Chapter 5
Physical Environment

This chapter provides environmental analyses relative to physical parameters of the project area. Components of this study include a setting discussion, impact analysis criteria, project effects and significance, and applicable mitigation measures. This chapter is organized as follows:

- Section 5.1, “Water Supply, Hydrology, and Delta Water Management”;
- Section 5.2, “Water Quality”;
- Section 5.3, “Geology and Groundwater”;
- Section 5.4, “Flood Control and Levee Stability”;
- Section 5.5, “Sediment Transport”;
- Section 5.6, “Transportation and Navigation”;
- Section 5.7, “Air Quality”;
- Section 5.8, “Noise”; and
- Section 5.9; “Climate Change.”

Section 5.1
Water Supply, Hydrology, and Delta Water Management

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on water supply, hydrology, and Delta water management.

Delta water management for agriculture, water supply diversions, and exports and the salinity of water diverted for waterfowl habitat in the managed wetlands of the Marsh officially became linked in the 1978 State Water Board Delta Water Control Plan and the water right decision (D-1485) Suisun Marsh salinity standards (objectives). D-1485 required DWR and Reclamation to prepare a plan to protect the beneficial use of water for fish and wildlife and meet salinity standards for the Marsh. Initial facilities included improved RRDS facilities to supply approximately 5,000 acres on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands with lower salinity water from Montezuma Slough, and the MIDS and Goodyear Slough outfall to improve supply of lower salinity water for the southwestern Marsh. These initial facilities were constructed in 1979 and 1980; the required Suisun Marsh Plan of Protection was prepared and approved in 1984. This section describes the impacts of the SMP alternatives on water supply in Suisun Marsh. The impacts on hydrodynamics (water flows and tidal elevations) also are described in this section; water quality effects (i.e., salinity and contaminants) are described in the next section (Section 5.2).

SWP and CVP projects affect Suisun Marsh salinity by regulating Delta outflow through upstream reservoir storage and releases and Delta exports. D-1485 (since 1978) and the currently applicable D-1641 (since 1995) require DWR and Reclamation to meet various Delta outflow and salinity objectives in the Delta and in the Marsh. These objectives limit the allowable exports during some periods of relatively low Delta inflows. The State Water Board suggested in D-1485 that "Full protection of Suisun Marsh now could be accomplished only by requiring up to 2 million acre-feet (maf) of freshwater outflow in dry and critical years in addition to that required to meet other standards." This was strong motivation for DWR and Reclamation to prepare a plan of protection for Suisun Marsh that would use other facilities or management actions to provide appropriate salinity in the Marsh. The SMSCG on Montezuma Slough near Collinsville, which began operating in October 1988, were constructed by DWR and Reclamation to improve the salinity in the Marsh channels without requiring the additional Delta outflow that the State Water Board had anticipated.

Summary of Impacts

Table 5.1-1 summarizes impacts from implementing the SMP alternatives on water supply, hydrology, and Delta water management. There are no significant impacts on water supply or Delta water management from implementing the SMP alternatives.

Table 5.1-1. Summary of Water Supply, Hydrology, and Delta Water Management Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
WTR-1: Reduction in Water Availability for Riparian Water Diversions to Managed Wetlands Upstream or Downstream of Restoration Areas	A, B, C	Less than significant	None required	–
WTR-2: Increased Tidal Velocities from Breaching of Managed Wetlands Levees	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
WTR-3: Improved Water Supply as a Result of Improved Flooding and Draining of Managed Wetlands	A, B, C	Beneficial	–	–
WTR-4: Increased Tidal Flows and Improved Water Supply as a Result of Dredging	A, B, C	Beneficial	–	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section to describe the conceptual linkage between Marsh management alternatives and Delta water management:

- *Comprehensive Review of Suisun Marsh Monitoring Data 1985–1995* (California Department of Water Resources 2001).
- *Suisun Marsh Ecological Workgroup Final Report* (California Department of Water Resources 2001).

- *Conceptual Model for Managed Wetlands in Suisun Marsh* (California Department of Fish and Game 2007).
- RMA modeling of the Marsh and tidal restoration alternatives (Appendix A, "Numerical Modeling in Support of Suisun Marsh PEIR/EIS Technical Memorandum, March 2008").
- *Draft Suisun Marsh Tidal Marsh and Aquatic Habitats Conceptual Model* (Conceptual Model 2010).
- *Design Guidelines for Tidal Wetland Restoration in San Francisco Bay* (PWA and Phyllis Faber 2004).

Regulatory Setting

Tidal hydraulic conditions and potential impacts are of concern to several federal and state agencies. Actual regulations, however, are limited and indirect.

Several federal agencies such as National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), and the Corps participate in the monitoring and analysis of tidal conditions in the San Francisco Estuary. FEMA regulates (i.e., evaluates) the 100-year flood frequency tidal elevation, which is determined to be about 7 feet above mean sea level (msl) (National Geodetic Vertical Datum [NGVD] 1929 datum) or 10 feet NAVD 1988 datum.

Several state agencies such as the State Water Board, DWR, and DFG have interests, jurisdictions, and regulatory authority within the Marsh, as generally described in Chapter 1. No specific regulations, however, govern tidal elevations, tidal flows, or tidal velocities in the Marsh channels. Several local agencies such as Solano County have interests, jurisdictions, and regulatory authority within the Marsh. The following sections describe the regulations applicable to water supply and Delta water management, including tidal hydraulic processes.

Federal

Many federal regulations intended to protect sensitive species are in place that affect water supply operations in Suisun Marsh and throughout the Delta. In the Marsh, NMFS and USFWS have implemented some restrictions on the unscreened diversions for the protection of winter-run Chinook salmon and delta smelt, respectively. The winter-run restriction applies from November–January for unscreened diversions, and limits each diversion to 25% of each diversion's capacity. Diversions are also not allowed from February 21 to March 31 on diversions without fish screens. The delta smelt restriction applies in April and May when unscreened diversions are restricted to 20% or 35% of each diversion's capacity, depending upon the presence of delta smelt in the Marsh. These protective measures require more skillful water management to provide sufficient soil leaching, soil moisture, and water depth in ponded areas during the winter and spring months. In addition to the Suisun Marsh specific water supply restrictions, the 2008 USFWS and 2009 NMFS BOs for the Coordinated Operation of the CVP and SWP (Operations BOs) dictate some water supply operations in the Marsh (operation of the SMSCG).

State

The State Water Resource Control Board Water Right Decisions and Water Quality Control Plans (WQCPs or Basin Plans) provide the framework for water supply in the Delta and for salinity standards for the water applied to managed wetlands in the Marsh.

The 1978 Bay-Delta WQCP and D-1485 in 1978 introduced the initial salinity objectives in the Marsh to protect the beneficial uses of water for fish and wildlife in the Marsh. The State Water Board directed DWR and Reclamation to prepare a plan of protection for Suisun Marsh. This provision initiated the development of facilities and management assistance within the Marsh. The 1995 Bay-Delta WQCP (State Water Resources Control Board 1995) and D-1641 (State Water Resources Control Board 1999) generally renewed the salinity objectives and management guidelines to protect the beneficial uses of water for fish and wildlife in the Marsh.

State permits and authorizations from DFG intended to protect state listed species including longfin smelt, delta smelt and Chinook salmon, are in place that affect water supply operations in Suisun Marsh and throughout the Delta.

Local

The SRCD has the primary local responsibility for water management practices on privately owned lands within the primary management area of the Suisun Marsh and provides local jurisdiction for the assistance with the management of water diversions and drainage facility operations. The Marsh water rights are riparian or pre-1914; the general requirements for reasonable beneficial uses apply.

Existing Conditions

Tidal Hydraulics of Suisun Bay and Suisun Marsh

Rainfall and Watershed Runoff

The largest gaged creek inflows enter from Suisun Creek to Chadbourne Slough and Green Valley Creek to Cordelia Slough in the northwest Marsh. Runoff from these 30– and 50–square mile watersheds is usually of short duration (1–5 days) with peak daily flows of about 800 cubic feet per second (cfs) to 1,350 cfs for an inch of runoff. Base flow is on the order of 3–5 cfs. Ledgewood Creek flows into Peytonia Slough with a similar runoff assumed (no gage). The Fairfield and Suisun wastewater treatment plant discharges about 20 cfs into Boynton Slough and has a (new) second discharge location into Peytonia Slough just north of Cordelia Road. Development on the periphery of the Marsh also contributes to runoff. Rainfall generally is retained in the managed wetlands and reduces the salinity until discharged with the normal managed wetlands discharges.

Tidal Elevations

Figure 5.1-1 shows the measured tidal elevations for July 2002 at Martinez, located at the downstream end of Suisun Bay. The tides are semi-diurnal (two tide cycles each lunar day of 24.86 hours) with unequal tide elevations on most days.

Table 5.1-2 gives the tidal range for the Port Chicago NOAA tide gage located upstream of Martinez. Using the 1929 NGVD datum (msl), the average (mean) tide elevation (MTL) is about 1.1 feet msl. The 1929 NGVD datum is used for most USGS 1:24000 quad sheets and was the datum for the RMA Bay-Delta model used for analysis of tidal effects. The average high tide or mean high water (MHW) elevation is about 3 feet, and the average of the highest tide or mean higher high water (MHHW) each day is about 3.5 feet. The average of the low tide elevations or mean low water (MLW) is about –0.7 foot, and the average (mean) lower low tide elevation (MLLW) is about –1.5 feet. The average tidal range therefore is defined as the difference between MHW and MLW, which is about 3.7 feet. But as Figure 5.1-1 indicates, the tidal range during a day can be higher or lower, depending on the 14.8-day cycle of spring (highest tidal range) and neap (lowest tidal range) tides. Spring tides can vary by 6 feet, from –1.5 feet to 4.5 feet msl.

Table 5.1-2. Tidal Elevation Statistics in Suisun Bay (Port Chicago NOAA Tidal Gage)

Tidal Elevation	1929 NGVD Datum	MLLW Datum	1988 NAVD Datum
Mean Higher High Water	3.45	4.91	6.13
Mean High Water Elevation	2.95	4.41	5.63
Mean Tide Elevation	1.12	2.58	3.8
Average Low Tide Elevation	-0.72	0.74	1.96
Average Lower Low Tide Elevation	-1.46	0.0	1.22

Figure 5.1-2 shows the measured monthly range of tidal elevations at Martinez for water years 1976–1991. The minimum tide elevation within each month varies somewhat from about –2.5 feet to about –2.0 feet msl. The 10% tidal

elevation (exposed to air for 10% of the month) varies from about –1.5 feet to –1.0 foot msl. The 30% tidal elevation (exposed 30% of the month) varies from about 0.0 feet to 0.5 foot msl. The 50% tidal elevation (median, exposed 50% of the month) varies from about 0.75 foot to 1.25 feet msl. The 70% tidal elevation (exposed 70% of the month) varies from about 1.75 feet to 2.25 feet msl. The 90% tidal elevation (exposed 90% of the month) varies from about 2.75 feet to 3.25 feet msl. The maximum monthly tidal elevation varies from about 4 feet to 5 feet msl. The MHW and MHHW correspond to the lower and upper range of the 90% monthly tidal elevation. The MLW and MLLW correspond to the upper and lower range of the 10% monthly tidal elevation. MTL corresponds to the 50% (median) tidal elevation.

Tidal Volumes

The ocean tides provide the water movement and water exchange within the Marsh. Water flows into the Marsh channels during flood (rising elevation) tides and fills the Marsh to the high tide elevation. Water flows out of the Marsh channels during ebb tides (declining elevation), draining the Marsh to the low tide elevation. Each channel will convey the water needed to fill or drain the upstream tidal volume, sometimes called the tidal prism. This is the volume between the MHW and the MLW elevations. If the Marsh had vertical walls, this volume would be the upstream surface area times the average tidal range of 3.7 feet (MHW – MLW). The highest tide each day has a larger tidal prism, defined as the difference in volume between MHHW and MLLW, a tidal range of almost 5 feet. The tidal prism upstream of a station can be measured with a tidal flow gage or simulated with a tidal hydraulic model.

Table 5.1-3 gives the surface area for tidal channels and tidal wetlands within the existing Marsh, estimated from the RMA tidal hydraulic model, which is based on existing bathymetric survey data. The area and volume estimates from the DWR tidal model of the Delta (DSM2) are given for comparison; the RMA model has a more detailed bathymetry for the Marsh channels. The volume of the Marsh channels and sloughs below MLLW (i.e., subtidal) is about 36,000 acre-feet (af). The volume of Marsh channels and tidal wetlands at MHHW is about 58,000 af. The intertidal volume is therefore about 22,000 af. The existing intertidal volume of the Marsh is about 40% of the total volume at MHHW, and the existing subtidal Marsh volume is about 60% of the total volume at MHHW. Most of the subtidal volume is in Montezuma Slough, Suisun Slough, and a few other large tidal sloughs. The average tidal volume (tidal prism) between MHW (55,500 af) and MLW (38,000 af) is about 17,500 af. The tidal exchange is therefore a large fraction (30%) of the Marsh MHHW water volume.

The surface area of the Marsh open to tidal action is about 3,700 acres at MLLW (elevation –1.4 feet msl) and about 5,800 acres at MHHW (elevation 3.4 feet msl). The intertidal area within the Marsh is about 2,100 acres. Because the area is 3,700 acres with a volume of 36,000 af at MLLW, the average depth of these subtidal channels and sloughs is about 10 feet. Zone 1 and Zone 4 are representative areas of managed wetlands that might be converted to tidal

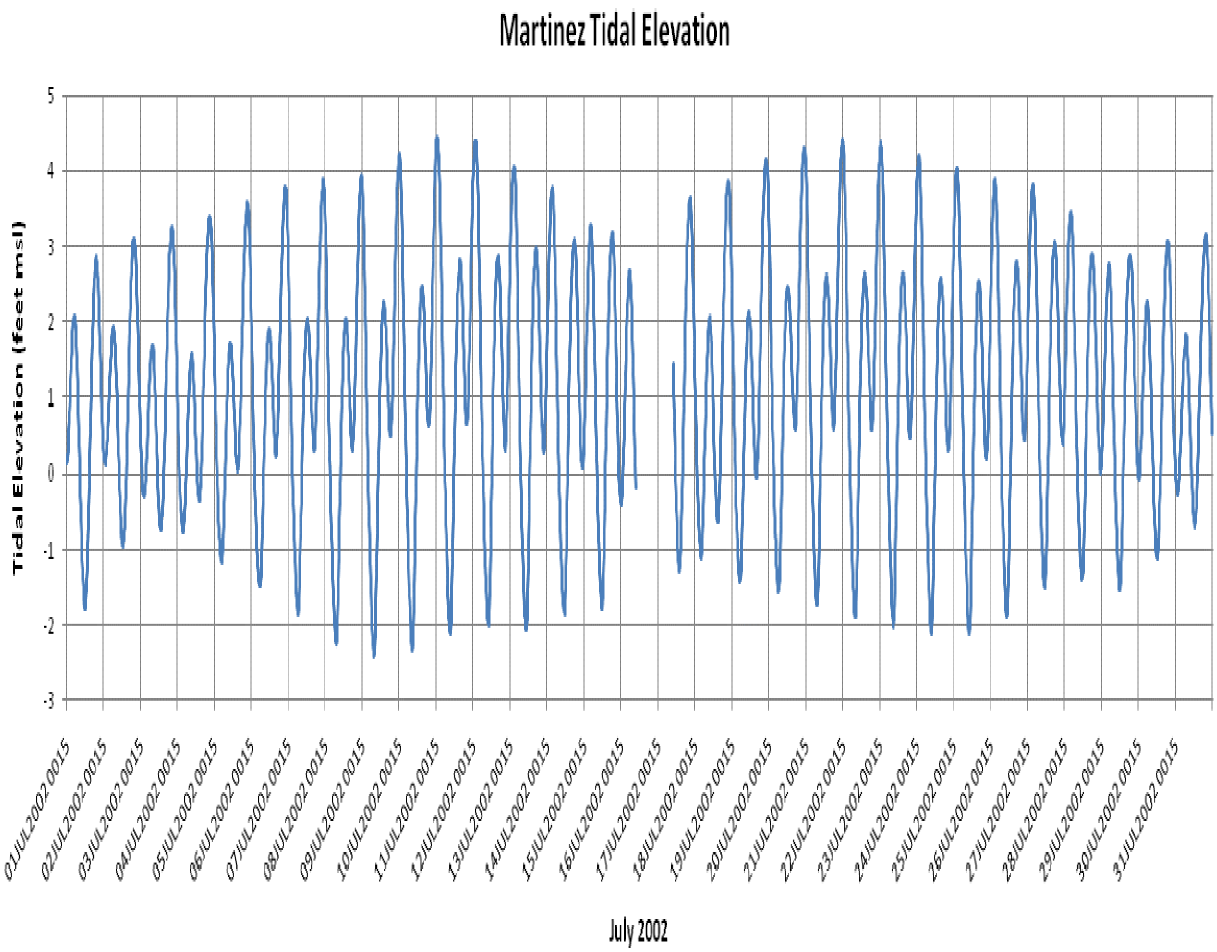

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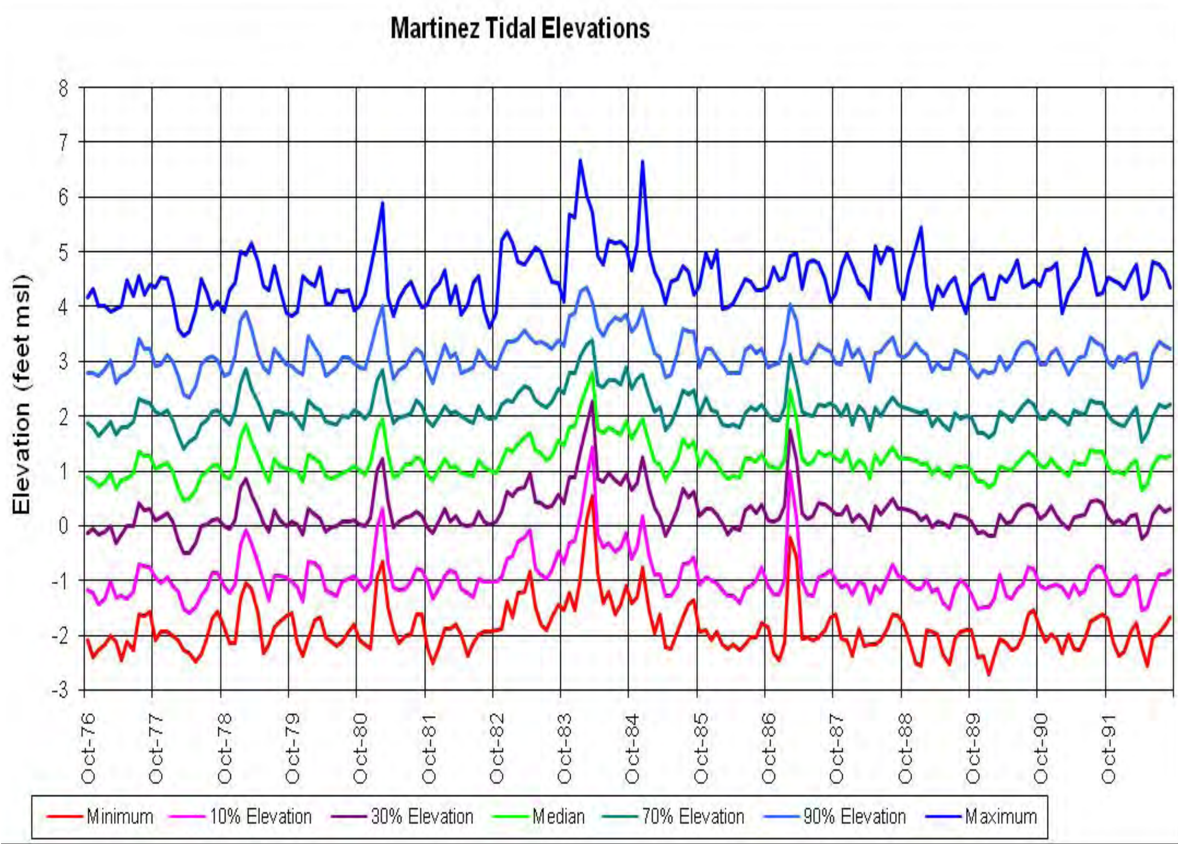
Figure 5.1-1
Measured Tidal Elevations at Martinez in July of 2002



Note: Highest tides correspond to major outflow periods in 1983 and 1984.

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Figure 5.1-2
Measured Monthly Distribution of Tidal Elevations at Martinez for Water Years 1976–1991

wetlands, as described in the Assessment Methods section and in Appendix A. The Zone 1 and Zone 4 areas and volumes are shown here to demonstrate that the intertidal and subtidal distribution of tidal marsh would be similar to the existing area and volume distribution of tidal channels within the Marsh.

Table 5.1-3. Summary of Suisun Marsh Tidal Geometry

Elevation (feet msl)	Tidal Range	Baseline Area (acre)	Baseline Volume (acre-feet)	DSM2 Area (acre)	DSM2 Volume (acre-feet)	Zone 1 Area (acre)	Zone 1 Volume (acre-feet)	Zone 4 Area (acre)	Zone 4 Volume (acre-feet)
5		7,326	68,485	3,804	54,128	1,949	14,502	3,302	27,174
4		6,531	61,481			1,951	12,553	3,310	23,869
3.4	MHHW	5,793	57,787			1,966	11,378	3,319	21,880
3	MHW	5,350	55,560	3,708	46,615	1,976	10,589	3,325	20,551
2		4,682	50,607			1,985	8,610	3,337	17,220
1	MTL	4,378	46,085			1,989	6,626	3,339	13,881
0		4,094	41,829	3,513	35,751	1,991	4,638	3,340	10,542
-1	MLW	3,797	37,870			1,540	2,939	3,105	7,265
-1.4	MLLW	3,700	36,367			1,328	2,350	2,988	6,054
-2		3,455	34,210	3,288	28,946	835	1,601	2,598	4,302
-3		2,909	30,975			383	880	1,402	2,133
-4		2,618	28,202			146	568	477	1,022
-5		2,405	25,678	2,364	20,199	114	455	138	624

Tidal Channels

Tidal channels perform two fundamental functions in the Marsh plain. First, tidal channels are the conduits through which water, sediment, nutrients, and aquatic organisms circulate into, around, and out of the Marsh. This transport function directly controls most of the physical conditions in a tidal marsh to which plants and wildlife are subject. Channels also provide habitat for a wide variety of fish and wildlife species. Vegetation along the channels provides edge habitat for birds and other wildlife species. Channels may provide shallow-water habitat for dabbling and diving ducks and other waterfowl. Channels provide forage and rearing habitat and movement corridors for a wide variety of fish species. Most tidal channels in Suisun Marsh are bordered by levees that protect managed wetlands. These levees are often a mix of dredged sediment and artificial materials such as riprap and often have fringing vegetation. Channel sediments are primarily mud (silt- and clay-size particles).

Montezuma Slough is the major tidal channel within the Marsh. The length of Montezuma Slough is about 32 km from the mouth at Suisun Bay (western end) to the head near Collinsville (western end). The major tributary channel to Montezuma Slough is Nurse Slough. Nurse Slough joins Montezuma Slough near the middle and extends about 5 km north along the east edge of Potrero Hills. Little Honker Bay is located on Nurse Slough adjacent to the Blacklock tidal wetlands, north of Kirby Hills. Denverton Slough extends north from Little Honker Bay.

Suisun Slough is the second major tidal channel within the Marsh. It has a length of about 21 km from the mouth at Suisun Bay (southern end) to Suisun City (northern end). Cordelia Slough joins Suisun Slough from the west, about 3 km upstream from the mouth of Suisun Slough. Cordelia Slough extends about 12 km along the northwest edge of the Marsh. Cordelia Slough crosses under the Southern Pacific Railroad and connects with Chadbourne Slough and several other small channels. Goodyear Slough joins Cordelia Slough near its mouth.

Hunter Cut connects Montezuma Slough and Suisun Slough about 7.5 km north of the mouth of Suisun Slough. Several small tidal sloughs branch from Suisun Slough. Wells Slough connects with Chadbourne Slough. Cutoff Slough connects Suisun Slough and Montezuma Slough about 15 km upstream from the mouth of Suisun Slough. Sheldrake Slough joins Suisun Slough from the west. Boynton Slough joins Suisun Slough from the west, and receives the freshwater discharge (of about 20 cfs) from the Fairfield–Suisun City wastewater treatment plant. Hill Slough joins Suisun Slough from the east and extends to the north of Potrero Hills. Peytonia Slough joins Suisun Slough just south of Suisun City.

Several other channels (historical tidal sloughs) have been isolated from tidal influence by the levees around the managed wetlands. The largest of these are Roaring River, Grizzly Slough, Frost Slough, Island Slough, and upper Tree Slough, which once were connected to Montezuma Slough, and Volanti Slough, which once connected with Suisun Slough.

Tidal Wetlands

Most of the historical tidal wetlands in the Marsh were separated from tidal flows with levees and converted (i.e., drained) for agricultural use. Later, these areas were converted to managed wetlands for waterfowl hunting and are regularly flooded in the late fall and early winter. Several of the major areas still open to tidal flows in the Marsh are ecological preserves. A total of 7,672 acres of tidal wetlands remains. Rush Ranch tidal wetlands are located north of Cutoff Slough. Hill Slough tidal wetlands are near the northern end of Suisun Slough, flowing to the north of Potrero Hills. Peytonia Slough Ecological Reserve is located at the northern end of Suisun Slough. Blacklock is a recently (2006) restored 70-acre tidal wetlands on Nurse Slough (little Honker Bay). Figure 5.1-3 shows the locations of these major existing tidal wetlands within the Marsh.

There are tidal wetlands along the Marsh sloughs and channels called fringe wetlands. These fringe wetlands are located along the levee bank or berm adjacent to the levee. The wetland usually extends about 5–10 feet from the levee, representing just an acre per mile. The total area of these intertidal bands

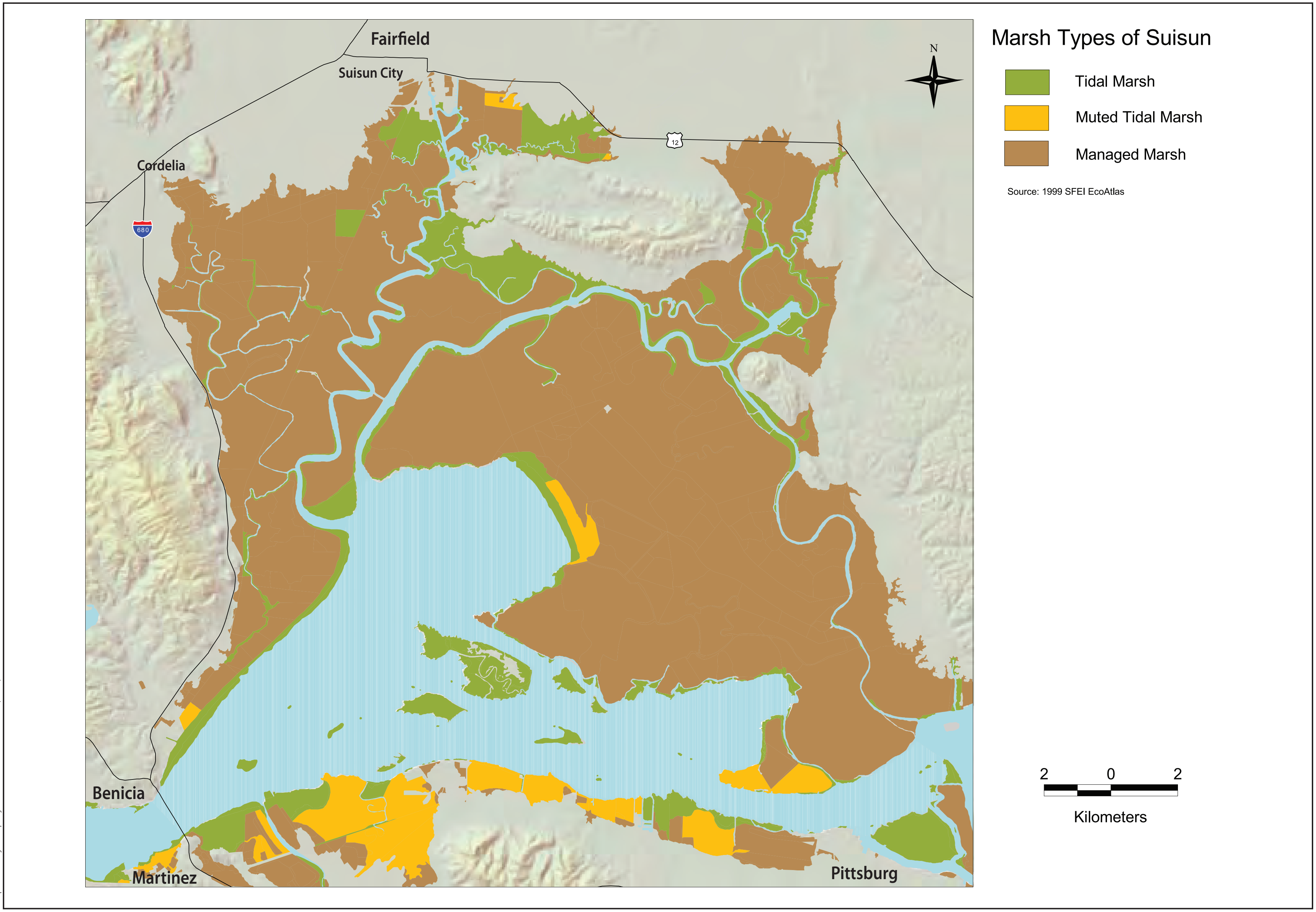

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Figure 5.1-3
Marsh Types in Suisun Marsh

along the channel banks is estimated to be 1,500 acres, which is the majority of the existing intertidal area in the Marsh.

Tidal marsh vegetation may be restricted to particular tidal inundation bands. For example, channels with bottom elevations below the MLLW are almost always inundated. This portion of the tidal marsh channels is called subtidal or shallow-water habitat. Bulrushes, cattails, tules, and other emergent vegetation can grow in the subtidal zone with elevations of less than –1.5 feet msl (MLLW). Some emergent vegetation can grow in the shallow habitat below MLLW, but most emergent vegetation is located above MLLW.

In the San Francisco Bay area, intertidal marsh vegetation is generally confined to above MTL, with mud-flats below this elevation. Low marsh in San Francisco Bay generally is defined as elevations of 1 foot msl to 3 feet msl (MTL to MHW). Dominant low marsh vegetation in Suisun Marsh includes bulrushes, tules, and cattails. The middle marsh is defined as a narrow band between elevation 3.0 feet and 3.5 feet (MHW to MHHW). This zone typically is dominated by saltgrass and pickleweed. The high marsh is defined as 3.5 to 5 feet msl (MHHW to spring-tide high water).

Managed Wetlands

About 52,112 acres in the Marsh are diked with low levees and managed as waterfowl habitat, but most are privately owned waterfowl hunting clubs. These managed wetlands are separated from the tidal sloughs by exterior levees, and water exchange is controlled by gated culverts. Waterfowl club managers control the timing and duration of flooding to promote growth of waterfowl food plants within the confines of existing regulatory constraints. Water levels are manipulated to optimize wetland plant diversity while preventing salt accumulation in the managed wetland soils. This is achieved by using the existing managed wetland topographical variation and contouring and ditching low areas to ensure adequate drainage to avoid trapping water in sinks and elevating salinities as a result of evaporation of remaining water.

Flooding and draining of these managed wetlands depends on the tidal elevation and location in the Marsh. Water is flooded onto the managed wetlands during periods of high tide when the channel elevation is higher than the flooded elevation. The managed wetlands cannot be flooded higher than MHHW unless a pump is used. Drainage without a pump cannot lower the water elevation below MLLW. Therefore, the land elevations of most of the managed wetlands are intertidal. Some of the lands are below MLLW and must be drained with ditches and pumps. Some subtidal areas in the managed wetlands that cannot be drained are managed as permanent ponds, with circulation, which provides habitat for resident and migratory waterfowl and wildlife.

Tidal Flows in Suisun Marsh

Tidal flow propagates into Suisun Marsh through western Grizzly Bay and creates large tidal exchanges at the mouth of Montezuma Slough (peak flow of about 50,000 cfs) and Suisun Slough (peak flow of about 15,000 cfs). The tides in the eastern Marsh are significantly less energetic, and peak tidal flows in the eastern end of Montezuma Slough are about 10,000 cfs. Tidal exchange occurs from both ends of Montezuma Slough, although the tidal flows are smaller (averaging about 5,000 cfs) at the upstream end (head) near Collinsville.

Tidal Flows in Suisun Slough

The mouth of Suisun Slough is the most downstream (western) channel in the Marsh. Suisun Slough supplies tidal flows to Cordelia Slough, Goodyear Slough, Wells-Chadbourne Slough, Cutoff Slough, Boynton Slough, Peytonia Slough, and Hill Slough.

Figure 5.1-4 shows the simulated tidal stage and tidal flow at the mouth of Suisun Slough (Godfather gage) and above Hunter Cut for July 2002. The tidal elevation in Suisun Slough is nearly identical to the tidal elevation at Martinez. The tidal elevation has a slight gradient in Suisun Slough, with a positive (downstream) elevation difference of about 0.5–1.0 foot during ebb tide, and a negative (upstream) elevation difference of about 0.5–1.0 foot during flood tide. At slack tide the water elevations are about equal throughout the Marsh channels. Figure 5.1-4 also shows the simulated tidal flows at the mouth of Suisun Slough for July 2002. Tidal flows are greatest at the beginning of ebb tide, when water begins to drain from the largest water surface area. The ebb-tide (i.e., downstream) flow decreases as the tidal elevation declines. Ebb tide flows are greatest during spring-tide periods when the higher high tide is followed by the lower low tide. The flood-tide (i.e., upstream) flows are more uniform throughout the month.

These tidal elevation changes and corresponding tidal flows can be summarized by calculating the cumulative tidal volumes during each ebb or flood tide. Figure 5.1-5 shows the simulated tidal volumes in Suisun Slough for July 2002. The tidal exchange occurs about twice each day as the tidal elevations rise and fall twice each day. The flood-tide volumes are fairly uniform, while the ebb tide volumes are more variable, ranging from less than 2,000 af to more than 5,000 af during the month. The average tidal volume at the mouth of Suisun Slough is about 3,000 af during each flood and ebb tide. Because a considerable tidal flow moves up Montezuma Slough to Hunter Cut and across to Suisun Slough, the tidal volume in Suisun Slough above Hunter Cut is greater than at the mouth of Suisun Slough. The tidal volume above Hunter Cut averages about 4,000 af during each ebb and flood tide.

Figure 5.1-5 also shows the tidal volumes for the mouth of Cordelia Slough, located about 1.5 miles upstream from the mouth of Suisun Slough and for the mouth of Hill Slough, located about 13.5 miles upstream from the mouth of Suisun Slough. The average tidal volume for Cordelia Slough is about 1,000 af. This includes tidal exchange into Goodyear Slough and portions of Chadbourne

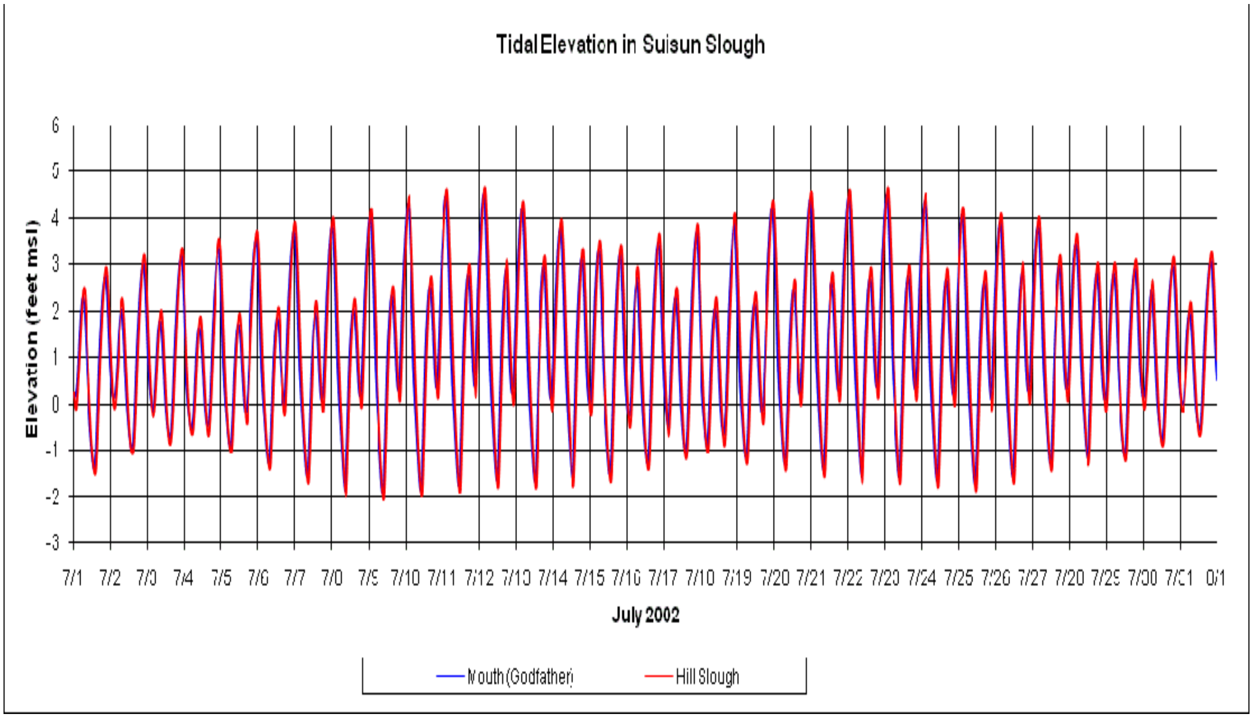

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Figure 5.1-4
Tidal Elevations and Tidal Flows in Suisun Slough for July 2002

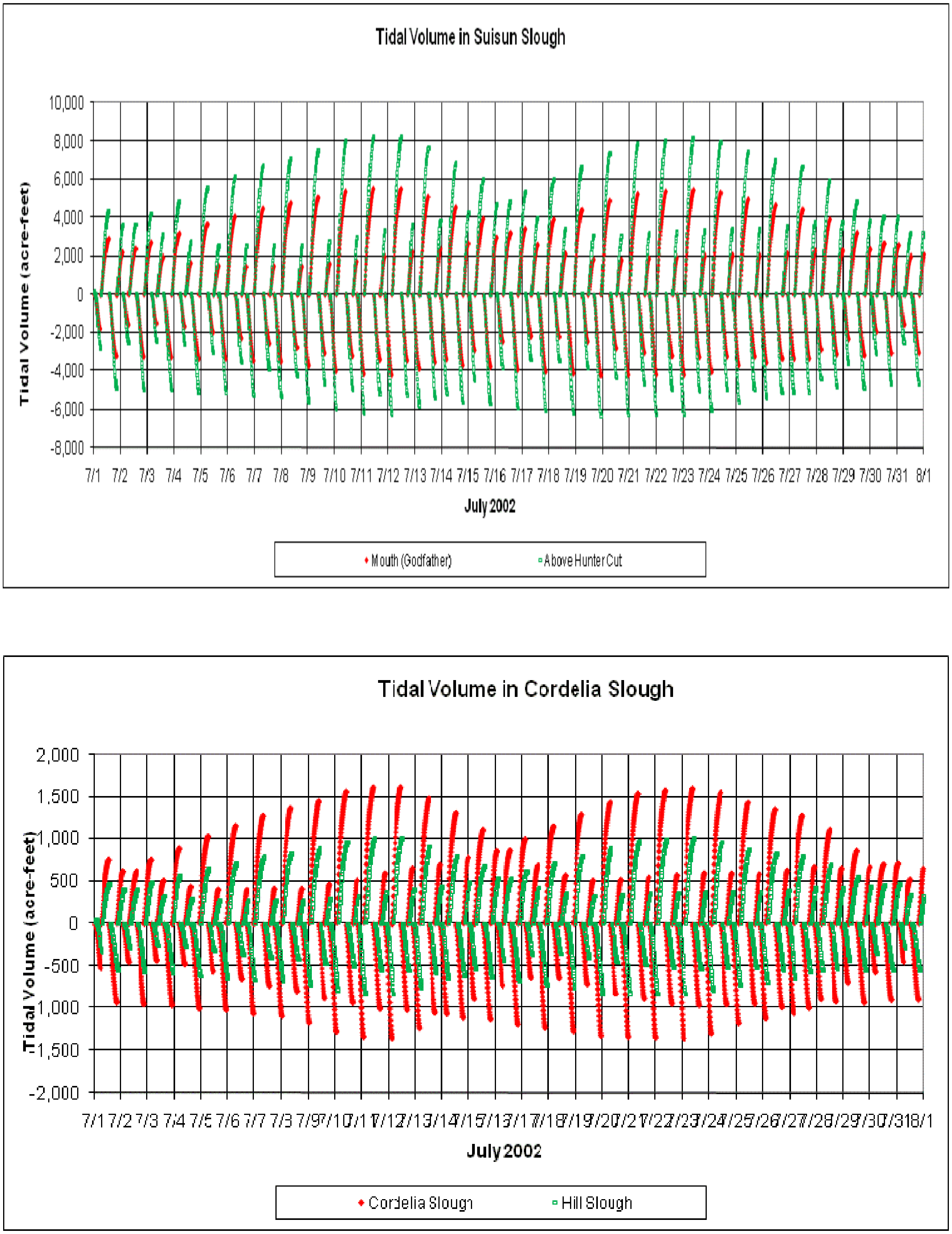

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Figure 5.1-5
Simulated Tidal Volumes in Suisun Slough and Tributary Sloughs in July 2002

Slough on the northeast side of the Southern Pacific Railroad. The average tidal volume at the mouth of Hill Slough is about 500 af.

Other tributary channels to Suisun Slough have similar tidal volumes corresponding to the upstream intertidal area and volume. Some of these tributary sloughs include tidal wetlands, but most of these tidal flows fill and drain the tidal slough channels and the fringe wetlands located along the margins of these tidal channels. Table 5.1-3 provides a summary of the subtidal and intertidal area and volume in each of these Suisun Slough tributaries. The average tidal volume is also given for reference.

Tidal Flows in Montezuma Slough

The downstream end of Montezuma Slough is just upstream (east) of the mouth of Suisun Slough. Almost all of the tidal exchange into Suisun Marsh comes from this northern end of Suisun Bay (Grizzly Bay). A small amount of tidal exchange enters the upstream end of Montezuma Slough. The tidal exchange at the upstream end of Montezuma Slough near Collinsville is nearly balanced without much net flow downstream in Montezuma Slough. For July 2002 conditions, the simulated net flow was –56 cfs (upstream toward Collinsville).

Figure 5.1-6 shows the simulated tidal elevation and tidal flows at the head of Montezuma Slough and upstream of Hunter Cut in Montezuma Slough. The simulated peak ebb tidal flows in Montezuma Slough upstream of Hunter Cut ranged from less than 30,000 cfs during neap tide to more than 45,000 cfs during spring tides. The simulated peak flood tidal flows upstream of Hunter Cut ranged from about 20,000 cfs to 30,000 cfs. The simulated tidal flows at the upstream end of Montezuma Slough (head) were about 7,500 cfs to 10,000 cfs. Careful examination of Figure 5.1-6b indicates that the tidal flow at the head of Montezuma begins entering the Marsh from the Sacramento River as high tide approaches (because of the net Delta outflow). This tidal flow into the Marsh continues for the first half of ebb tide, but then the flow direction reverses and water moves upstream (east) toward Collinsville in the second half of the ebb tide. This suggests that the two ends of Montezuma Slough act as separate tidal sloughs, with a null-zone (i.e., no net flow) located somewhere upstream of Nurse Slough (near Meins Landing).

Figure 5.1-7 shows the simulated tidal volumes at the two ends of Montezuma Slough. Because a major portion of the Montezuma Slough flow connects with Suisun Marsh through Hunter Cut, the tidal volumes upstream of Hunter Cut are also shown in Figure 5.1-7. The average tidal volume at the mouth of Montezuma Slough is about 11,000 af. The average tidal volume above Hunter Cut is about 7,500 af. The average tidal volume in Hunter Cut is about 3,500 af. The average tidal flow at the head of Montezuma Slough near Collinsville is about 2,300 af.

Figure 5.1-7 also shows the simulated tidal volumes in Montezuma Slough at Belden's Landing and in Nurse Slough, which is the major tributary to Montezuma Slough. The average tidal volume in Nurse Slough is about 2,500 af. The average tidal volume at Belden's Landing is about 5,700 af. Because the flows at Belden's Landing and at the head of Montezuma Slough are in the same direction, the majority of the Nurse Slough tidal volume enters from downstream in Montezuma Slough.

