions that can promote habitats more endemic to the South Bay ecosystem. This would be a beneficial impact.

No mitigation is required for beneficial impacts.

5.3.4 Pond Management Alternative 3: Phased Initial Discharge

The only difference between Pond Management Alternatives 2 and 3 is in the timing of initial discharge of pond waters. As described in Chapter 2, under Pond Management Alternative 2, water control structures would be installed in summer or fall and initial discharge of the existing pond contents would begin the following year in March/April when salinities within the ponds and receiving waters are the lowest. Under Alternative 3, on the other hand, the initial discharge from a limited number of ponds would occur in July/August, with discharge from other pond systems occurring in subsequent years. Ponds with a July/August initial release are noted in Table 2-1.

Impacts and mitigation measures under Pond Management Alternative 3 would be mostly the same as those under Pond Management Alternative 2 (see Section 5.3.3). After initial discharge, operational water levels and salinities would be the same as for Alternative 2 No additional increases in long-term sediment contaminant bioavailability or potential wildlife exposure are anticipated due to the timing of the initial discharge. The mobility and bioavailability of inorganic contaminants in sediments (addressed under Sediments Impact-1) may be reduced under the July/August initial discharge scenario (Alternative 3) due to reduction in the freshening effect and other changes, as described below.

> *SEDIMENTS IMPACT-1:* The mobility and bioavailability of inorganic contaminants may increase within project ponds.

Under Alternative 3, this impact will be reduced compared to similar impacts under Alternative 2. The phased timing of initial release proposed under Alternative 3 would allow releases to occur in such a way as to minimize impacts to water quality. For example, the initial release of several pond systems is planned for July, when incoming water salinities are higher. As described in Chapter 2, initial release of Alviso System A7, which contains Ponds A5 and A8 with elevated mercury and selenium, is anticipated to occur in July. Initial release from Baumberg Systems 2, 8A, and 11 is also planned for July under this alternative**.** Limited sampling data for Baumberg System 2 doesn't indicate elevated levels of inorganics. Sampling data do not presently exist for Baumberg Systems 8A and 11. The higher Bay water salinity would result in reduced freshening effects in these ponds during the initial discharge period only. Although this impact is reduced under Alternative 2, it is still potentially significant. Since freshening is only a concern where pond sediments contain elevated levels of inorganic chemicals, mitigation for this impact includes sampling for these chemicals and monitoring their mobility (Sediments Mitigation Measures 1A, 1B, and 1C, below). In addition, effects potentially attributable to freshening may be mitigated by implementing additional water control measures proposed in Sediments Mitigation Measure-1D.

Significance: Potentially significant.

> *SEDIMENTS MITIGATION MEASURE-1A:* Conduct pre-project sampling of sediments from specific ponds, in accordance with the project Additional Sediment Sampling Analysis Plan (SAP).

See Appendix J and discussion under Sediments Impact-1, Section 5.3.3.

> *SEDIMENTS MITIGATION MEASURE-1B:* Conduct post-implementation monitoring in areas with elevated concentrations of inorganics to determine whether conditions are occurring that would increase contaminant mobility (e.g., methylation, acidification, or oxidation of sediments, or visual observation of increased drying or wetting/drying cycles).

See discussion under Sediments Impact-1, Section 5.3.3.

> *SEDIMENTS MITIGATION MEASURE 1C:* If post-implementation monitoring indicates the presence of conditions that would increase contaminant mobility, implement water management measures to mitigate these conditions.

See discussion under Sediments Impact-1, Section 5.3.3.

> *SEDIMENTS MITIGATION MEASURE 1D*: If post-implementation monitoring (Sediments Mitigation Measure 1B) during the Initial Release Period identifies elevated levels of inorganic impacts in discharge waters, potentially attributable to freshening effects, this impact may be mitigated in future releases by implementing additional water control measures designed to reduce freshening effects.

See discussion under Sediments Impact-1, Section 5.3.3.

Post-mitigation Significance: Less than significant