In summary, the simulated tidal flows entering the Marsh channels during each flood tide and leaving the Marsh channels during each ebb tide are a total of about 16,500 af. This is very close to the average tidal volume of 17,500 af estimated from the tidal marsh geometry. This difference is largely attributable to the tidal flow locations being slightly upstream from the mouth of Suisun Slough and Montezuma Slough. As already described, the subtidal volume of 38,000 af (MLW) is about twice the intertidal exchange volume. About one-third of the maximum Marsh volume is replaced during each tidal cycle.

Montezuma Slough Salinity Control Gate Operations

The SMSCG were constructed in 1987 and began operating in 1988 to reduce salinity in the Marsh channels during the salinity control season of October through May, when D-1485 objectives were specified. The relatively complex tidal flows in and out of the head of Montezuma Slough near Collinsville require that the gates be operated in real-time with monitoring of the tidal elevations and flows. Operation of the gates generally involves closing the gates whenever tidal flows would be upstream from Montezuma Slough to the Sacramento River. The gates remain open when tidal flows move into Montezuma Slough to provide the maximum inflow of fresh water to Montezuma Slough. Operations are regulated by the Operations BOs.

The summary of simulated tidal volume at the head of Montezuma Slough can be used to describe the basic SMSCG operations on tidal flows. The average tidal volume for both ebb and flood tides is about 2,300 af during each tidal period (two each day). Therefore, by blocking the upstream tidal volume, a net inflow of about 4,600 af/day of low salinity Sacramento River water will be "pumped" into the upper end of Montezuma Slough. However, the tidal range in Montezuma and Nurse Sloughs will remain about the same, so the flood tide volume entering from the mouth of Montezuma Slough (estimated as 11,000 af) will remain the same, but the ebb tide volume will be increased to 13,200 af). Gate operations will create a net downstream flow in Montezuma Slough of about 2,300 af during each tidal cycle. Because this is about 20% of the flood tide volume entering from the mouth of Montezuma Slough, the salinity gradient within Montezuma Slough will be shifted downstream. The salinity effects of this tidal pumping produced by the SMSCG operations will be more fully described in Section 5.2, Water Quality.

Tidal Velocities in Suisun Marsh

Tidal velocities in the Marsh channels and sloughs are controlled by the tidal flows and the cross sections in the Marsh channels and sloughs. Figure 5.1-8 shows the simulated tidal velocities in several of the major sloughs for July 2002. The peak velocities are generally less than 2–3 feet per second (fps). The natural processes of scouring and deposition produce channel sections that are in equilibrium with these processes and the upstream tidal area (volume). Velocities of more than 3 fps are likely to scour mud and sand bottoms.

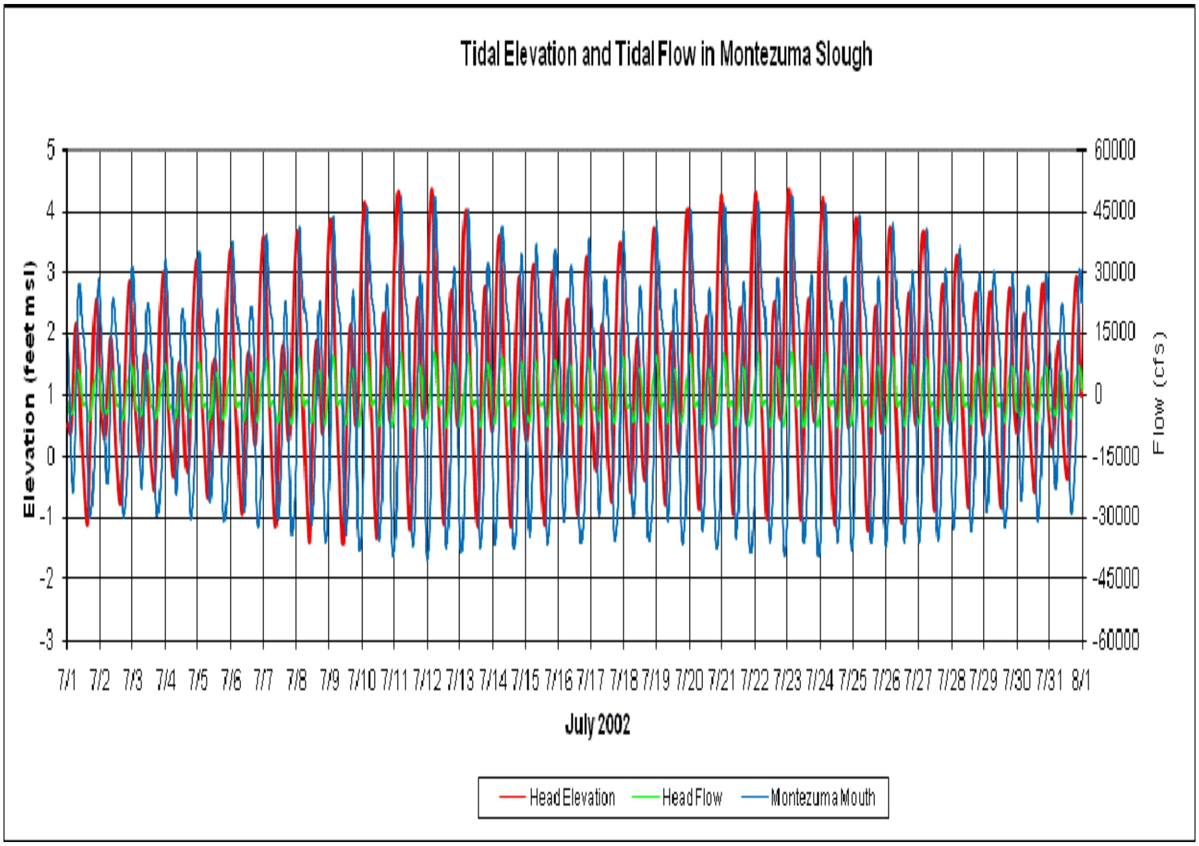


Figure 5.1-6a. Simulated Tidal Elevations and Tidal Flows at the Mouth and Head of Montezuma Slough for July 2002

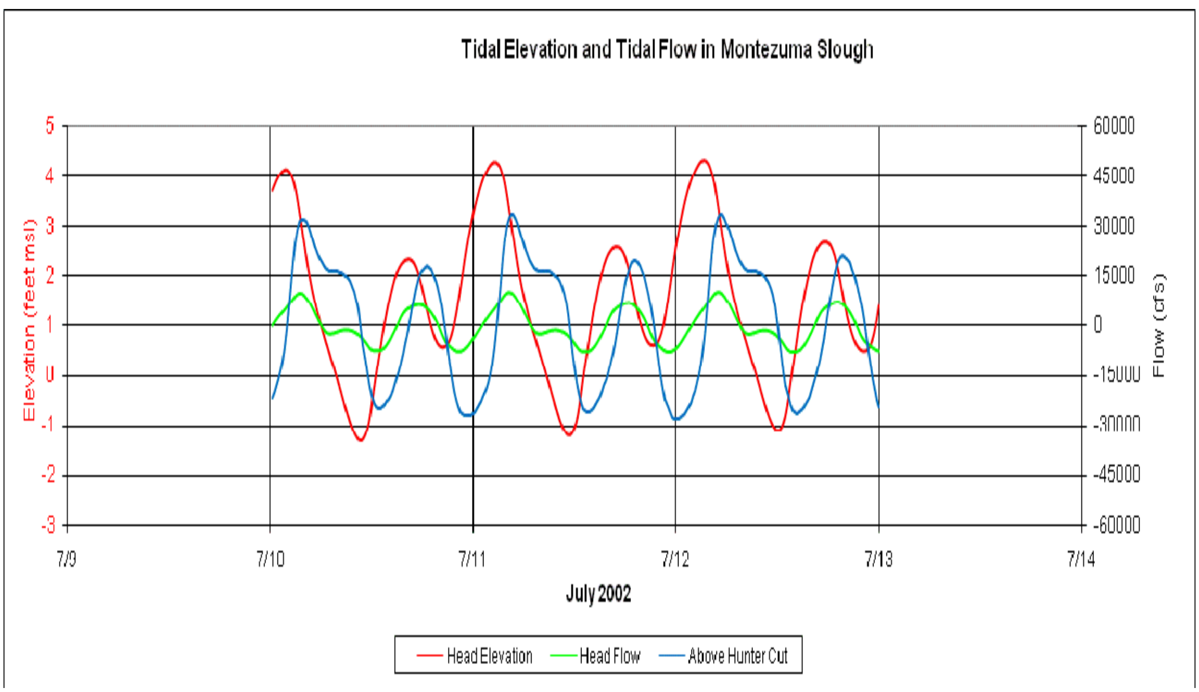
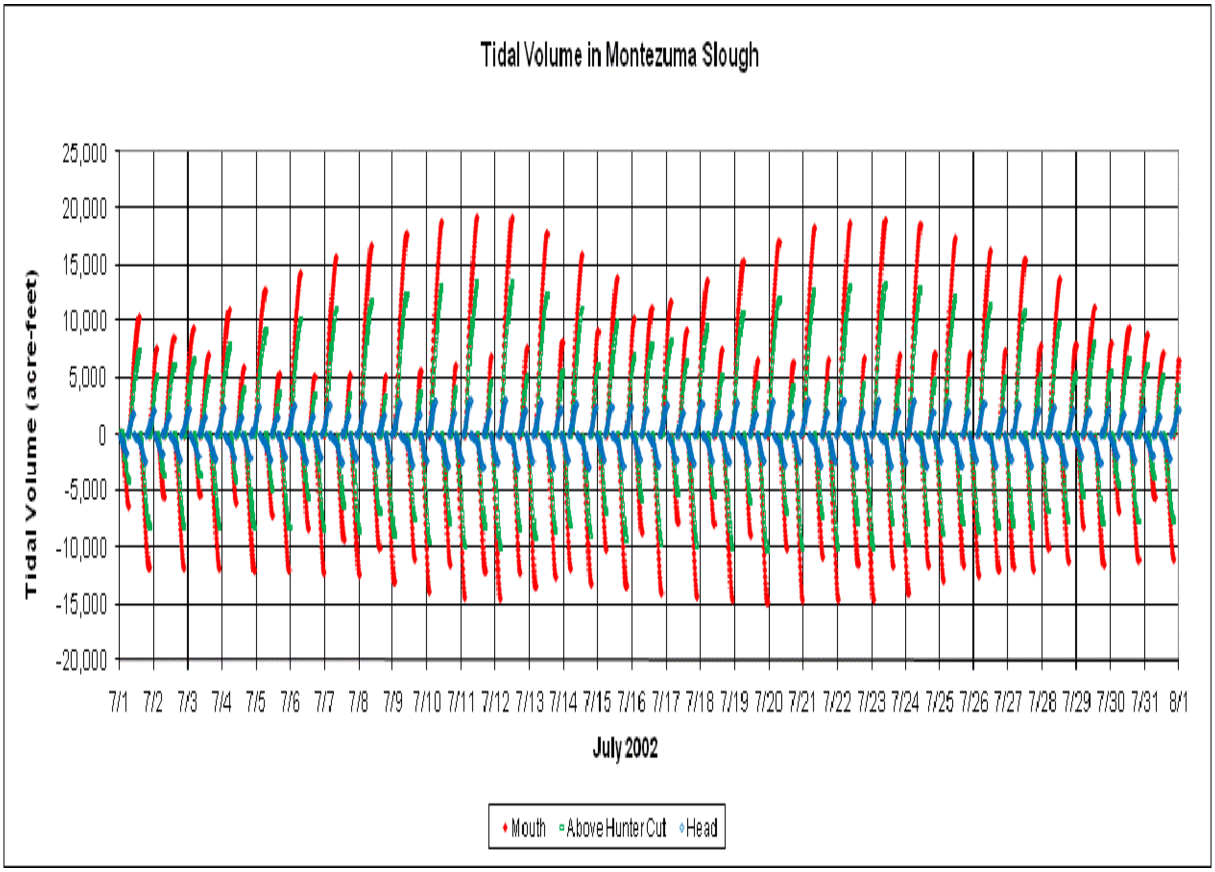


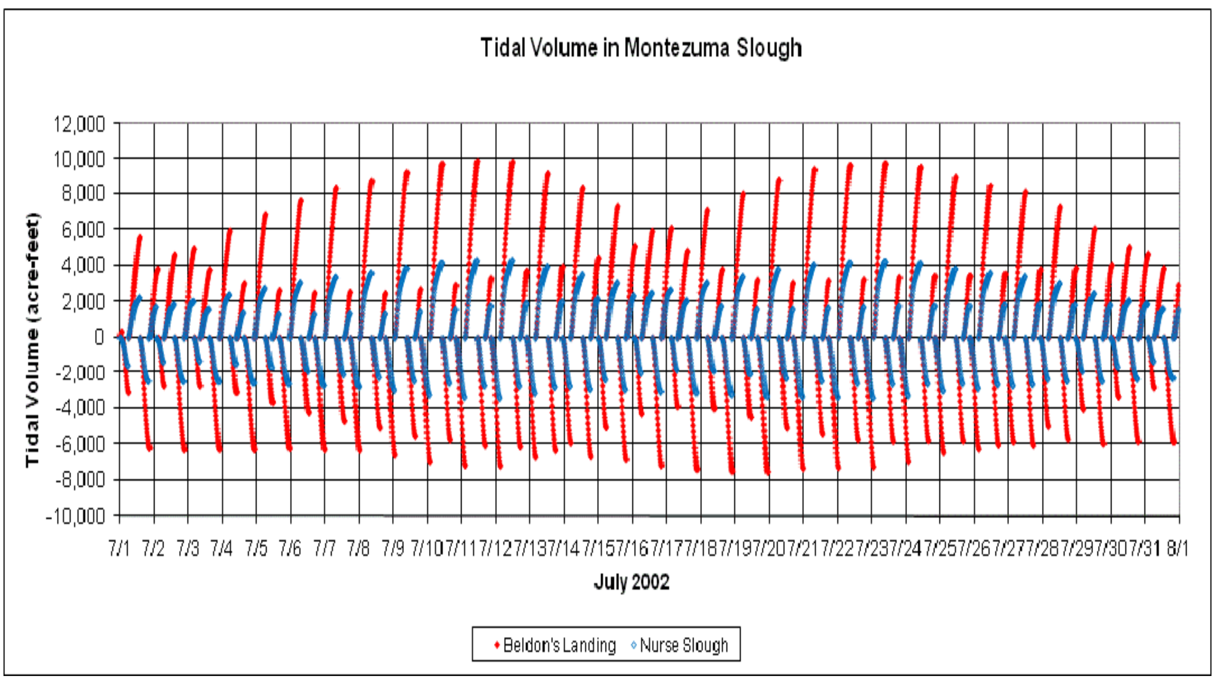
Figure 5.1-6b. Detail of Tidal Simulation for July 10–12, 2002

Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

ICF INTERNATIONAL

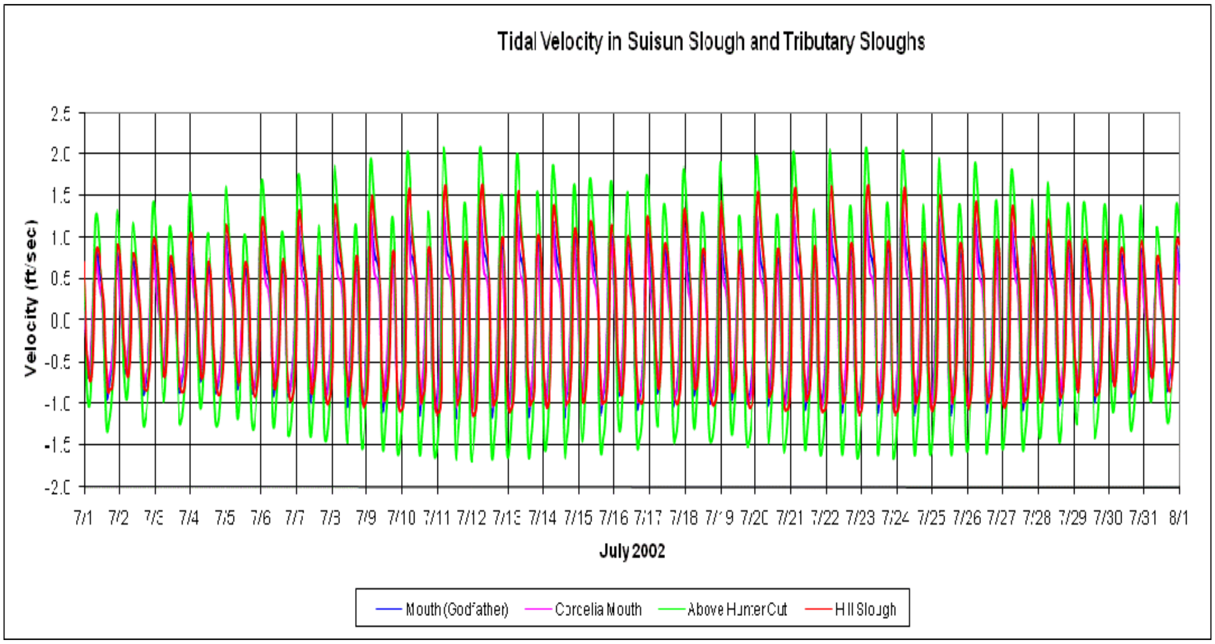
Figure 5.1-6

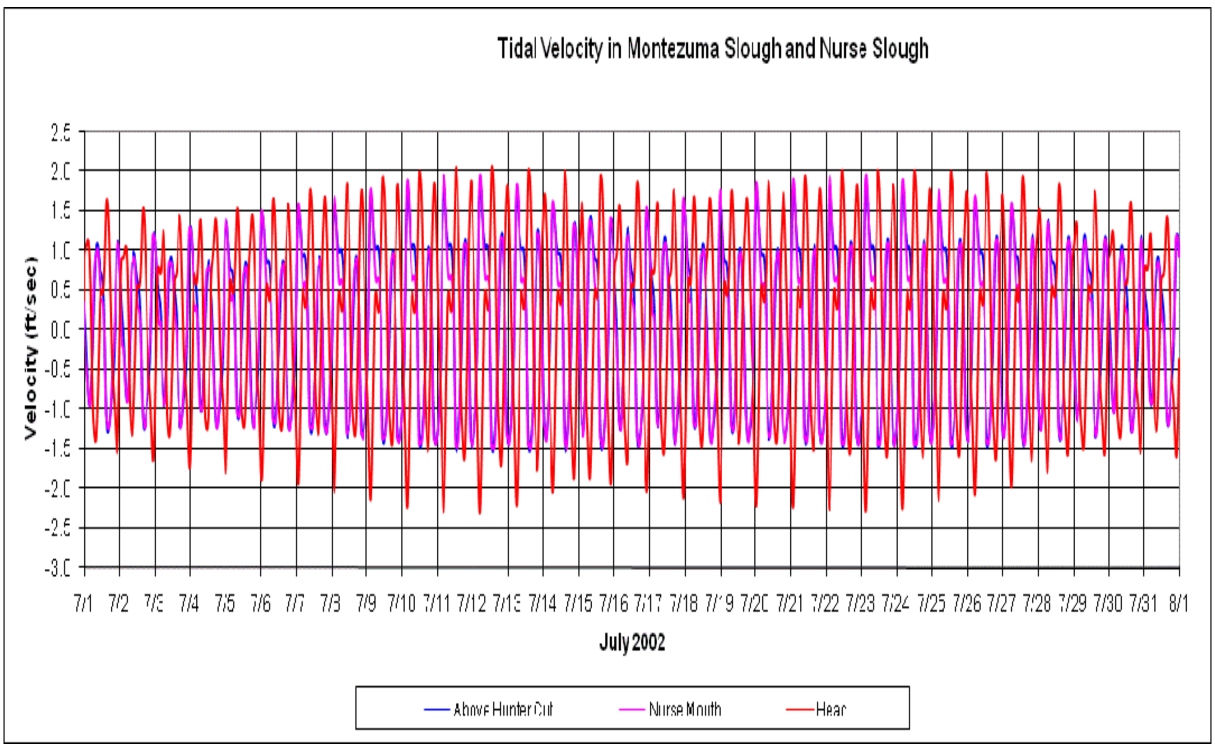




Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

Figure 5.1-7
Simulated Tidal Volumes in Montezuma Slough and Nurse Slough for July 2002





Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

Figure 5.1-8
Simulated Tidal Velocities in Marsh Channels (Sloughs) for July 2002

Cohesive clay sediment may be less susceptible to scour. Velocities in some connecting channels, such as Hunters Cut, may be higher because of the tidal elevations differences between the channels. Higher velocities also may be expected in levee breaches and main channels of restored tidal wetlands.

Water Supply in Suisun Marsh and Delta

Recent Historical Delta Outflow

Table 5.1-4 gives the monthly historical Delta outflow in 1968–2007. The last column gives the annual total water volume in thousands of acre-feet (taf). The table is arranged by water years because the flooding in the Marsh managed wetlands for waterfowl habitat begins in October. This period corresponds to the historical record when Marsh salinity and Delta water management have been considered linked. These historical Delta outflows were regulated by D-1485 outflow and salinity objectives in the Delta and in the Marsh from 1978 to 1994, and by D-1641 objectives that include similar salinity objectives in the Delta and in the Marsh, revised Delta outflow requirements for the location from the Golden Gate Bridge of the 2 parts per thousand (ppt) salinity gradient (X2), and new limits on the export/inflow ratio (E/I) from 1995 to 2007.

The historical Delta outflow is important for this environmental evaluation of potential impacts from implementing the plan because it controls Marsh salinity and the subsequent beneficial uses for fish and wildlife in the managed wetlands. Table 5.1-5 gives the general relationship between Delta outflow and salinity near the downstream (western) end of the Marsh (Fleet) and at the upstream (eastern) end of the Marsh (Collinsville). See Figure 1-6 for map of Marsh. Also shown is the relationship between Delta outflow and the X2 location. The range of regulated Delta outflow ranges from about 3,000 cfs to about 12,000 cfs. Over this range of outflow, the EC at Fleet varies from 25,000 microSiemens per centimeter (µS/cm) to about 11,000 µS/cm. The corresponding range of EC at Collinsville varies from about 12,000 µS/cm to about 1,500 µS/cm. The X2 location varies from about 91 km (near Emmaton) to 75 km (near Chipps Island or Mallard Slough). These outflow-EC relationships will be described more fully in Section 5.2, Water Quality.

Table 5.1-4. Historical Monthly Average Delta Outflow (cfs) for Water Years 1968–2007 (Source: DWR DAYFLOW database)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (taf)
1968	16,719	16,202	20,498	24,257	52,061	40,314	9,932	6,737	3,666	3,684	5,264	6,004	**12,348**
1969	5,453	11,120	25,682	123,140	159,046	93,506	69,375	64,564	46,596	13,143	12,458	20,188	**38,377**
1970	19,484	19,964	46,190	193,121	111,326	55,986	11,027	10,761	6,214	5,256	7,947	14,587	**30,094**
1971	13,423	26,117	85,369	64,190	34,196	32,049	36,972	26,406	21,218	11,654	12,988	19,660	**23,217**
1972	13,957	13,743	23,967	21,339	21,968	18,127	7,542	5,140	2,891	6,211	6,487	10,476	**9,181**
1973	11,935	25,944	27,133	101,686	102,165	76,907	22,191	11,699	7,212	4,599	5,963	11,153	**24,384**
1974	14,071	59,945	76,406	138,699	59,178	77,575	109,547	25,544	16,943	9,366	12,784	20,981	**37,423**
1975	18,529	23,991	28,018	17,489	57,330	66,834	34,519	28,796	22,508	11,129	9,523	13,419	**19,891**
1976	16,901	17,921	19,954	9,310	7,471	7,788	8,729	3,937	3,775	4,186	4,394	3,583	**6,541**
1977	3,611	3,643	4,213	4,363	4,878	3,007	2,977	3,909	2,383	3,049	2,383	2,717	**2,477**
1978	2,046	4,003	8,570	66,157	56,159	85,619	61,170	40,759	8,945	3,854	5,814	11,718	**21,313**
1979	9,600	10,928	8,780	30,522	46,341	38,087	14,485	13,435	5,316	5,264	3,357	4,972	**11,403**
1980	7,799	12,172	19,029	118,220	121,655	99,152	28,628	20,804	14,790	11,065	4,122	9,803	**28,117**
1981	7,321	6,662	12,487	18,325	21,171	26,483	11,648	9,143	4,596	5,306	3,148	4,696	**7,873**
1982	5,214	36,001	86,287	97,674	92,555	80,088	142,192	57,782	28,123	16,741	13,309	25,802	**40,910**
1983	22,975	39,152	88,908	89,762	175,756	266,623	118,100	98,659	70,929	43,759	24,484	31,442	**64,266**
1984	32,283	74,137	154,587	100,906	41,515	34,916	14,637	11,093	7,925	10,127	8,179	13,586	**30,600**
1985	11,899	25,953	31,066	15,120	15,590	10,410	6,846	7,291	5,113	4,835	2,248	3,175	**8,406**
1986	3,366	6,890	9,430	15,209	205,414	169,447	46,539	15,810	9,223	7,293	5,054	10,726	**29,647**
1987	10,608	7,732	8,986	10,818	16,859	22,916	6,212	4,845	3,382	3,724	2,772	1,737	**6,047**
1988	3,761	4,291	9,454	19,591	3,039	4,481	11,417	4,659	3,082	3,732	2,305	2,251	**4,377**
1989	3,142	6,619	7,231	3,604	6,379	38,928	11,687	7,379	6,156	6,163	4,469	6,446	**6,554**
1990	4,887	5,478	4,399	9,886	6,788	3,813	5,923	7,700	4,846	3,966	4,461	2,450	**3,895**
1991	3,405	4,495	6,383	3,973	7,361	24,579	3,701	3,862	4,002	3,318	2,558	3,761	**4,315**
1992	3,909	3,909	7,623	6,413	28,759	13,283	6,258	3,255	3,426	2,983	2,824	3,366	**5,141**
1993	4,350	4,126	11,603	57,886	55,022	63,969	44,296	25,188	27,078	9,450	9,422	5,306	**19,047**
1994	5,118	7,381	12,361	10,787	20,557	10,595	8,150	7,941	3,782	4,495	3,335	5,506	**5,978**

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	**Annual (taf)**
1995	3,217	5,356	9,629	107,487	72,836	200,645	90,837	98,047	46,754	26,789	10,876	19,629	**41,801**
1996	11,371	8,383	27,709	32,144	126,912	89,148	42,032	46,021	15,270	9,156	9,592	7,293	**25,486**
1997	4,742	10,035	84,538	262,325	118,694	33,699	14,142	12,257	8,199	9,286	8,639	3,914	**34,299**
1998	4,826	10,153	15,351	71,545	230,854	104,441	88,395	67,612	71,736	30,856	19,893	20,060	**43,487**
1999	12,280	20,636	47,241	38,021	98,804	69,106	35,509	22,138	13,664	10,463	5,930	4,784	**22,542**
2000	4,258	6,803	10,467	21,541	94,092	87,828	27,233	22,057	8,823	9,123	6,024	4,622	**18,156**
2001	5,724	4,742	5,996	15,211	19,567	23,404	12,158	9,612	7,404	4,645	3,153	4,123	**6,944**
2002	4,259	8,205	24,733	38,734	12,029	16,964	11,892	13,483	7,374	5,662	3,768	4,108	**9,164**
2003	4,184	7,331	28,885	51,440	29,622	15,761	22,029	41,877	11,719	9,631	6,874	3,447	**14,050**
2004	4,288	6,626	23,820	32,104	68,091	56,256	21,948	12,354	5,651	7,317	5,204	4,676	**14,922**
2005	8,508	6,708	12,449	33,589	24,922	38,546	29,876	50,929	27,838	9,378	5,586	6,897	**15,404**
2006	4,764	5,249	47,943	156,265	55,278	124,121	183,031	82,004	37,105	12,044	8,914	8,610	**43,806**
2007	3,948	5,182	9,238	8,316	21,337	14,039	11,235	9,313	7,793	5,354	3,724	4,616	**6,216**
Minimum	2,046	3,643	4,213	3,604	3,039	3,007	2,977	3,255	2,383	2,983	2,248	1,737	**2,477**
Average	8,803	14,598	29,815	56,029	62,589	58,486	36,125	25,370	15,336	9,201	7,006	9,157	**19,952**
Maximum	32,283	74,137	154,587	262,325	230,854	266,623	183,031	98,659	71,736	43,759	24,484	31,442	**64,266**

Table 5.1-5. Relationship between Delta Outflow and Salinity (EC) at the Downstream (Fleet) and Upstream (Collinsville) Ends of Suisun Marsh

Effective Delta Outflow (cfs)	EC at Fleet (µS/cm)	EC at Collinsville (µS/cm)	Location of X2 (km from GG)
3,000	25,000	12,000	90.7
4,000	23,000	9,500	87.3
5,000	21,000	7,500	84.7
6,000	19,500	6,000	82.6
7,000	18,000	5,000	80.8
8,000	16,500	4,000	79.2
9,000	15,000	3,000	77.8
10,000	13,500	2,250	76.6
11,000	12,000	1,750	75.5
12,000	11,000	1,500	74.5

µS/cm = microSiemens per centimeter.
cfs = cubic feet per second.
GG = Golden Gate Bridge.
km = kilometers.

Salinity, controlled by Delta outflow, is also important for aquatic habitat conditions that influence the distribution and abundance of fish species and other aquatic organisms. These potential impacts will be discussed in Section 5.2, Water Quality, and Section 6.1, Fish.

Historical Central Valley Project and State Water Project Exports

Table 5.1-6 gives the monthly historical CVP exports during 1968–2007. This period corresponds to the historical record when Marsh salinity and Delta water management have been considered linked. These historical CVP exports include the period prior to the SWP exports and San Luis Reservoir operations, which began in 1969. Before the San Luis Reservoir was completed, the CVP exports were used directly for water deliveries along the Delta-Mendota Canal. The CVP exports have been less seasonal since San Luis Reservoir operations began. The CVP pumping plant has a maximum diversion of about 4,600 cfs, and has been regulated by D-1485 objectives from 1978 to 1994, and by D-1641 objectives from 1995 to 2007.

Table 5.1-7 gives the monthly historical SWP exports during 1968–2007. This period corresponds to the historical record when Marsh salinity and Delta water management have been considered linked. The SWP exports generally increased with higher water demands through the 1970s and 1980s. Water demands have been relatively constant and SWP exports have varied with water availability since 1995. The SWP pumping plant had a maximum capacity of about 6,000 cfs until 1988, when four pumps were added to provide a maximum pumping capacity of 10,300 cfs, but the pumping is limited to 6,680 cfs by existing regulatory requirements. The SWP exports were regulated by D-1485 objectives from 1978 to 1994, and by D-1641 objectives from 1995 to 2007.

The historical exports indicate the magnitude of Delta water management that is controlled by CVP and SWP operations. Although the Delta outflow requirements may limit Delta exports, these outflow requirements are conditions on the water rights permits to protect salinity for other beneficial uses.

Table 5.1-6. Historical Monthly Average Central Valley Project Exports (cfs) for Water Years 1968–2007 (Source: DWR DAYFLOW database)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (taf)
1968	1,586	964	428	638	1,721	3,282	3,771	4,165	4,200	4,738	3,902	3,597	**1,997**
1969	3,785	2,298	1,105	2,883	2,998	2,206	1,886	2,187	1,890	2,703	4,366	2,244	**1,844**
1970	1,629	366	0	412	1,481	1,757	3,644	3,562	4,230	4,447	3,559	2,281	**1,653**
1971	2,046	470	8	24	2,312	3,805	3,339	3,609	4,440	4,563	4,372	2,779	**1,918**
1972	2,858	2,322	1,943	1,034	3,253	3,904	3,527	4,065	3,319	4,228	4,391	3,937	**2,346**
1973	3,368	0	0	1,472	631	641	2,473	4,477	4,591	4,640	4,489	3,806	**1,855**
1974	3,342	2,993	1,551	1,235	3,474	4,237	2,564	4,380	4,396	4,498	4,520	3,320	**2,444**
1975	3,440	0	10	2,687	4,189	3,760	4,213	3,949	3,996	4,612	4,490	3,637	**2,349**
1976	3,604	3,833	3,881	4,055	4,584	4,563	4,399	4,540	3,735	3,459	4,564	4,539	**3,008**
1977	3,170	2,518	1,569	3,630	2,250	2,028	1,002	1,657	310	354	1,094	1,641	**1,281**
1978	488	1,638	2,168	3,871	4,065	3,985	2,741	2,066	4,133	4,505	4,166	3,781	**2,264**
1979	2,952	3,206	3,178	2,699	1,227	1,986	3,182	2,991	2,987	4,549	4,558	4,382	**2,296**
1980	3,910	1,031	0	0	2,754	3,236	3,837	2,915	2,863	4,569	4,541	3,509	**2,006**
1981	3,566	3,852	3,788	4,083	3,656	1,942	3,684	3,136	3,458	4,351	4,110	3,314	**2,590**
1982	2,111	1,435	785	1,804	3,788	4,123	3,452	2,984	2,935	2,911	4,349	2,065	**1,971**
1983	2,239	3,337	3,139	3,864	3,947	3,934	3,662	2,823	2,975	3,971	4,266	3,345	**2,502**
1984	2,081	954	1,604	1,373	3,811	4,283	3,961	2,990	2,985	4,676	4,378	3,118	**2,190**
1985	3,614	3,893	3,956	3,859	4,039	3,949	3,900	2,991	3,000	4,573	4,376	4,096	**2,790**
1986	3,927	3,719	3,871	3,881	3,940	2,435	2,783	2,998	2,993	4,450	4,385	4,010	**2,618**
1987	4,000	3,693	4,010	4,004	4,030	2,379	4,339	2,998	2,998	4,435	4,565	4,284	**2,758**
1988	3,998	3,931	4,034	4,063	4,098	4,083	4,083	2,971	2,993	4,479	4,531	4,592	**2,895**
1989	3,547	3,602	4,166	4,183	4,097	4,112	3,987	2,999	2,996	4,739	4,704	4,422	**2,870**
1990	4,217	4,165	4,113	4,137	4,095	4,109	4,253	2,770	2,987	3,661	3,033	3,195	**2,697**
1991	1,107	1,588	2,277	1,883	2,606	3,722	2,882	1,277	894	1,633	1,659	1,852	**1,408**
1992	1,730	2,009	1,855	3,196	2,463	4,094	1,718	846	790	897	989	1,594	**1,342**
1993	967	1,278	1,219	4,006	4,026	4,082	2,882	1,524	1,990	4,303	4,362	4,379	**2,108**

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (taf)
1994	4,311	4,240	4,144	2,277	3,870	2,268	1,562	1,123	1,328	2,512	2,440	3,541	**2,023**
1995	2,480	2,488	3,534	4,141	4,218	2,372	3,326	2,985	4,067	4,463	4,386	4,387	**2,581**
1996	4,334	4,223	4,273	4,272	3,589	739	2,395	2,074	4,416	4,449	4,379	4,295	**2,626**
1997	4,196	4,123	4,083	2,022	557	4,344	2,719	1,744	4,439	4,396	4,429	4,322	**2,510**
1998	4,281	4,201	4,075	3,952	2,956	2,062	1,446	2,320	2,862	4,060	4,371	4,357	**2,474**
1999	4,162	2,136	33	2,978	4,317	4,108	1,710	1,703	3,336	4,426	4,391	4,279	**2,262**
2000	4,249	4,195	2,544	3,205	4,108	3,380	2,207	1,263	3,045	4,319	4,386	4,250	**2,487**
2001	4,208	4,061	3,910	2,737	3,519	1,883	2,177	857	2,997	4,135	4,130	4,081	**2,332**
2002	3,625	3,756	3,677	4,145	3,604	4,182	2,145	857	2,535	4,355	4,337	4,279	**2,505**
2003	4,088	3,671	3,333	4,262	4,274	4,355	1,899	1,465	4,413	4,200	4,308	4,267	**2,685**
2004	4,303	4,324	4,150	4,358	3,968	4,141	1,956	961	3,632	4,374	4,430	4,393	**2,722**
2005	4,350	4,293	3,794	4,217	3,889	3,377	2,121	1,071	4,167	4,374	4,408	4,362	**2,679**
2006	4,342	4,287	4,275	3,918	4,321	3,262	816	1,803	3,363	4,406	4,401	4,378	**2,628**
2007	4,316	4,034	4,140	4,353	4,368	4,023	2,728	843	2,478	4,390	4,429	4,334	**2,679**
Minimum	488	0	0	0	557	641	816	843	310	354	989	1,594	**1,281**
Average	3,263	2,828	2,616	2,995	3,377	3,278	2,884	2,473	3,154	3,995	4,049	3,681	**2,330**
Maximum	4,350	4,324	4,275	4,358	4,584	4,563	4,399	4,540	4,591	4,739	4,704	4,592	**3,008**

Table 5.1-7. Historical Monthly Average State Water Project Exports (cfs) for Water Years 1968–2007 (Source: DWR DAYFLOW database)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (taf)
1968	138	76	167	439	47	1,153	1,479	1,287	284	206	772	1,820	**476**
1969	2,314	2,631	2,572	2,805	1,648	1,143	1,253	975	491	526	556	177	**1,032**
1970	273	628	727	655	385	436	880	283	570	568	834	647	**416**
1971	423	1,482	1,844	1,780	777	846	1,023	843	1,186	1,781	2,148	1,000	**917**
1972	836	640	401	515	407	2,634	2,668	2,216	1,802	665	2,364	2,879	**1,091**
1973	2,915	3,472	3,383	1,428	483	575	795	1,833	2,570	2,820	3,067	1,794	**1,526**
1974	2,479	1,825	1,732	682	1,923	1,972	1,561	2,635	4,545	5,994	4,761	1,620	**1,921**
1975	1,057	1,877	2,744	2,717	2,445	2,245	1,993	1,521	357	398	4,326	4,024	**1,550**
1976	3,870	4,116	3,896	4,139	3,067	3,713	570	869	335	574	2,176	3,689	**1,878**
1977	1,313	1,564	1,090	3,300	1,971	1,722	280	1,310	385	510	425	167	**847**
1978	168	890	3,552	5,937	6,209	1,823	574	1,017	3,491	3,511	4,194	3,657	**2,100**
1979	2,105	2,278	2,785	1,339	1,659	2,294	2,611	3,098	3,166	4,687	5,713	4,795	**2,211**
1980	3,690	4,715	5,894	6,310	3,376	1,069	1,492	1,688	3,012	2,252	4,605	4,092	**2,555**
1981	3,010	2,487	2,901	4,095	3,509	2,813	4,304	1,131	336	2,457	5,002	3,311	**2,132**
1982	3,680	3,197	4,343	3,355	5,614	6,247	6,108	2,970	955	1,057	3,673	3,166	**2,668**
1983	2,973	2,667	5,229	6,175	6,208	1,352	112	404	1,974	1,174	2,833	764	**1,912**
1984	344	732	484	302	1,889	2,586	3,675	2,860	3,078	4,653	4,981	2,258	**1,685**
1985	1,859	4,000	4,452	1,898	3,478	4,561	3,361	3,094	3,402	4,734	5,584	4,485	**2,710**
1986	3,604	3,485	5,881	5,044	2,061	706	1,863	3,183	3,061	4,019	5,423	6,338	**2,705**
1987	3,451	3,020	3,102	2,127	2,707	3,089	2,578	2,184	2,055	4,377	5,075	4,615	**2,319**
1988	1,756	1,377	4,827	6,227	5,802	4,234	4,362	3,184	2,785	3,370	4,123	3,385	**2,747**
1989	1,924	2,339	2,871	5,875	3,968	6,024	6,408	3,121	2,153	4,634	6,452	6,171	**3,136**
1990	6,149	6,060	6,184	6,347	6,315	6,363	5,289	500	385	2,434	3,502	2,577	**3,138**
1991	2,295	2,122	2,780	2,884	1,794	5,933	4,560	1,368	985	870	2,081	2,287	**1,812**
1992	3,447	1,036	1,190	3,088	3,530	6,269	1,246	815	1,107	533	1,580	2,793	**1,612**
1993	765	1,050	2,742	7,564	5,205	1,864	2,745	1,777	2,124	4,305	6,313	6,452	**2,583**

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (taf)
1994	6,455	2,595	6,288	3,496	1,912	1,921	336	707	499	1,721	3,523	3,695	**2,013**
1995	2,779	3,586	3,903	7,508	4,573	533	147	1,279	3,428	5,976	4,823	2,887	**2,500**
1996	2,947	1,235	113	5,707	2,976	2,735	1,801	2,617	5,118	6,085	6,255	5,870	**2,633**
1997	5,514	5,834	3,576	629	1,706	2,577	1,809	1,357	2,688	5,320	4,466	5,797	**2,496**
1998	4,323	4,916	6,838	3,195	234	0	17	909	2,189	3,575	4,431	4,476	**2,134**
1999	4,824	2,191	2,072	1,426	938	2,948	3,105	1,640	1,124	6,277	6,686	6,956	**2,439**
2000	4,986	5,185	3,778	6,454	7,391	5,554	3,048	1,713	4,382	5,852	6,287	6,504	**3,692**
2001	5,050	5,316	4,791	3,929	4,734	5,880	1,724	594	269	3,688	4,077	3,606	**2,635**
2002	983	3,246	6,119	6,466	4,976	3,896	2,114	677	2,265	6,241	6,844	4,199	**2,900**
2003	1,754	3,139	4,165	5,771	6,385	6,216	2,578	983	5,965	6,705	7,004	6,783	**3,458**
2004	2,862	3,828	4,278	6,830	6,408	6,888	2,143	753	1,697	6,342	6,651	5,015	**3,251**
2005	2,843	3,825	4,226	7,801	4,938	3,616	3,868	1,914	5,600	7,162	7,147	7,149	**3,625**
2006	6,303	5,277	6,559	3,184	4,901	2,662	2,713	2,061	3,663	6,862	7,133	7,126	**3,527**
2007	6,024	5,382	6,586	3,454	2,474	3,022	2,088	534	457	6,589	6,765	5,341	**2,954**
Minimum	138	76	113	302	47	0	17	283	269	206	425	167	**416**
Average	2,862	2,883	3,527	3,822	3,276	3,053	2,282	1,598	2,149	3,538	4,366	3,859	**2,248**
Maximum	6,455	6,060	6,838	7,801	7,391	6,888	6,408	3,184	5,965	7,162	7,147	7,149	**3,692**

Managed Wetlands Water Supply

The water supply for the managed wetlands within the Marsh is through riparian and appropriative water rights. Water supply is for waterfowl habitat flooding operations and soil leaching for vegetation management. The majority of diversions occur in October and November at the beginning of the waterfowl habitat flooding period.

The SRCD estimates that the total flooded wetland acreage is about 40,000 acres, and the flooded depth averages about 1 foot. Therefore, the total diversions in October are likely about 40,000 acre-feet. This water is circulated throughout the managed wetlands and then drained back into the slough channels. The water used for soil leaching for salt control and evapotranspiration of the drained wetlands/vegetation in the summer is harder to estimate, but will not exceed seasonal evaporation (about 2 feet). Some of this water is supplied by rainfall, so the total water diversions are likely between 100,000 and 150,000 acre-feet. More details of the managed wetlands water management are provided in the Conceptual Model for Managed Wetlands in Suisun Marsh (California Department of Fish and Game 2007).

Environmental Consequences

Assessment Methods

Timing of availability of the water supply for the managed wetlands in the Marsh is directly related to tidal hydraulics because most water is diverted by gravity to the managed wetlands. These flooding operations rely on adequate tidal water elevations to divert water from the channels. The RMA hydrodynamic model has been used as the primary tool for identifying and evaluating potential tidal hydraulic changes from the SMP alternatives. The tidal hydraulic changes have been evaluated with comparative simulations of tidal hydraulics in 2002 and 2003, which were selected as the evaluation period for RMA modeling because these were recent years with relatively low Delta outflow, so the salinity conditions in the Marsh were relatively high (typical of low-outflow years). An alternative may change tidal flows and tidal elevations in the Marsh by increasing the amount of tidal wetlands that exchange water with the channels of Suisun Marsh during the tidal cycle. Changes in tidal elevations and tidal flows, both upstream and downstream of connections with new tidal wetlands, are somewhat difficult to anticipate; mathematical modeling is the most accurate method for simulating these effects. Two possible distributions of new tidal wetlands within the Marsh have been simulated to estimate the likely general effects from substantial new tidal wetlands (about 7,500 acres in each representative simulation). These simulations assumed all the tidal wetland restoration occurred at one time and looked at the immediate effect on tidal elevations of the total restoration. The simulations did not consider how sea level rise may interact with the tidal restoration actions when predicting tidal elevation changes. The simulations also did not look at tidal elevation changes from tidal restoration actions after the change to determine if the potential tidal elevation changes would continue over any part of the SMP planning horizon.

Based on the variables in the simulation, tidal restoration of existing managed wetlands would increase the tidal flow in the Marsh channels between Suisun Bay and the breached levee connections to the tidal wetlands. Tidal flows upstream from the new levee breaches would not be reduced if the tidal channel is large enough to convey the increased tidal flows. Table 5.1-3 shows the increased tidal areas and tidal volumes that would be added to the existing Marsh channels and tidal wetlands if about 2,000 acres of managed wetlands ("Zone 1" example in the southwest corner of Suisun Slough and Suisun Bay) were restored to tidal action with levee breaches. The additional subtidal volume would be about 2,350 af, and the additional tidal volume between MLLW and MHHW (about 5 feet difference) would be about 9,000 af. A slightly larger restoration of about 3,350 acres ("Zone 4" example in the northeast corner on Montezuma Slough) would add a subtidal volume of about 6,000 af and increase the tidal volume by about 16,000 af between MLLW and MHHW. Therefore, about 25% of the example tidal restoration volumes would be subtidal (below MLLW) and about 75% would be intertidal (i.e., above MLLW). The estimated channel volumes from the DSM2 tidal hydraulic model geometry are similar to those of the revised geometry used in the RMA model. The existing RMA model geometry has about 20% more volume at MLLW and MHHW. The RMA model geometry is assumed to be more accurate. More discussion of the effects of simulated tidal restoration on the Marsh channel tidal hydraulics and water quality (salinity) can be found in Appendix A, "Numerical Modeling in Support of Suisun Marsh EIR/EIS."

Changes in tidal hydraulics in Suisun Marsh also can influence the tidal flows and velocities upstream in the Delta channels. This change in tidal exchange can influence salinity intrusion (i.e., tidal mixing) upstream in the Delta and at the water supply diversions and export pumping locations. These salinity effects will be described and evaluated in the Section 5.2, Water Quality.

Potential effects of Delta water management (CVP and SWP operations) on the salinity of Suisun Marsh water diversions are adequately protected under existing conditions by the Delta outflow constraints and water quality objectives included in the water rights decisions (D-1485 and D-1641) that regulate the CVP and SWP exports and other permitted diversions from the Delta. These established standards in conjunction with the Revised SMPA and the PAI Fund are assumed to offset or prevent any potential salinity impacts on the water supply used for beneficial use of fish and wildlife in the managed wetlands within the Marsh. Likewise, because of the protection provided by established water quality objectives, potential impacts of tidal restoration on salinity that would limit the availability or impair the beneficial uses of upstream municipal water supplies are assumed to be negligible.

The nearest municipal water supply diversions are the City of Antioch and the CCWD intake at Mallard Slough, across from Chipps Island. However, because these water diversions are operated only when salinity is below specific thresholds during periods of high Delta outflows, no impacts on these diversions from Suisun Marsh water management or restoration programs are anticipated.

Significance Criteria

Significance criteria have been developed for one possible impact from new tidal wetland restoration in the Marsh related to water supply.

The possible impact is a reduction in the water availability for the water supply of the managed wetlands. The primary water supply for managed wetlands comes from riparian diversions. A reduction in the amount of water available for riparian diversion as the water supply to the managed wetlands caused by tidal wetlands restoration is considered significant.

The primary issues with water availability for the water supply to managed wetlands are amount of water and timing of water available. The restoration of tidal wetlands is not a consumptive use of water and therefore does not have a significant impact on the amount of water available. The restoration of tidal wetlands could affect the timing of available water related to the riparian water supply by alteration of tidal elevations or velocities.

The normal tidal range within the Marsh is about 5 feet. The RMA tidal hydraulic modeling (Appendix A) indicates that reductions in the MHHW elevations and increases in the MLLW elevations are possible at locations adjacent to substantial acreage of tidal wetlands restoration. These possible changes in tidal elevation range (difference between MHHW and MLLW) would result from additional tidal flows and volumes moving into and out of the restored wetlands. The operation of the managed wetland water supply depends on filling the wetlands during high tides. Changes to tidal elevations could affect the timing of water availability for riparian water diversion to managed wetlands.

Increases in the maximum channel tidal velocities could also affect the timing of water availability for riparian water diversion to managed wetlands. Tidal velocities in the Marsh channels and sloughs are generally moderate, with maximum velocities of between 1 fps and 2 fps, depending on the size of the channel cross section and the upstream tidal volume (upstream area). An increase in average channel velocity to more than 2 fps or an increase of more than 1 fps in an existing channel could affect the timing water availability for diversion.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, some restoration of tidal marsh and natural levee breaching would occur. Changes in tidal hydraulic conditions of water elevation fluctuations or velocity fluctuations in the Suisun Marsh channels may occur, depending on the location of the restoration and natural breaching. Changes in tidal conditions upstream in the Delta channels would not be anticipated. The risk of levee failure would remain at existing levels or increase as maintenance of exterior levees continues to be deferred. Following a levee breach, the tidal flows would be changed both upstream and downstream of the breach. After the levee breach is repaired, the tidal conditions would return to the baseline tidal flows and velocities. The likelihood of levee failure under existing conditions is generally known from the historical frequency of levee breaches, and is expected to increase under the No Action Alternative as a result of deferred maintenance and the effects of sea level rise. The primary change in water supply in the Marsh under the No Action Alternatives would result from a regulatory constraint on operations of managed wetlands as a result of limited restoration. Absent the SMP, it is anticipated that NMFS and FWS BOs for the operations of the managed wetlands would not allow continued operations of the same magnitude as current conditions. This could limit the available water supply through restrictions on flood and drain practices. However, Delta water management would continue under D-1641 outflow requirements, export limits, water quality objectives, and other restrictions related to the CVP/SWP Long Term Operations BOs.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Proposed tidal restoration of 5,000 to 7,000 acres throughout the Marsh over the 30-year period may cause tidal hydraulic changes in some of the existing channels. As part of the site-specific assessment, the initial tidal restoration design would be compared to the existing conditions with modeling studies to determine the extent of any hydraulic effects. Reduction of impacts generally will involve tidal restoration design changes (i.e., number of breaches, locations, lengths, and depths) or modifications in the existing channels (e.g., placement of riprap or local dredging). After restoration to tidal wetlands, the existing channels may experience some hydraulic adjustments (i.e., widening in response to higher tidal flows and velocities). However, the hydraulic modeling of the Marsh used fixed channel geometry and therefore represents the first year of tidal marsh restoration, without any substantial hydraulic adjustments.

Restoration Impacts

Impact WTR-1: Reduction in Water Availability for Riparian Water Diversions to Managed Wetlands Upstream or Downstream of Restoration Areas

The impact would be due to a change in timing of water availability for water supply to the managed wetlands due to changes in tidal elevations. Tidal flows into restored tidal wetlands may affect the tidal range in the sloughs adjacent to the restored tidal wetlands. The reduction in tidal range upstream would be caused by the diversion of the flood-tide channel flow into the tidal wetlands, and the drainage from the tidal wetlands during ebb-tide would reduce the drainage of the slough upstream from the restored wetlands. The diversion of a portion of the tidal flows would cause a greater dissipation of the tidal energy through the breach and within the new tidal wetlands area. A similar reduction in the tidal range downstream from the tidal wetlands breach could be caused by increased drainage from the slough and restored wetlands at low tide. Modeling results (see Appendix A, "Numerical Modeling in Support of Suisun Marsh EIR/EIS") and field measurements in sloughs with temporary breaches in managed wetlands levees have demonstrated this effect.

The changes in tidal elevation could affect the timing of water available to the riparian diversions. While the total amount of water available for diversion would not change, changes in tidal elevation would have a small effect on the timing of water availability due to the intertidal location of most manage wetlands in the Marsh. For one season or a portion of one season, the timing of water availability may experience a small change on a diurnal basis due to reduced tidal elevation differences. This change of timing would not significantly affect the beneficial use of the water for fish and wildlife in the managed wetlands and would not affect the amount of water supply available during the diversion periods.

The current operations of some of the managed wetlands could be effected for limited periods of time by reduced tidal elevation differences due to infrastructure limitations, but the amount of water available in tidal sloughs to divert would not be changed.

As described in Chapter 2, breaches will be designed to ensure that tidal flows remain below about 2 fps to prevent tidal muting (i.e., reduced tidal range) that is caused by the increased water surface gradient during peak tidal flows in channels with relatively high velocities.

Conclusion: Less than significant No mitigation required.

Impact WTR-2: Increased Tidal Velocities from Breaching of Managed Wetlands Levees

Tidal velocities in the Marsh channels and sloughs are generally moderate, with maximum velocities of between 1 fps and 2 fps, depending on the size of the channel cross section and the upstream tidal volume (upstream area). These maximum tidal velocities occur regularly (four times each day). An increase in average channel velocity to more than 2 fps or an increase of more than 1 fps in an existing channel is considered a significant change in tidal velocities and may result in local sediment scour or vegetation disruption. As described in Chapter 2, restoration designs will incorporate breach locations to minimize upstream tidal muting, tidal elevation changes, channel scour, and hydraulic changes. This can be accomplished by locating breaches on larger channels or allowing more openings to reduce the effects of the increased tidal flows on tidal elevations and velocities.

Breaches will be designed to ensure that tidal flows remain below 3 fps to prevent tidal muting or scouring that is caused by the increased water surface gradient during peak tidal flows in channels with relatively high velocities.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities

Impact WTR-3: Improved Water Supply as a Result of Improved Flooding and Draining of Managed Wetlands

The increased frequency of managed wetland activities has the potential to improve the ability to flood and drain managed wetlands. Activities that involve improving diversion such as installation and replacement of water control structures, and DWR/Reclamation activities such as maintenance of RRDS, would improve managed wetland water supply for those managed wetlands that implemented these activities. This would be a beneficial water supply impact for individual managed wetlands.

Conclusion: Beneficial.

Impact WTR-4: Increased Tidal Flows and Improved Water Supply as a Result of Dredging

Dredging is proposed to obtain source materials for levee maintenance throughout the Marsh. This includes dredging around water control structures and fish screens. Therefore, dredging would improve the ability of managed wetlands to obtain water supplies for flooding operations. Additional water management facilities and improved maintenance procedures would benefit the water management operations within the Marsh. Dredging channels for levee maintenance materials also would have an indirect effect of improving tidal circulation in dredged channels by increasing the total channel volume.

Conclusion: Beneficial.

Alternative B: Restore 2,000–4,000 Acres

Impacts for Alternative B would be similar to those described for Alternative A. Alternative B involves less tidal restoration, so any minor changes in timing of water availability for water supply would be of less magnitude and would occur in fewer areas of the Marsh.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C would be similar to those described for Alternative A. Alternative C involves more tidal restoration, and therefore localized changes in timing of water available for diversions may occur more frequently throughout the Marsh, however any impacts to water supply from these minor timing changes would be less than significant.

Section 5.2
Water Quality

Introduction

This section describes the existing environmental conditions and possible beneficial and deleterious impacts on water quality that may result from implementing SMP alternatives.

The Affected Environment subsection below establishes the existing environmental context against which potential impacts may be considered. The Impact Analysis subsection specifically identifies potential impacts, their causes and estimated extents, and mitigation measures to reduce impacts to less-than-significant levels, where appropriate.

Salinity is the best understood and most managed water quality parameter in the Marsh. Delta water management for agriculture and water supply diversions and exports and the salinity of water diverted for waterfowl habitat in the managed wetlands of the Marsh became linked in the State Water Board's 1978 *Water Quality Control Plan for the Sacramento–San Joaquin Delta and Suisun Marsh* (1978 WQCP) and D-1485 Suisun Marsh salinity standards (objectives). The State Water Board required a plan of protection for Marsh water quality conditions. Initial facilities, including an improved RRDS to better supply approximately 5,000 acres on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands with lower salinity water from Montezuma Slough and the MIDS and Goodyear Slough outfall to improve water supply for the southwestern Marsh, were constructed in 1979 and 1980. The Plan of Protection for Suisun Marsh was approved in 1984.

Delta outflow is the primary factor governing salinity in the Marsh. Sloughs in the Marsh are used to flood and drain managed wetlands in support of habitat for resident and migratory wildlife and waterfowl hunting. Increased salinity in water used in managed wetlands inhibits wetland diversity and food-plant productivity intended to attract waterfowl species. Therefore, in addition to other critical water quality parameters, this section explores existing salinity conditions and the possible changes to salinity within the Marsh that may result from the SMP or its alternatives. In addition to salinity in the Marsh, the SMP and alternatives have the potential to affect salinity as distant as the south Delta CVP and SWP export facilities. Modeling of salinity impacts is described in great detail in Appendix A. Overall, minimal salinity effects are expected to occur.

The majority of impacts on water quality can be grouped as conventional pollutants or chemical contaminants. Besides potential adverse changes in salinity levels, other conventional water quality pollutants include low dissolved oxygen (DO), elevated water temperature, and increased levels of suspended sediment (SS). Chemical contamination includes elevated levels of mercury, especially in fish and other aquatic species. (Impacts on fish are discussed in Section 6.1.) In the context of the SMP, the primary anticipated sources of water quality pollution are annual discharges from existing managed wetlands and temporary construction activities during tidal wetlands restoration. However, this analysis assesses only the change in restoration and managed wetland activities associated with the SMP alternatives.

Summary of Impacts

Table 5.2-1 summarizes water quality impacts from implementing SMP alternatives. There are currently chronic significant, albeit temporary and localized, impacts on water quality from annual discharges of poor-quality (e.g., low-DO, high sulfur compound–containing) water from some managed wetlands. These impacts are expected to be reduced under the No Action Alternative and with implementation of the three project alternatives. No significant impacts on water quality solely from implementing any of the SMP action alternatives are anticipated.

Table 5.2-1. Summary of Water Quality Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
WQ-1: Increased Salinity in Suisun Marsh Channels from Increased Tidal Flows from Suisun Bay (Grizzly Bay) as a Result of Restoration	A, B, C	Less than significant	None required	–
WQ-2: Changes to Salinity of Water Available for Managed Wetlands from October to May	A, B, C	Less than significant	None required	–
WQ-3: Increased Salinity at Delta Diversions and Exports	A, B, C	Less than significant	None required	–
WQ-4: Possible Changes to Methylmercury Production and Export as a Result of Tidal Restoration	A, B, C	Less than significant	None required	–
WQ-5: Improved Dissolved Oxygen Concentrations in Tidal Channels from Reduced Drainage of High Sulfide Water from Managed Wetlands	A, B, C	Beneficial	None required	–
WQ-6: Temporary Changes in Water Quality during Construction Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Managed Wetland Activities Impacts				
WQ-7: Temporary Degradation of Water Quality during Implementation of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WQ-8: Temporary Degradation of Water Quality during Dredging, Including Possible Increases in Mercury Concentrations	A, B, C	Less than significant	None required	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- California Department of Water Resources. 1998. Suisun Marsh Preservation Agreement Amendment Three Actions as a means to provide equivalent or better protection than channel water salinity standards at Suisun Marsh Stations S-35 and S-97. Suisun Marsh Branch, Environmental Services Office.
- California Department of Water Resources. 2000. *Comprehensive Review of Suisun Marsh Monitoring Data 1985–1995*.
- California Department of Water Resources. 2001. *Final Report of the Suisun Marsh Ecological Workgroup Chapter 6 Hydrology and Water Quality Sub-Committee*. Prepared for the State Water Board.
- DWR and Reclamation electrical conductivity (EC) monitoring records. Available from IEP and CDEC.
- NMFS Biological Opinion and Essential Fish Habitat Consultation for the 2006 Regional General Permit 3 Extension (National Marine Fisheries Service 2006).
- Resource Management Associates (RMA) (2008) Bay-Delta and Suisun Marsh 2-D Model Calibration and Comparison of Tidal Marsh Restoration (Appendix A).
- San Francisco Bay RWQCB 2010. Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan).
- State Water Resources Control Board. 1978. *Water Quality Control Plan for the Sacramento–San Joaquin Delta and Suisun Marsh* (1978 WQCP).

- State Water Resources Control Board. 1995. *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (1995 WQCP).
- State Water Resources Control Board. 2006. *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (2006 WQCP).
- State Water Resources Control Board. 1978. Water Right Decision 1485.
- State Water Resources Control Board. 1999. Water Right Decision 1641.
- State Water Resources Control Board. 2000. Revised Water Right Decision 1641.
- U.S. Environmental Protection Agency. 2001. *Water Quality Criterion for the Protection of Human Health: Methylmercury*, EPA-823-R-01-001. Washington, D.C.: Office of Water, pp. xiv, 5-56–5-59, 7-1–7-2.
- Wesley A. Heim, Dr. Kenneth Coale, and Mark Stephenson. 2003. *Methyl and Total Mercury Spatial and Temporal Trends in Surficial Sediments of the San Francisco Bay-Delta, CALFED Bay-Delta Mercury Project Final Report*. October. Moss Landing Marine Lab.
- Marc Beutel, Brown and Caldwell; Khalil Abu-Saba, Larry Walker and Associates. 2004. Mercury Technical Memorandum – Final Draft.
- Letitia Grenier, April Robinson, Shira Bezalel, Jennifer Hunt, Aroon Melwani and Josh Collins. 2008. South Baylands Mercury Project 2007 Year-end Progress Report.

Regulatory Setting

Implementation of Federal Water Quality Law

The Clean Water Act is the Nation’s water quality law, administered by the EPA, with regulatory assistance from the Corps. It generally applies to all navigable waters of the United States. As intended, many day-to-day administrative and regulatory requirements of this act are administered by local, state, and Indian Tribe organizations—for example, in California by the State Water Board and RWQCBs.

The nine RWQCBs designate official beneficial uses of water (e.g., various uses of water to maintain aquatic and wildlife habitats) for all California water bodies, establish water quality objectives (allowable limits) on pollutants intended to protect designated beneficial uses, and develop effective implementation and enforcement plans. The region-specific planning information necessary to manage the State’s water quality is contained in regional Water Quality Control Plans (Basin Plans), developed and revised periodically by the RWQCBs. Additional plans and policies are prepared as necessary. In particular, the RWQCBs are required by the Clean Water Act to identify impaired water body segments, those waters chronically failing to meet water quality objectives, and to develop total maximum daily loads (TMDLs) (the amounts of pollution that can be safely tolerated while still achieving objectives) for every pollutant-impaired water body segment combination identified.

Three of the state water quality agencies have direct jurisdiction over parts of the Delta: the State Water Board, the San Francisco Bay RWQCB, and the Central Valley RWQCB. The San Francisco Bay RWQCB, through its regional Basin Plan, has general water quality jurisdiction over the Marsh, Suisun Bay, and, of course, the San Francisco Bay estuary. Beneficial uses for the Suisun Marsh and associated sloughs include estuarine, spawning, and migrating habitat uses for fish species, recreational uses (contact and non-contact) and wildlife habitat uses. Mercury, specifically methylmercury (MeHg), in Suisun Bay is one example of a pollutant–water body combination that has an EPA-approved TMDL requiring regulatory action by the San Francisco Bay RWQCB. Meanwhile, because of the complex, sensitive, and multi-jurisdictional issues involved in one of California's most important watershed areas, the State Water Board Division of Water Rights Bay-Delta Program has for many years developed specific water quality standards for the Delta, including the Suisun Bay area, through various water rights decisions and regional water quality control plans.

State Water Quality Objectives

Salinity

The State Water Board established salinity standards for the protection of Suisun Marsh fish and wildlife starting with its 1978 regional water quality plan (1978 WQCP) and accompanying water rights decision (D-1485). The interim salinity standard was a maximum EC of 12.5 milliSiemens per centimeter (mS/cm) from October to May of all water-year types and locations. These interim salinity standards were to remain in place for 5 years until the Suisun Marsh Plan of Protection was developed, some initial facilities were constructed, and salinity monitoring stations were established.

At the end of the 5-year period, the D-1485 salinity objectives were implemented at eight locations (shown in Figure 1-6) for all water-year types. Maximum salinity (as EC) levels varied from 8 to 19 mS/cm depending on month (October to March) and Delta outflow (19 mS/cm in October, 15.5 mS/cm in November and December, 12.5 mS/cm in January, 8 mS/cm in February and March, and 11 mS/cm in April and May). The State Water Board also required a minimum Delta outflow of 10,000 cfs from February to May in wet-water years. Flow requirements were included in the standards, in part, to help meet salinity requirements. Objectives were not established for summer months because only limited use of water for pond circulation and irrigation of some wetland vegetation occurs from June to September in any particular year.

The revised 1995 WQCP retained the D-1485 monthly standards for Marsh monitoring sites. Salinity objectives at monitoring sites S-35 (Goodyear Slough) and S-97 (Cordelia Slough) had not been implemented because the State Water Board extended the effective date of compliance at these locations by specific orders (October 30, 1997; August 14, 1998; April 30, 1999; and November 1, 1999). Monthly salinity objectives were implemented at three eastern Marsh locations: Collinsville, Montezuma Slough at National Steel, and Montezuma Slough near Belden's Landing. The Revised SMPA includes the same salinity objectives, and the State Water Board will continue to waive requirements at S-35 and S-97 if equivalent or better protection of the Marsh can be shown through the implementation of the Revised SMPA and the PAI Fund. Instead of numeric standards, a narrative standard was applied. There was disagreement among the many parties with interests in the Marsh as to the efficacy of a narrative standard. The USFWS testimony differed from that of the SMPA agencies. The USFWS expressed concern over the proposed operations of the SMSCG and the efficacy of the D-1641 narrative standard.

In May 1995, the State Water Board asked DWR to convene the Suisun Ecological Workgroup (SEW), with the primary purpose of determining the appropriate measures and objectives to protect and maintain the beneficial uses of the Suisun Marsh to address the need for a salinity standard for the Marsh based on the varied resources existing there. This process required the review of the numeric and narrative salinity standards for the Marsh. The SEW individual workgroups came up with disparate recommendations based on the resources they were examining; namely, brackish marsh vegetation, aquatic habitat, wildlife, and waterfowl. These subgroups were unable to reconcile their differences, and their final report went forward to the State Water Board with a chapter devoted to each resource group and resource-specific recommendations.

The narrative standard calls for maintaining healthy tidal marsh within Suisun Marsh. If the narrative standard is retained, the question of the health of these areas can be answered by the triennial vegetative survey conducted by DWR in cooperation with DFG as part of the SMPA Suisun Monitoring Agreement, which is a "companion" agreement to the SMPA. The survey is designed to detect changes in the vegetative makeup of the Marsh and can distinguish between wetland types. The brackish tidal wetlands are included in that survey, and it therefore can serve as a measure of compliance with the narrative standard. In addition, one of the SMP goals is to increase the amount of tidal marsh while concurrently enhancing existing managed marsh. Therefore, tidal marsh restoration and programs to enhance endangered plant species habitat will provide additional protection and contribute to the recovery of these species.

The 1995 WQCP included a new salinity objective in Suisun Bay known as X2, which allowed the State Water Board to help regulate salinity by controlling flow. X2 is the 2 parts per thousand isohaline point, defined as the location of the 2 parts per thousand salinity contour (isohaline), 1 meter off the bottom of the estuary, as measured in kilometers (km) upstream from the Golden Gate. (The 1995 WQCP used an EC value of 2.64 mS/cm to represent the X2 point.) Biologists determined that regulating the location of X2 in the months of February to June downstream of Collinsville in Honker Bay or Suisun Bay proved beneficial to fish species there, and this may benefit fish in Marsh channels, as well. Figure 5.2-1 shows the location of all water quality compliance and monitoring stations established in the 1995 WQCP and subsequently in D-1641).

Dissolved Oxygen

The minute-by-minute concentration of DO throughout the water column is critical for the immediate survival and long-term viability of fish and other aquatic species. The San Francisco Bay RWQCB Basin Plan DO objective for the Suisun Marsh is 7 milligrams per liter of water (mg/l) or more of DO (or at least 80% of maximum saturation within the water column of DO). Deleterious effects on aquatic organisms may occur at low DO concentrations below 5 mg/l. Therefore, as required by water quality law, the DO objective includes a buffer to ensure that oxygen concentrations stay at acceptable levels for the most vulnerable beneficial uses of water (e.g., maintenance of aquatic habitat for the most sensitive aquatic species). Because the oxygen saturation concentration is temperature-dependent, this minimum DO objective is intended to be particularly protective during warm water temperatures. The warmer water becomes, the less DO it can retain. The oxygen saturation point is about 9.2 mg/l in 20 degrees Celsius (°C) (68 degrees Fahrenheit [°F]) water but only about 8.4 mg/l in 25°C (77°F) water. As a result, temperature-sensitive species, such as salmon, become oxygen-deprived more easily in higher water temperatures.

DO levels increase in water through gradual gas exchange with the atmosphere at the surface of a body of water; turbulent action (e.g., spray and foaming); the release of oxygen throughout the water column by aquatic plants, particularly algae (during daylight hours); and other chemical and physical pathways. Oxygen is removed from water by those same aquatic plants (at night) and by aerobic bacteria, common to most water bodies, at any time. Excessive aquatic bacterial activity (i.e., mass digestion of over-ample food supplies resulting in too-rapid bacteria population increases)—as can occur when water bodies receive excessive amounts of dead organic material—often can result in sudden, catastrophic declines in DO levels. Fish kills can occur in waterways lacking significant flows and, as a result, adequate flushing and mixture.

The analytical process for quantifying the uptake of DO by biological organisms in water is called biochemical oxygen demand (BOD). It involves monitoring DO concentrations in water samples over a set period of time in strictly controlled laboratory conditions (e.g., at a particular temperature). Like DO, BOD is measured in milligrams of oxygen per liter of water. The higher the BOD, the greater the bacterial demand for oxygen and the greater the potential impact on multi-cellular, water-breathing aquatic organisms (e.g., fish, insects, amphibians). Relatively high BOD is required to reduce oxygen concentrations below 5 mg/l. However, this easily can occur under the right conditions in artificially impounded water bodies subject to high organic loads (e.g., from dead or decaying vegetation, the influx of animals wastes, contamination by fertilizers and other organic materials). Moderate BOD commonly reduces DO levels to as low as 7 mg/l.

Another factor related to BOD and DO can be an excess of algae or other aquatic plants. Plants both increase (through photosynthesis in daylight) and decrease (from respiration at night) DO concentrations. Under healthy environmental conditions, the results of these two activities are balanced and DO levels remain adequate both day and night. But under adverse conditions (e.g., long periods of sunlight, warm water temperatures, together with high nutrient loads), algae and other aquatic (often nonnative) plants can proliferate, reach excessive levels, and seriously deplete DO levels. Nighttime demands on oxygen in water from algae blooms can rapidly reduce DO concentrations to near zero, killing water-breathing organisms before oxygen levels have time to recover during daylight hours. And when weather conditions change rapidly (e.g., cloudiness increases, temperatures fall significantly) or herbicides (or herbicidal pollutants) are discharged, large-scale algae die-offs in impounded, slow-moving water bodies can fuel excessive BOD, again seriously reducing DO levels.

The factors discussed above are pertinent to considerations of Suisun Marsh because under certain conditions, managed wetlands contribute to the problems discussed; less so for tidally influenced wetland, where on the average regular flushing generally helps ensure adequate oxygen levels and fewer incidences of algal blooms or excessive BOD.

Temperature

The temperature quality objectives, developed by the State Water Board for estuaries, are (a) any increase in surface water temperature must be less than 4°F (outside a mixing zone) and (b) a change in 25% of the cross section of a river must be less than 1°F. These limits were intended to help control major thermal power-plant cooling discharges. No monthly temperature standards apply.

Suspended Sediment

The San Francisco Bay RWQCB Basin Plan includes objectives for turbidity and SS concentrations. Generally a discharge or dredging activity should not increase the turbidity by more than 10% in water where natural turbidity is greater than 50 nephelometric turbidity units (NTUs).

Mercury

Current Pertinent Mercury Regulatory Guidelines

Both the San Francisco Bay and the Central Valley RWQCB staffs have prepared or are preparing TMDL plans for better control of total mercury and methylmercury in San Francisco Bay and Delta waters. The current (as of October 2010) draft Central Valley RWQCB Delta TMDL recommends a maximum of 0.24 part of methylmercury per one million parts of fish tissue (ppm) in 350 millimeter (mm) (14-inch) largemouth bass, to protect humans who may consume these sports fish. For its draft TMDL effort, Central Valley RWQCB staff has estimated methylmercury values in both water and fish tissue that should be protective of human consumers, as well as fish and wildlife.

The San Francisco Bay TMDL for mercury has a median goal for total mercury in SS of 0.2 ppm, about half the current median level. Discussed in the San Francisco Bay mercury TMDL documents are control measures to reduce mercury input to the bay from upstream (e.g., the Delta, Suisun Bay) and from wastewater treatment facilities. However, because of the large remnant load of existing mercury already present in bay sediments (a legacy of historical mining upstream), these control measures probably will not significantly lower total mercury levels in suspended bay sediment. The bay mercury TMDL also set target criteria of 0.03 ppm methylmercury in small prey fish (<75 mm) that may be eaten by waterfowl and shore birds, and 0.2 ppm methylmercury in large sport fish. Methylmercury levels in about half the fish sampled as part of the San Francisco Bay Regional Water Quality Monitoring Plan (RMP) (conducted by the San Francisco Estuary Institute) are currently above, and therefore violate, these criteria.

The San Francisco Bay RWQCB is currently developing a TMDL to address multiple pollutants, including mercury, in the Suisun Marsh.

Other Water Quality Parameters

The San Francisco Bay RWQCB Basin Plan includes other water quality objectives intended to protect fish and wildlife, recreation and drinking water beneficial uses against various chemical pollutants. One compound of potential concern is ammonia.

Ammonia, a nitrogen-containing compound, commonly exists in water in two forms—the more toxic un-ionized (un-dissociated) “free ammonia” (NH_3), and the much less toxic, ionized (charged) ammonium compound (NH_4^+). The ratio in water of free ammonia to ammonium ions (which together compose total ammonia) increases with increased pH and temperature—i.e., proportionally more toxic NH_3 makes up total ammonia under warmer and more alkaline conditions.

As stated, free or un-ionized ammonia is the form most hazardous to fish and other aquatic organisms. The LC_{50}—the lethal concentration at which 50% of test animals die within a standard length of time (e.g., 96 hours)—of un-ionized ammonia for salmonids species in fresh water can range from 0.2 to 0.7 milligrams of ammonia per liter. Free ammonia therefore is categorized as *highly* toxic by the EPA, and the RWQCB Basin Plan establishes a region-wide water quality objective of 0.025 mg/l as N (annual median).

Ammonia compounds often exist naturally in wetlands as part of a complex nitrogen cycle of physical, chemical, and biological activities. Their production may be related to the natural breakdown of dead vegetation, waste excretions from resident fish and animals, atmospheric deposition of nitrogen, and waste treatment and other discharges. Fortunately, free ammonia is rapidly diluted and degrades to less toxic forms readily in the aquatic environment. Nonetheless, nitrogen-containing materials, including the byproducts of ammonia, from natural and artificial fertilizers and from sewage are often a major biostimulatory (though not necessarily toxic) factor in many California watersheds, fueling the excessive growth of algae and other aquatic plants. Ammonia therefore could be of hypothetical localized concern in the Marsh during temporary dredging operations or more permanently in the vicinity of the treated wastewater discharge into Boynton Slough.

For this document, the assessment of potential impacts from ammonia relies on a qualitative evaluation of likely effects of the alternatives. Experience shows (e.g., DFG Napa–Sonoma Marsh restoration project) that the transformation of previously ponded wetlands into healthy salt marsh habitat should reduce, and certainly not increase, conditions that encourage free ammonia production. Denser populations of salt marsh plants would help remove nitrogen compounds from the water column and sediments. Also, daily tidal flows would help dilute, degrade, and transport away ammonia compounds and by-products. Therefore, any impact from ammonia from restoration activities is expected to be minimal at most and most likely insignificant.

Local

Solano County and local municipalities do not specifically regulate water quality in the managed or tidal wetland areas in Suisun Marsh. The Fairfield-Suisun Sewer District has a National Pollutant Discharge Elimination System (NPDES) permit (a Clean Water Act-based point source pollution permit issued by the RWQCB) which controls its discharge of treated wastewater to the Marsh. The District discharges about 20 cfs of effluent to Boynton Slough. Depending on or despite the level of treatment, such discharges can, over time or during emergency overflow events, be sources of nutrients and other pollutants, including mercury.

Relationship between Delta Outflow and X2 (Salinity Gradient)

Table 5.1-5 shows the basic relationships between effective Delta outflow and the EC values at Fleet and at Collinsville, as well as the estimated X2 locations. The historic Delta outflow values were used to calculate the end of month X2 locations for 1968 to 2007. Over the 40-year period, X2 values averaged 74 km upstream of the Golden Gate, ranging from a minimum 41 to a maximum 98 km. For comparison, Martinez is located at about 54 km, both the downstream (mouth) of Suisun Slough and Port Chicago at about 64 km, and the upstream end of Montezuma Slough at Collinsville at about 81 kilometers upstream from the Golden Gate, the mouth of the San Francisco Bay Estuary.

As discussed above, the X2 isohaline objective currently corresponds to an average electrical conductivity value of 2.64 mS/cm. This objective helps maintain the X2 point downstream of Collinsville from February through June in all years (except in May and June of years where the Sacramento River Index is less than 8.1 maf). This suggests that salinity at the upstream end of the Marsh near Collinsville would be relatively low. The X2 location is, by design, required to be downstream of Chipps Island (now Mallard Slough) at kilometer 75 for several days each month, depending on the previous month's runoff. This generally provides fairly low salinity (less than 5 mS/cm) at the downstream end of Montezuma Slough and Suisun Slough. The X2 salinity objective is intended to provide protection for managed brackish-water wetlands from excessive Suisun Bay salinity in winter and spring months, when water is pumped from Marsh sloughs to help leach salts from soils in managed wetlands.

Calculations using an X2 regression equation (San Francisco Estuary Project 1993) show that an outflow of about 7,000 cfs would maintain average salinity (as EC) at about the 2.64 mS/cm standard near Collinsville, at the upstream entrance to the Marsh and at the upstream end of Montezuma Slough. Such salinity would generally be satisfactory for those Grizzly Island diversions near the SMSCG.

Relationship between Delta Outflow and Suisun Marsh Salinity

The outflow of fresh water from the upstream Delta controls the Suisun Bay salinity gradient and corresponding Suisun Marsh channel salinity conditions. Salinity levels at both the mouth of Suisun Slough and the mouth of Montezuma Slough are very similar to salinity measured in Suisun Bay at Port Chicago (opposite Roe Island). Similarly, salinity in the upstream portion of Montezuma Slough is similar to salinity at Collinsville. The SMSCG reduce salinity in Montezuma Slough, with the most noticeable effects seen at the National Steel and Belden's Landing stations. The impacts on salinity of the SMSCG are less at Hunter Cut and smaller still in Suisun Slough and the tributary sloughs. Minimal impacts from the SMSCG occur in western areas of the Marsh (Cordelia Slough and Goodyear Slough).

Local runoff from Green Valley Creek and Suisun Creek potentially could lower salinity in Cordelia Slough and Suisun Slough after storm events. However, the greatest local runoff often accompanies large flows from the Delta, so salinity-lowering impacts from local runoff in general may be relatively unimportant as salinity throughout the Marsh will already be relatively low when local runoff stands to make the greatest contribution. The 20 cfs discharge of treated wastewater effluent from the Fairfield-Suisun wastewater treatment plant to Boynton Slough provides an additional source of relatively non-salty water year-round that slightly reduces salinity in the upstream end of Suisun Slough.

One source of quantitative data is daily estimates of Delta outflow calculated using the DWR DAYFLOW database. Calculations were based on measured inflows, measured exports, and estimated channel depletions (diversions for agriculture minus drainage and runoff pumped from the Delta islands). Although daily variations in Delta outflow can be large, the average salinity at any particular station in the Estuary responds slowly, with a definite time-lag response. CCWD staff (Denton and Sullivan 1993) calculated the effective outflow based on the sequence of daily Delta outflow values. The equation used is similar to the X2 equation and results in a "moving average" of outflow. CCWD staff also found that salinity (measured as EC or concentration of chloride) at each Estuary station could be estimated from the effective outflow with a negative exponential equation. Based on these calculations, the daily average salinity (as EC) at Martinez, Port Chicago, and Collinsville can be estimated accurately from the daily effective outflow, providing a descriptive procedure for evaluating the range of seasonal salinity in the Marsh as a function of the seasonal Delta outflow conditions.

Measured Suisun Marsh Salinity (Electrical Conductivity)

Figure 5.2-2 illustrates daily Delta outflow, estimated effective outflow, and salinity (as EC) for Suisun Bay stations in 2002 and 2003. The salinity gradient in Suisun Bay can be identified from these data. During periods of high outflow, Suisun Bay salinity is reduced and the salinity gradient is smaller. During periods of low Delta outflow, the salinity (as EC) at Martinez increases to about 30 mS/cm, and the salinity upstream increases proportionally.

Modeled Delta outflow estimates are lower than daily (sampled) Delta outflow measurements when actual Delta outflow is increasing, and effective outflow estimates are higher than daily outflow readings when Delta outflow is decreasing. The effective Delta outflow model is similar to a 14-day moving average of Delta outflow. The minimum effective outflow was less than 5,000 cfs in the fall of both 2002 and 2003. The SMSCG were operated during the October–December period in both years. Delta outflow increased sufficiently in December 2002 to reduce the Marsh channel salinity to meet the salinity objective from January through May 2003, so the SMSCG were not operated after December 2002. As the effective outflow increases, the salinity at all Suisun Bay stations and in the Marsh decreases. As the effective outflow declines, the salinity at all Suisun Bay stations and in the Marsh increases.

Figure 5.2-3 compares estimated salinity against actual measured salinity (as EC) for various Suisun Bay locations. Salinity data from Martinez (generally the highest) and Collinsville (the lowest) define the full range of salinity values in the Suisun Bay area. The top chart portrays measured (actual) salinity during 2002 and 2003 at Collinsville, the SMSCG, and Martinez, and estimated salinity (using CCWD equations) for Collinsville and Martinez. Delta outflow is also portrayed (blue line). As shown, estimated and actual salinity values coincide reasonably well.

The bottom chart plots actual and estimated salinity (as EC) at each Suisun Bay station against effective (modeled) Delta outflow. Collinsville salinity (as EC) declines rapidly as effective outflow increases. This model suggests that Delta outflow is a major factor controlling salinity in Suisun Bay and adjacent Suisun Marsh channels.

The top graph in Figure 5.2-4 compares actual salinity (as EC) measured at several locations along Montezuma Slough in 2002 and 2003. Note a roughly inverse relationship between measured salinity and modeled outflow for all sites (except, naturally, at the SMSCG).The bottom chart illustrates data for the same parameters and time period at Suisun Slough sample sites (fleet data are provided for comparison in both the upper and lower chart). Once again, salinity and flow appear to be inversely related. This suggests that flow is a key impact on salinity levels throughout the Marsh.

Hill Slough salinity was probably lower than the other Suisun Slough stations because of the 25 cfs of low salinity treated wastewater from the Fairfield-Suisun treatment plant discharged into Boynton Slough near the upstream end of Suisun Slough. Tidal mixing distributes this non-saline water throughout the upper end of Suisun Slough (including Peytonia, Boynton, and Hill Sloughs).

Based on current measurements and modeling, Delta outflow is postulated to be the major factor controlling salinity in the Marsh. Dilution of the western sloughs (e.g., Cordelia and Chadbourne Sloughs) occurs after major local storm runoff events. Salinity at the upper end of Suisun Slough is diluted by the Fairfield-Suisun treated wastewater of about 25 cfs. Each year's data reveals a different seasonal salinity regime, controlled by the seasonal pattern of effective outflow.

Suisun Marsh Salinity Control Gates

The SMSCG near Collinsville began operating in October 1988. The gates control salinity by allowing tidal flow from the Sacramento River into Montezuma Slough during ebb (outgoing) tides but restricting the tidal flow from Montezuma Slough during flood (incoming) tides. The SMSCG cause a net inflow (about 2,500 cfs) of low-salinity Sacramento River water into Montezuma Slough. Operation of the SMSCG lowers salinity in some Marsh channels, primarily those in the eastern Marsh, and results in a net movement of water from east to west. The SMSCG generally are operated from October through May to meet the Suisun Marsh salinity standards (objectives). They generally are not operated when salinity becomes lower than the monthly salinity objectives because of high Delta outflow. The operation of the SMSCG may increase the salinity in Honker Bay and the Delta slightly because the forced diversion into Montezuma Slough reduces the net outflow past Chipps Island and may allow slightly higher seawater intrusion from tidal mixing.

The SMSCG normally are operated from October through May by DWR to help meet D-1641 Suisun Marsh salinity standards for that critical period. The SMSCG have been operated in September occasionally to help reduce Marsh channel salinity prior to initial flooding of managed wetlands in October. Flooding managed wetlands with low-salinity water in late September or early October helps prevent the buildup of salt in flooded (and later dried) temporary pond sediments and improves food plant production for preferred waterfowl species during non-flooded periods later in the year.

Restrictions on unscreened diversions to managed wetlands are intended for the protection of delta smelt and winter-run Chinook salmon, but make it more difficult to manage soil leaching cycles efficiently. It therefore is important to managed wetlands that the intake of salt be reduced to the extent possible during the initial flooding.

Figure 5.2-4 suggests that the SMSCG operation in October of 2002 and 2003 reduced Montezuma Slough salinity somewhat in both years. Hunter Cut, Belden's Landing, and National Steel salinity levels dropped noticeably following SMSCG operations. The Collinsville salinity readings remained relatively constant during the period of SMSCG operations, probably because the effective Delta outflow remained relatively low during that period. Higher Delta outflow in December summarily reduced the Collinsville salinity as well as salinity at the other Suisun Bay stations.

The total number of days the SMSCG are operated varies from year to year. From 1988 to 2004 the SMSCG were operated between 60 and 120 days from October to December. With time and operational experience, achieving salinity standards requires fewer days of SMSCG operation. In 2006 and 2007, the SMSCG were operated periodically between 10 and 20 days annually. This level of operation should continue in the future, except perhaps during the most extreme hydrologic conditions.

Dissolved Oxygen and Temperature

As described above, oxygen concentrations in water and water temperature are somewhat related. Higher water temperatures generally result in lower DO concentrations because the maximum amount of oxygen that can be held dissolved in water (the saturation level) decreases with increased water temperature. This is one reason that unusually warm water temperatures negatively affect some aquatic animals. In Suisun Marsh, low DO levels and warm water conditions may result when discharges of long-impounded water from managed wetlands temporarily overwhelm receiving water in the tidal sloughs. This can occur throughout the Marsh but has been associated most with small dead-end sloughs in Region 1. In compliance with the previous ESA/Essential Fish Habitat (EFH) consultation terms and conditions, managed wetland managers have implemented the following actions:

- eliminate as much drainage discharge to Boynton and Peytonia Sloughs as deemed possible and relocate drainage to Suisun Slough;
- discourage growth of and mow broad-leaved vegetation prior to flood-up to reduce BOD while ponds are inundated;
- increase circulation in managed wetlands to reduce BOD and total organic levels in drainage water (i.e., help prevent incidences of "black water"); and
- implement rapid flooding and drainage to increase water aeration.

These measures are only partially effective in controlling DO and in some cases they could exacerbate the impacts if all the discharges from landowners occur over the same short period of time.

SRCD monitored Peytonia, Boynton, Suisun, Cordelia, Chadbourne, and Goodyear Sloughs in 2006 and 2007 for temperature and DO conditions (Suisun Resource Conservation District and California Department of Fish and Game 2009). DO concentrations in discharge water were consistently less than 5 mg/l, whereas DO levels in receiving (slough channel) waters were generally higher than that level. (Boynton Slough DO concentrations were generally lower than measurements at other ambient stations. The Fairfield-Suisun wastewater discharge may be a factor in the low Boynton Slough DO measurements, although the discharge satisfies the ambient monitoring DO requirements specified by the San Francisco Bay RWQCB. UC Davis researchers also have monitored selected areas in the Marsh. Preliminary results suggest that DO levels have improved in many small tidal sloughs with previous problems.

Suspended Sediment and Contaminants

SS concentrations have been measured at several locations throughout Suisun Marsh. Ruhl and Schoellhamer (2004) measured SS concentrations at a shallow-water site (Honker Bay) and a deep-water channel (Mallard Island) from December 1996 through July 1997. They found similar temporal trends caused by tidal velocities and storm events at both the shallow-water and deep-channel sites. In December, SS was relatively low (25–50 mg/l) at both sites but increased following the first-flush winter storm event to 100–150 mg/l in Honker Bay and 50–100 mg/l at Mallard Island.

The Blacklock Restoration Project is located on Nurse Slough adjacent to Little Honker Bay and provides an example of background SS levels. DWR measured SS concentrations at two locations in Nurse Slough from December 2004 to April 2006 as part of background monitoring for the restoration plan (see Figure 5.2-5). Average SS concentration was about 100 mg/l. Concentrations were lowest (about 50 mg/l) in fall 2005. It appears that Suisun Bay and the Marsh channels have a reasonably high and relatively constant SS concentration of about 50–100 mg/l.

SS binds metals and other potentially toxic chemicals and pollutants, including mercury. However, as discussed elsewhere in this section, clear, predictable relationships among the various forms of mercury, appearing in different media (e.g., water, sediment, living tissue), often are lacking or at least are not well understood. At present, there are no firm grounds to assume that temporary changes to SS levels during habitat restoration will result in higher (or lower) levels of organic mercury, the form of most concern, in resident fish and other species.

Mercury and Methylmercury

The concentration of total mercury in sediments at various levels sampled throughout San Francisco Bay averages about 0.4 ppm (Conaway et al. 2007). However, total mercury levels in deeper bay sediments (which are probably more representative of older, pre-mining and pre-industrial, natural background conditions) average only about 0.05 ppm (almost 10 times less). The higher total mercury levels in shallow, more recent bay sediment layers probably originated with upstream mining (i.e., historical use of elemental mercury in gold processing) and from industrial activities surrounding the Bay-Delta. In comparison, Sacramento River sediment averages about 0.1 ppm in total mercury (one-fourth that of the Bay concentration). The gradual influx of this relatively cleaner sediment into the Bay-Delta therefore may contribute to a long-term overall reduction in the average total mercury load in San Francisco Bay estuary sediments.

As previously discussed, methylmercury concentrations in sediment normally are not correlated with total sediment mercury levels, being linked instead to amounts of sulfate and organic materials in sediment. For example, methylmercury sediment concentrations are generally less than 1% of total mercury levels, but were found as high as 5% in wetlands sediment with relatively high organic peat content near Franks Tract (Choe et al. 2004).

The concentration of SS in Suisun Bay and the Marsh channels is often relatively high (e.g., 50–100 mg/l), and similar concentrations have been measured in Little Honker Bay near the Blacklock tidal wetlands restoration. Mercury is strongly adsorbed onto sediment particles, so inorganic mercury historically entered Suisun Marsh channels from Suisun Bay through tidal transport, creating legacy total mercury sediment concentrations similar in magnitude to those in upper-level San Francisco Bay sediments (i.e., 0.4 ppm).[1]

[1] Slotten et al. (2002) sampled surficial sediments (top 1 cm) throughout Suisun Marsh and the Delta and analyzed the samples for total mercury. Mercury concentrations in Suisun Marsh generally ranged from 0.20 to 0.33 ppm (dry weight). Heim et al. (2003) collected sediment from Suisun Bay and Grizzly Bay and found total mercury concentrations averaging 0.3 ppm (dry wt) with some sites above 0.5 ppm (dry wt). Hornberger et al. (1999) found that the mercury concentration in surficial sediment from Grizzly Bay was about 0.3 ppm. However, the concentration increased to 0.95 ppm at a depth of 30 cm. The mercury-enriched zone persisted to about 80 cm before declining to a background concentration of 0.05 to 0.08 ppm. The higher mercury concentrations in sediments 30–80 cm deep were attributed to hydraulic mining debris.

Slotten et al. (2002) found that flooded tracts characterized by dense submergent and/or emergent aquatic vegetation and highly organic sediments had greater levels of methylmercury in sediment than adjacent non-wetland control sites. These sites generated all of the most elevated sediment methylmercury samples, with vegetated wetlands tracts exhibiting up to 10 times greater methylmercury concentrations than adjacent control sediments. In Suisun Bay, sediment samples were collected from the Ryer Island tidal marsh and the adjacent Grizzly Bay. Methylmercury concentrations on Ryer Island were 2.15 nanograms of methylmercury per gram of sediment (ng/g) compared to 0.30 ng/g in the adjacent channel. (A nanogram is 1/1000 of a microgram [µg].) 2 nanograms are equivalent to about 2 parts of methylmercury per 1 billion parts of sediment, or about 0.5% of the total mercury content of 0.4 ppm. Methylmercury concentrations are generally less than 1% of total mercury in Bay-Delta sediment. The local production of methylmercury by sulfate-reducing bacteria, which may be controlled by the organic content of the sediment, is likely the most important factor for methylmercury concentration. The methylmercury moves into the pore water and is transported to the water column. Benthos (invertebrates, clams) may ingest mercury from the sediments. Phytoplankton and zooplankton incorporate mercury from the water. Fish are exposed to water (very low concentrations) and to the phytoplankton and zooplankton and benthos that they eat.

Mercury concentrations[2] in bivalve organisms (e.g., mussels, clams) range from about 0.5 to 2.5 ppm (dry weight). This is somewhat higher than mercury concentrations found in game fish tissue in the estuary. The national human health criterion for mercury in fish tissue is 0.3 ppm, as established by the EPA (U.S. Environmental Protection Agency 2001). The San Francisco Bay RWQCB mercury TMDL has established a fish tissue methylmercury objective of 0.2 ppm for game fish. The mercury objective for small fish used as prey (forage) by waterfowl, shore birds, and other wildlife is 0.03 ppm. Many of the small fish in the Bay-Delta have average mercury concentration of about 0.025 to 0.075 ppm (Greenfield et al. 2006).

Environmental Consequences

Assessment Methods

Dissolved Oxygen

Changes in levels of DO in Marsh channels are related primarily to annual discharges of poor-quality water from adjacent managed wetlands. Hunting club management procedures create yearly low DO conditions in impounded seasonal waterfowl ponds. When these waters are discharged into sloughs with minimal tidal flushing, the quality of water in the sloughs can decrease significantly, at

[2] Tissue samples are frequently measured in the laboratory for total mercury, as most mercury in animal tissue is methylmercury.

least temporarily. Discharges into the Marsh from adjacent developed and agricultural areas likely contribute to the problem. Tidal restoration of portions of the Marsh would result in fewer poor-quality (e.g., low-DO) conditions. Because the level of improvement to DO concentration levels in Marsh sloughs from tidal restoration cannot be quantified precisely, impacts are described qualitatively.

Total Organic Carbon

There is no evidence to suggest that tidal wetlands will produce larger volumes of vegetation and export more total organic carbon (TOC) than managed seasonal wetlands. There are few measurements of TOC export from managed wetlands, and the contribution of TOC from tidal wetlands has not been measured reliably. Therefore, these impacts are evaluated qualitatively.

Suspended Sediment

The level of SS in Suisun Bay and Marsh sloughs is closely related to measurements of turbidity. Many contaminants are found to be strongly adsorbed (i.e., bound) to sediment particles. The San Francisco Bay Basin Plan SS objectives (turbidity) require the effects of discharge or dredging to be no more than a 10% increase in background levels. Evaluating turbidity in a hydraulically complicated, tidally influenced bay-marsh system is difficult, at best. Impacts of upstream flow, storm and wind events, and existing narrow channels can be difficult to separate from any short-term restoration/construction activities. As there are no measurements of SS or turbidity concentrations in the yearly managed-wetland discharges, the effects of tidal restoration and dredging will be discussed qualitatively.

Methylmercury

The possibility of either increasing or decreasing the amount of methylmercury exported into the bay by restoring tidal wetlands (as compared to maintaining existing managed wetlands) is possible but not yet scientifically proven. Most area experts suspect that low-lying, continuously wet tidal wetlands generally produce and export smaller quantities of methylmercury than do managed wetlands. However, there are no comprehensive studies comparing methylmercury production and export between tidal and seasonal wetlands.

Salinity

Salinity is an important water quality parameter for Suisun Marsh because the presence of salt negatively affects the ability of wetland managers to encourage the growth of vegetation that supports preferred waterfowl species. Salinity in the Marsh is controlled primarily by salinity in Suisun Bay. The salinity of water applied annually to managed wetlands, as well as yearly management (e.g., drainage, leaching) practices, controls the cumulative buildup of salt in managed wetlands soils, which in turn affects vegetation for preferred duck and waterfowl species.

An RMA hydrodynamic and water quality model of San Francisco Bay and the Delta was manipulated to identify and evaluate potential salinity impacts from SMP alternatives. The model evaluated 2 restoration scenarios (Set 1 and Set 2) as shown in Figure 5.2-6, which were intended to capture the range of salinity effects based on different restoration configurations. Details are provided in Appendix A.

The model was used to test the hypothesis that introduced tidal flow to Marsh areas bordering the bay might increase salinity in the Delta and Marsh channels used as a source for seasonal-pond flood-up and at water supply diversion locations. Likely changes to salinity as the result of tidal restoration are described in Appendix A. The RMA model was used to simulate tidal conditions and salinity in the Marsh and Delta for 2002 and 2003 because actual outflow in those years was generally low and those years therefore represent a worst-case (i.e., relatively high fall salinity) scenario.

Using the 2002–2003 low-flow period, comparisons of simulated salinity levels and actual measured salinity values at 14 key monitoring sites suggest that salinity levels in the western portion of Suisun Marsh will not be significantly affected by any of the tidal restoration scenarios (see Appendix A).

Significance Criteria for Water Quality Assessment

Dissolved Oxygen

The San Francisco Bay RWQCB Basin Plan water quality objectives for DO are 7 mg/l for Estuary waters above the Carquinez Bridge, and a 3-month median level of at least 80% of the DO saturation point. A significant deleterious impact on some sensitive species may occur when oxygen concentrations fall below that number (<7 mg/l), or from any reduction in DO levels of more than 20% below the oxygen saturation level. DO levels below the legal water quality objective (7 mg/l) have been observed in virtually all sloughs of the Marsh including Grizzly Bay.

Turbidity

The RWQCB Basin Plan turbidity objectives prohibit more than a 10% increase in turbidity attributable to waste discharge in waters where natural turbidity is above 50 NTU. Turbidity is often directly related to the level of SS. An increase in SS (turbidity) from dredging or tidal restoration of more than 10% of the average background concentration is considered significant. A 10% increase may be difficult to detect because the measured turbidity variations in Suisun Bay and Marsh channels are relatively large during the daily tidal cycles and within the monthly spring-neap tidal cycle.

Mercury

Accurate determination of quantitative significance thresholds for judging potential impacts from methylmercury production and export is difficult because of the complicated nature of mercury chemistry in the environment and indefinite relationships among mercury levels in various media (sediment, water, and animal tissue). Water quality objectives (San Francisco Bay RWQCB Basin Plan) for mercury in Suisun Bay and Marsh saline and brackish waters are in units of total, not methyl-, mercury per water volume: 2.1 µg/l (1-hour average). (For fresh water [salinity <1,000 ppm], the 1-hour average is 2.4 µg/l.) As stated elsewhere, the statistical relationships between total mercury in water and methylmercury in water and living animals are often poor and non-predictive. Yet any impact on natural resources is related to the level of methylmercury in resident animals. Nonetheless, these total mercury objectives, developed by the EPA, are intended to be conservatively protective against bioaccumulation of methylmercury in the food chain and apparently are the only mercury-related water quality objectives that apply to the Suisun area.

No methylmercury water quality objectives and no methylmercury TMDL as yet applies specifically to Suisun Bay or Marsh waters. A methylmercury TMDL for the upstream, primarily freshwater Delta adopted in April 2010 by the Central Valley RWQCB includes target numbers of 0.03 mg/kg (<5 cm), 0.08 (trophic level 3), and 0.24 mg/kg (trophic level 4) for fish tissue, and a corresponding concentration of 0.06 ng/l for ambient fresh waters, all intended to protect human health and wildlife.

For downstream waters a San Francisco Bay mercury TMDL includes target values for protection of (a) human health of 0.2 mg/kg (wet weight) in sport fish and (b) wildlife of 0.03 mg/kg (wet weight) in fish 3 to 5 cm in length (i.e., prey items for many larger fish and for birds). That same TMDL includes target numbers for total mercury in SS (0.2 ppm, dry weight). Again, total mercury levels in sediments do not necessarily accurately predict methylmercury levels in resident animals.

As there are no applicable methylmercury water quality objectives for the Suisun Bay area, determinations of mercury-related significance must be predominantly qualitative. Impacts were considered significant if an alternative would:

- violate any applicable water quality standards or waste discharge requirements,
- degrade surface water and/or groundwater quality, or

- discharge contaminants into the waters of the United States.

Salinity

Any increase in salinity exceeding State Water Board Delta salinity standards is a significant impact. For purposes of this analysis, however, those increases that do not exceed objectives, but are nonetheless greater than 10% of the applicable monthly salinity objective, are also considered significant.[3] Salinity changes that are less than 10% of the maximum monthly criteria are similar to natural variability and are not likely to cause significant harm to natural habitat or species.

For Suisun Marsh objectives, the lowest salinity (as EC) objective is 8 mS/cm in February and March, so the most restrictive guideline would be an increase of more than 0.8 mS/cm in February or March. For the upper Delta water supply intakes, the salinity objective is 1 mS/cm, so the 10% guideline would be a change in salinity of more than 0.1 mS/cm. This guideline is intended to protect the water quality for managed wetland habitat, as well as the salinity at Delta drinking water intakes and agricultural diversions.

Environmental Impacts

No Action Alternative

The existing management of salinity conditions with the operation of the SMSCG would continue as it has since 1988 to lower salinity during the fall and winter period when water is applied to the managed wetlands. Actual operations of the SMSCG would depend on environmental conditions and regulatory constraints by BOs for the Continued Operation of the CVP and SWP (U.S. Fish and Wildlife Service 2008; National Marine Fisheries Service 2009) and other application permits. Uncontrolled levee breaches could occur and, if not repaired, could result in small changes in salinity regimes in the Marsh and, potentially, the Delta. The extent of this change would be based on the size and location of the breaches and whether they are repaired. However, without adequate supplies of levee materials to maintain levees at current standards as well as address sea level rise, the potential for levee failure and resultant changes in water quality will increase over time.

[3] A 10% change in the baseline salinity value would not be considered significant in an estuarine tidal slough or channel unless the baseline salinity was approaching the maximum monthly objective. A 10% (or 5% or 20%) change in baseline salinity has been considered significant in some previous salinity impact analyses. However, if the baseline monthly salinity is relatively low, the significance criteria will be relatively small. A small change in salinity is not likely to cause concern. On the other hand, salinity that increases by a substantial fraction of the monthly salinity objective is potentially harmful.

The No Action Alternative also assumes that absent the SMP, it would be difficult for managed wetland operations to continue as a result of an inability to secure the necessary environmental permits. As such, it is expected that most, if not all, managed wetland flood and drain activities would cease, and the current water quality degradation from managed wetland operations likewise would be reduced. This would result in an improvement in many water quality parameters, including DO, BOD, sulfide, and methylmercury.

Cattle grazing, common on grasslands in Potrero Hills and other surrounding uplands, contributes to (a) increased sediment in adjacent sloughs, (b) degradation or elimination of riparian habitat, (c) trampling of tidal wetland vegetation along sloughs, and (d) introduction of excessive nutrients. Agricultural drainwater from the northwestern and northeastern Marsh contaminates creeks and sloughs in the northwestern and northeastern Marsh with pesticides, herbicides, and fertilizers. Permitted discharges of stormwater and treated wastewater, plus the occasional pollutant spill, also would continue to contribute proportionately and seasonally to Marsh water degradation.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact WQ-1: Increased Salinity in Suisun Marsh Channels from Increased Tidal Flows from Suisun Bay (Grizzly Bay) as a Result of Restoration

Increased tidal flows in Marsh channels from restoration would not significantly increase salinity in channels connecting Suisun Bay with restored tidal wetlands. Seasonal magnitude of salinity in the Marsh would continue to be governed primarily by Delta outflow and operation of the SMSCG. Therefore, changes to salinity are expected to be insignificant.

Additional tidal wetland within the Marsh would increase the tidal flows throughout the Marsh channels and could increase the salinity in the channels between Suisun Bay and the new tidal wetlands. The magnitude of the salinity effects would depend on the location (and breach connection) of the new tidal wetlands and the size (acreage) of the new tidal wetlands. Restoration with tidal connection to Suisun Bay or Honker Bay may have the largest salinity effects. The effects would be greatest during period of low Delta outflow when the Suisun Bay salinity is highest and the salinity gradients within Suisun Bay and along Montezuma Slough are strongest. However, the seasonal magnitude of the salinity in the Marsh would continue to be governed by Delta outflow and operation of the SMSCG.

Modeling by RMA suggests that maximum changes in monthly average salinity in the Marsh would be less than 10% (Appendix A). Figures 5.2-7 to 5.2-13 show simulated salinity in selected Marsh channels for baseline conditions and for simulated tidal restoration conditions (with about 7,500 acres of new tidal restoration) for years 2002 and 2003. Salinity changes in the Marsh sloughs would depend on the additional tidal restoration upstream and downstream from the stations, as well as the location within the Marsh. For example, Goodyear Slough and Cordelia Slough salinity probably would not change with additional tidal wetland restoration in the Marsh because salinity in the western Marsh is strongly controlled by Delta outflow and the corresponding Suisun Bay salinity. The results from this modeling generally indicated the following changes in salinity:

- Mouth of Suisun Slough—No change.
- Montezuma Slough at Hunter's Cut—The simulated restoration cases did not change the EC at Hunter's Cut by more than 1 mS/cm (Figure 5.2-7). No significant change.
- Montezuma Slough at Belden's Landing—The simulated restoration cases did not change the EC at Belden's Landing by more than 1 mS/cm (Figure 5.2-8). No significant change.
- Montezuma Slough at National Steel—Estimated reduction in salinity by about 1 mS/cm (Figure 5.2-9). No significant change.
- Suisun Slough at Volanti—Estimated increase in salinity by about 1 mS/cm (Figure 5.2-10). No significant change.
- Hill Slough—Estimated increase in salinity by about 1 mS/cm (Figure 5.2-11). No significant change.
- Cordelia Slough—The simulated restoration cases had little effect on the simulated EC in Cordelia Slough (Figure 5.2-12). No significant change.
- Goodyear Slough at Morrow—The simulated restoration cases had little effect on the simulated EC in Goodyear Slough (Figure 5.2-13). No significant change.

Models suggest that monthly salinity changes would likely be less than about 5 to 10% of the baseline monthly salinity value, and hence would be less than the significance criteria (10% of salinity objective from October to May). For maximum seasonal salinity values in October (about 15–20 mS/cm) any increase in salinity caused by tidal wetland restoration above the maximum monthly objective (19 mS/cm) would be significant. Any change of more than 10% (1.9 mS/cm) also would be considered significant. Simulated changes in the Marsh locations are much less than these values. Salinity changes in the Marsh channels therefore would be less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WQ-2: Changes to Salinity of Water Available for Managed Wetlands from October to May

As described under Impact WQ-1, models predict that salinity changes at Suisun Marsh monitoring locations, including the eastern channels, would be much less than the maximum allowed by monthly objectives. Also, any change in salinity would be substantially less than 10% of the objectives at those locations. Additionally, the seasonal salinity pattern (determined primarily by Delta outflow) would remain similar, and any potential change to salinity should not reduce the value of Marsh channel water for managed wetlands flood and drain operations.

Conclusion: Less than significant. No mitigation required.

Impact WQ-3: Increased Salinity at Delta Diversions and Exports

Models indicate that any increases in salinity in channels and sloughs upstream can be eliminated by physically connecting tidal wetlands to existing Marsh channels, rather than directly to Suisun Bay. Using this design, any upstream salinity impacts from tidal restoration would be less than significant. Figures 5.2-14 and 5.2-15 indicate that even the largest increase in upstream salinity would be much less than 10% of the average baseline salinity, with no month increasing by more than 10% of any pertinent salinity objective.

Conclusion: Less than significant. No mitigation required.

Impact WQ-4: Possible Changes to Methylmercury Production and Export as a Result of Tidal Restoration

Many, if not most, northern California environmental mercury experts suspect that tidal wetland habitat produces and exports less methylmercury than managed wetlands. Unfortunately, authoritative studies comparing methylmercury production and export among the tidal and non-tidal wetlands are lacking. There is no evidence to conclude that tidal restoration in the Marsh would lead to increased problems with methylmercury for fish and wildlife (and consumers). One preliminary, unpublished account focusing on water entering and leaving the newly tidal Blacklock area suggests an overall reduction in the export of methylmercury in water. This result must also remain preliminary and unsubstantiated. However, ultimately it is not the amount of inorganic or even organic mercury in sediment or in water that is most critical, but the amount of organic mercury that appears in representative, resident organisms and that enters the food chain. As yet there are insufficient data to conclude that those amounts would increase with tidal restoration.

It is reasonable to assume that tidal wetland restoration in Suisun Marsh will not result in increased methylmercury compared to the baseline export of mercury (total or methyl-) in sediment or soils from managed wetlands to tidal sloughs during flood and drain activities. In cooperation with regional monitoring and research efforts, sediment and fish monitoring will be conducted at several restoration sites. Ongoing information can be used adaptively to correct long-term construction and management plans and activities associated with restoration.

Some experts suspect an actual benefit of less methylmercury being exported by tidal marshes than from existing habitat may occur.

Conclusion: Less than Significant. No mitigation required.

Impact WQ-5: Improved Dissolved Oxygen Concentrations in Tidal Channels from Reduced Drainage of High Sulfide Water from Managed Wetlands

As a result of the conversion of managed wetland to tidal wetland, there is the potential of increasing DO and reducing sulfide concentrations in Marsh channels, thereby improving overall water quality conditions. The extent to which this happens depends on the location of restoration sites. Sites with little or no previous DO problems probably would not see a noticeable benefit. Managed wetlands with low-DO events that are restored to tidal influence should see the greatest improvement in water quality. Tidal restoration therefore is expected to have a beneficial impact on water quality because it would increase levels of DO and improve overall water quality in Marsh channels.

Conclusion: Beneficial.

Impact WQ-6: Temporary Changes in Water Quality during Construction Activities

Remobilization of sediments into the water column caused by restoration activities such as levee breaching can lead to temporary, localized increases in SS and DO. However, construction activities would be spread throughout the Marsh and over the 30-year implementation period.

Additionally, as described in Chapter 2 in the Environmental Commitment section, Erosion and Sediment Control Plan and Stormwater Pollution Prevention Plan, SS will be minimized during project activities. Because of the short duration, limited extent of local construction activities, implementation of the appropriate best management practices, and environmental commitments to minimize and control erosion, these temporary water quality impacts would be less than significant.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact WQ-7: Temporary Degradation of Water Quality during Implementation of Managed Wetland Activities

Increased frequency of managed wetland activities and new activities occurring on the waterside of levees could result in temporary and localized impacts on water quality. These activities would occur in small, distinct, localized areas throughout the Marsh and be minimized through the implementation of standard BMPs, as described in Chapter 2.

Conclusion: Less than significant. No mitigation required.

Impact WQ-8: Temporary Degradation of Water Quality during Dredging, Including Possible Increases in Mercury Concentrations

Project dredging would result in a temporary degradation of water quality as a result of disturbing channel-bottom sediments. Water quality parameters that might be affected would include levels of SS, ammonia, and possibly mercury (in SS). But the form of mercury in the SS probably would be predominantly inorganic, with minor or no additional impacts on aquatic life expected. Temporary changes in turbidity would be minimal and localized, and because the minimum SS concentrations in the Marsh are relatively high, the effects of dredging in Marsh channels would not likely change the already relatively turbid conditions. The localized and temporary impacts would be similar to increased levels of SS caused by spring tides and major runoff events. These effects on SS concentrations in the tidal channels of the Marsh are expected to be less than 10% of the background (e.g., about 50 mg/l).

While levels of inorganic mercury may increase temporarily, there currently exists no reasonable evidence to assume a significant increase in methylmercury concentrations in Marsh or Bay organisms as a result of these temporary dredging activities.

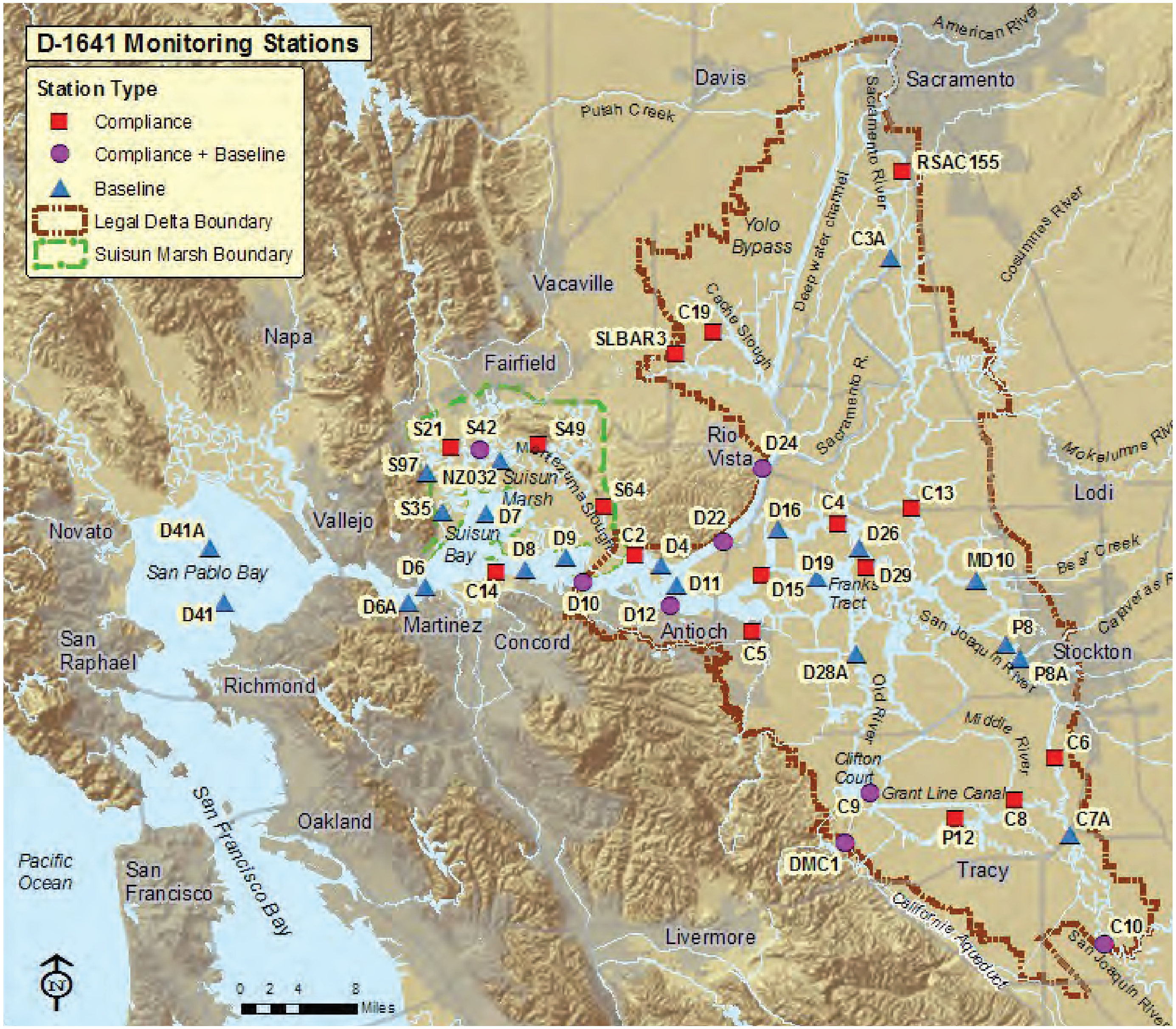
Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Impacts of Alternative B are similar to those described for Alternative A. Under Alternative B, less tidal restoration would occur, so the magnitude of any adverse or beneficial impacts described for restoration under Alternative A would be less for Alternative B, and the impacts of managed wetland activities would increase compared to Alternative A. The significance of adverse impacts would be the same as under Alternative A.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C are similar to those described for Alternative A. Under Alternative C, more tidal restoration would occur, so the magnitude of any adverse and beneficial impacts described for restoration under Alternative A would increase under Alternative C, and impacts related to managed wetland activities would decrease compared to Alternative A. The significance of adverse impacts would be the same as under Alternative A.



Location	Station
Martinez	D6
Port Chicago	C14
Chipps Island	D10
Collinsville	C2
Jersey Point	D15
Clifton Court Forebay (SWPExports)	C9
Delta Mendota Canal (CVP Exports)	DMC1

Source: Source: Department of Water Resources, Bay Delta and Tributaries (BDAT) website.

Graphics/Projects/project number/document (date) SS

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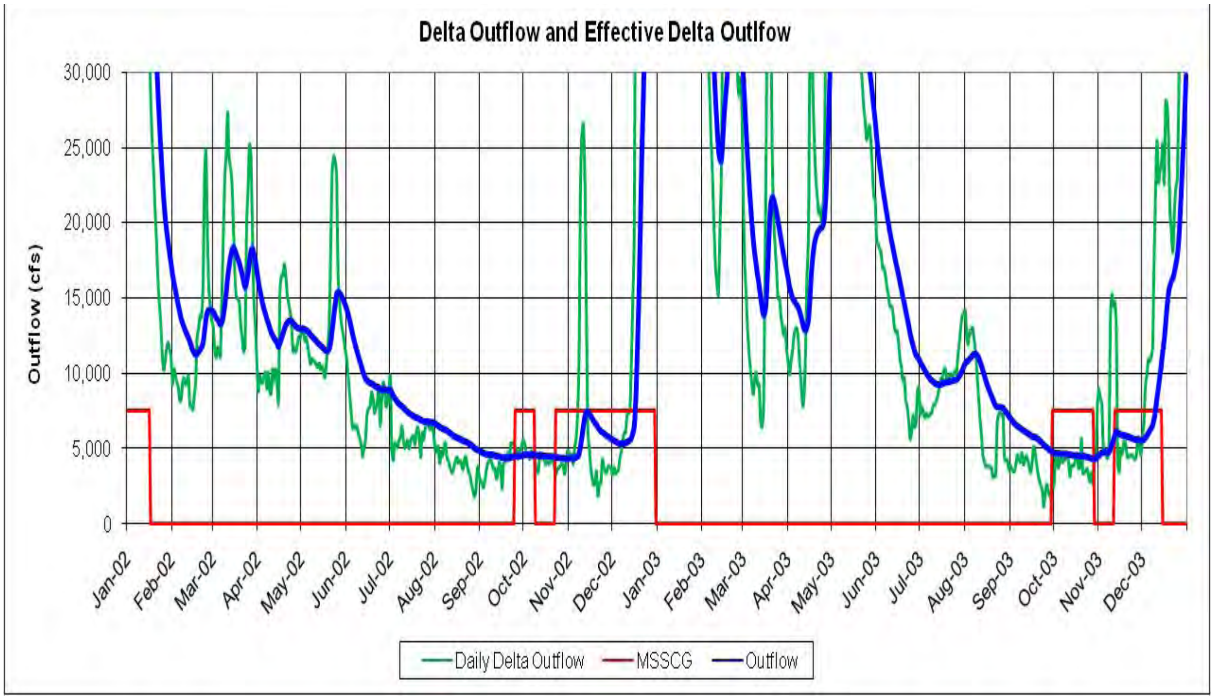
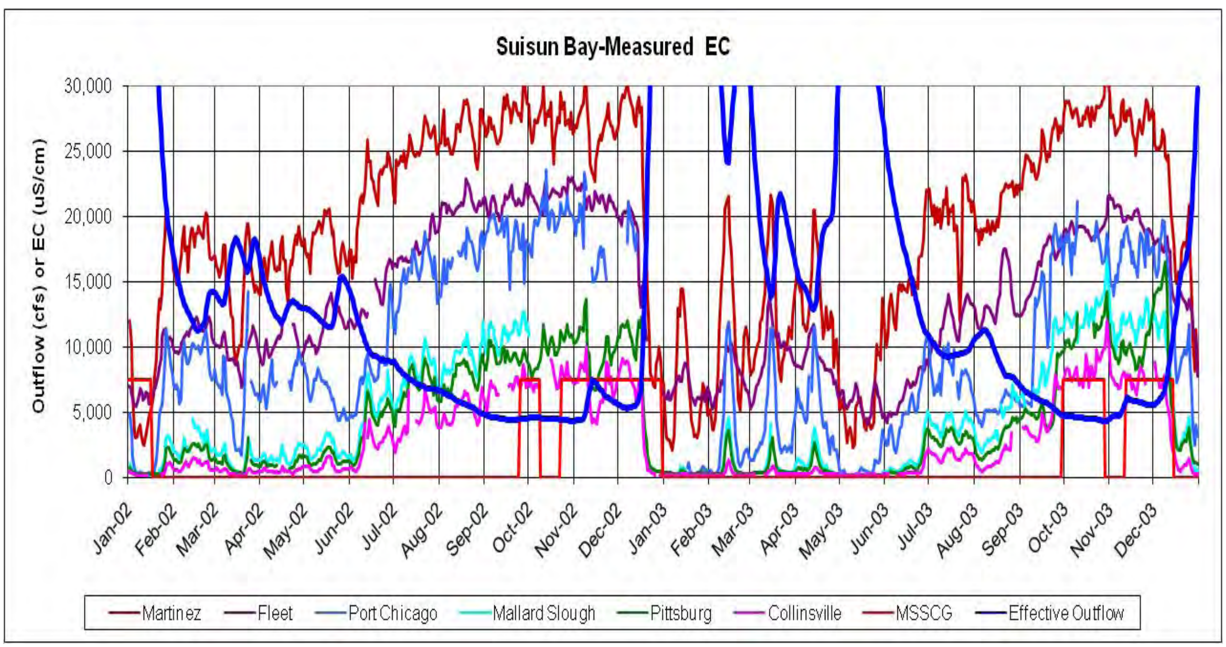
Figure 5.2-1
Map of Water Right Decision1641 Monitoring Stations

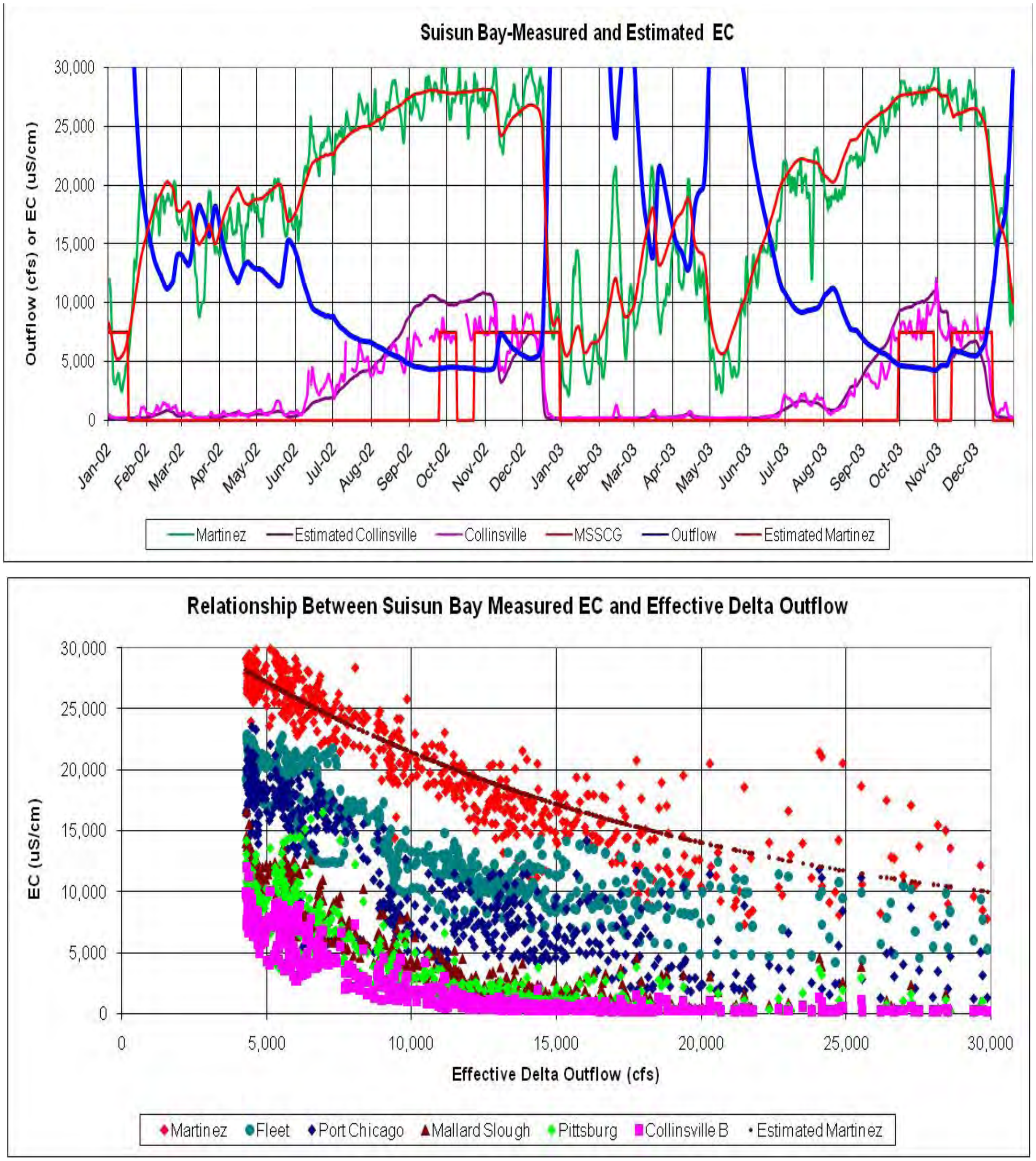




Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

ICF INTERNATIONAL

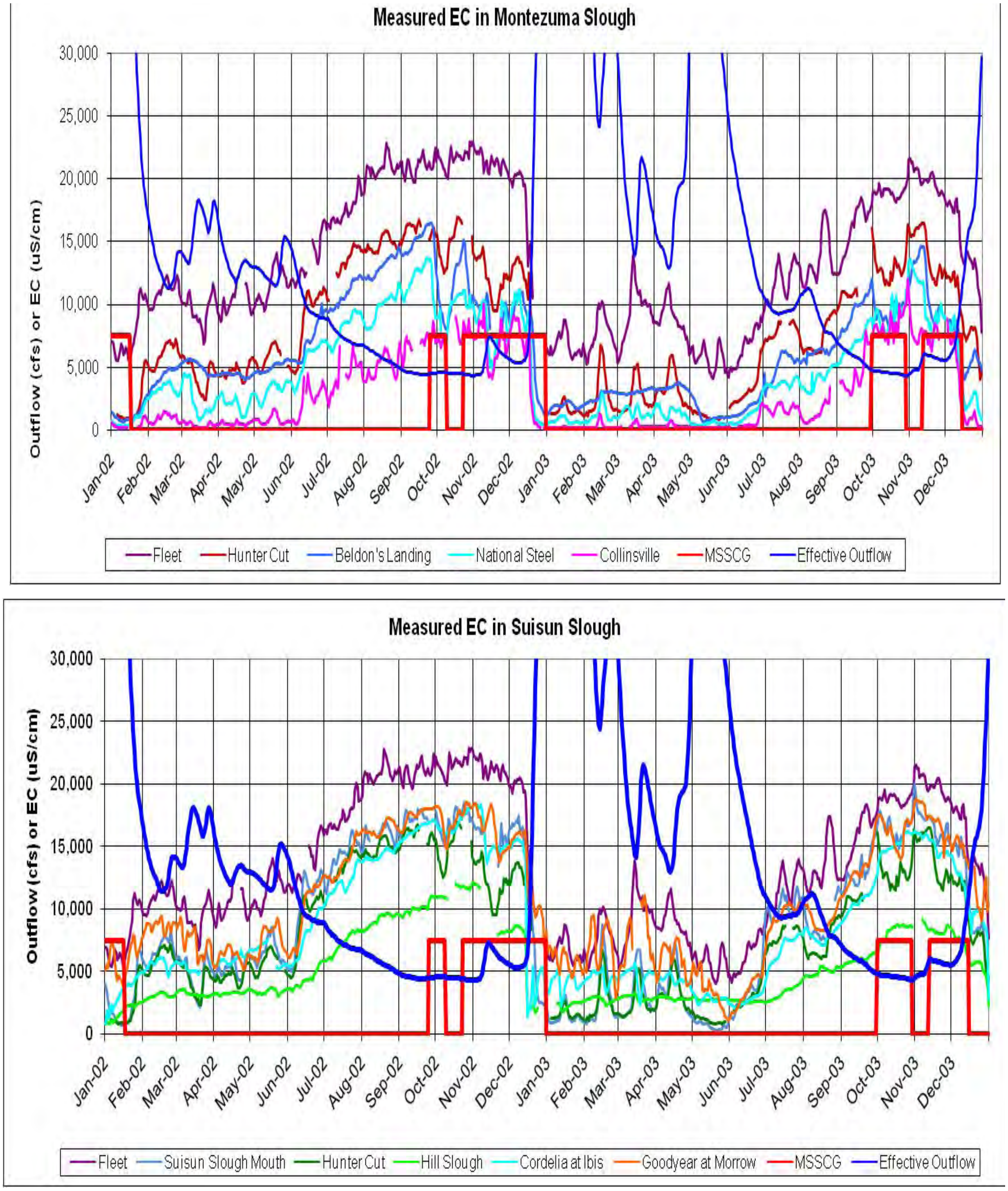
Figure 5.2-2
Daily Delta Outflow, Effective (G-model) Delta Outflow,MSSCG Operations and Measured Daily Average EC in Suisun Bay for 2002 and 2003



Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

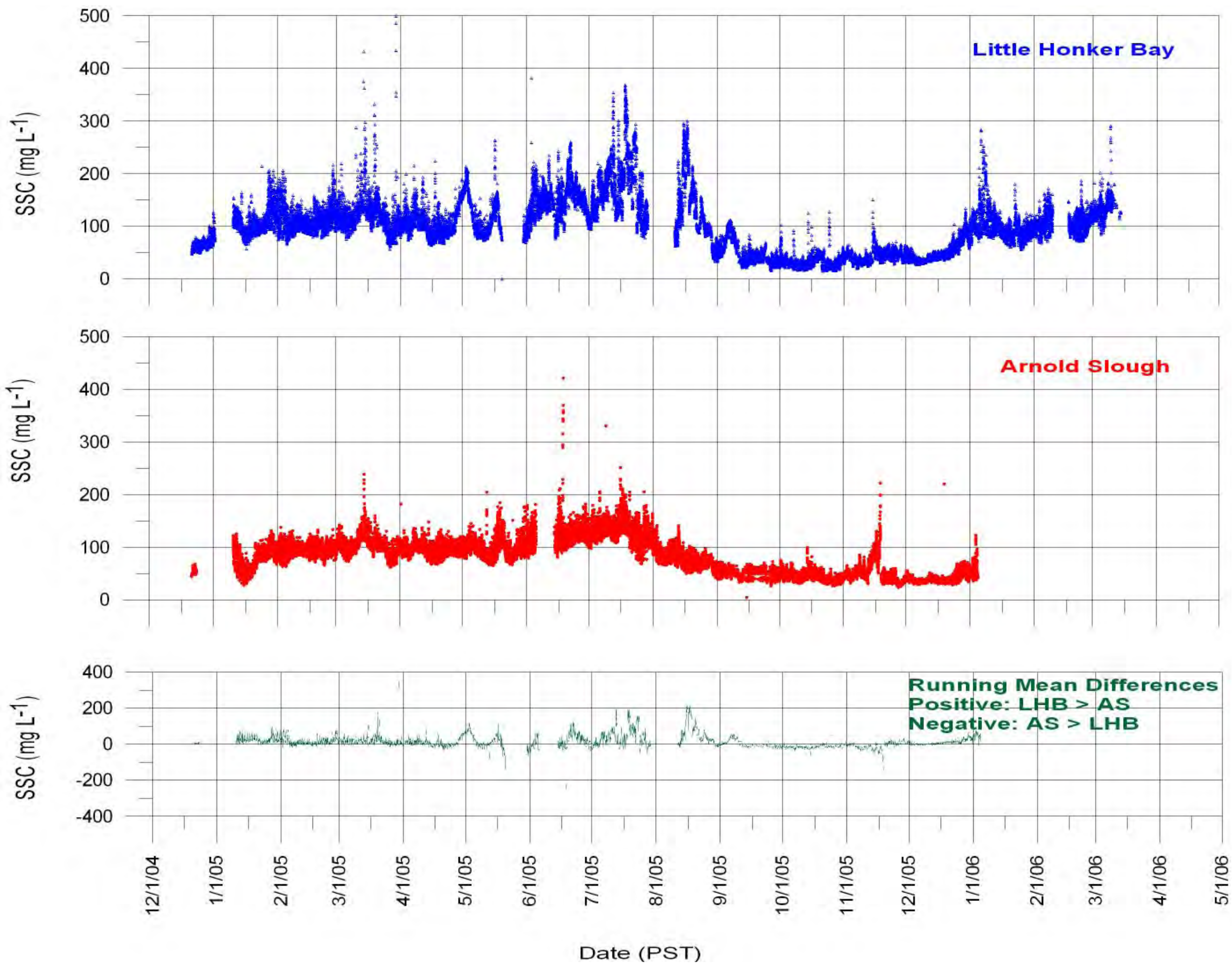
ICF INTERNATIONAL

Figure 5.2-3
Measured EC at Martinez and Collinsville with Relationship between Suisun Bay EC and Effective (G-model) Delta Outflow in 2002 and 2003



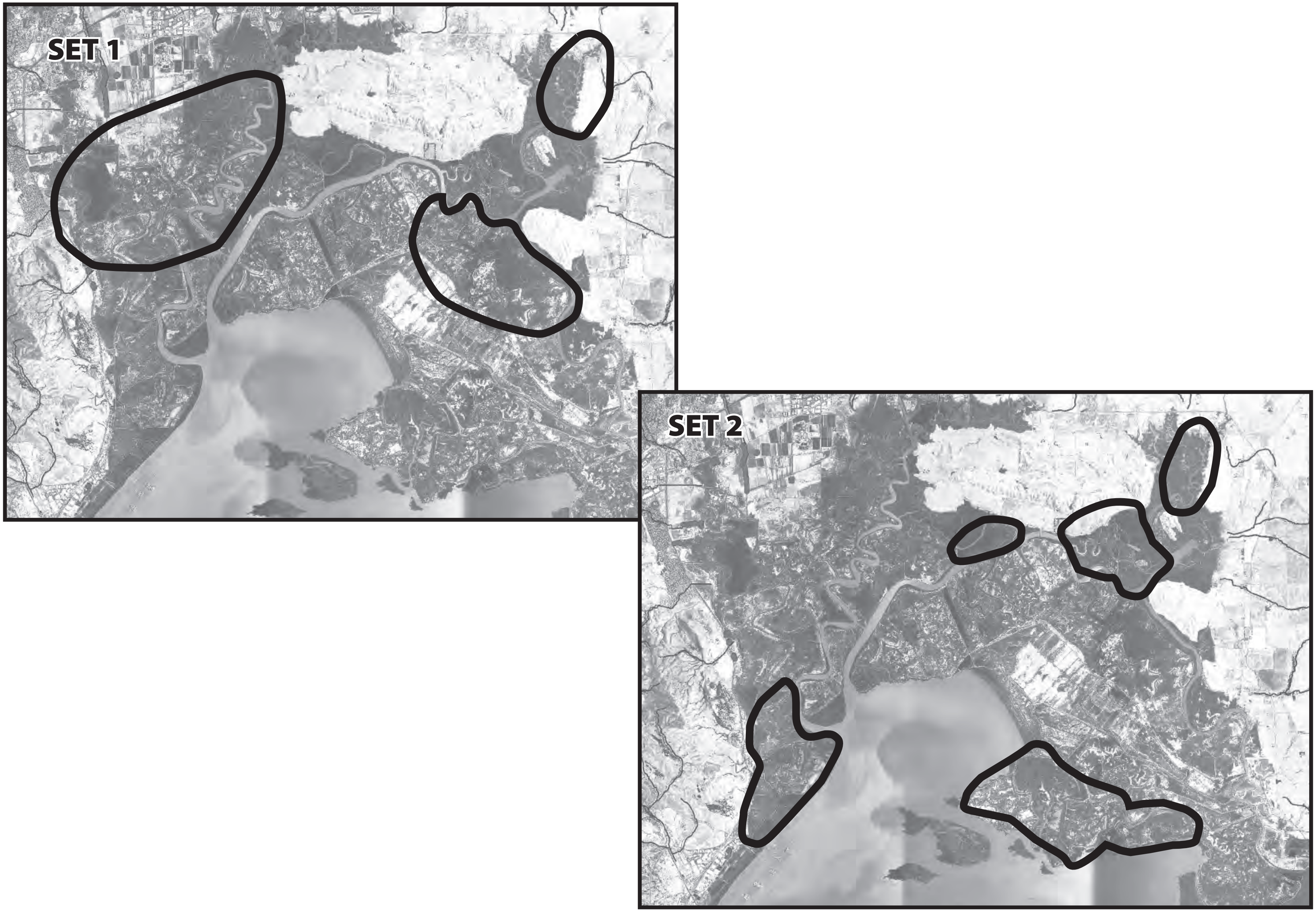
Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

Figure 5.2-4
Measured EC at Montezuma Slough and Suisun Slough Stations in 2002 and 2003



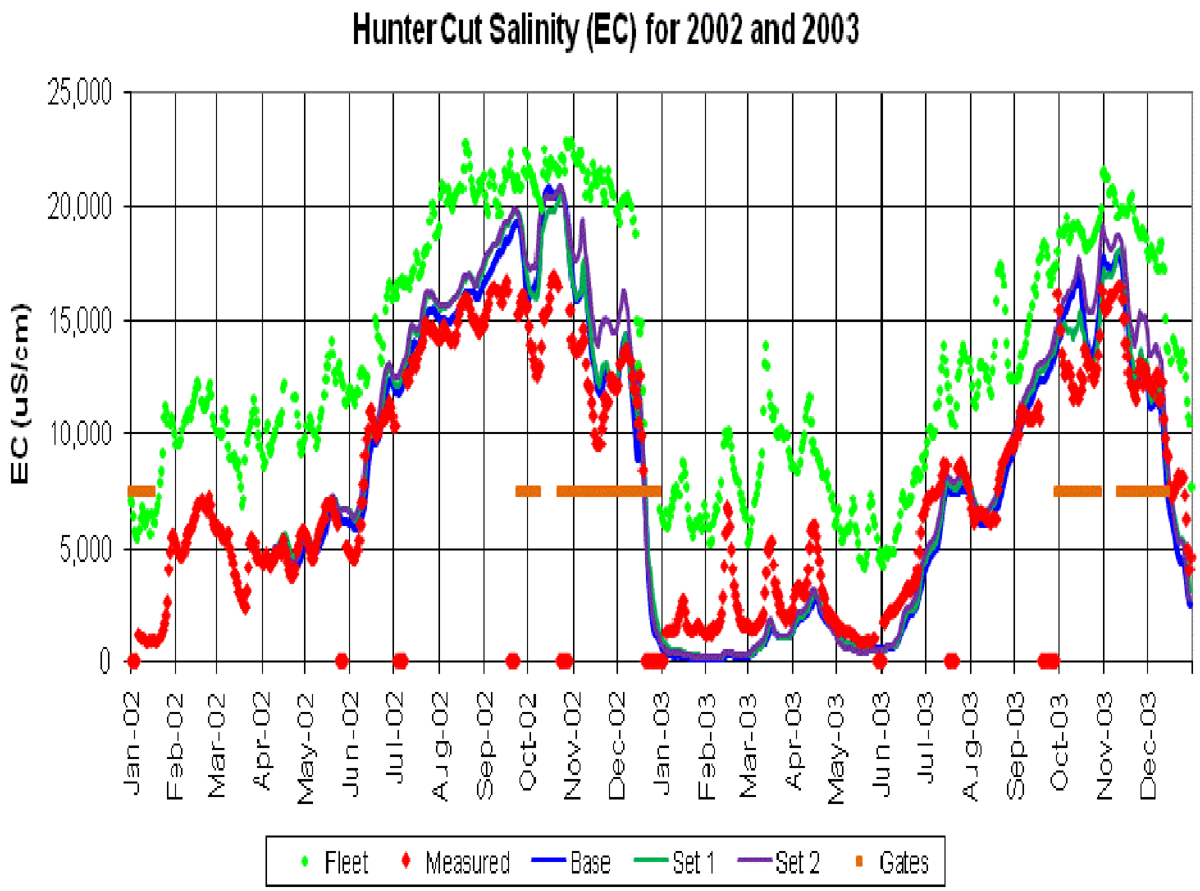
ICF INTERNATIONAL

Figure 5.2-5
Measured Suspended Sediment Concentration (SSC) in Little Honker Bay and Arnold Slough Adjacent to the Blacklock Tidal Restoration Site for 2005



Graphics/Projects/project number/document (date) SS

Figure 5.2-6
Approximate Congurations of Modeled Restoration Areas



Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

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Figure 5.2-7
Measured EC and Simulated EC in Montezuma Slough at Hunter Cut (2 Miles Upstream from the Mouth) for 2002 and 2003

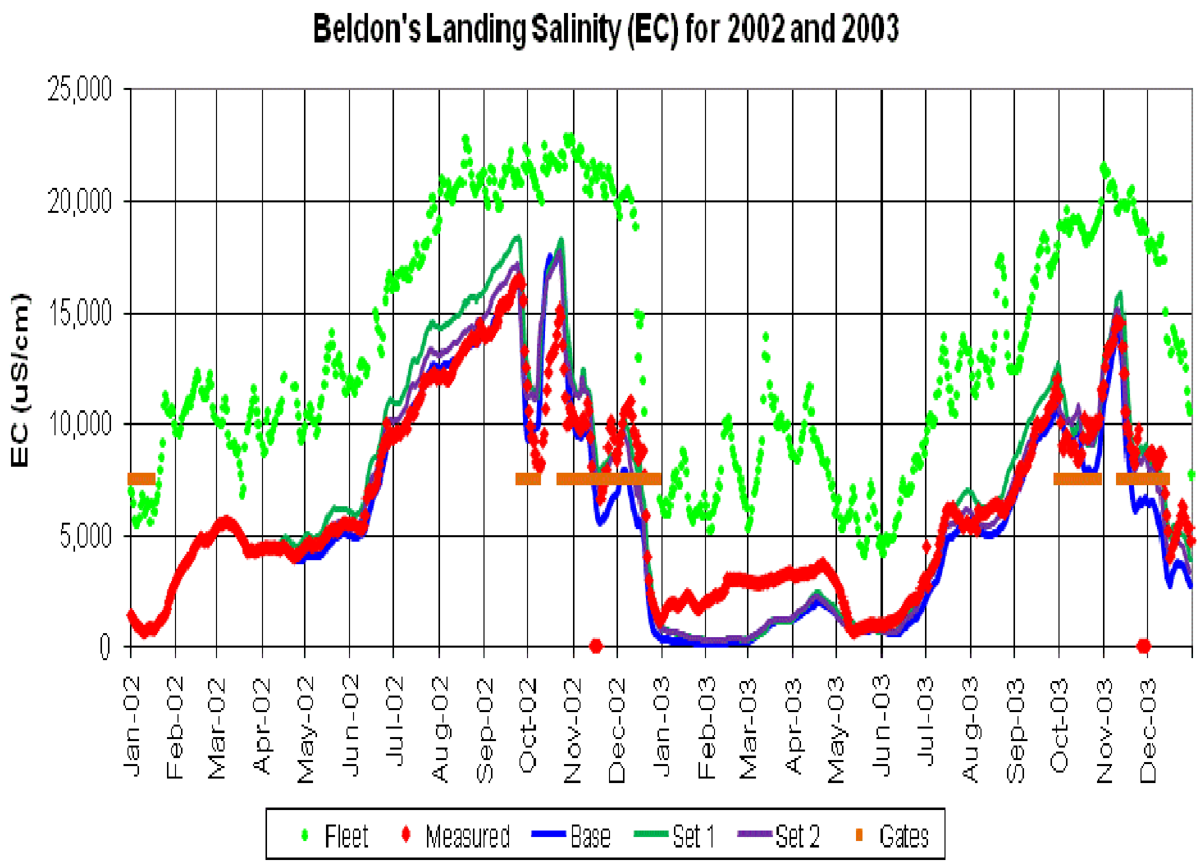

Figure 5.2-8
Measured EC and Simulated EC in Montezuma Slough at Beldon's Landing for 2002 and 2003

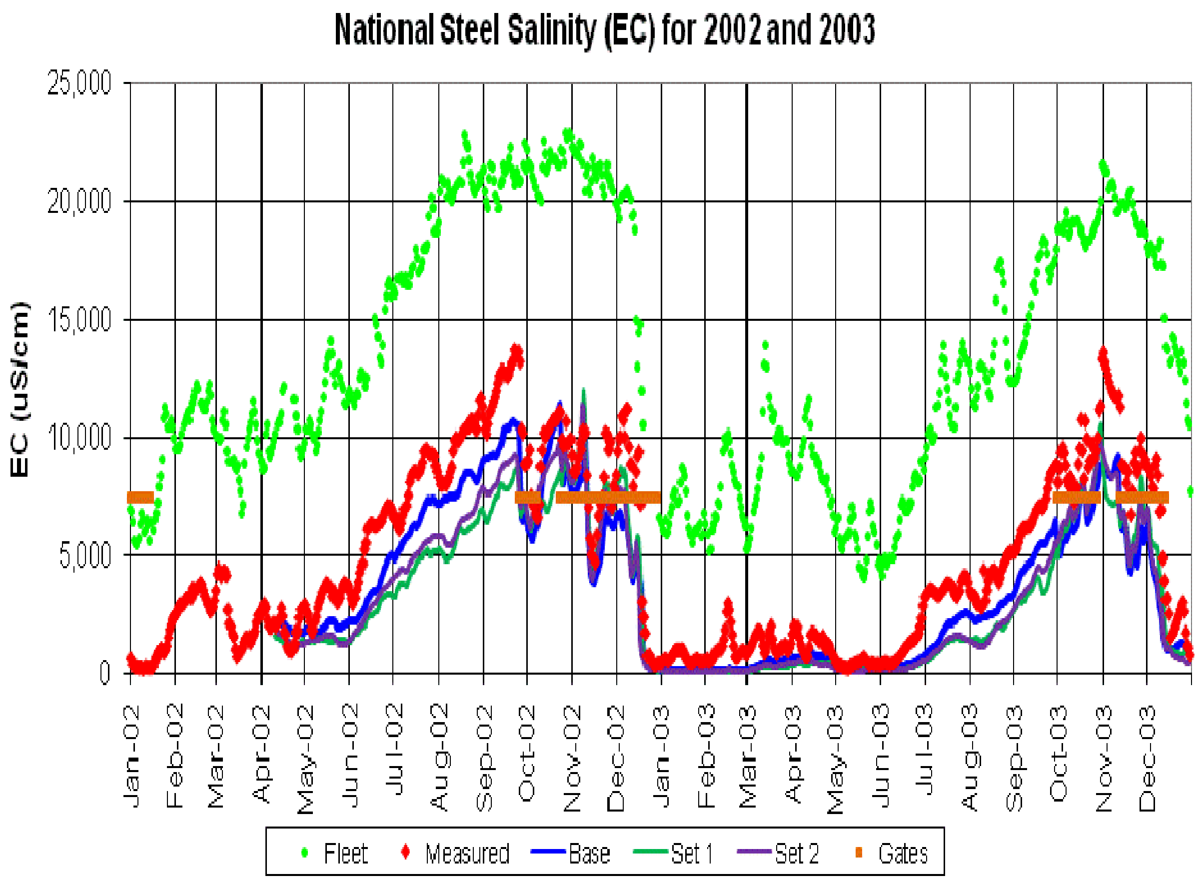

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Figure 5.2-9
Measured EC and Simulated EC in Montezuma Slough at National Steel for 2002 and 2003

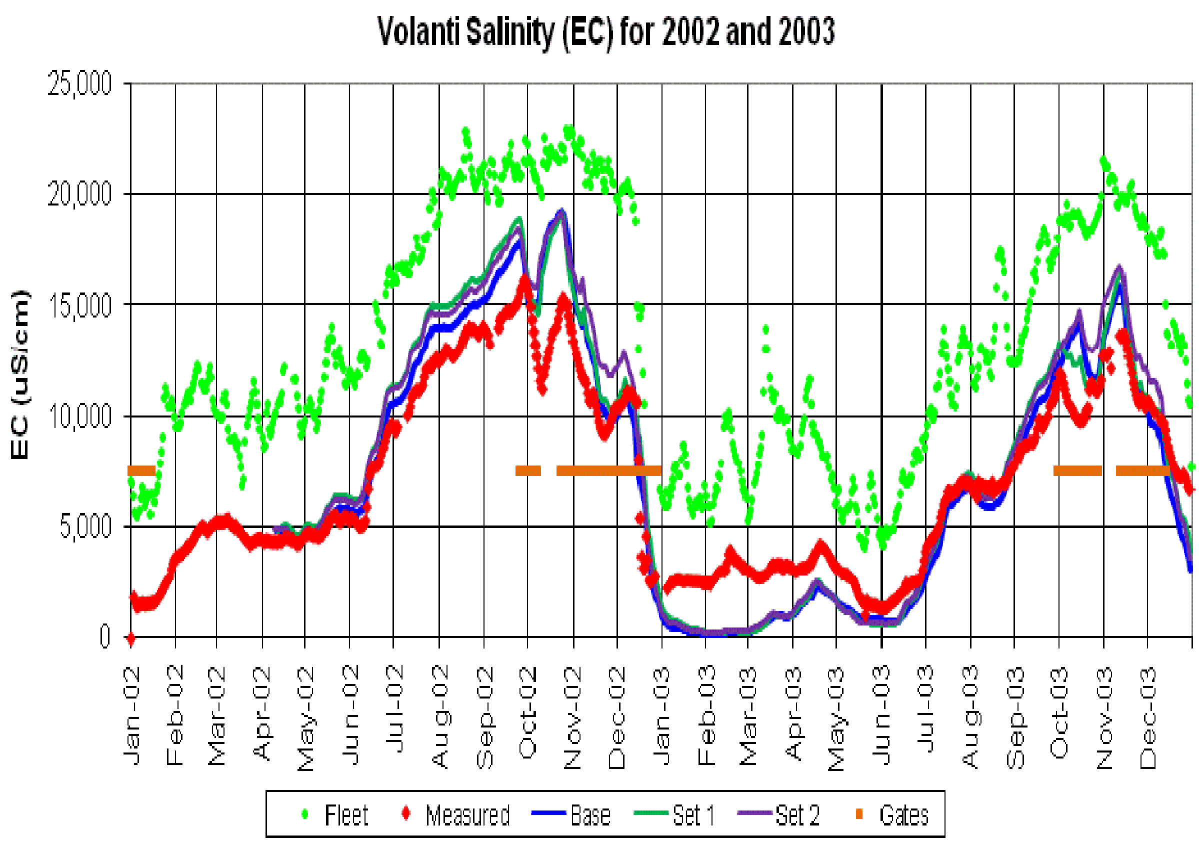

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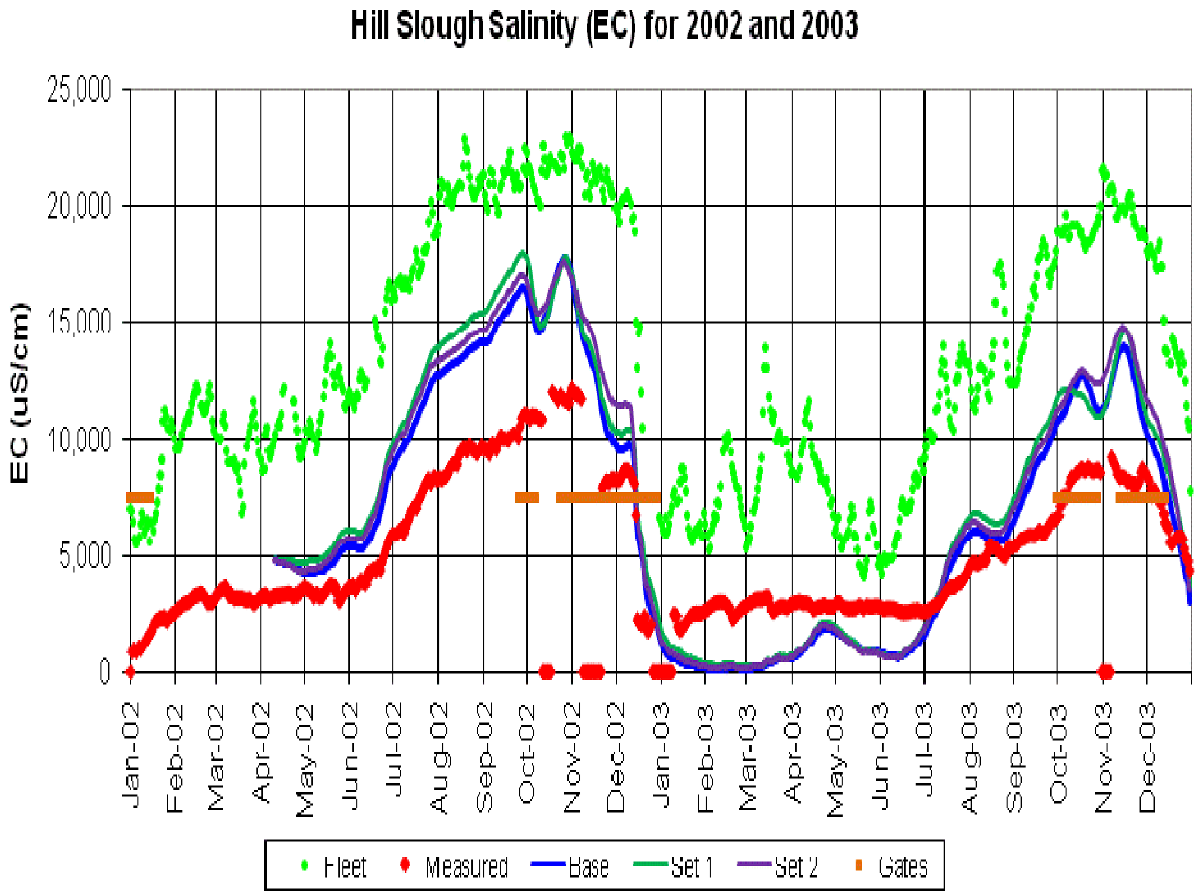
Figure 5.2-10
Measured EC and Simulated EC in Suisun Slough at Volanti for 2002 and 2003



ICF INTERNATIONAL

Figure 5.2-11
Measured EC and Simulated EC in Hill Slough for 2002 and 2003

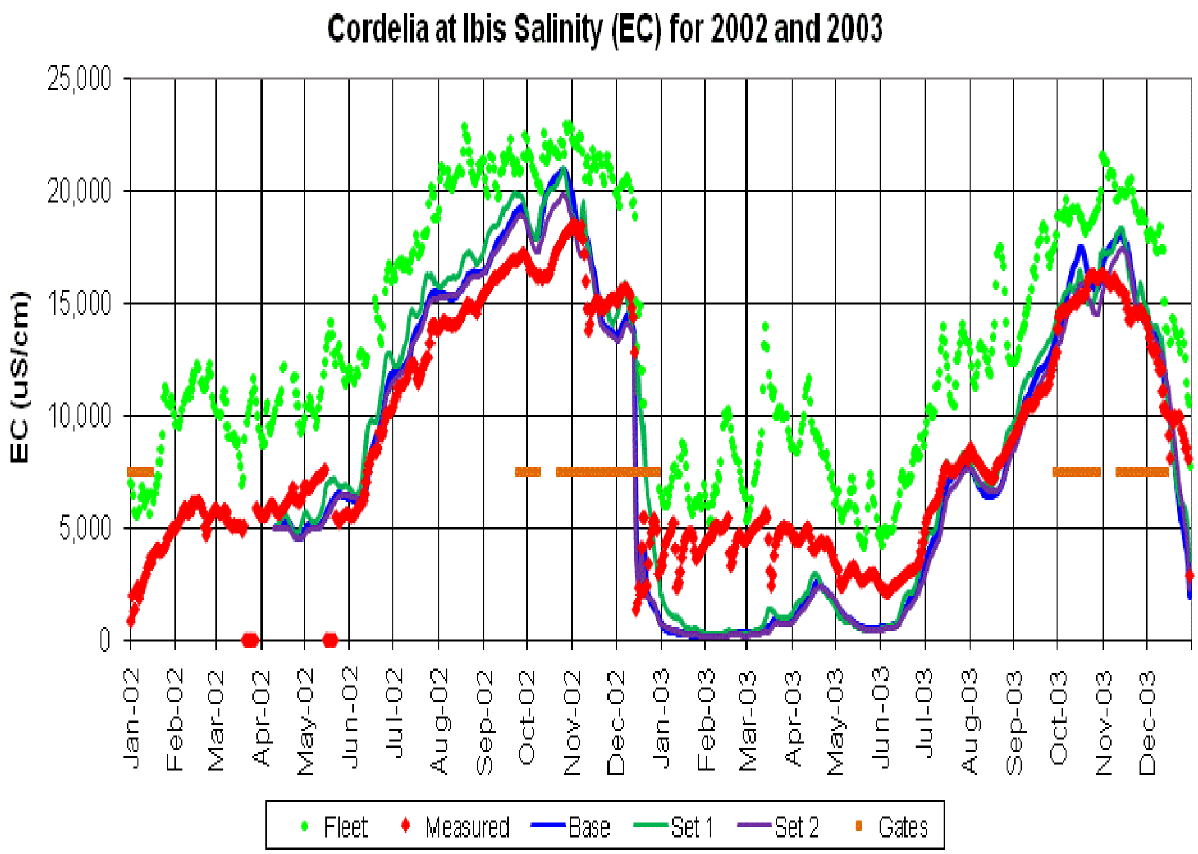
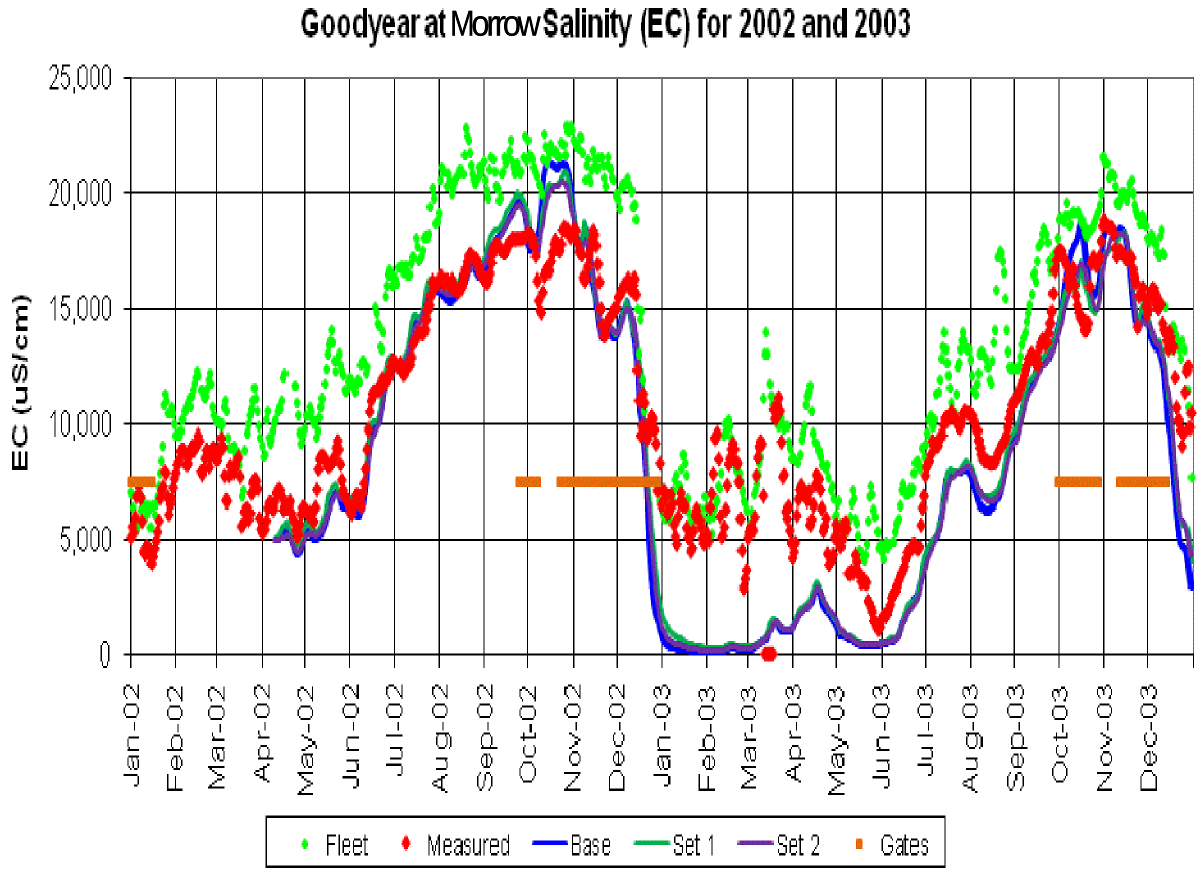


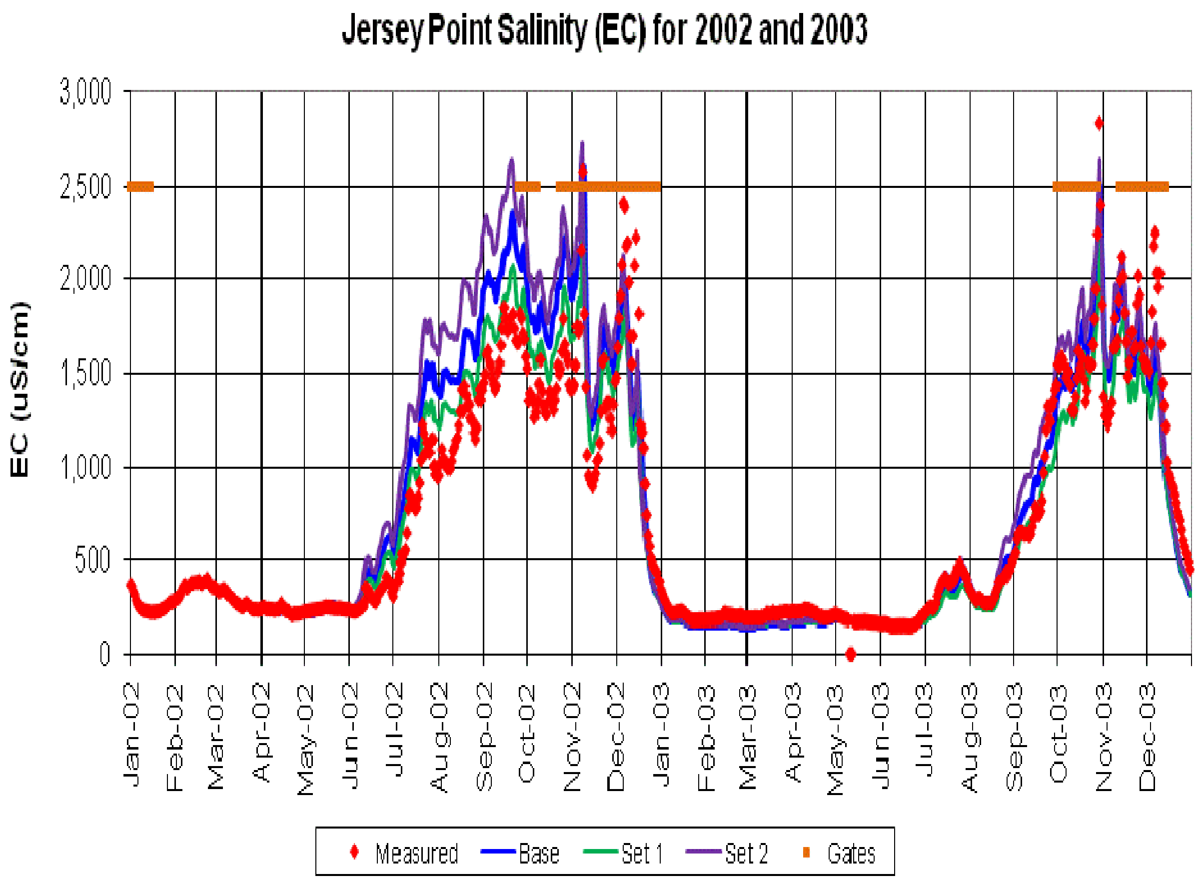
Figure 5.2-12
Measured EC and Simulated EC in Cordelia Slough at Ibis for 2002 and 2003



Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

ICF INTERNATIONAL

Figure 5.2-13
Measured EC and Simulated EC in Goodyear Slough at Morrow for 2002 and 2003



Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

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Figure 5.2-14
Measured EC and Simulated EC at Jersey Point for 2002 and 2003

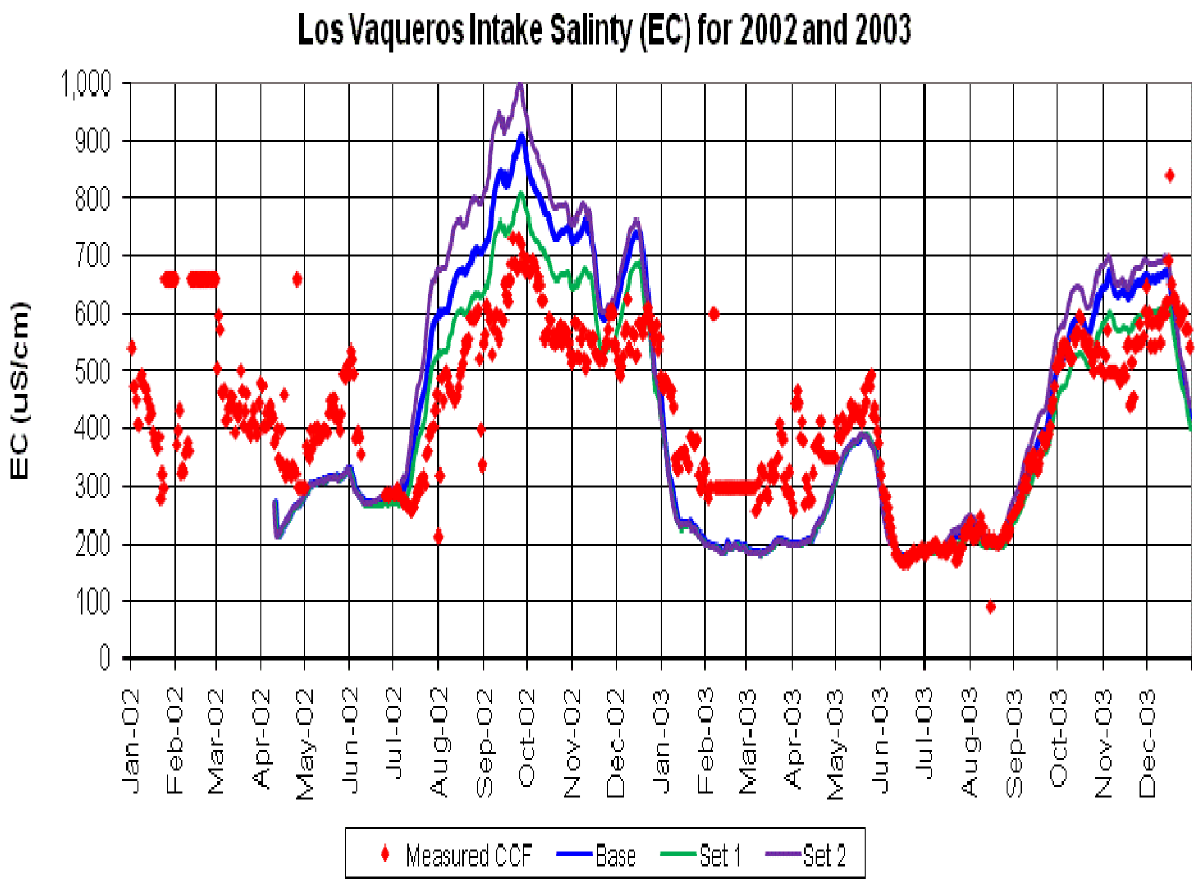

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Figure 5.2-15
Measured EC (at CCF) and Simulated EC in Old River at CCWD Los Vaqueros Reservoir Intake for 2002 and 2003

Section 5.3
Geology and Groundwater

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on geology and groundwater resources.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts. The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 5.3-1 summarizes impacts on geology, seismicity, soils, mineral resources, and groundwater from implementing the SMP alternatives. There would be no significant impacts on geology, seismicity, soils, mineral resources, and groundwater from implementing the SMP alternatives.

Table 5.3-1. Summary of Impacts on Geology, Seismicity, Soils, Mineral Resources, and Groundwater

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
GEO-1: Potential to Create Unstable Cut or Fill Slopes	A, B, C	Less than significant	None required	–
GEO-2: Potential for Accelerated Soil Erosion	A, B, C	Beneficial or Less than significant	None required	–
GEO-3: Potential Loss of Topsoil Resources	A, B, C	Less than significant	None required	–
GEO-4: Reduction in Availability of Non-Fuel Mineral Resources	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
GEO-5: Reduction in Availability of Natural Gas Resources	A, B, C	Less than significant	None required	–
GW-6: Potential for Altered Salinity in Shallow Suisun Marsh Groundwater	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
GEO-1: Potential to Create Unstable Cut or Fill Slopes	A, B, C	Less than significant	None required	–
GEO-2: Potential for Accelerated Soil Erosion	A, B, C	Less than significant	None required	–
GEO-5: Reduction in Availability of Natural Gas Resources	A, B, C	No impact	–	–
GEO-7: Potential for Damage to Structures as a Result of Surface Fault Rupture, Groundshaking and/or Seismically Induced Ground Failure (Liquefaction)	A, B, C	Less than significant	None required	–
GEO-8: Potential for Damage to Structures as a Result of Landslides, Including Seismically Induced Landslides	A, B, C	Less than significant	None required	–

Affected Environment

Sources of Information

Background information in this section was derived from sources in the published geologic literature. No new fieldwork or other research was conducted for the preparation of this EIS/EIR. Specific reference information is given in the text. Key sources used in compiling this section include:

- maps and reports published by the U.S. Geological Survey (USGS) and California Geological Survey (CGS);
- soil surveys by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) (formerly U.S. Soil Conservation Service);
- the Solano County General Plan (Solano County 2008) and background reports prepared for the recent General Plan update (EDAW/AECOM 2006a, 2006b);
- publications of the California Department of Conservation's Division of Oil, Gas, and Geothermal Energy;
- California Department of Water Resources' Bulletin 118 (*California's Groundwater*) (California Department of Water Resources 2003);

- the San Francisco Bay Conservation and Development Commission's *Suisun Marsh Protection Plan* (San Francisco Bay Conservation and Development Commission 1976);and
- the Solano County Water Agency's *Integrated Regional Water Management Plan and Strategic Plan* (Solano County Water Agency 2005).

Existing Conditions

Regional Geologic Setting

The plan area is located near the east flank of the Coast Ranges, in the east-central portion of California's Coast Ranges geomorphic province (e.g., Norris and Webb 1990).

The Coast Ranges province is characterized by echelon northwest-trending mountain ranges formed over the past 10 million years or less by active uplift related to complex tectonics of the San Andreas fault/plate boundary system (e.g., Norris and Webb 1990, Buising and Walker 1995, Atwater and Stock 1998). The Coast Ranges Province extends westward to the coastline and beyond, including the Farallon Islands offshore; on the east, it abuts the Great (Central) Valley province (Norris and Webb 1990). The eastern rangefront is defined by faults that have been interpreted as contractile features associated with shortening along an axis approximately normal to the rangefront (e.g., Sowers et al. 1992, Unruh et al. 1995; see also Jennings 1977 for regional mapping) but may also locally accommodate a right-lateral component of motion (e.g., Richesin 1996).

The eastern Coast Ranges are broadly antiformal. At the general latitude of the project area, they consist of a central "core" of Mesozoic units—including mafic and ultramafic rock allied with the Coast Range ophiolite, and lithologically diverse units of the Franciscan complex—flanked on the west by extensive exposures of Miocene volcanic rocks (Sonoma Volcanics) and on the east by an upward-younging sequence of marine and terrestrial sedimentary units that ranges in age from Cretaceous (Great Valley Group) to Neogene (Monterey Group, San Pablo Group, Sonoma Volcanics, and Huichica Formation). The area's larger drainages preserve several generations of alluvial fan and stream deposits ranging in age from Pleistocene to Holocene (Wagner and Bortugno 1982; Graymer et al. 2002).

Topography and Geology of Project Site

Suisun Bay occupies a topographic depression in the easternmost portion of the Coast Ranges. This low area is defined on its west side by uplift along the active Green Valley and Concord fault trends (Wagner and Bortugno 1982; Wagner et al. 1990; Hart and Bryant 1997; Graymer et al. 2002) and on the east by the

Pittsburg−Kirby Hills fault zone, which is likely allied to the Mt. Diablo thrust system to the south and may also be active, as discussed in more detail below (Unruh and Hector 1999). West of Suisun Bay the Coast Ranges rise steeply; east of Suisun Bay are the rolling Montezuma Hills, which consist of uplifted sedimentary strata of early Pleistocene age, with active (Holocene) alluvium in stream drainages that dissect the uplift. Low-lying flat areas of current and former marshland that border the Bay proper are underlain by Bay Mud deposits of Holocene age. To the north of Suisun Bay, the Potrero Hills, which form the topographically higher central portion of Grizzly Island, consist primarily of tightly folded and faulted marine sedimentary rocks of Eocene age, flanked by an apron of late Pleistocene alluvial fan deposits (Graymer et al. 2002).

Geologic Hazards

Primary Seismic Hazards—Surface Fault Rupture[1] and Groundshaking

The only faults known to be active in the immediate project vicinity are the Concord and Green Valley faults, which cross the project area at the westernmost end of Suisun Bay. Both of these structures are zoned by the State of California pursuant to the Alquist-Priolo Act and are recognized as Type B seismic sources by the Uniform and California Building Codes (International Conference of Building Officials 1997, 2001). The western edge of the project area, along the mapped traces of the Concord and Green Valley faults, is thus at some risk of surface fault rupture.

To date, the potential for Holocene activity on the Pittsburg−Kirby Hills fault zone has not been studied extensively, and this system is not zoned by the State of California or recognized by the Uniform Building Code. However, recent work suggests that it may be active. Peat layers of Holocene age thicken markedly toward the fault's surface trace, indicating active valley floor subsidence along this trend during Holocene time (Williams and Gabet 1997). A north-northwest trending alignment of earthquake foci along the west margin of the Montezuma Hills likely is associated with the Pittsburg−Kirby Hills system, and physical features suggestive of Holocene activity—such as well developed topographic lineaments and aligned drainages—coincide with the zone's mapped fault traces (Unruh and Hector 1999). In addition, the Pittsburg−Kirby Hills fault may be related to the Mt. Diablo Thrust system to the south (Unruh and Hector 2007), which is also increasingly thought to be Holocene-active (e.g., Sawyer 1999). With this in mind, there also may be some risk for surface fault rupture along the eastern margin of the project area, where the Pittsburg−Kirby Hills fault zone marks the edge of the Montezuma Hills uplift.

In addition to some level of localized surface fault rupture hazard, the entire project area is likely to experience strong groundshaking during the lifespan of

[1] *Surface fault rupture* is a rupture at the ground surface along an active fault, caused by earthquake or creep activity.

the project. Recent USGS studies estimate a 62% probability of at least one earthquake with a magnitude of 6.7 or greater occurring on one of the faults of the greater San Francisco Bay Area in the next 30 years, and a 10% probability of a magnitude 7.0 or greater event during the same timeframe (U.S. Geological Survey Working Group on California Earthquake Probabilities 2003). Table 5.3-2 summarizes current information on earthquake recurrence intervals and maximum credible earthquake (MCE) for key structures in and near the project area.

Table 5.3-2. Maximum Credible Earthquake and 30-Year Earthquake Probabilities for Principal Active Faults in Project Vicinity

Fault	Magnitude of MCE	30-Year Probability[a]
San Andreas	6.9–7.9[a]	All ruptures: 0.24 Magnitude≥6.7: 0.24 Magnitude≥7.0: 0.18 Magnitude≥7.5: 0.09
Hayward−Rodgers Creek	6.5–7.3[a]	All ruptures: 0.40 Magnitude≥6.7: 0.27 Magnitude≥7.0: 0.11 Magnitude≥7.5: 0.00
Green Valley−Concord	6.0–6.7[a]	All ruptures: 0.26 Magnitude≥6.7: 0.04 Magnitude≥7.0: 0.00 Magnitude≥7.5: 0.00
Calaveras	5.8–6.9[a]	All ruptures: 0.59 Magnitude≥6.7: 0.11 Magnitude≥7.0: 0.02 Magnitude≥7.5: 0.00
Greenville	6.2–6.9[a]	All ruptures: 0.08 Magnitude≥6.7: 0.03 Magnitude≥7.0: 0.01 Magnitude≥7.5: 0.00
Macaama (South)	6.9[b]	Not Provided
West Napa	6.5[b]	Not Provided
Pittsburg−Kirby Hills	>6[d]	Unknown
Cordelia	>6[c]	Unknown

Sources:
[a] U.S. Geological Survey Working Group on California Earthquake Probabilities 2003.
[b] International Conference of Building Officials 1997.
[c] Information compiled from multiple published sources, in Jones & Stokes (2005)
[d] Unruh and Hector 1999.

Secondary Seismic Hazards—Liquefaction and Ground Failure

The State of California maps areas subject to secondary seismic hazards pursuant to the Seismic Hazards Mapping Act of 1990. To date, this effort has focused on the Los Angeles Basin–Orange County region and the San Francisco Bay area, where dense populations are concentrated along active faults. State seismic hazards maps have not been issued for the Suisun Bay area, and no such mapping is planned in the immediate future (California Geological Survey 2004).

In general, however, liquefaction risks are greatest where the shallow substrate consists of loose or unconsolidated sands or silts that are saturated by groundwater; areas of Holocene Bay Mud substrate surrounding Suisun Bay are thus at high risk of liquefaction (Figure 5.3-1) (EDAW/AECOM 2006a, 2006b). Liquefaction risks are low in alluvial fan areas adjacent to the Montezuma and Potrero Hills and very low in the consolidated deposits interior to these uplifts (EDAW/AECOM 2006a, 2006b).

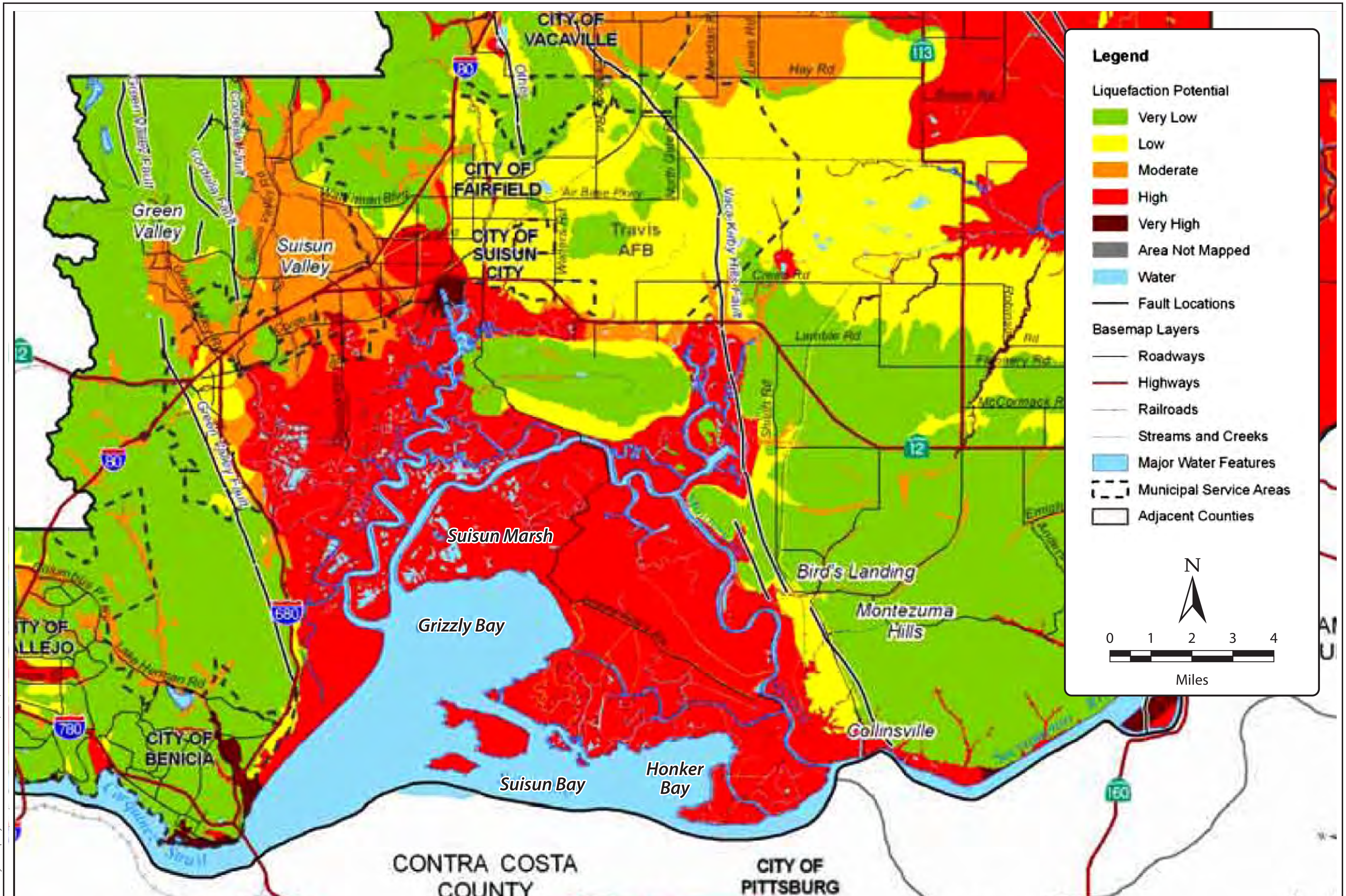
Landslides

The project area is located in flat marshland topography, and as such the majority of the project area is not subject to landslide hazard. However, U.S. Geological Survey landslide mapping, and landslide susceptibility maps in baseline reports prepared for the County's recent General Plan update, identify substantial landslide potential in some of Solano County's hillslope areas (Wentworth et al. 1997; EDAW/AECOM 2006b). Portions of the project area at the base of steep, landslide-prone uplifts are in potential landslide runout areas and subject to corollary risks. These portions include the strip along I-680 at the west edge of Suisun Marsh and alluvial/marshlands downslope from the western tip of the Potrero Hills (Figure 5.3-2).

Soils

Soils of Suisun Bay's bayland and marsh areas include the Joice muck, Tamba mucky clay, and Suisun peaty muck, with small enclaves of remaining active tidal marsh substrate. Areas of Reyes silty clay, and Valdez loams (Valdez silty clay loam, clay substratum; Valdez silt loam, drained) are also present (Bates 1977).

The Joice and Suisun series occur in nearly level areas of salt marsh or former salt marsh and are very poorly drained organic soils that formed from the accumulation of hydrophytic plant remains with an input of fine-grained mineral sediment (Bates 1977). A typical profile of the Joice muck consists of black, saline clayey muck to depths of more than 60 inches. Permeability is limited; surface water tends to pond, and erosion hazard is slight (Bates 1977). The



Source: County of Solano 2006, 2008.

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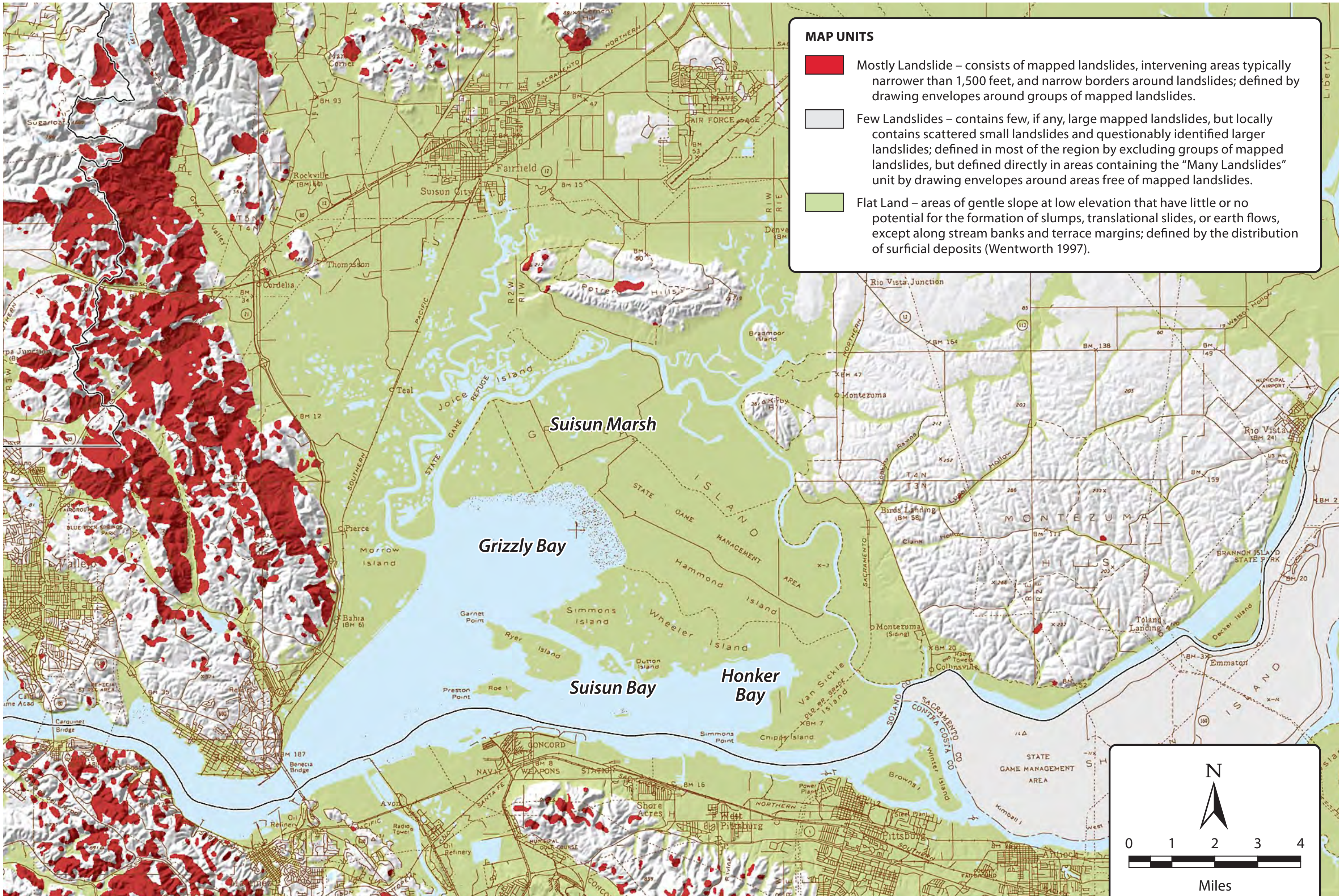
Figure 5.3-1
Liquefaction Susceptibility



Source: Adapted from Wentworth et al. 1997.

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Figure 5.3-2
Summary Distribution of Landslides and Earth Flows

Suisun peaty muck consists of more than 60 inches of dark-colored muck that contains dark reddish-brown plant fibers. Permeability is rapid, but under natural conditions the water table is shallow (10–20 inches below ground surface), so surface water tends to pond. Erosion is not a hazard in the Suisun peaty muck (Bates 1977).

The Tamba series also occurs in nearly level areas of current and former salt marsh and consists of very poorly drained organic-rich soils. Tamba series soils formed in alluvium derived from mixed sources and in hydrophytic plant remains. In a typical profile, the Tamba mucky clay consists of about 10 inches of light brownish-gray, grayish-brown, and yellowish-brown mottled mucky clay overlying about 30 inches of mottled gray and black mucky clay, which in turn overlies a substratum consisting of more than 30 inches of gray mucky clay. Permeability of the subsoil is moderate, and under natural conditions the water table (12–36 inches below ground surface) so surface water tends to pond. Erosion hazard is slight (Bates 1977).

Active tidal marsh is a very poorly drained, strongly saline land type restricted to areas between constructed levees and bodies of water. Tidal marsh substrate ranges from mud flats to a mixture of hydrophytic plant remains and alluvial sediment (Bates 1977).

The Reyes series occurs in nearly level areas of current and former salt marsh and consists of poorly drained soils that are very strongly acid and saline. Reyes soils formed in alluvium derived from mixed sources. A typical Reyes profile, like that of the Reyes silty clay, consists of about 7 inches of light gray, yellowish-red, and grayish-brown mottled silty clay overlying about 35 inches of mottled gray silty clay, which in turn overlies a substratum of gray silty clay. The substratum is moderately alkaline *in situ* but becomes strongly acid when exposed to the air and allowed to dry. The water table is 24–48 inches below ground surface under natural conditions. Permeability is slow, and surface water ponds on Reyes soils. Erosion is a slight hazard (Bates 1977).

The Valdez series consists of poorly drained soils that formed in nearly level areas on alluvial fans. Valdez soils are also present in some areas where dredge spoils have been disposed of. A typical Valdez profile includes about 12 inches of light-colored mottled silty clay loam, overlying about 20 inches of light-colored mottled and stratified silty clay loam and very fine sandy loam, which in turn overlies a subsoil consisting of more than 40 inches of slightly darker colored mottled and stratified silty clay loam, silt loam, and very fine sandy loam. The Valdez silty loam, drained, has a profile similar to this, except that the texture is silt loam throughout, and salinity is lower. Artificial drainage maintains the fluctuating water table at depths of more than 4 feet below ground surface. Permeability is moderately slow, runoff is slow, and erosion hazard is slight in the Valdez silt loam, drained. The Valdez silty clay loam, clay substratum is also similar to the typical Valdez profile but is underlain by a buried clay soil at a depth of 35–50 inches below ground surface. It is a moderately to strongly saline soil. Permeability is slow, runoff is slow, and erosion hazard is slight in the Valdez silty clay loam, clay substratum. The water table is 3–5 feet below ground surface in this unit (Bates 1977).

Land Subsidence

Portions of Suisun Marsh have undergone marked subsidence, although not near as much as the neighboring Delta area. This is believed to be the result of diking and removal from tidal inundation—where formerly saturated peaty soils allowed to dry out, plant material oxidizes, decays, and becomes more compact. Drying also allows the mineral soil matrix to compact, as pore space is no longer filled by water. Agricultural and managed wetland activities such as disking, which accelerates the drying and oxidation processes, likely have contributed to accelerated subsidence. The amount of subsidence in various parts of Suisun Marsh is believed to be controlled by the thickness of the soil column and the abundance and distribution of organic material (Siegel pers. comm.). In other parts of the Bay Area and in parts of the Central Valley, land subsidence has been caused by groundwater overdraft; the contribution of groundwater withdrawal, if any, to Suisun Marsh subsidence has not been evaluated (Siegel pers. comm.). Active tectonics also can result in subsidence but are not thought to have contributed to recent subsidence in Suisun Marsh (Siegel pers. comm.).

Natural Gas Reserves

Natural gas refers to hydrocarbons that occur naturally in a gas or vapor state at ordinary temperatures and pressures. Natural gas consists primarily of methane but also may contain a smaller percentage of ethane, propane, and other gaseous hydrocarbons. Impurities such as nitrogen, carbon dioxide, hydrogen sulfide, and water (brines) also may be present (Jackson 1997). Already an essential energy source for heating, electricity generation, and transportation, natural gas is expected to increase in importance in coming years, because it offers a “cleaner” alternative to other petroleum products and coal. However, world reserves of natural gas are limited and likely will be exhausted within the next 50 years (EDAW/AECOM 2006c).

Known for “dry” or nonassociated gas (i.e., natural gas produced without concurrent production of crude oil), the Sacramento Valley and Delta areas are home to some of California’s most important gas reserves. Figure 5.3-3 shows natural gas fields in Solano County. Although production rates have declined somewhat in recent years and are expected to continue on a downward trend, as of 2005 the county had about 900 active natural gas extraction wells. Most of these wells are located in proven fields, although gas field boundaries are expanding in some areas. (EDAW/AECOM 2006c.)

The Rio Vista field, east of Suisun Bay, has been the largest producer of dry gas in northern California and one of the largest gas producers in California for a number of years (e.g., California Department of Conservation, Division of Oil,

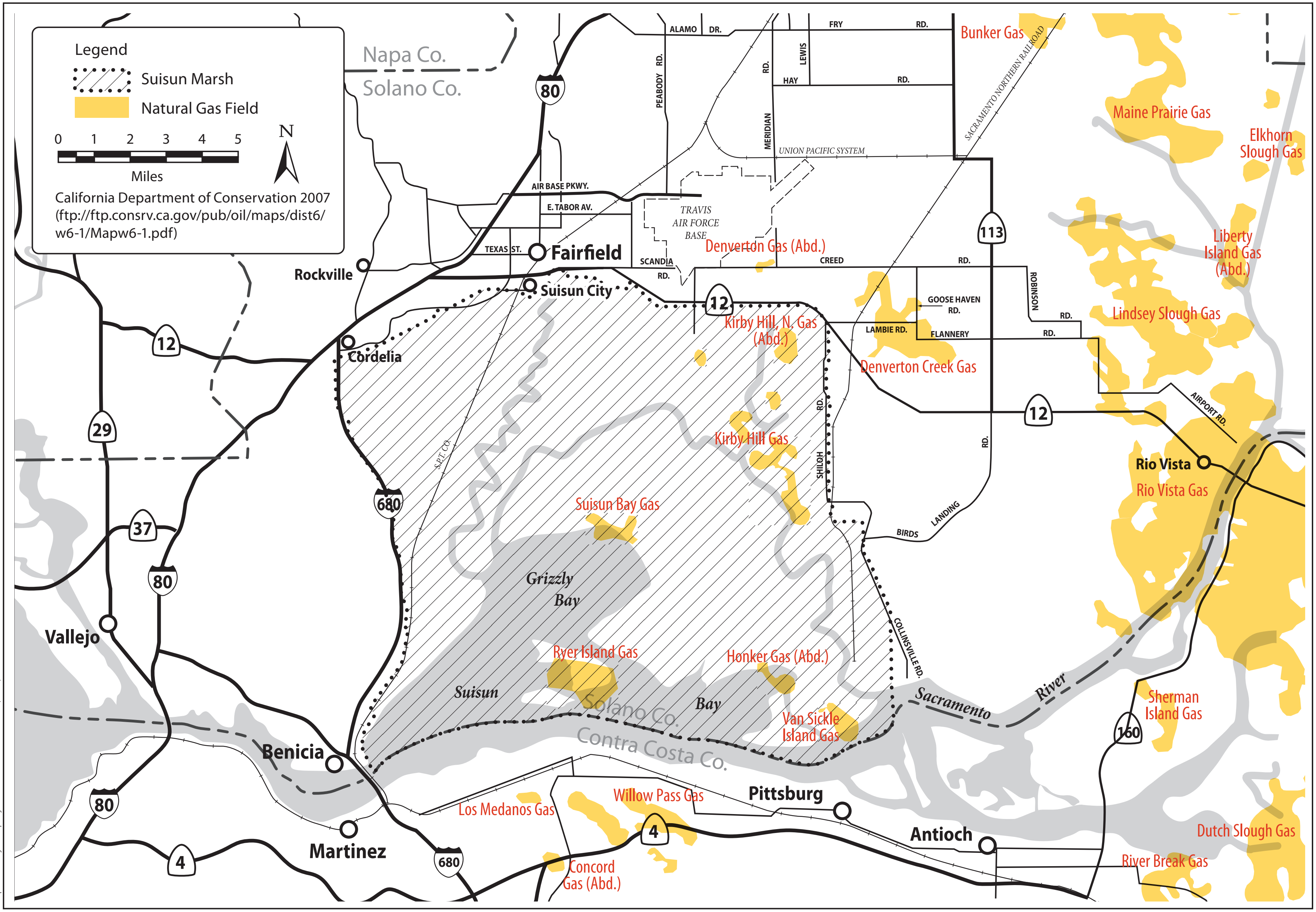

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Figure 5.3-3
Natural Gas Fields

Gas, and Geothermal Resources 2004, 2006). In the immediate project area, active gas fields include Ryer Island and Suisun Bay (California Department of Conservation, Division of Oil, Gas, and Geothermal Resources 2008). Nearby Kirby Hill is an important natural gas storage field (EDAW/AECOM 2006c).

Non-Fuel Mineral Resources

Solano County is rich in non-fuel mineral resources, including mercury, construction sand and gravel, stone products, clay, calcium, and sulfur (EDAW/AECOM 2006a). Figure 5.3-4 shows the location and distribution of known mineral resources in the county.

As shown in Figure 5.3-4, small areas zoned MRZ-2 and MRZ-3 for aggregate resources are located along the edge of the plan area, in and adjacent to the city of Vallejo. Portions of the Potrero Hills also are zoned MRZ-3 for sand and gravel resources. One operating quarry is located on the north flank of the Potrero Hills uplift, and other active sand, gravel, and stone quarries are located in and adjacent to the city of Benicia, along the west side of the plan area. Mercury also has been produced in this portion of the county (EDAW/AECOM 2006a).

Groundwater Resources

The project area overlies the Suisun-Fairfield Valley Groundwater Basin, which is the second-largest groundwater basin in Solano County, with an area of 133,600 acres. The Suisun-Fairfield basin is bounded on the north and west by foothills of the Coast Ranges uplift, on the south by marshlands bordering Suisun Bay, and on the east by the low bedrock ridges that crop out southeast from Vacaville to the Montezuma Hills (Thomasson et al. 1960; Solano County Water Agency 2005).

The Suisun-Fairfield Valley groundwater basin recharges by infiltration on the Suisun Valley floor and along stream channels and drains generally southward into Suisun Marsh, where groundwater provides freshwater mixing and flushing action (San Francisco Bay Conservation and Development Commission 1976). The most important water-bearing formations are the gravel and sand deposits within the older alluvium, which are up to 200 feet thick. These are underlain at depth by a thick sequence of non–water-bearing marine sedimentary deposits of Mesozoic-Paleogene age (Great Valley Complex) and by volcanic rocks associated with the Sonoma Volcanics of Miocene age.

Groundwater supplies municipal, agricultural, and rural residential uses in Solano County (Solano County Water Agency 2005). To date, however, groundwater use has not been accurately quantified, and the SCWA's Integrated Regional Water Management Plan (IRWMP) identifies the need for better understanding of groundwater supply and demand as a key issue for water management in the county (Solano County Water Agency 2005). Nonetheless, existing data suggest that the Suisun-Fairfield basin is not a significant source of supply because of low yields (average = 200 gallons per minute [gpm], maximum = 500 gpm) and poor water quality (total dissolved solids [TDS] averaging 410 mg/l and ranging as high as 740 mg/l) (Solano County Water Agency 2005; California Department of Water Resources 2003). However, several small communities and individual landowners on the periphery of the Marsh, as wells as a few parcels in the Primary Zone of the Marsh, use groundwater for their domestic water supply.

An existing well in the Grizzly Island Wildlife Area provides brackish water with a high mineral content. With the exception of the few landowners that use groundwater for domestic supplies, well water typically is used for lawn irrigation, and drinking water is imported.

Regulatory Setting

Federal

Geology, Geologic Resources, and Geologic Hazards—Clean Water Act, Section 402(p)

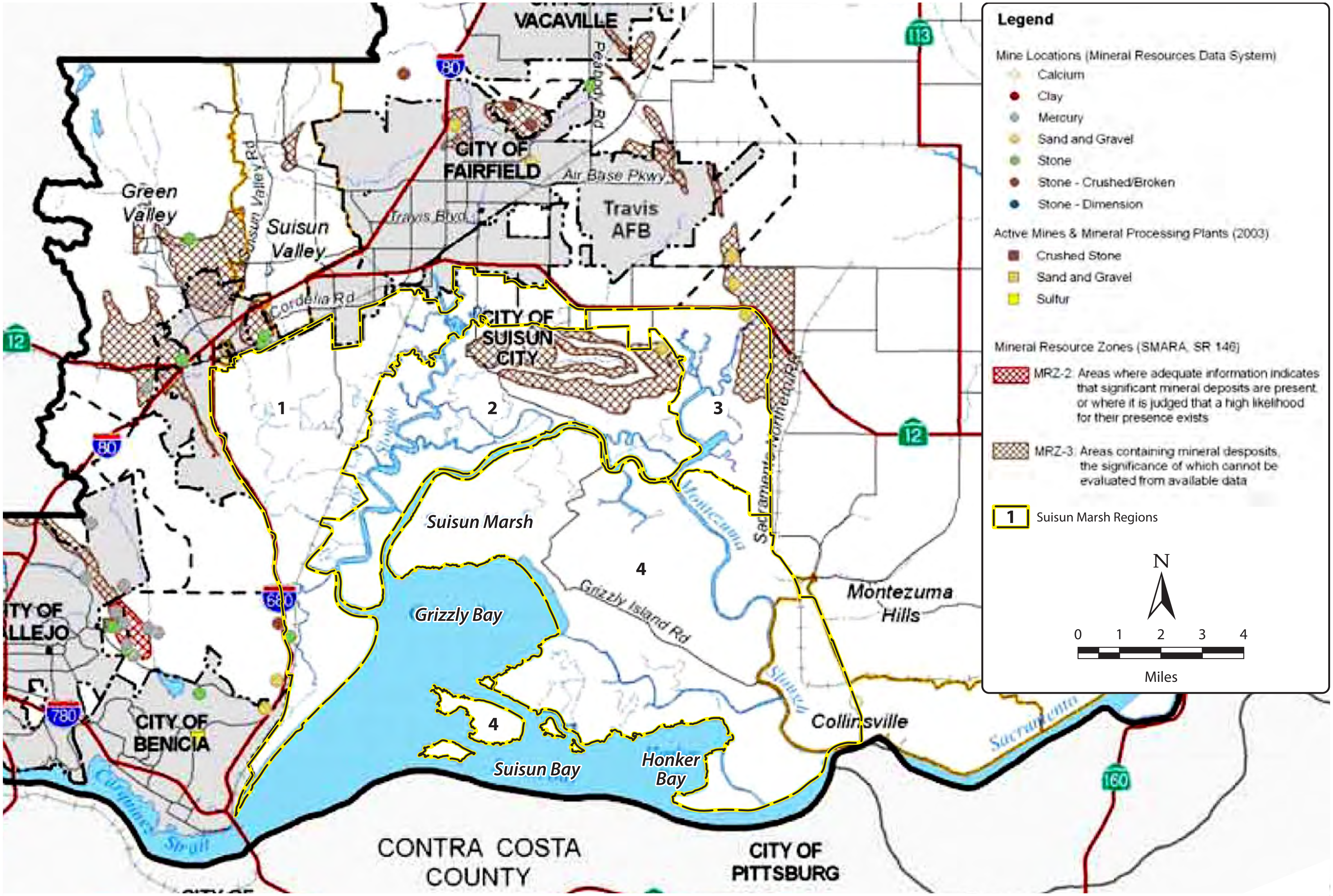
Amendments to the CWA in 1987 added Section 402(p), which created a framework for regulating municipal and industrial stormwater discharges under the NPDES program. In California, the State Water Board is responsible for implementing the NPDES program; pursuant to the state's Porter-Cologne Water Quality Control Act (Porter-Cologne Act) (see discussion in Water Quality section of this EIS/EIR), it delegates implementation responsibility to the state's nine RWQCBs.

Under the NPDES Phase II Rule, any construction project disturbing 1 acre or more must obtain coverage under the state's NPDES General Permit for Stormwater Discharges Associated with Construction Activity (General Construction Permit). The purpose of the Phase II rule is to avoid or mitigate the effects of construction activities, including earthwork, on surface waters. To this end, General Construction Permit applicants are required to file a Notice of Intent to Discharge Stormwater with the RWQCB that has jurisdiction over the construction area and to prepare a stormwater pollution prevention plan (SWPPP) stipulating BMPs that will be in place to avoid adverse effects on water quality.

Additional information on other aspects of the CWA is provided in the Water Quality section of this EIS/EIR.

Groundwater—Clean Water Act, Other Sections

As discussed in more detail in the Hydrology and Water Quality section, the CWA is the primary federal law that protects the quality of the nation's waters.



Source: Solano County General Planning Documents, 2006 and 2008.

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Figure 5.3-4
Mineral Resources

It operates on the principle that all discharges of pollutants into the nation's waters are unlawful unless specifically authorized by a permit; permit review is the CWA's primary regulatory tool.

Groundwater quality is indirectly protected by the permit review under CWA Section 402 (permits for discharge of stormwater from construction sites, discussed briefly in the preceding section), and to some extent by the Section 404 process (permits for discharge of dredged and fill materials to waters of the United States).

Broader protection is provided by Section 401, which stipulates that any project requiring a federal permit must be reviewed for its potential effects on water quality, and Section 303(d); under Section 303(d) and California's Porter-Cologne Act of 1969 (discussed below), the State of California is required to establish beneficial uses of state waters and to adopt water quality standards to protect those beneficial uses.

State

Geology, Geologic Hazards, and Geologic Resources

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code [PRC] Section 2621 et seq.), originally enacted in 1972 as the Alquist-Priolo Special Studies Zones Act and renamed in 1994, is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults and strictly regulates construction in the corridors along active faults (earthquake fault zones). It also defines criteria for identifying active faults, giving legal weight to terms such as *active*, and establishes a process for reviewing building proposals in and adjacent to earthquake fault zones.

Under the Alquist-Priolo Act, faults are zoned and construction along or across them is strictly regulated if they are "sufficiently active" and "well-defined." A fault is considered sufficiently active if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined for purposes of the act as referring to approximately the last 11,000 years). A fault is considered well-defined if its trace can be clearly identified by a trained geologist at the ground surface or in the shallow subsurface, using standard professional techniques, criteria, and judgment (Hart and Bryant 1997).

Seismic Hazards Mapping Act

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (PRC Sections 2690–2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including strong groundshaking, liquefaction, and seismically induced landslides. Its provisions are similar in concept to those of the Alquist-Priolo Act: the state is charged with identifying and mapping areas at risk of strong groundshaking, liquefaction, landslides, and other corollary hazards, and cities and counties are required to regulate development within mapped seismic hazard zones.

Under the Seismic Hazards Mapping Act, permit review is the primary mechanism for local regulation of development. Specifically, cities and counties are prohibited from issuing development permits for sites within seismic hazard zones until appropriate site-specific geologic and/or geotechnical investigations have been carried out and measures to reduce potential damage have been incorporated into the development plans.

Surface Mining and Reclamation Act

The Surface Mining and Reclamation Act of 1975 (SMARA) (PRC Sections 2710–2719) is the principal legislation addressing mineral resources in California. SMARA was enacted in response to land use conflicts between urban growth and essential mineral production. Its stated purpose is to provide a comprehensive surface mining and reclamation policy that will encourage the production and conservation of mineral resources while ensuring that:

- adverse environmental effects of mining are prevented or minimized;
- mined lands are reclaimed and residual hazards to public health and safety are eliminated; and
- consideration is given to recreation, watershed, wildlife, aesthetic, and other related values.

SMARA governs the use and conservation of a wide variety of mineral resources, although some resources and activities are exempt from its provisions, including excavation and grading conducted for farming, construction, or recovery from flooding or other natural disaster.

SMARA provides for the evaluation of an area's mineral resources using a system of mineral resource zone (MRZ) classifications that reflect the known or inferred presence and significance of a given mineral resource. The MRZ classifications are based on available geologic information, including geologic mapping and other information on surface exposures, drilling records, and mine data; and socioeconomic factors such as market conditions and urban development patterns. The MRZ classifications are defined as follows.

- **MRZ-1**: Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
- **MRZ-2:** Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood for their presence exists.
- **MRZ-3:** Areas containing mineral deposits, the significance of which cannot be evaluated from available data.

- **MRZ-4:** Areas where available information is inadequate for assignment into any other MRZ.

The State of California is responsible for mineral resources zoning under SMARA, but SMARA implementation and enforcement authority rests with the local jurisdiction and is carried out through the county or city land use planning process and codes. Solano County's SMARA implementing regulations are contained in Chapter 29 of the County Code.

Marsh Development Permits

In the primary management area of Suisun Marsh, a new project involving grading would require a BCDC marsh development permit. Depending on the size of the project and the amount of work, the project could either require an administrative permit or a major permit (requiring a public hearing). Individual projects will be evaluated based on project activities and project proponents to determine the appropriate permitting mechanism. It is anticipated that restoration activities under the SMP would require a permit.

Groundwater

Porter-Cologne Water Quality Control Act of 1969

The Porter-Cologne Act, passed in 1969, dovetails with the CWA. Both laws are discussed in detail in the Hydrology and Water Quality section of this EIS/EIR. Briefly, the Porter-Cologne Act established the State Water Resources Control Board and divided the state into nine regions, each overseen by an RWQCB. The State Water Board has primary responsibility for the quality of the state's surface and groundwater supplies, but much of its daily implementation authority is delegated to the nine RWQCBs, which are responsible for implementing Sections 401 and 402 of the CWA. They also oversee implementation of CWA Section 303(d). In general, the State Water Board manages water rights and regulates statewide water quality, and the RWQCBs focus on water quality within their respective regions.

The Porter-Cologne Act requires the RWQCBs to develop water quality control plans (Basin Plans) that designate beneficial uses of California's major surface water bodies and groundwater basins and establish specific narrative and numerical water quality objectives for those waters. *Beneficial uses* represent the services and qualities of a water body—i.e., the reasons why the water body is considered valuable. *Water quality objectives* reflect the standards necessary to protect and support those beneficial uses. Basin Plan standards are implemented primarily by using the NPDES permitting system to regulate waste discharges so that water quality objectives are met. Under the Porter-Cologne Act, Basin Plans must be updated every 3 years.

The Suisun Marsh area is within the jurisdiction of the San Francisco Bay RWQCB, headquartered in Oakland.

Groundwater Management Act

California's Groundwater Management Act (California Water Code Sec. 10750–10756) gives existing local agencies expanded authority over the management of groundwater resources in basins recognized by DWR. Its intent is to promote the voluntary development of groundwater management plans in order to ensure stable groundwater supplies for the future. Under the act, a groundwater management plan is defined as providing for "planned use of the groundwater basin yield, storage space, transmission capability, and water in storage."

The act stipulates the technical components of a groundwater management plan as well as procedures for such a plan's adoption, including passage of a formal resolution of intent to adopt a groundwater management plan, and holding a public hearing on the proposed project. The act also requires agencies to adopt rules and regulations to implement an adopted plan and empowers agencies to raise funds to pay for the facilities needed to manage the basin, such as extraction wells, conveyance infrastructure, recharge facilities, and testing and treatment facilities.

Local

Grading

Solano County has adopted the 1997 Uniform Building Code and 2001 California Building Standards Code, including the optional appendices that regulate earthwork. The County's grading codes (also referred to as the Grading, Drainage, Land Leveling and Erosion Control Ordinance) are contained in Chapter 31 of the County Code, and do not apply to federal or state agencies. The County requires grading permits for most earthwork, with the exception of the following.

- Small excavations and fills (those with no more than 8,000 square feet disturbed, an excavated volume less than 150 cubic yards, a finished depth less than 4 feet, and slopes no steeper than 2:1).
- Landscaping of areas smaller than 10,000 square feet.
- Excavation for structures—such as pools, basements, and septic tanks—that are typically covered through other permit processes.
- Permitted land leveling for agricultural purposes.
- Agricultural activities on previously graded or leveled lands.
- Utility trenches, wells, and exploratory excavations by licensed personnel.
- Activities in disposal areas, landfills, quarries, stockpiles, and other operations where a County Use Permit has been granted
- Grading for fire roads and firebreaks.
- Grading by Solano County or Special Districts; grading for projects on state- or federally owned or operated lands.

- Grading within the Suisun Primary Marsh Area.

Mineral and Energy Resources

The Resources Element of the County General Plan (Solano County 2008) recognizes the economic importance of the county's mineral resources and contains policies (Policy RS.P-32) to ensure that

- areas with important mineral resources are zoned and developed in ways that maintain resource availability;
- mineral extraction activities are performed in a manner that is compatible with surrounding land uses;
- adverse environmental effects of extractive activities are avoided; and
- mined sites are properly restored following closure, consistent with SMARA requirements and surrounding land uses.

General Plan policies regarding natural gas resources differ somewhat from those for non-fuel mineral resources. The General Plan recognizes the past and current importance of natural gas in Solano County but also stresses that natural gas has a limited lifespan as an alternative to other fossil fuels. General Plan Policy RS.P-54 identifies the importance of "responsible extraction, storage, and transportation of natural gas resources" to "minimize the impact on the natural environment" (Solano County 2008).

Groundwater

The SCWA was established in 1951 to provide untreated water to water service agencies in Solano County from the federal Solano Project and the North Bay Aqueduct of the SWP. SCWA is responsible for delivering water to water service agencies and monitoring efforts to mitigate stormwater runoff. An IRWMP (Solano County Water Agency 2005) has been developed for the SCWA and its member cities and districts. The IRWMP proposes regionwide policies and projects to meet key strategic issues identified by stakeholder groups, including the management of the county's groundwater resources. The IRWMP identifies lack of knowledge about groundwater resources as a key management concern, limiting understanding of groundwater problems and opportunities in areas where insufficient monitoring has taken place (Solano County Water Agency 2005).

Environmental Consequences

Assessment Methods

Impacts related to geology, seismicity, soils, and mineral and groundwater resources were assessed qualitatively, based on published information and professional judgment, in light of the current standards of care for engineering geology, mineral resources management, and groundwater management. Analysis of geology-related impacts focused on the potential for increased risk of personal injury, loss of life, damage to property or facilities, and reduced availability of important mineral resources. Analysis of groundwater impacts focused on the potential for the project to deplete groundwater resources or degrade water quality in the groundwater basin.

Significance Criteria

Impacts would be significant and would require mitigation if the proposed action were to result in any of the following.

- Exposure of people, structures, or facilities to hazards involving:
    - rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map or based on other substantial evidence of active faulting;
    - strong seismic groundshaking;
    - seismically induced ground failure, including but not limited to liquefaction;
    - landslides, including seismically induced landslides; or
    - expansive soils, as defined in the current California Building Code.
- Creation of unstable cuts or fills.
- Substantial loss of topsoil resources; substantially accelerated soil erosion.
- Loss or substantial reduction in availability of a known mineral resource of regional or statewide value.
- Loss or substantial reduction in availability of a locally important mineral resource recovery site.
- Substantial depletion of groundwater supplies or interference with groundwater recharge.
- Long-term groundwater overdraft; appreciable land subsidence as a result of groundwater overdraft.
- Interference with the normal operation of existing nearby wells or a substantial increase in pumping cost at those wells such that they could not

support existing land uses or planned land uses for which permits have been granted.

- Detectable degradation of groundwater quality.
- Increased seepage losses from sloughs, canals, and streams.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, the SMP would not be implemented, and land use decision making would continue under current plans and practices. Limited marsh restoration and managed wetland enhancement are expected to occur through several separate projects unrelated to the SMP.

As there would be no change from baseline land use, current conditions, practices, and outcomes relative to geology, soils, natural gas, and non-fuel mineral resources would remain unchanged under the No Action alternative. However, the reduction in frequency of managed wetland activities would limit the potential for soil disturbance throughout the Marsh.

Depending on their location and extent, marsh restoration projects under the No Action Alternative might have some potential to affect the salinity of shallow groundwater, especially during dry periods when inland recharge is substantially diminished, but if this occurs, it would represent a return to a more natural hydrologic pattern and would be considered an overall benefit. Aquifer stratigraphy in Suisun Marsh is not well documented, so it is unclear whether shallow infiltration could affect the producing aquifer. However, because wells in Suisun Marsh are not used for potable, municipal, or agricultural supply, even if producing aquifers were affected, there would be little or no effect on the use of well water, particularly in light of the limited extent of restoration anticipated under the No Action Alternative.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact GEO-1: Potential to Create Unstable Cut or Fill Slopes

The proposed action would entail activities requiring fill placement and/or excavation, including but not necessarily limited to placement of locally obtained fill (dredge spoils) to raise levee crest elevations. Excavation associated with restoration would be limited to grading to create desired habitat features and removal of levee portions to inundate the restoration area. Fill would be applied mainly to improve both interior and exterior levees, but may also be used to create islands or other upland transition areas as part of restoration design. Excavation would be limited by both volume and geographic location, thus minimizing risks of soil instability. Additionally riprap and other bank protection would be implemented to protect newly created or modified slopes from excessive instability and erosion. As a result, project activities are not expected to create unstable cut or fill slopes, and would likely benefit slopes in both newly created tidal and existing managed wetlands.

Conclusion: Less than significant. No mitigation required.

Impact GEO-2: Potential for Accelerated Soil Erosion

Soils in Suisun Marsh are clay-rich and are not highly erodible, but ground-disturbing activities—such as earthwork to breach levees and fill placement to expand and maintain the levees that are not removed—nonetheless would have the potential to increase rates and extent of soil erosion. However, as described in Chapter 2, project proponents will implement an erosion and sediment control plan consistent with the current engineering standard of care and also will be required to implement a SWPPP for CWA compliance for activities that disturb an area of more than 1 acre. Additionally, restoration sites will be managed to establish vegetation before breaching, which would limit erosion. With these protective measures in place, impacts related to the potential for accelerated soil erosion would be substantially avoided or minimized, and are expected to be less than significant.

Restoring tidal action to portions of Suisun Marsh would increase the mobility of sediment in reconnected tidal channels and mudflat areas. This would entail some scour and localized sediment deposition. However, the cycle of tidally driven sediment erosion, transport, and redeposition would reflect the restoration of natural processes interrupted by the existing levee and dike system, so it is viewed as a benefit and does not require mitigation. Sediment transport is analyzed in more detail in Section 5.5, Sediment Transport.

Conclusion: Beneficial or less than significant. No mitigation required.

Impact GEO-3: Potential Loss of Topsoil Resources

Topsoil is the fertile, organic-rich upper portion of a soil profile; under natural conditions, it is present only where a soil profile has developed over time. Thus, some portions of the project area—active tidal channels and mudflats, where sediment is regularly remobilized by tidal currents—are unlikely to support topsoil.

Nonetheless, in areas where topsoil is present, construction of new project facilities would require removal of the existing topsoil layer. Other ground-disturbing activities—such as earthwork to breach levees and fill placement to expand and maintain the levees that are not removed—also would have some potential to result in removal and loss of topsoil resources where they are present. Ground disturbance would be confined to the minimum area necessary for project purposes, and, where feasible, topsoil would be sidecast and stockpiled for on-site reuse. The amount of topsoil lost as a result of project activities would be reduced to the extent feasible; in consideration of the comparatively small loss of topsoil and the overall project outcome of restoring, enhancing, and preserving marshland ecology (including an intact soil profile, where originally present) over a large area, impacts are evaluated as less than significant.

Conclusion: Less than significant. No mitigation required.

Impact GEO-4: Reduction in Availability of Non-Fuel Mineral Resources

Small areas zoned MRZ-2 and MRZ-3 for aggregate resources are located along the edge of the project area, in and adjacent to the city of Vallejo. Portions of the Potrero Hills also are zoned MRZ-3 for sand and gravel resources. One operating quarry is located on the north flank of the Potrero Hills uplift, and other active sand, gravel, and stone quarries are located in and adjacent to the city of Benicia, along the west side of the project area. Mercury also has been produced in this portion of the county (EDAW/AECOM 2006a).

To the extent that restored marsh habitat is viewed as incompatible with mineral resource extraction on nearby parcels, the proposed action could lead to long-term shifts in land use planning priorities, rendering extractive activities less feasible in the future. However, because the known mineral resources are not within the project area and are located only in limited areas on the periphery, it is not expected that restoration would result in changes in land uses related to mineral extraction.

Conclusion: Less than significant. No mitigation is required.

Impact GEO-5: Reduction in Availability of Natural Gas Resources

Several proved natural gas fields are located in or near the plan area, as shown in Figure 5.3-3 above. As discussed in the previous impact for non-fuel mineral resources, habitat restoration may be viewed as incompatible with continued, new, or renewed extraction of natural gas. To the extent that restored marsh habitat is viewed as incompatible with natural gas extraction, the proposed action could render natural gas extraction less feasible in the future. Regardless, restoration activities would occur only on lands purchased from willing sellers, and natural gas still would be extracted in other areas in and around the Marsh.

Conclusion: Less than significant. No mitigation required.

Impact GW-6: Potential for Altered Salinity in Shallow Suisun Marsh Groundwater

Restoring tidal connectivity and increasing the acreage of tidal wetland in Suisun Marsh would increase the area exposed to saline and brackish surface water. In normal years, groundwater moves from inland areas toward the marsh, where it provides freshwater flushing; thus, in most years, restoration likely would have little to no effect on groundwater salinity. In dry periods, when inland recharge is substantially diminished, there might be some potential for increased infiltration of saline waters into the shallow subsurface in Suisun Marsh. This would represent a return from the marsh's present condition to a more natural hydrologic pattern, representing an overall benefit. Aquifer stratigraphy in Suisun Marsh is not well documented, so it is unclear whether shallow infiltration could affect the producing aquifer. However, because wells in Suisun Marsh are not used for potable, municipal, or agricultural supply, even if producing aquifers were affected, there would be little or no effect on the use of well water.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact GEO-1: Potential to Create Unstable Cut or Fill Slopes

The proposed action would entail activities requiring fill placement and/or excavation, including but not necessarily limited to placement of locally obtained fill (dredge spoils) and raise levee crest elevations for purposes of managed wetland enhancement. Excavation for enhancement would be limited to the interior areas of managed wetlands and center channels of tidal sloughs. Fill would be applied mainly to improve both interior and exterior levees. Excavation would be limited by both volume and geographic location, thus minimizing risks of soil instability. Additionally riprap and other bank protection would be implemented to protect newly created or modified slopes from excessive instability and erosion. As a result, project activities are not expected to create unstable cut or fill slopes, and would likely benefit slopes in managed wetlands.

Conclusion: Less than significant. No mitigation required.

Impact GEO-2: Potential for Accelerated Soil Erosion

Soils in Suisun Marsh are clay-rich and are not highly erodible, but ground-disturbing activities would have the potential to increase rates and extent of soil erosion. However, managed wetland enhancement activities would not result in ground disturbance substantially above the currently implemented land management. Additionally, areas that may be disturbed within the managed wetlands are contained behind levees, water is not discharged until the wetlands are fully flooded, vegetation within the wetlands helps reduce suspended sediments, the low tide discharges are minimal compared to the total volume of the flooded managed wetland areas and area disturbed, and impacts related to the potential for accelerated soil erosion would be substantially avoided or minimized through BMPs required as part of the CWA permit conditions. As such, impacts are expected to be less than significant.

Conclusion: Less than significant. No mitigation required.

Impact GEO-5: Reduction in Availability of Natural Gas Resources

Several proved natural gas fields are located in or near the plan area, as shown in Figure 5.3-3 above. Enhancement activities would not change the current potential for natural gas extraction because there would be no changes in land use or other factors that would limit extraction potential.

Conclusion: No impact.

Impact GEO-7: Potential for Damage to Structures as a Result of Surface Fault Rupture, Groundshaking and/or Seismically Induced Ground Failure (Liquefaction)

The only three types of structures that would be constructed under the SMP are levees, duck blinds, and pump platforms. The principal concern related to surface fault rupture, groundshaking, and liquefaction would be the potential for structural damage, although injury and loss of life are also possible. As discussed in Geologic Hazards above, the westernmost end of the Suisun Marsh area is traversed by the active Concord and Green Valley faults, both of which are zoned by the State of California under the Alquist-Priolo Earthquake Fault Zoning Act. The eastern edge of the plan area also may be subject to surface fault rupture hazard along the Pittsburg−Kirby Hills fault zone, which is not zoned by the state but likely is also active. The area of Holocene Bay Mud substrate surrounding the Bay—which includes most of the area informally referred to as Suisun Marsh—is also at high risk of liquefaction in moderate and larger earthquakes. Both groundshaking and liquefaction have the potential to damage new project facilities.

If new levees, pump platforms, and duck blinds are constructed near the alignment of the active Concord or Green Valley fault, they could be at risk of damage as a result of surface fault rupture associated with this fault system. There also may be some potential for damage to pump station structures constructed along the Pittsburg−Kirby Hills fault zone.

Duck blinds would be small facilities, occupied only a few hours out of each hunting season month (October–November), and they likely would be exempt from the triggering criteria of the Alquist-Priolo Act, which applies to structures that have a human occupancy rate of more than 2,000 person-hours per year.

This slight increased risk of potential structural damage to new levees, duck blinds, and pump platforms would be in limited locations in the Marsh and would not be considered significant. Additionally, the placement of materials on levees would improve levee stability.

Conclusion: Less than significant. No mitigation required.

Impact GEO-8: Potential for Damage to Structures as a Result of Landslides, Including Seismically Induced Landslides

The project area is located in flat marshland topography, and as such the majority of the project area is not at risk of landslides. However, lands at the base of steep, slide-prone uplifts are in potential landslide runout areas; these include the strip along I-680 at the west edge of Suisun Marsh, and marshlands downslope from the western tip of the Potrero Hills. Any new project facilities constructed in such areas could be at risk of substantial damage with minor corollary risks to personal safety. However, few structures would be constructed in areas subject to damage from landslides, and because these structures generally are not occupied, there would not be a substantial change from current conditions with the implementation of Alternative A.

Conclusion: Less than significant. No mitigation is required.

Alternative B: Restore 2,000–4,000 Acres

Impacts under Alternative B would be very similar to those described for the proposed action, with the following principal differences.

- Alternative B would result in less extensive tidal restoration and could entail less major earthwork because less levee breaching would be required. However, the increased enhancement compared to Alternative A would result in more ground-disturbing activities in managed wetlands and dredging activities in channels. Additionally, there would be more levee improvements through increased enhancement. The level of significance of impacts described for Alternative A would be the same for Alternative B.
- Reduced tidal restoration likely also would decrease land use planning pressures identified as potentially unfavorable to mineral resources and natural gas extraction. This would be particularly true for mineral resources because of substantial reductions in proposed restoration in Regions 1, 2, and 4 (see Figure 5.3-4). The level of significance of impacts described for Alternative A would be the same for Alternative B.

Alternative C: Restore 7,000–9,000 Acres

Impacts under Alternative C would be broadly similar to those described for the proposed action, with the following principal differences.

- Alternative C would result in substantially more extensive tidal restoration than Alternative A, and would have greater potential for temporary soil instability due to levee breaching. Impacts related to ground disturbance, topsoil loss, and accelerated soil erosion in managed wetlands would be less than Alternative A, and still would be less than significant because the same environmental commitments and regulatory requirements identified for the proposed action (topsoil reuse, Erosion and Sediment Control Plan, SWPPP) would apply under Alternative C. The overall level of significance of impacts described for Alternative A would be the same for Alternative C.
- Increased extent of tidal restoration would increase land use planning pressures identified as potentially unfavorable to mineral resources and natural extraction (see Figure 5.3-4). The level of significance of impacts described for Alternative A would be the same for Alternative C.
- Increased extent of tidal restoration would increase the potential for impacts on shallow groundwater. However, impacts still are expected to be less than significant overall for the same reasons identified above for the proposed action.

Section 5.4
Flood Control and Levee Stability

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on flood control and levee stability.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 5.4-1 summarizes impacts on flood control and levee stability from implementing the SMP alternatives. There would be no significant impacts on flood control and levee stability from implementing the SMP alternatives.

Table 5.4-1. Summary of Flood Control and Levee Stability Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
FC-1: Increased Potential for Catastrophic Levee Failure and Flooding Resulting from Restoration Activities That Expose Interior Levees to Tidal Action	A, B, C	Less than significant	None required	–
FC-2: Changes in Flood Stage and Flow Capacity in Suisun Marsh Channels as a Result of Increased Tidal Prism and Flood Storage Capacity	A, B, C	Beneficial	–	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
FC-3: Temporary Decrease in Levee Stability Resulting from Construction Activities	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
FC-4: Reduction in Potential for Catastrophic Levee Failure and Flooding Resulting from Improvements in Exterior Levee Maintenance	A, B, C	Beneficial	–	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- Suisun Marsh Charter Group Levee Conceptual Model—State of Knowledge, Draft Final (California Department of Water Resources 2005).
- Suisun Marsh Numerical Modeling, RMA (January 2008, PowerPoint).
- CALFED Suisun Marsh Levee Investigation Report (California Department of Water Resources 2000).
- DRMS Study Phase 1 Report (California Department of Water Resources 2007).
- Suisun Marsh Levee Evaluation (Ramlit and Associates 1983).

The Suisun Marsh is protected from tidal action and high water events by 200 miles of exterior levees. Several miles of interior levees are also maintained to separate land with differing uses and management practices. Exterior levees provide the Marsh with necessary flood protection and vehicle access. They also play a role in maintaining channels in the Marsh and thus have the potential to influence salinity in the Marsh and as far as the south Delta CVP and SWP diversions. Levees in the Marsh have not been constructed to an engineered standard nor have they been maintained to the standard of an urban or an agricultural levee.

The majority of Suisun Marsh, including wildlife habitat, is situated at or below mean tide elevation. Levees serve as the primary flood protection for Suisun Marsh lands, infrastructure, and natural resources. Exterior levees are used in conjunction with interior levees, ditches, and water control structures to retain, exclude, and direct water.

Where possible, levees were constructed on existing channel berms to take advantage of the existing natural topography throughout the Marsh. Levee configurations throughout the Marsh vary considerably in material composition, cross-sectional geometry, strength, and stability (California Department of Water Resources 2005).

Since the early 1800s levees were constructed primarily with dredged material removed from the adjacent channels. As levees have been maintained, some of the longstanding levees have increased in size as additional dredged material has been placed on the crown, seaward side, and landside. Due to regulatory constraints, options for maintaining Marsh levees are limited to the use of materials from within the managed wetlands or by very limited importation. Subsidence requires additional placement of material to raise and reinforce the levees.

Levee failures can result in flooding that can affect the regional salinity of the adjacent waterways, tidally restored sites, and managed wetlands. Historical flooding, including the flooding in 1998, prompted DWR to complete a levee breach analysis study to determine whether there was a correlation between levee failures in Suisun Marsh and salinity increases in the Delta. The study concluded that portions of the exterior levee system in Suisun Marsh may be important to controlling salinity. The August 1999 breach at the Sunrise Club on Chadbourne Slough (280 acres) is an example of a small breach (180 feet in width) that had localized impacts on salinity for adjacent landowners. Larger, region-wide breaches and flooding in the Marsh, as in 1998, can have water quality effects in the Delta that can affect SWP and CVP operations (California Department of Water Resources 1999, 2000, 2001).

While levee failure mechanisms are well understood, the mechanism causing a sudden failure is rarely able to be determined. Therefore, it is important to inspect levees and adequately maintain them to prevent failure. In Suisun Marsh, levee overtopping has been the historical failure mechanism (Chappell pers. comm.). (Overtopping is a systematic design failure which causes erosion that then breaches the levee as opposed to a breach caused by an internal structural failure of the levee.) As levees subside, the available freeboard (the distance between the high tide or flood elevation and the top of the levee) is reduced and the potential for overtopping is increased. Wave action and sea level rise also can reduce the effective freeboard. Over time, without maintenance all levees eventually will fail.

As described in Chapter 2, most if not all restoration activities will require some amount of levee improvements to ensure that adjacent properties are adequately protected from flooding. These upgrades will likely include levee raises and contouring, brush boxes, riprap, or other wave and wind protection.

Regulatory Setting

Federal

There are no federal mandates for flood control and levee stability in the Marsh.

State

There are no state mandates for flood control and levee stability in the Marsh.

Local

Suisun Resource Conservation District Levee Standards

In 1980, *SRCD's Management Program to Preserve, Protect, and Enhance the Plant and Wildlife Communities within the Primary Management Zone of the Suisun Marsh* was developed, and included minimum standards for levee design in the Marsh. These standards assume that the maximum water depth against an exterior levee is 7 feet above sea level and the maximum depth against an interior levee is 3 feet above sea level. The SRCD management program acknowledges that when these water elevation conditions are exceeded special design levee standards are required. Table 5.4-2 shows the applicable standards for typical exterior and interior levees.

Table 5.4-2. Applicable Standards for Typical Exterior and Interior Levees

Levee Type	Crown Width	Freeboard	Sideslopes
Exterior	12 feet	2 feet; 3 feet where wave action occurs	2:1
Interior	10 feet	1 foot minimum; if water depth is greater than 1 foot, freeboard should be equal to water depth and not exceed 3 feet	2:1

Suisun Marsh Levee Investigation Team

CALFED established the Suisun Marsh Levee Investigation Team (SMLIT) in 1998 to gather information on the costs and benefits of including Suisun Marsh levees in the CALFED Program, especially as they relate to CALFED Water Quality, Water Supply Reliability, and ERP goals. The SMLIT used computer models to evaluate hydrodynamics and salinity impacts of controlled and uncontrolled levee breaches in Suisun Marsh. The SMLIT final report was completed as the Suisun Marsh Charter process was initiated. The SMLIT agreed that implementation of their recommendations should be carried out within the context of the SMP. The SMLIT recommended:

- establishment of an interim plan that emphasizes development of an emergency response program,
- establishment of a base-level Marsh-wide maintenance program,
- establishment of a program for enhanced protection that is modeled on the current special flood control projects program and the special projects program,
- development of a criteria and evaluation methodology for acceptable parcel characteristics,
- establishment of an application of focused research toward an engineering strategy for levee breaching and maintenance,
- development of methods to obtain more accurate topographical data for Suisun Marsh for planning purposes,
- examination of sedimentation processes in the Marsh to explore possible means of creating sediment accretions throughout Suisun Marsh,
- inclusion of adaptive management techniques to pursue any tidal marsh conversion efforts,
- the addition of Suisun Marsh levees to the CALFED Levee Program Risk Assessment and Risk Management Strategy,
- funding for an emergency response element to address Suisun Marsh levees,
- structuring funding for improvements to Suisun Marsh levees to avoid competition with the already strained resources for the maintenance of levees currently included in the Delta Subventions Program,
- concurrent implementation of restoration and maintenance improvements, and
- focus first on lands in public ownership for habitat conversion opportunities.

Environmental Consequences

Assessment Methods

The RMA hydrodynamic and water quality model of the San Francisco Bay and the Delta (described in Appendix A) was used to predict changes in stage, velocity, and flow to compare alternative scenarios for Marsh restoration that impacts flood control and levee stability in Suisun Marsh.

Significance Criteria

Significance of impacts is determined by using significance criteria set forth in the State CEQA Guidelines and professional standards and practices. Impacts on flood risks are considered significant if implementation of an alternative would:

- significantly raise flood stage elevations along flood control levees;
- increase the frequency and duration of inundation on lands within the flood control area; or
- 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 flood control levee.

Impacts on the levee system are considered significant if an alternative would substantially increase:

- seepage,
- levee settlement,
- wind erosion,
- scour,
- sediment deposition, or
- subsidence of land adjacent to levees.

In addition, an impact on the levee system is considered significant if an alternative would substantially decrease:

- levee stability;
- inspection, maintenance, or repair capabilities;
- current levee slope protection;
- emergency response capabilities;
- channel conveyance capacity; or
- ability of the levees to withstand seismic loading.

Environmental Impacts

No Action Alternative

The No Action Alternative would rely on the existing level of maintenance activities to inspect, assess, and maintain the exterior levee system. The inability to obtain permits for managed wetland activities, including levee maintenance, would further reduce the level of maintenance activities. Currently, maintenance efforts are not able to keep up with the current rate of levee degradation. Suisun

Marsh is already susceptible to flooding during major flood events, and continued wave erosion (fetch-generated and boat traffic) rates are putting several miles of exterior levees at risk for failure during less frequent flood events and potential "summer failure" (e.g., Jones Tract). If the No Action alternative is selected, the flood risk in Suisun Marsh would continue to increase as a result of deferred maintenance.

Alternative A: Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact FC-1: Increased Potential for Catastrophic Levee Failure and Flooding Resulting from Restoration Activities That Expose Interior Levees to Tidal Action

As a result of levee breaches and other actions that may be implemented as part of SMP tidal wetland restoration actions, interior levees may become exterior levees, thus increasing their exposure to tidal action for which they were not intended. To reduce the potential risk for failure of these levees, they would be improved to meet exterior levee standards. The Suisun Marsh exterior levee section standard requires a crown (top width) of 12 feet and 2:1 (H:V) side slopes. In addition, the levee must provide necessary freeboard above the 100-year flood. Necessary freeboard is described as 2 feet of freeboard under normal conditions and 3 feet of freeboard in wave-prone areas. The 100-year flood elevation is estimated at 10.0 feet NAVD 88. This datum should be compared against other tidal and survey datums in use in the Marsh prior to any levee evaluation. The 200 miles of exterior levee locations and any proposed "new" exterior levees associated with planned breaches will be evaluated to determine the proper freeboard requirement. Levee profile and crown surveys will be completed to determine compliance with the standard and identify areas needing improvements.

Additionally, benches, berms, and erosion protection such as brush boxes, vegetation, and riprap that would be included to establish a range of marsh habitats also would serve to protect the levee from wind and wave erosion. These improvements would be implemented prior to breaches that would expose them to tidal action to ensure that there is no point during which an unimproved interior levee is exposed to tidal action.

Conclusion: Less than significant. No mitigation required.

Impact FC-2: Changes in Flood Stage and Flow Capacity in Suisun Marsh Channels as a Result of Increased Tidal Prism and Flood Storage Capacity

The creation of additional tidal wetland habitat through breaching of existing exterior levees would increase the acreage of land available to draw tidal flows overland and increase flood storage capacity during storm events. This additional area would have varying effects on the adjacent waters that would supply flow to the tidal wetland areas. Preliminary hydraulic modeling suggests that the addition of tidal prism through the breaching of levees and restoration of tidal wetlands would reduce tidal stages in the adjacent channels and bays (Appendix A, “Numerical Modeling in Support of Suisun Marsh PEIR/EIS Technical Memorandum, March 2008”). The magnitude and extent of stage reduction would be dependent on the volume of additional tidal prism and the location within the Marsh.

This reduction in stage in channels adjacent to restoration areas likely would be a beneficial change relative to flooding, as the channels would have a greater carrying capacity during storm events, and levees within the restoration area would be improved to meet exterior levee standards, as described above.

Conclusion: Beneficial.

Impact FC-3: Temporary Decrease in Levee Stability Resulting from Construction Activities

During construction of new levee sections or rehabilitation of levees to bring them up to a minimum standard, the levee may be subject to ground shaking and increased ground pressures from heavy equipment or placement of fill. This additional loading may exceed the potential for the existing levee material or levee foundation material to support the levee section (i.e., shear strength) and may cause rapid settling or fracture of the levee section. As described in Chapter 2, specific project proponents will control construction equipment access and placement of fill to maintain acceptable loading based on the shear strength of the foundation material.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact FC-4: Reduction in Potential for Catastrophic Levee Failure and Flooding Resulting from Improvements in Exterior Levee Maintenance

The SMP includes a program to improve levee maintenance activities for exterior levees. This would be accomplished by increasing slope stability and reducing erosion, overtopping, and failure through placement of riprap or alternative bank protection measures, as well as modifying the heights of exterior levees, which would require dredging and importation of appropriate levee materials (e.g., mineral soils and clays). Depending on existing conditions, work may occur on the waterside slope, landside slope, or both. Improved levee stability would reduce the risk of catastrophic levee failure.

Conclusion: Beneficial.

Alternative B: Restore 2,000–4,000 Acres

Compared to Alternative A, this alternative includes more managed wetland activities that would accommodate the reduced restoration that leaves more exterior levees to be maintained. Less restoration also would lead to less need to bolster interior levees to meet exterior levee standards. Similarly, there would be fewer changes in tidal stage and muting. However, the level of significance for the impacts identified for Alternative A would be the same for Alternative B.

Alternative C: Restore 7,000–9,000 Acres

This alternative calls for more restoration than Alternative A, which reduces the need for some exterior levee maintenance, but the reduced application of managed wetland activities is not expected to change the overall flood protection improvements described in Alternative A. There would be more changes in tidal stage and muting; nonetheless, the level of significance for the impacts identified for Alternative A is the same for Alternative C.

Section 5.5
Sediment Transport

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on sediment transport.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 5.5-1 summarizes impacts on sediment transport from implementing the SMP alternatives. There would be no significant impacts on sediment transport from implementing the SMP alternatives.

Table 5.5-1. Summary of Sediment Transport Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
ST-1: Increased Scour in Bays or Channels Upstream and Downstream of Habitat Restoration Areas	A, B, C	Less than significant	None required	–
ST-2: Deposition of Sediment in the Restored Tidal Wetlands	A, B, C	Beneficial or Less than significant	None required	–
ST-3: Changes in Regional Sedimentation and Scour Patterns in Suisun Marsh	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Managed Wetland Activities Impacts				
ST-4: Increase in Erosion Adjacent to Dredging Sites	A, B, C	Less than significant	None required	–
ST-5: Increase in Deposition at Dredging Sites	A, B, C	Less than significant	None required	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- Draft Results for Discussion. RMA Suisun Marsh Models, January 2008 (PowerPoint) (RMA 2008).
- *Proposed Negative Declaration and Environmental Assessment/Initial Study for the Proposed Blacklock Restoration Project* (California Department of Fish and Game and Bureau of Reclamation 2006).
- *Conceptual Model Scalar Transport and Suisun Marsh Geometry: Implications of Tidal Marsh Restoration on Formerly Diked Wetlands. Suisun Marsh Planning* (California Department of Water Resources).

Suisun Marsh Sediment Supply

The Sacramento–San Joaquin River system in combination with the tidal influences of San Francisco Bay is the primary hydraulic and sediment transport source in Suisun Marsh. The Suisun Marsh sediment supply is influenced by the continuous input of SS from the Sacramento River, which can enter the Marsh through Montezuma Slough. However, tidal currents and wind-driven suspension of mudflats in Suisun Bay and the Marsh channels also provide a continuous source of suspended sediment. Local tributaries north of Suisun Marsh provide infrequent floodflows and sediment pulses that coincide with precipitation events in southern Solano County.

SS concentrations have been measured at several locations throughout Suisun Marsh. Ruhl and Schoellhamer (2004) measured SS concentrations at a shallow-water site (Honker Bay) and a deep-water channel (Mallard Island) from December 1996 through July 1997. They found similar temporal trends caused by tidal velocities and storm events at both the shallow-water and deep-channel sites. In December, SS was relatively low (25–50 mg/l) at both sites but increased following the first-flush winter storm event to 100–150 mg/l in Honker Bay and 50–100 mg/l at Mallard Island.

The Blacklock Restoration Project is located on Nurse Slough adjacent to Little Honker Bay and is a good example of how SS may be affected by restoration activities. DWR measured SS concentrations using optical backscatter sensors at two locations in Nurse Slough from December 2004 to April 2006 as part of background monitoring for the restoration plan. The SS data are displayed in Figure 5.2-5. The average SS concentration was about 100 mg/l. The SS concentrations were lowest, about 50 mg/l, in fall 2005. It appears that Suisun Bay and the Marsh channels have a reasonably high and relatively constant SS concentration of about 50 mg/l. This provides a large amount of particles for adsorbing metals and other potentially toxic chemicals and pollutants.

Suisun Marsh Sediment Transport

RMA has developed a two-dimensional (2-D) hydraulic model of San Francisco Bay and the Delta to assess the potential changes in Suisun Marsh hydrodynamics related to potential restoration scenarios (Appendix A). While this model does not calculate sediment transport or geomorphologic changes expected to occur in the channels and bays over time, it does provide changes in velocity that can be used to better understand how sediment may be mobilized and transported.

In general the Marsh channels could be considered to be in a state approaching equilibrium. Dredging of channels has been limited in scale over the last 10 to 15 years. Channels are accumulating sediment where channel velocities are low enough for sediment to settle out of the water column. Where channel velocities are higher, sediments are suspended and carried in the direction of flow until they settle out again. In addition, wind-driven wave action and boat wakes provide enough energy to re-suspend and mobilize sediment. Scour zones and depositional zones could be expected to remain the same into the future, unless the tidal prism (i.e., upstream tidal volume) or channel geometries in the Marsh are altered (i.e., restoration efforts change tidal prism, and dredging operations alter channel geometry).

Increasing tidal prism would involve breaching levees to provide additional tidal habitat directly connected to bays, sloughs, or channels in the Marsh. Sediment is expected to be carried through these breaches by tidal flows and deposited in the new tidal areas. These sediments would come from the available SS in the water column or from sediment that is mobilized by increased channel velocities or wave energy. Early predictions from the RMA 2-D model indicate that channel velocities will increase by 3 to 4 fps locally at levee breaches and sloughs that will convey increased tidal flows to the breach sites. The modeled velocity increases are localized and do not persist great distances upstream or downstream. Therefore, the sediment contributions from these increased velocities would be limited and may reach a new sedimentation equilibrium quickly. It would be expected that some channel or bank erosion would occur in the area of increased velocity if scour countermeasures or enlarged breach areas are not installed. Based on preliminary hydraulic modeling, it appears that tide-driven channel velocities will not increase enough to mobilize more sediment from the Marsh channels. Therefore, sediment supplies that are expected to deposit in the restoration areas will come from the existing sediment supply in the water column that results from wind/wave–driven re-suspending of sediments on nearby shallow mudflats or shallow water along the channel banks.

Environmental Consequences

Assessment Methods

Assessment of environmental impacts associated with sedimentation and scour has been accomplished through application of quantitative modeling (Appendix A). This modeling has been used to forecast the potential for, and patterns of, sedimentation and erosion in Suisun Marsh channels.

Significance Criteria

The criteria used for determining the significance of an impact on sedimentation and scour are based on the State CEQA Guidelines and professional standards and practices. Impacts may be considered significant if implementation of an alternative would:

- substantially alter the existing drainage pattern of the site or area, including the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation off site or in areas not identified for deposition in the proposed restoration design.

Environmental Impacts

No Action Alternative

For the No Action Alternative, some restoration and natural levee breaching may occur. In these areas, existing sedimentation and/or scour rates could temporarily change. However, managed wetland activities would cease or decrease as a result of regulatory restrictions. Therefore, there would be no impacts.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact ST-1: Increased Scour in Bays or Channels Upstream and Downstream of Habitat Restoration Areas

As tidal restoration is implemented and areas are opened to tidal influences and floodflows, the adjacent waterways that supply the tidal water volume may experience increased velocities and have a greater potential to mobilize sediment. It is expected that each new levee breach would experience local scour as increased volumes of water pass through the opening on the tidal cycle and during flood events. Some adjacent channels would scour and increase their conveyance areas to supply additional tidal water volume to the new habitats. However, as part of the restoration design, breach locations would be selected to minimize scour and channel hydraulic changes. Also, as discussed in Chapter 2 under Environmental Commitments, site-specific hydraulic simulation modeling and scour analysis would occur. All final restoration designs would be simulated with the RMA model (or equivalent model) to verify that the effects of scour are minimized.

Conclusion: Less than significant. No mitigation required.

Impact ST-2: Deposition of Sediment in the Restored Tidal Wetlands

Breaching of levees and dikes would encourage natural deposition of sediment in the tidal wetland restoration areas. Removal of the levee or dike and restoring the tidal function to the managed wetland areas would create slow and shallow tidal flows. Under these conditions, SS from the water column typically will be deposited. The rate of deposition would depend on the residence time of tidal flow, depth of tidal flooding, and concentration and gradation of SS. Natural deposition within the tidal wetlands would restore a range of wetland elevations, providing the expected tidal habitat conditions.

Conclusion: Beneficial or less than significant. No mitigation required.

Impact ST-3: Changes in Regional Sedimentation and Scour Patterns in Suisun Marsh

The intent of the plan is to restore greater tidal function to Suisun Marsh. Breaching exterior levees and dikes that have allowed reclamation of historical marsh lands would return these lands to tidal marsh. The increased marsh area effectively would increase the tidal prism (i.e., the amount of water that can flood the marsh on the high tide). This increase in the tidal prism would increase local channel velocities and provide greater low-velocity tidal habitats in the restored wetland areas, which would change the overall sedimentation in Suisun Marsh.

Some channels may experience local scour attributable to increased velocity as more water travels to the restoration areas. In addition, the restoration areas would have greater capacity to trap or accept deposited sediments. Regionally, the channels in the Marsh would adjust to accommodate the higher restored tidal flow, but the channels would reach a new sedimentation equilibrium over time. Areas that typically are targeted for dredging likely would remain areas of deposition, so the local supply of sediments for levee maintenance and strengthening are not expected to be reduced.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact ST-4: Increase in Erosion Adjacent to Dredging Sites

Channel dredging would occur in center channels and would avoid emergent vegetation. As such, it is not expected to encroach on levee profiles or benches adjacent to levees. Although localized scour and deposition in the vicinity of dredging areas would be temporarily modified as dredged sites refill with sediment, it is not expected that channel erosion would be increased beyond what generally occurs in the dynamic (i.e., tidal) Marsh.

Conclusion: Less than significant. No mitigation required.

Impact ST-5: Increase in Deposition at Dredging Sites

Following dredging operations, the deeper channel sections would have the greatest potential for trapping deposited sediments, which may reduce depositional rates in adjacent channels or restored tidal habitat areas. As the entire sediment budget of the Marsh adjusts to restoration area sediment demands and changes in channel geometry attributable to restoration and dredging, sedimentation rates throughout the Marsh are expected to vary.

Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Impacts for Alternative B would be the same as for Alternative A but to a lesser extent.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C would be the same as for Alternative A but to a greater extent.

Section 5.6
Transportation and Navigation

Introduction

This section describes the existing transportation and navigation conditions and the consequences of implementing the SMP alternatives on transportation and navigation resources.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts. For example, the setting identifies transportation and navigation in the action area because the action could have an effect on transportation and navigation in the plan area.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 5.6-1 summarizes transportation and navigation impacts from implementing the SMP alternatives. There would be no significant impacts on transportation and navigation resources from implementing the SMP alternatives.

Table 5.6-1. Summary of Transportation and Navigation Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities	A, B, C	Less than significant	None required	–
TN-2: Temporary Increases in Road Hazards during Construction Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
TN-3: Damage to Roadway Surfaces from Construction Activities	A, B, C	Less than significant	None required	–
TN-4: Impacts to Air Traffic Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone	A, B, C	Less than significant	None required	–
TN-6: Temporary Reduction in Boat Access during Construction Activities	A, B, C	Less than significant	None required	–
TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service	A, B, C	Less than significant	None required	–
TN-8: Short-Term Reduction in Navigable Areas Resulting from Increased Velocities after Restoration Activities	A, B, C	Less than significant	None required	–
TN-9: Temporary Reduction in Boat Access during Dredging Activities	A, B, C	Less than significant	None required	–
TN-10: Increases in Navigable Areas of Suisun Marsh	A, B, C	Beneficial	–	–
TN-11: Operations and Maintenance Increase in Traffic	A, B, C	Less than significant	None required	–
Managed Wetland Activities				
TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities	A, B, C	Less than significant	None required	–
TN-2: Temporary Increases in Road Hazards during Construction Activities	A, B, C	Less than significant	None required	–
TN-3: Damage to Roadway Surfaces from Construction Activities	A, B, C	Less than significant	None required	–
TN-4: Impacts to Air Traffic Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone	A, B, C	Less than significant	None required	–
TN-6: Temporary Reduction in Boat Access during Construction Activities	A, B, C	Less than significant	None required	–
TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service	A, B, C	Less than significant	None required	–
TN-9: Temporary Reduction in Boat Access during Dredging Activities	A, B, C	Less than significant	None required	–
TN-11: Operations and Maintenance Increase in Traffic	A, B, C	Less than significant	None required	–

Affected Environment

Roadway Network

The primary regional roadways serving Suisun Marsh are located around the Marsh perimeter and include Interstate 80 (I-80) (Urban Interstate Freeway) and SR 12 (Rural Major Arterial) to the north, SR 4 to the south, and Interstate 680 (I-680) (Major Collector) to the west. I-80 connects Solano County to the San Francisco and Sacramento metropolitan areas. I-680 connects the county to the east Bay Area, and SR 12 and SR 4 act as major arterials connecting major urban areas (Figure 5.6-1).

Solano County maintains several roads in the interior Marsh that serve rural developments, managed wetlands and agricultural operations, and other uses in the Marsh. Table 5.6-2 lists these roads in relation to Suisun Bay. The Operations division of the Solano County Public Works Department surveys the roads every 2 weeks to assess public safety issues and need for any repairs. If major repairs are deemed necessary, a 5-year road improvement plan is implemented. The County also conducts annual surveys to measure major road damage and repair needs. The plan area can be accessed via some combination of the local roadways listed below. There are also many roads within the Marsh that are privately owned and maintained. The key local roadways in the Marsh are shown in Figure 5.6-2.

Table 5.6-2. Local Roads in Suisun Marsh

North of Suisun Bay *East of I-80/I-680 and South of SR 12*	**Northeast of Grizzly Bay**	**East of Montezuma Slough**
• O'Rher Road	• Van Sickle Road	• Lambie Road
• Cordelia Road	• Grizzly Island Road	• Flannery Road
• Chadbourne Road	• Redhouse Road	• Little Honker Road
• Thomasson Lane	• Potrero Hill Lane	• Olsen Road
• Ramsey Road	• Killdeer Road	• Birds Landing Road
• Goodyear Road	• Scally Road	• Montezuma Hills Road
• Jacksnipe Road	• Rio Vista Road	• Coleville Road
• Pierce Harbor Lane	• Nurse Slough Road	• Fire Truck Lane
• Morrow Lane	• Explosive Technology Road	
• Lake Herman Road		

Rail

The Union Pacific Railroad (UPRR) runs through the western portion of the Marsh and carries freight cars between Bay Area ports and the rest of the country (Figure 5.6-1). The Capitol Corridor (Amtrak) uses the UPRR line and has a station in Suisun City. This passenger line connects regionally and nationally (Solano County General Plan 2008, T-17). The California Northern Railroad runs a short line freight service. They lease 250 miles of Union Pacific Railroad tracks from Suisun City to Schellville and other areas (California Northern Railroad Company no date).

The Concord Naval Weapons Station is located along the southern perimeter of Suisun Bay, immediately south of Ryer Island and north of SR 4 (Figure 5.6-1). The station houses three commercial class 1 railroads (GlobalSecurity.org 2008).

Boats

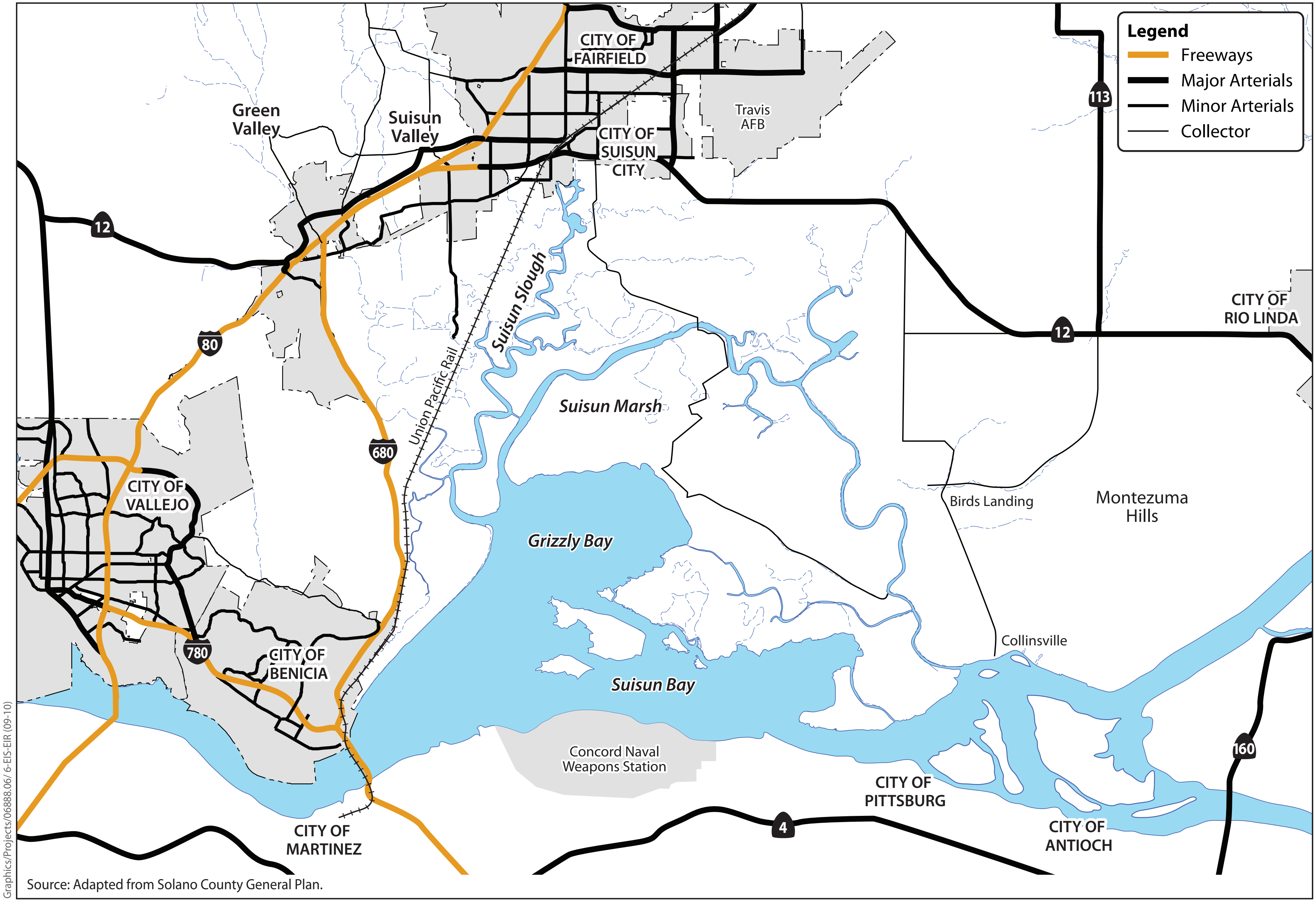
Suisun Bay is a major navigational and recreational water body and serves as the entrance to the Delta. Suisun Marsh is a 102,053-acre marsh with many navigable channels throughout. Figure 5.6-3 shows the major surface waters in and around the Marsh. Bays and minor and major sloughs comprise 26,980 acres of navigable channels (Table 6.2-2, "Suisun Marsh Acreage by Habitat Type and Region"). The two major channels are Montezuma and Suisun Sloughs. Suisun Slough runs from Grizzly Bay to the northern portion of the Marsh, and Montezuma Slough runs from the eastern side of Grizzly Bay to the western side, with several smaller channels diverging from it. Other navigable waterways are Cordelia, Denverton, Nurse, and Hill Sloughs.

Most of the Marsh is navigable by small boats, and some channels, such as Montezuma and Suisun Sloughs, are navigable by much larger boats. A major navigation channel is the Suisun Bay channel, which connects to the Carquinez Strait.

As described in the Recreation section, launching locations in the Marsh include Suisun City boat ramp, Suisun City Marina, and Solano Yacht Club, all located in Suisun Slough, Belden's Landing located in Montezuma Slough, and McAvoy Yacht Harbor and Yacht Club, located on Suisun Bay at Bay Point. In addition, there are marinas on the Contra Costa shoreline near Pittsburg and Antioch that provide access to Suisun Bay. Most boating in the Marsh is recreational such as fishing, water and jet skiing, kayaking, and canoeing (See Section 7.4, Recreation). Most of the sloughs are narrow, and when tides recede, the sloughs become shallow, limiting some access.

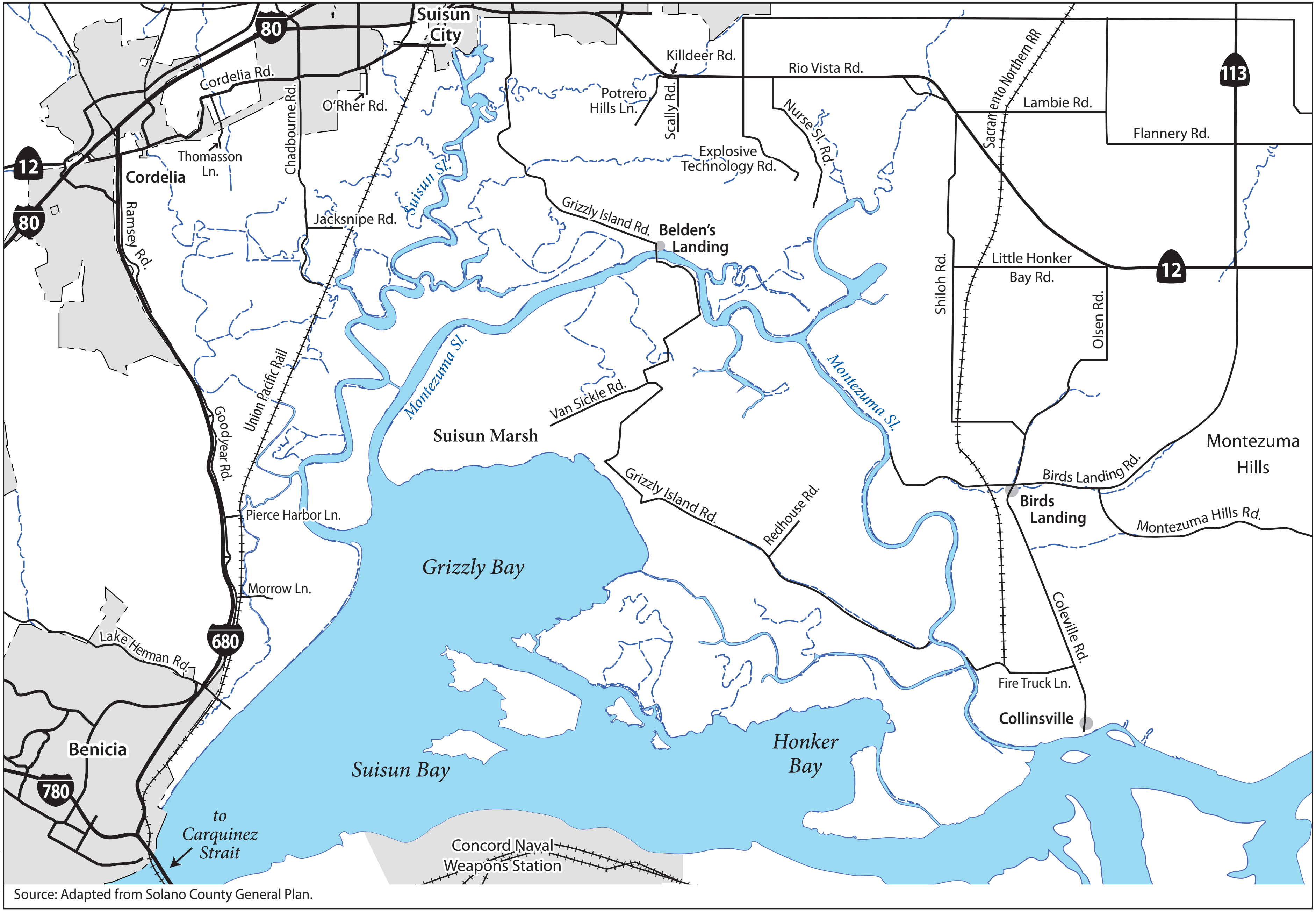
Aviation Facilities

Travis Air Force Base (AFB) is located approximately 1 mile from the northern boundary of the SMP area (on the northeast side of SR 12). Travis AFB handles more cargo and passengers than any other military air terminal in the United States and is home to the 60th Air Mobility Wing, the largest air mobility organization in the United States Air Force (Figure 5.6-1).



ICF INTERNATIONAL

Figure 5.6-1
Major Highways, Rail Lines, and Aviation Facilities Surrounding Suisun Marsh

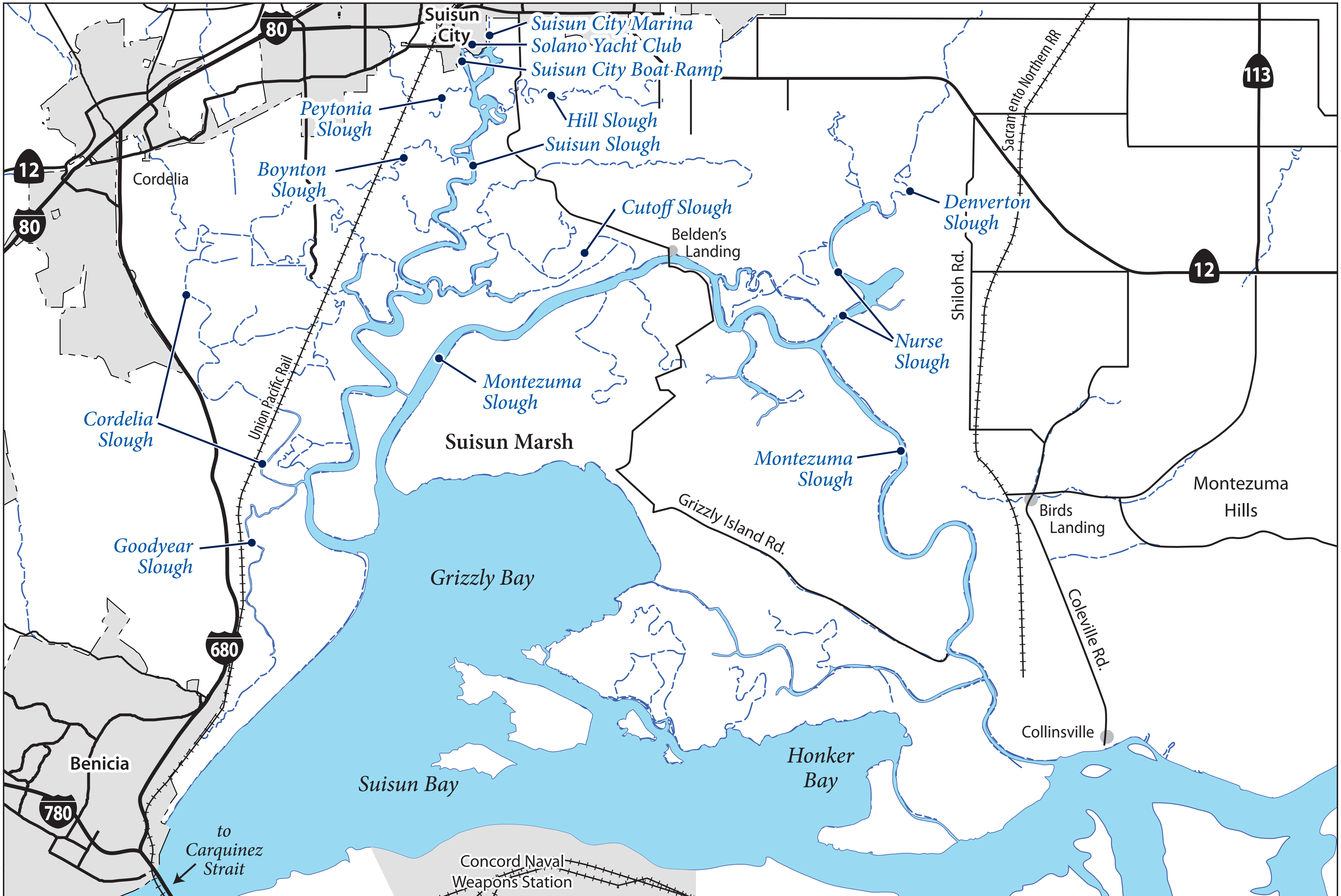


Source: Adapted from Solano County General Plan.

Graphics/Projects/06888.06/ 6-EIS-EIR (09-10)

ICF INTERNATIONAL

Figure 5.6-2
Local Roadways in and around Suisun Marsh



Source: Adapted from Solano County General Plan.

Graphics/Projects/06888.06/ 6-EIS-EIR (09-10)

ICF INTERNATIONAL

Figure 5.6-3
Surface Waters in and around Suisun Marsh

The Concord Naval Weapons Station, the location of which is described in the Rail section, above, currently has three commercial air terminals and three military air terminals (GlobalSecurity.org 2008).

Sources of Information

The following key sources of information were used in the preparation of this section:

- Solano County General Plan, Land Use and Circulation Element (Solano County Planning Department 1992), and
- City of Suisun City—Wal-Mart Walters Road West Project Draft EIR (Michael Brandman Associates 2008).

Regulatory Setting

Federal

Federal Aviation Administration

Standards for airport and air traffic safety and service are under the jurisdiction of the Federal Aviation Administration (FAA). The FAA's guidance regarding prevention of bird airstrike hazard (BASH) addresses land uses such as waste disposal operations, water management facilities, wetlands, dredge spoil contaminant areas, agricultural activities, golf courses, and landscaping near airports that could attract wildlife. BASH is addressed in Advisory Circular 150/5200-33B Hazardous Wildlife Attractants on or near Airports (Federal Aviation Administration 2007), which recommends setbacks from airport operations. Depending on the aircraft type (piston or turbine-powered) distances regulated by BASH range from 5,000 feet (0.93 mile) to 10,000 feet (1.86 miles) from air operations areas. For all airports, the FAA recommends a perimeter of 5 miles from air operations area for approaching and departing aircraft. The Advisory Circular also recommends that the FAA be given the opportunity to review proposed land uses and evaluate their effects on aviation safety. Based on its review, FAA may request implementation of appropriate management measures to reduce potential hazards to aircraft.

Local

Solano County Transportation Authority

The Solano County Transportation Authority sets forth various goals, objectives, and policies that would apply to projects in the county. Applicable goals, objectives, and policies from the Arterials, Highways, and Freeways Element of the Solano Comprehensive Transportation Plan, dated June 2005, that are applicable to the proposed project include:

- Objective A—Preserve the System: Preserve the physical and operational condition of existing roadway facilities as a means of protecting past transportation investments and maintaining an effective system.
- Policy 1: Encourage member jurisdictions and Caltrans to maintain level of service (LOS) E or better conditions during the a.m. and p.m. peak hours on roadways of countywide significance.

Solano County Airport Land Use Commission

The Solano County Airport Land Use Commission regulates land use around Travis AFB by recommending to cities that projects in their jurisdictions comply with the Travis AFB Land Use Compatibility Plan. The plan identifies land use compatibility policies applicable to future development near Travis AFB. The policies are designed to ensure that future land uses in the surrounding area will be compatible with potential aircraft activity at the base. In certain circumstances, local governments have the ability to override the decisions of the Airport Land Use Commission.

The Travis Air Force Base Land Use Compatibility Plan prohibits land uses that would create glare or distracting lights; sources of dust, steam, or smoke; sources of electrical interference with aircraft communications or navigation; or any land use (e.g., landfills) that may attract an increased number of birds. Land has been acquired to the north and east of Travis AFB and is reserved for open space or future base expansion. Areas surrounding Travis AFB are also designated as Zones A, B1, B2, C, and D (Figure 7.1-3). Compatibility Zone D, in which Suisun Marsh is located, includes all other locations beneath any of the Travis AFB airspace protection surfaces delineated in accordance with Federal Aviation Regulations Part 77. Limitations on the height of structures are the only compatibility factors within this zone.

Solano County General Plan

Cities and counties are responsible for planning, designing, constructing, operating, and maintaining local public roadways within their jurisdictions. The Solano County General Plan Circulation Element informs and describes the existing and future circulation conditions in unincorporated sections of Solano County (Solano County 2008).

According to the *Road Improvement Standards and Land Development Requirements*,

> the goal of Solano County is to maintain a Level of Service C on all roads and intersections. In addition to meeting the design widths and standards contained in this document, all projects shall be designed to maintain a Level of Service C, except where the existing level of service is already

below C, the project shall be designed such that there will be no decrease in the existing level of service.

Solano County will issue an encroachment permit whenever construction activities would be conducted within the public right-of-way. Encroachment permits are intended to safeguard the affected jurisdictions' properties, by providing either preventive measures to be implemented during project construction or corrective measures if damage occurs.

Any encroachment within the right-of-way of a state highway or route would be subject to Caltrans regulations, including issuance of an encroachment permit and the provision of temporary traffic control systems. Such a system could include traffic control warning signs, lights, and/or safety devices to ensure the safety of the traveling public.

Environmental Consequences

Assessment Methods

The impacts resulting from SMP alternatives have been assessed based on assumptions about construction-related traffic and navigational disruptions in the plan area. It is assumed that construction of the various SMP alternative components would occur over the 30-year SMP implementation period and would be intermittent. The types and numbers of equipment in use at one time cannot be determined at this time, but it is assumed that minimal overlap in major restoration or managed wetland activities would occur. However, specific projects may require further analysis to describe in more detail any potential impacts on traffic resulting from implementation of that specific project. The SMP alternatives are compared to the No Action Alternative, and that potential change in transportation and/or navigation is described. The significance of potential changes is determined based on the significance criteria described below. Mitigation measures are recommended, as necessary, to reduce significant transportation and navigation impacts.

While described as a planning tool, existing and potential LOS resulting from Plan implementation is not included because there would be no permanent impacts from roadway modifications and construction impacts would be minimal and short-term. Except for during construction activities, additional vehicle trips would be minimal and are not expected to change vehicle/capacity ratios noticeably.

Significance Criteria

For the purposes of this analysis, a significant traffic impact would occur if the implementation of an SMP alternative would:

- cause traffic operations on a roadway or at an intersection to degrade (e.g., because of increased traffic generated by construction vehicles and/or loss of a travel lane to accommodate the construction work zone);
- cause a substantial increase in traffic relative to the traffic volume of the local traffic network;
- result in lengthy delays for transit riders;
- result in an inadequate parking capacity;
- substantially impede access to local streets or adjacent uses, including emergency access;
- substantially increase hazards because of a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment);
- conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks); or
- cause temporary or permanent disruption of rail operations.

For the purposes of this analysis, a significant air traffic impact would occur if implementation of an SMP alternative would:

- result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that would result in substantial safety risks;
- conflict with the recommendations of the FAA's Advisory Circular 150/5200-33B (Federal Aviation Administration 2007) by creating bird habitat within 5,000 feet of airports serving piston-powered aircraft and/or 10,000 feet of airports serving turbine-powered aircraft; or
- conflict with designated land use zones within Travis AFB.

For the purposes of this analysis, a significant navigation impact would occur if implementation of an SMP alternative would:

- substantially impede or block navigational craft;
- create safety conflicts in Delta waterways; or
- reduce the navigable area of the Marsh.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, limited restoration activities would occur. Traffic generated by private property owners and recreational users would continue to circulate locally within the plan area and on roadways adjacent to the plan area similar to current conditions. Thus, it is not expected that impacts on LOS at major intersections and roadway segments adjacent to and within the plan area would occur.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities

Implementation of the proposed action could result in impacts associated with construction of the various SMP components that would require the use of construction equipment and potentially the importation of fill and other materials. Construction-related impacts could result from trips made by construction equipment and workers to and from a project site. Construction activities associated with implementing the SMP are the major impact mechanism for transportation effects, particularly construction equipment and the importation of soil, plantings, and other materials. During critical construction periods, public access would be restricted or controlled.

Material may be brought to a project area by barge and/or by truck. In addition, short-term construction traffic would consist of the transport of the work crew, and construction trucks delivering equipment and materials. Substantial amounts of fill hauled in to project areas by trucks, as well as other construction-related equipment and worker vehicles, could result in adverse impacts on transportation, including rail and public transit, depending on the number of trucks, total truck trips, and roadways used.

It is anticipated that the average restoration project would require up to 10 roundtrip truck trips and 10 worker trips a day for up to 30 days. The routes would be designed to ensure total loads and capacities are not exceeded. As shown in Figure 5.6-2, the primary roads that would be used for entry into the Marsh are Grizzly Island Road, Chadbourne Road, Shiloh Road, and Birds Landing Road. All of these roads dead-end in the Marsh, and there is no traffic beyond that generated by visitors to the Marsh. These roads are rural connector roads that operate at a high LOS, except during busy recreational events in the Marsh, such as opening day of duck hunting season. As described in Chapter 2, no major construction activities would occur on days known or expected to have a significant increase in traffic as a result of events in the Marsh. As such, the short-term addition of these additional trips is not expected to affect circulation on roads in the Marsh. Arterial roads and highways would not be affected by an additional 20 roundtrips per day of construction vehicles and worker trips.

Some smaller restoration activities would not generate traffic that would cause a substantial increase in the number of vehicles on the road or changes in circulation. However, for those projects that have the potential to result in significant traffic impacts, a traffic control plan, as described in the environmental commitments section of Chapter 2, will be implemented to ensure that impacts related to traffic during construction are minimal and less than significant.

Conclusion: Less than significant. No mitigation required.

Impact TN-2: Temporary Increases in Road Hazards during Construction Activities

The majority of the proposed project would be constructed away from existing major road networks and areas of residential or urban development. As such, the likelihood of accidents involving construction equipment resulting in potentially dangerous situations for the general public is low. The potential for hazards depends on the type of equipment and roadways used, as well as roadway conditions. Increased hazards would occur when roads are narrower or have other characteristics that make maneuvering difficult, equipment is larger and/or more difficult to maneuver, or roadways used include those that are used by the general public to access various areas of the Marsh. Restoration design planning will take into account access to the site, but potential road hazards may remain. As such, a traffic control plan will be implemented for each major site-specific action that has the potential to create a significant hazard to ensure that such risks are minimized or eliminated.

Conclusion: Less than significant. No mitigation required.

Impact TN-3: Damage to Roadway Surfaces from Construction Activities

Implementing the proposed project would require the transport of construction equipment and material, including but not limited to long-reach excavators, excavators, dozers, box scrapers, tractors, pipes, riprap, etc. Some roads within the Marsh may not be designed to accommodate such traffic, and therefore, there is potential for damage to roads by construction activities, construction vehicles, and transport of equipment. As described in the Environmental Commitments section of Chapter 2, the specific project proponent will conduct pre- and post-construction assessments of roadways to determine whether any roads are damaged during construction of the SMP alternatives. If damage is found, and is determined to be attributable to the SMP action, the damage will be repaired through an MOU with Solano County.

Conclusion: Less than significant. No mitigation required.

Impact TN-4: Impacts to Air Traffic Attributable to Restoration Activities

Implementation of the SMP alternatives include restoring tidal marsh habitat, which could result in more diversity of birds and other wildlife to the Suisun Marsh area than currently are present. The total acres of wetlands in the Marsh would be similar to existing conditions, but there would be shifts in the types of wetlands. In some instances, additional wetlands may be created on the periphery of tidal wetlands through inundation of upland areas. Compared to the existing tidal marsh and managed wetland acreage, the overall increase in acreage of these habitats would not significantly change wildlife or bird usage of the Marsh. Additionally, restoration and managed wetland activities would occur far enough away from the airport that bird activity would not affect air traffic patterns.

Conclusion: Less than significant. No mitigation required.

Impact TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone

As discussed above under Solano County Airport Land Use Commission, Suisun Marsh restoration would occur in Zone D under the Travis Air Force Base zoning areas. Zone D compatible land use is restricted only by the height of features that would be built. None of the proposed SMP activities are expected to result in major structures that would be considered tall enough to conflict with the Zone D land use.

Conclusion: Less than significant. No mitigation required.

Impact TN-6: Temporary Reduction in Boat Access during Construction Activities

Implementation of the SMP alternatives would include in-channel work related to restoration. In-channel work may require the reduction of some channel area available for boating and other navigation. It is expected that in-channel work related to levee breaching for restoration, specifically dredging or levee repair, would be conducted sporadically throughout the Marsh over the 30-year period, would be temporary, and would not result in permanent reductions in navigable areas. The only major navigational channel is located in Suisun Bay, and plan activities are not expected to affect this area.

Additionally, as described in the environmental commitments section of Chapter 2, specific project proponents would develop and implement a traffic and navigation control plan in coordination with affected jurisdictions and emergency service providers to reduce construction-related effects and hazards in the waterway during the construction period, including postings warning boaters of construction activities in compliance with the California Uniform State Waterway Marking System.

Conclusion: Less than significant. No mitigation required.

Impact TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service

Restoration or other activities could affect the integrity of levees holding the rail line for the Union Pacific Railroad by causing increased inundation and erosion, depending on the specific location and type of SMP activities implemented. Breaches will be designed to avoid levees where rail lines sit. Restoration activities will be designed to protect rail lines. Work occurring within a particular right-of-way determined by the railroads may result in delays or other temporary disruptions to rail service, depending on the type of activities implemented. As described in the environmental commitments section of Chapter 2 under the Traffic and Navigation Control Plan, specific project proponents will coordinate with the Union Pacific Railroad prior to beginning any work within a right away of a rail line to ensure that the integrity of the rail line is maintained and to minimize disruptions to service.

Conclusion: Less than significant. No mitigation required.

Impact TN-8: Short-Term Reduction in Navigable Areas Resulting from Increased Velocities after Restoration Activities

Levee breaches associated with restoration activities could result in changes in velocities adjacent to the breach location (see Section 5.1, Water Supply, Hydrology, and Delta Water Management, and Section 5.5, Sedimentation Transport.) Increased velocities in these areas are expected to be temporary and localized to the immediate breach site location but could interfere with navigation by temporarily creating areas within the Marsh that are unsafe or not navigable. If such an impact occurs, it is expected to be temporary and minimal and would not interfere substantially with the ability of boats or other watercraft to maneuver through the Marsh area. Additionally, as described in Chapter 2, these areas will be marked to warn boaters of risks and direct them to a safe alternate route.

Conclusion: Less than significant. No mitigation required.

Impact TN-9: Temporary Reduction in Boat Access during Dredging Activities

Dredging from major and minor tidal sloughs and bays over the 30-year SMP implementation period, with the first 10 years as the most intensive period, could result in temporary reductions in boat access in isolated areas throughout the Marsh. Clamshell dredging could occur either from a barge within the channel or from the top of a levee, depending on restrictions caused by channel width or existing vegetation. From a barge, clamshell dredges would require a small tugboat to maneuver within the channel, resulting in a substantial area of the channel occupied by dredging equipment, depending on the width of the channel and the size of the barge. Dredging from the levee crown generally would require less channel space, but restrictions on boating in the immediate area still would be in place. Once dredging is complete, no further restrictions would be implemented. Dredging activities therefore would result in a temporary reduction in boat access, especially within the first 10 years of SMP implementation. Dredging would be temporary and spread throughout the Marsh area over the 30-year implementation period. It is not expected that a substantial number of individual projects or activities would be implemented at the same time, and therefore it is not expected that in-channel work would disrupt boat access in more than a minor area of the Marsh at any given time.

As described in the environmental commitments section of Chapter 2, specific project proponents would develop and implement a traffic and navigation control plan in coordination with affected jurisdictions and emergency service providers to reduce construction-related effects and hazards in the waterway during the construction period. The navigational signage environmental commitment described in Chapter 2 also would help to ensure that there are no substantial disruptions.

Conclusion: Less than significant. No mitigation required.

Impact TN-10: Increases in Navigable Areas of Suisun Marsh

Under the proposed project, the restoration of approximately 5,000 to 7,000 acres of tidal marsh would lead to an increase in the navigable areas of Suisun Marsh. The total increase in navigable areas depends on which areas are restored, beginning elevations, sedimentation rates, and sea-level rise. Some restored areas may begin with large navigable areas, but as sediment accumulates, water becomes shallow and the navigable area is reduced. Regardless, it is expected that there would be a net increase in navigable areas compared to existing conditions.

Conclusion: Beneficial.

Impact TN-11: Operations and Maintenance Increase in Traffic

Upon completion of construction of restoration, minimal traffic would be generated. There could be some monitoring efforts, but the associated increase is not expected to be noticeable. Additionally, it is not expected that the shift in habitat types would generate new trips.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities

Impacts to the roadway system as a result of managed wetland activities would be similar to those described for restoration activities, but to a lesser extent. Most managed wetland activities would not generate traffic that would cause a substantial increase in the number of vehicles on the road or changes in circulation. A traffic control plan will be implemented to ensure that construction-related traffic impacts are minimal and less than significant.

Conclusion: Less than significant. No mitigation required.

Impact TN-2: Temporary Increases in Road Hazards during Construction Activities

Increases in road hazards as a result of managed wetland activities would be similar to those described for restoration activities, but to a lesser extent. In general, the increased frequency of current and the implementation of new managed wetland activities is not expected to require a substantial number of equipment pieces imported to the Marsh during any one period. Restoration actions have the highest potential to increase road hazards.

Conclusion: Less than significant. No mitigation required.

Impact TN-3: Damage to Roadway Surfaces from Construction Activities

This impact would be similar to that described for restoration activities. Certain marsh management activities would require the transport of construction equipment and material, including but not limited to long-reach excavators, tractors, pipes, riprap, etc. There is potential for damage to roads by construction activities, construction vehicles, and transport of equipment. As described in the Environmental Commitments section of Chapter 2, the specific project proponent will conduct pre- and post-construction assessments of roadways to determine whether any roads are damaged during construction of the managed wetland activities. If damage is found, and is determined to be attributable to the managed wetland activity, the damage will be repaired by the County through an MOU between the land owner conducting the managed wetland activity and Solano County.

Conclusion: Less than significant. No mitigation required.

Impact TN-4: Impacts to Air Traffic Attributable to Restoration Activities

This impact would be similar to that described for restoration activities. Enhancing managed wetlands could result in more diversity of birds and other wildlife to the Suisun Marsh area than currently are present. However, compared to the existing tidal marsh and managed wetland acreage, the overall increase in acreage of these habitats would not significantly change wildlife or bird usage of the Marsh. Additionally, managed wetland activities would occur far enough away from the airport that bird activity would not affect air traffic patterns.

Conclusion: Less than significant. No mitigation required.

Impact TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone

This impact would be the same as that described for restoration activities. Managed wetland activities would occur in Zone D under the Travis Air Force Base zoning areas. Zone D compatible land use is restricted only by the height of features that would be built. None of the proposed SMP activities are expected to result in major structures that would be considered tall enough to conflict with the Zone D land use.

Conclusion: Less than significant. No mitigation required.

Impact TN-6: Temporary Reduction in Boat Access during Construction Activities

This impact would be similar to that described for restoration activities. Implementation of the SMP alternatives would include in-channel work related to managed wetland activities, which may require the reduction of some channel area available for boating and other navigation. It is expected that in-channel work related to activities for managed wetland activities, specifically dredging or levee repair, would be conducted sporadically throughout the Marsh over the 30-year period, would be temporary, and would not result in permanent reductions in navigable areas. The only major navigational channel is located in Suisun Bay, and plan activities are not expected to affect this area.

Conclusion: Less than significant. No mitigation required.

Impact TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service

This impact would be similar to that described for restoration activities. Activities associated with wetland management will not impact rail lines. As described in the environmental commitments section of Chapter 2 under the Traffic and Navigation Control Plan, specific project proponents will coordinate with the Union Pacific Railroad prior to beginning any work in the right of way of a rail line to ensure that the integrity of the rail line is maintained and to minimize disruptions to service.

Conclusion: Less than significant. No mitigation required.

Impact TN-9: Temporary Reduction in Boat Access during Dredging Activities

This impact would be the same as that described for restoration activities. Dredging from major and minor tidal sloughs and bays could result in temporary reductions in boat access in isolated areas throughout the Marsh, especially within the first 10 years of SMP implementation.

It is not expected that a substantial number of individual projects or activities would be implemented at the same time, and therefore it is not expected that in-channel work would disrupt boat access in more than a minor area of the Marsh at any given time. Additionally, as described in Chapter 2, alternate boating routes will be identified if dredging impedes navigation. Furthermore, the majority of the managed wetland activities would be conducted on private lands. Therefore, there would be no substantial disruption to boat access during dredging activities.

Conclusion: Less than significant. No mitigation required.

Impact TN-11: Operations and Maintenance Increase in Traffic

This impact would be similar to that described for restoration activities. Minimal traffic would be generated. There could be some increase in traffic during monitoring efforts, but the associated increase is not expected to be noticeable.

Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Impacts for Alternative B are similar to those described for Alternative A. There would be less tidal restoration, and more managed wetland subject to managed wetland activities. The magnitude and types of impacts resulting from Alternative B would be similar to those described above for Alternative A, except that there would be fewer benefits related to navigation because less tidal restoration would occur. Additionally, there would be fewer large construction projects related to restoration and less potential to result in changes in circulation, increased hazards, or road damage. Compared to the No Action Alternative, Alternative B would result in less-than-significant impacts related to traffic circulation, increased traffic, road and air traffic hazards, and roadway damage and beneficial impacts related to increases in navigable areas.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C are similar to those described for Alternative A. There would be more tidal restoration, and less managed wetland subject to managed wetland activities. The magnitude and types of impacts resulting from Alternative C would be similar to those described above for Alternative A, except that there would be additional benefits related to navigation as more tidal restoration would occur. Additionally, there would be more large construction projects related to restoration and more potential to result in changes in circulation, increased hazards, or road damage. Compared to the No Action Alternative, Alternative C would result in less-than-significant impacts related to traffic circulation, increased traffic, road and air traffic hazards, and roadway damage and beneficial impacts related to increases in navigable areas.

Section 5.7
Air Quality

Introduction

This section describes the existing conditions and the consequences of implementing the SMP alternatives on air quality.

Summary of Impacts

Table 5.7-1 summarizes impacts on air quality from implementing the SMP alternatives. There would be no significant impacts on air quality from implementing the SMP alternatives.

Table 5.7-1. Summary of Impacts on Air Quality

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
AQ-1: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration	A, B, C	Significant	AQ-MM-1: Limit Construction Activity during Restoration AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures	Less than significant
AQ-2: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Current Management Activities	A, B, C	Significant	AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures	Less than significant
AQ-3: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with New Management Activities	A, B, C	Less than Significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
AQ-4: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration and Management Activities Combined	A, B, C	Significant	AQ-MM-1: Limit Construction Activity during Restoration AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures AQ-MM-4: Limit Construction Activity during Restoration and Management	Less than significant
AQ-5: Construction-Related Diesel Health Risk Associated with Restoration	A, B, C	Less than significant	None required	–
AQ-6: Construction-Related Diesel Health Risk Associated with Current Management Activities	A, B, C	Less than significant	None required	–
AQ-7: Construction-Related Diesel Health Risk Associated with New Management Activities	A, B, C	Less than significant	None required	–
AQ-8: Construction-Related Diesel Health Risk Associated with Restoration and Management Activity Combined	A, B, C	Less than significant	None required	–
AQ-9: Increase in Construction Emissions in Excess of Federal *de Minimis* Thresholds	A, B, C	Less than significant	None required	–
AQ-10: Increase in Construction-Related Odor	A, B, C	Less than significant	None required	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section.

- Bay Area Air Quality Management District (BAAQMD) CEQA Guidelines (Bay Area Air Quality Management District 1999).
- BAAQMD Workshop Draft Options Report: CEQA Thresholds of Significance (Bay Area Air Quality Management District 2009).
- California Air Resources Board's (ARB's) *Proposed Amendments to the Area Designation Criteria and Area Designations for State Ambient Air Quality Standards and Maps of Area Designations for State and National Ambient Air Quality Standards* (California Air Resources Board 2006).

- ARB's Aerometric Data Analysis and Management System (ADAM) databases (California Air Resources Board 2009).
- EPA air data (U.S. Environmental Protection Agency 2009).
- SCAQMD Final Methodology to Calculate Particulate Matter (PM) 2.5 and PM2.5 Significance Thresholds, October 2006 (Santa Clara Air Quality Management District 2006).
- Starcrest Consulting Group, 2007, Puget Sound Maritime Air Emissions Inventory, prepared April 2007 (Starcrest Consulting Group 2007).
- 2008 Estimated annual Average Emissions-San Francisco Bay Area Air Basin (California Air Resources Board 2008a).
- Yolo-Solano County Air Quality Management District (YSAQMD), 2007, Handbook for Assessing and Mitigating Air Quality Impacts, adopted July 11, 2007 (Yolo-Solano County Air Quality Management District 2007).

Regional Climate and Meteorology

Cool rainy winters and warm dry summers characterize the climate of Solano County. Similar to the rest of the Bay Area, Solano County is classified as a Marine West Coast Climate type with Mediterranean characteristics. The average rainfall ranges from 17 to 20 inches per year. Winter temperatures are generally 40º to 60ºF, and summer temperatures are generally 55º to 80ºF. The prevailing wind direction is from the west. Typical wind speeds in the County are less than 5 miles per hour (mph) in the fall and winter and approximately 10 mph in the spring and summer.

The Carquinez Strait runs from Rodeo to Martinez. It is the only sea-level gap between San Francisco Bay and the Central Valley. The Carquinez Strait subregion includes the lowlands bordering the strait to the north and south, as well as the area adjoining Suisun Bay and the western part of the Delta as far east as Bethel Island. Further, the subregion extends from Rodeo in the southwest and Vallejo in the northwest to Fairfield in the northeast and Brentwood in the southeast.

Prevailing winds are from the west in the Carquinez Strait. During the summer and fall, high pressure offshore coupled with low pressure in the Central Valley causes marine air to flow eastward through the strait. The wind is strongest in the afternoon. Afternoon wind speeds of 15 to 20 mph are common throughout the strait region. Annual average wind speeds are 8 mph in Martinez, and 9 to 10 mph farther east. Sometimes atmospheric conditions cause air to flow from the east. East winds usually contain more pollutants than the cleaner marine air from the west. In summer and fall, this can cause elevated pollutant levels to move into the central Bay Area through the strait. These high-pressure periods are usually accompanied by low wind speeds, shallow mixing depths, higher temperatures, and little or no rainfall.

Summer mean maximum temperatures reach about 90°F in the subregion. Mean minimum temperatures in winter are in the high 30s (°F). Temperature extremes are especially pronounced in sheltered areas farther from the moderating effects of the strait itself (e.g., at Fairfield).

Many industrial facilities with significant air pollutant emissions (e.g., chemical plants and refineries) are located in the Carquinez Strait region. The pollution potential of this area is often moderated by high wind speeds. However, upsets at industrial facilities can lead to short-term pollution episodes, and emissions of unpleasant odors may occur at any time. Receptors downwind of these facilities could suffer more long-term exposure to air contaminants than individuals elsewhere. Consequently, it is important that local governments and other lead agencies maintain buffer zones around sources of air pollution sufficient to avoid adverse health and nuisance impacts on nearby receptors. Areas of the subregion that are traversed by major roadways (e.g., Interstate 80) also may be subject to higher local concentrations of carbon monoxide (CO), particulate matter, and certain toxic air contaminants (TACs) such as benzene.

Criteria Pollutants and Local Air Quality

Description of Pollutants

The federal and state governments have established ambient air quality standards for six criteria pollutants: ozone (O_3), CO, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter, and lead (Table 5.7-2). O_3 and NO_2 generally are considered regional pollutants because these pollutants or their precursors affect air quality on a regional scale. Pollutants such as CO, SO_2, and lead are considered local pollutants that tend to accumulate in the air locally. Particulate matter is considered a local and regional pollutant. The pollutants of greatest concern in the plan area are CO, O_3, and inhalable particulate matter (PM2.5 and PM10 [particulate matter 2.5 microns or less and 10 microns or less in diameter, respectively]). Brief descriptions of these pollutants, as well as TACs, follow.

Table 5.7-2. Ambient Air Quality Standards Applicable in California

			Standard (parts per million)		Standard (micrograms per cubic meter)		Violation Criteria	
Pollutant	Symbol	Average Time	California	National	California	National	California	National
Ozone*	O_3	1 hour	0.09	NA	180	NA	If exceeded	NA
		8 hours	0.070	0.075	137	147	If exceeded	If fourth highest 8-hour concentration in a year, averaged over 3 years, is exceeded at each monitor within an area
Carbon monoxide	CO	8 hours	9.0	9	10,000	10,000	If exceeded	If exceeded on more than 1 day per year
		1 hour	20	35	23,000	40,000	If exceeded	If exceeded on more than 1 day per year
(Lake Tahoe only)		8 hours	6	NA	7,000	NA	If equaled or exceeded	NA
Nitrogen dioxide	NO_2	Annual arithmetic mean	0.030	0.053	57	100	If exceeded	If exceeded on more than 1 day per year
		1 hour	0.18	NA	339	NA	If exceeded	NA
Sulfur dioxide	SO_2	Annual arithmetic mean	NA	0.030	NA	80	NA	If exceeded
		24 hours	0.04	0.14	105	365	If exceeded	If exceeded on more than 1 day per year
		1 hour	0.25	NA	655	NA	If exceeded	NA
Hydrogen sulfide	H_2S	1 hour	0.03	NA	42	NA	If equaled or exceeded	NA
Vinyl chloride	C_2H_3Cl	24 hours	0.01	NA	26	NA	If equaled or exceeded	NA
Inhalable particulate matter	PM10	Annual arithmetic mean	NA	NA	20	NA	NA	NA
		24 hours	NA	NA	50	150	If exceeded	If exceeded on more than 1 day per year
	PM2.5	Annual arithmetic mean	NA	NA	12	15	NA	If 3-year average from single or multiple community-oriented monitors is exceeded
		24 hours	NA	NA	NA	35	NA	If 3-year average of 98th percentile at each population-oriented monitor within an area is exceeded
Sulfate particles	SO_4	24 hours	NA	NA	25	NA	If equaled or exceeded	NA
Lead particles	Pb	Calendar quarter	NA	NA	NA	1.5	NA	If exceeded no more than 1 day per year
		30-day average	NA	NA	1.5	NA	If equaled or exceeded	NA
		Rolling 3-Month average	NA	NA	NA	0.15	If equaled or exceeded	Averaged over a rolling 3-month period

Notes: All standards are based on measurements at 25ºC and 1 atmosphere pressure. National standards shown are the primary (health effects) standards. NA = not applicable.

* The U.S. Environmental Protection Agency recently replaced the 1-hour ozone standard with an 8-hour standard of 0.08 part per million. EPA issued a final rule that revoked the 1-hour standard on June 15, 2005. However, the California 1-hour ozone standard will remain in effect.

Source: California Air Resources Board 2008b.

Ozone

O_3 is a respiratory irritant and an oxidant that increases susceptibility to respiratory infections, and can cause substantial damage to vegetation and other materials. O_3 is a severe eye, nose, and throat irritant. O_3 also attacks synthetic rubber, textiles, plants, and other materials and causes extensive damage to plants by leaf discoloration and cell damage. O_3 is not emitted directly into the air; it is formed by a photochemical reaction in the atmosphere. O_3 precursors—reactive organic gases (ROG) and oxides of nitrogen (NO_X)—react in the atmosphere in the presence of sunlight to form O_3. Because photochemical reaction rates depend on the intensity of ultraviolet light and air temperature, O_3 is primarily a summer problem. ROG and NO_X are emitted by mobile sources and stationary combustion equipment.

Carbon Monoxide

CO is essentially inert to plants and materials but can have significant impacts on human health. It combines readily with hemoglobin and thus reduces the amount of oxygen transported in the bloodstream. Effects on humans range from slight headaches to nausea to death. Motor vehicles are the dominant source of CO emissions in most areas. High CO levels develop primarily during winter when periods of light winds combine with the formation of ground-level temperature inversions, typically from evening through early morning. These conditions result in reduced dispersion of vehicle emissions. Motor vehicles also exhibit increased CO emission rates at low air temperatures.

Inhalable Particulate Matter

Particulates can damage human health and retard plant growth. Health concerns associated with suspended particulate matter focus on those particles small enough to reach the lungs when inhaled. Particulates also reduce visibility and corrode materials. Particulate emissions are generated by a wide variety of sources, including agricultural activities, industrial emissions, dust suspended by vehicle traffic and construction equipment, and secondary aerosols formed by reactions in the atmosphere. The federal and state standards for particulate matter apply to two classes of particulates: PM10 and PM2.5.

Toxic Air Contaminants

TACs are pollutants that may be expected to result in an increase in mortality or serious illness, or that may pose a present or potential hazard to human health. Health effects of TACs include cancer, birth defects, neurological damage, damage to the body's natural defense system, and diseases that lead to death. The ARB identifies diesel exhaust particulate matter as a TAC.

Federal and State Ambient Air Quality Standards

The State of California and the federal government each have established ambient air quality standards for air pollutants (see Table 5.7-2). For some pollutants, separate standards have been set for different periods, with most standards set to protect public health; however, for some pollutants, standards have been based on other values, such as protection of crops, protection of materials, or avoidance of nuisance conditions.

Monitoring Data and Attainment Status

The existing air quality conditions in the plan area can be characterized by monitoring data collected in the region. The nearest air quality monitoring station in the vicinity is located at 304 Tuolumne Street, Vallejo, CA 94590, which is located in an urbanized area upwind of the Marsh. Air quality monitoring data from the Vallejo monitoring station are summarized in Table 5.7-3. These data represent air quality monitoring data for the last 3 years for which complete data are available (2006 to 2008).

As indicated in Table 5.7-3, the station has experienced no violations of the state 1-hour O_3 standard, 12.6 violations of the state PM10 standard, three violations of the federal 8-hour O_3 standard, no violations of the federal and state CO standards, and 25.1 violations of the federal PM10 standard during the last 3 years for which complete data are available.

Table 5.7-3. Ambient Air Quality Monitoring Data Measured at the Vallejo 304 Tuolumne Street Monitoring Station

Pollutant Standards	2006	2007	2008
1-Hour Ozone			
Maximum 1-hour concentration (ppm)	0.080	0.078	0.109
1-hour California designation value	0.08	0.08	0.08
1-hour expected peak day concentration	0.083	0.077	0.083
Number of days standard exceeded[a]			
CAAQS 1-hour (>0.09 ppm)	0	0	0
8-Hour Ozone			
National maximum 8-hour concentration (ppm)	0.069	0.066	0.075
National second-highest 8-hour concentration (ppm)	0.064	0.056	0.072
State maximum 8-hour concentration (ppm)	0.070	0.067	0.075
State second-highest 8-hour concentration (ppm)	0.064	0.056	0.073
8-hour national designation value	0.057	0.054	0.060
8-hour California designation value	0.065	0.061	0.067
8-hour expected peak day concentration	0.066	0.061	0.067
Number of days standard exceeded[a]			
NAAQS 8-hour (>0.075 ppm)	0	0	0
CAAQS 8-hour (>0.070 ppm)	0	0	3

Pollutant Standards	2006	2007	2008
Carbon Monoxide (CO)			
National[b] maximum 8-hour concentration (ppm)	2.94	2.70	2.31
National[b] second-highest 8-hour concentration (ppm)	2.73	2.60	1.96
California[c] maximum 8-hour concentration (ppm)	2.94	2.70	2.31
California[c] second-highest 8-hour concentration (ppm)	2.73	2.60	1.96
Maximum 1-hour concentration (ppm)	3.7	3.3	2.7
Second-highest 1-hour concentration (ppm)	3.5	3.3	0.9
Number of days standard exceeded[a]			
NAAQS 8-hour (≥9 ppm)	0	0	0
CAAQS 8-hour (≥9.0 ppm)	0	0	0
NAAQS 1-hour (≥35 ppm)	0	0	0
CAAQS 1-hour (≥20 ppm)	0	0	0
Particulate Matter (PM10)[d]			
National[b] maximum 24-hour concentration (μg/m^3)	46.6	49.1	42.1
National[b] second-highest 24-hour concentration (μg/m^3)	43.9	47.3	31.4
State[c] maximum 24-hour concentration (μg/m^3)	50.1	52.4	43.6
State[c] second-highest 24-hour concentration (μg/m^3)	47.2	51.1	32.4
State annual average concentration (μg/m^3)[e]	19.8	19.0	–
National annual average concentration (μg/m^3)	19.1	18.2	16.0
Number of days standard exceeded[a]			
NAAQS 24-hour (>150 μg/m^3)[f]	0	0	–
CAAQS 24-hour (>50 μg/m^3)[f]	0	12.6	–
Particulate Matter (PM2.5)			
National[b] maximum 24-hour concentration (μg/m^3)	42.2	40.8	50.0
National[b] second-highest 24-hour concentration (μg/m^3)	40.5	40.0	47.0
State[c] maximum 24-hour concentration (μg/m^3)	44.0	41.5	51.2
State[c] second-highest 24-hour concentration (μg/m^3)	43.2	41.3	50.0
National annual designation value (μg/m^3)	10.2	9.8	9.8
National annual average concentration (μg/m^3)	9.8	9.8	9.9
State annual designation value (μg/m^3)	13	12	12
State annual average concentration (μg/m^3)[e]	12.4	12.0	–
Number of days standard exceeded[a]			
NAAQS 24-hour (>35 μg/m^3)	5.9	12.1	7.1

Sources: California Air Resources Board 2009; U.S. Environmental Protection Agency 2009.

Notes: CAAQS = California Ambient Air Quality Standards. NAAQS = National Ambient Air Quality Standards. – = insufficient data available to determine the value.

[a] An exceedance is not necessarily a violation.

[b] National statistics are based on standard conditions data. In addition, national statistics are based on samplers using federal reference or equivalent methods.

[c] State statistics are based on local conditions data, except in the South Coast Air Basin, for which statistics are based on standard conditions data. In addition, State statistics are based on California approved samplers.

[d] Measurements usually are collected every 6 days.

[e] State criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.

[f] Mathematical estimate of how many days concentrations would have been measured as higher than the level of the standard had each day been monitored.

If monitored pollutant concentrations meet state or federal standards over a designated period of time, the area is classified as being in attainment for that pollutant. If concentrations violate the standards, the area is considered a nonattainment area for that pollutant. If data are insufficient to determine whether a pollutant is violating the standard, the area is designated as unclassified. The attainment status of Solano County is listed in Table 5.7-4.

Table 5.7-4. Federal and State Attainment Status for Solano County

	Solano County	
Pollutant	Federal	State
1-hour O_3	–[1]	Nonattainment
8-hour O_3	Marginal nonattainment	–
CO	Moderate (≤12.7 ppm) maintenance	Attainment
PM10	Unclassified/attainment	Nonattainment
PM2.5	Nonattainment (pending)	Nonattainment

[1] Previously in nonattainment area, no longer subject to the 1-hour standard as of June 15, 2005.

Sensitive Receptors

According to the YSAQMD, a sensitive receptor is generically defined as a location where human populations, especially children, seniors, or sick persons are found, and there is reasonable expectation of continuous human exposure according to the averaging period for the ambient air quality standards (e.g., 24-hour, 8-hour, 1-hour). Examples of sensitive receptors are residences, hospitals, and schools. Sensitive receptors in the plan area include scattered single-family residences and waterfowl hunting clubhouses.

Regulatory Setting

Federal

The federal Clean Air Act (CAA), promulgated in 1963 and amended twice thereafter (including the 1990 amendment), establishes the framework for modern air pollution control. This act directs the EPA to establish ambient air standards for six pollutants: O_3, CO, lead, NO_2, particulate matter, and SO_2. The standards are divided into primary and secondary standards; the former are set to protect human health within an adequate margin of safety and the latter to protect environmental values, such as plant and animal life.

The primary legislation that governs federal air quality regulations is the Clean Air Act Amendments of 1990 (CAAA). The CAAA delegates primary responsibility for clean air to the EPA. The EPA develops rules and regulations to preserve and improve air quality, as well as delegating specific responsibilities to state and local agencies.

Federal Conformity Requirements

The CAAA of 1990 requires that all federally funded projects come from a plan or program that conforms to the appropriate state implementation plan (SIP). Federal actions are subject to either the transportation conformity rule (40 CFR 51[T]), which applies to federal highway or transit projects, or the General Conformity Rule (40 CFR 51[W]), which applies to all other federal actions.

General Conformity Requirements

The purpose of the General Conformity Rule is to ensure that federal actions conform to applicable SIPs so that they do not interfere with strategies employed to attain the national ambient air quality standards (NAAQS). The rule applies to federal actions in areas designated as nonattainment areas for any of the six criteria pollutants and in some areas designated as maintenance areas. The rule applies to all federal actions except:

- programs specifically included in a transportation plan or program that is found to conform under the federal transportation conformity rule,
- projects with associated emissions below specified *de minimis* threshold levels, and
- certain other projects that are exempt or presumed to conform.

A general conformity determination would be required if a proposed action's total direct and indirect emissions fail to meet any of the following two conditions:

- emissions for each affected pollutant for which the region is classified as a maintenance or nonattainment area for the national standards are below the *de minimis* levels indicated in Tables 5.7-5 and 5.7-6. As described below, the *de minimis* thresholds applicable to this proposed action are:
  - NO_X: 100 tons/year
  - Volatile organic compounds (VOCs): 100 tons/year, and
  - CO: 100 tons/year.

If any of the two conditions above are not met, a general conformity determination must be performed to demonstrate that total direct and indirect emissions for each affected pollutant for which the region is classified as amaintenance or nonattainment area for the national standards would conform to the applicable SIP.

However, if the above two conditions are met, the requirements for general conformity do not apply because the proposed action is presumed to conform to the applicable SIP for each affected pollutant. As a result, no further analysis or determination would be required.

Table 5.7-5. Federal *de Minimis* Threshold Levels for Criteria Pollutants in Nonattainment Areas

Pollutant	Emission Rate (Tons per Year)
Ozone (ROG/VOC or NO_X)	
Serious nonattainment areas	50
Severe nonattainment areas	25
Extreme nonattainment areas	10
Other ozone nonattainment areas outside an ozone transport region[1]	100
Other ozone nonattainment areas inside an ozone transport region[1]	
ROG/VOC	50
NO_X	100
CO: All nonattainment areas	100
SO_2 or NO_2: All nonattainment areas	100
PM10	
Moderate nonattainment areas	100
Serious nonattainment areas	70
PM2.5	
Direct emissions	100
SO_2	100
NO_X (unless determined not to be a significant precursor)	100
ROG/VOC or ammonia (if determined to be significant precursors)	100
Pb: All nonattainment areas	25

Note: *de minimis* threshold levels for conformity applicability analysis.

[1] Ozone Transport Region is comprised of the States of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, the Consolidated Metropolitan Statistical Area that includes the District of Columbia and northern Virginia (Section 184 of the Clean Air Act).

Underlined text indicates pollutants for which the region is in non-attainment, and a conformity determination must be made.

Source: 40 CFR 51.853.

Table 5.7-6. Federal *de Minimis* Threshold Levels for Criteria Pollutants in Maintenance Areas

Pollutant	Emission Rate (Tons per Year)
Ozone (NO_X, SO_2 or NO_2)	
All maintenance areas	100
Ozone (ROG/VOC)	
Maintenance areas inside an ozone transport region[1]	50
Maintenance areas outside an ozone transport region[1]	100
<u>CO: All maintenance areas</u>	<u>100</u>
PM10: All maintenance areas	100
PM2.5	
Direct emissions	100
SO_2	100
NO_X (unless determined not to be a significant precursor)	100
ROG/VOC or ammonia (if determined to be significant precursors)	100
Pb: All maintenance areas	25

Note: *de minimis* threshold levels for conformity applicability analysis.

[1] Ozone Transport Region is comprised of the States of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, the Consolidated Metropolitan Statistical Area that includes the District of Columbia and northern Virginia (Section 184 of the Clean Air Act).

<u>Underlined</u> text indicates pollutants for which the region is in maintenance, and a conformity determination must be made.

Source: 40 CFR 51.853.

Because the plan has federal funding, and is not a transportation project, it is subject to the General Conformity Rule. As indicated in Table 5.7-4, the plan area is classified federally as a marginal nonattainment area for the 8-hour O_3 standard, a pending nonattainment area for the PM2.5 standard, and a moderate maintenance area for CO. Consequently, to fulfill general conformity requirements, an analysis must be undertaken to identify whether the proposed action's total emissions of O_3, PM2.5, and CO are below the appropriate *de minimis* levels indicated in Tables 5.7-5 and 5.7-6.

It should be noted that after June 15, 2005, federal conformity for O_3 is based on the 8-hour standard rather than the 1-hour standard. To represent a worst-case scenario, the conformity determination in this analysis is based on the most stringent *de minimis* classification from Tables 5.7-5 and 5.7-6.Responsibility for achieving California's standards, which are more stringent than federal standards, is placed on the ARB and local air districts and is to be achieved through district-level air quality management plans that will be incorporated into the SIP. In California, the EPA has delegated authority to prepare SIPs to the ARB, which, in turn, has delegated that authority to individual air districts.

The ARB traditionally has established state air quality standards, maintaining oversight authority in air quality planning, developing programs for reducing emissions from motor vehicles, developing air emission inventories, collecting air quality and meteorological data, and approving SIPs.

Responsibilities of air districts include overseeing stationary source emissions, approving permits, maintaining emissions inventories, maintaining air quality stations, overseeing agricultural burning permits, and reviewing air quality–related sections of environmental documents required by CEQA.

The California Clean Air Act of 1988 (CCAA) substantially added to the authority and responsibilities of air districts. The CCAA designates air districts as lead air quality planning agencies, requires air districts to prepare air quality plans, and grants air districts authority to implement transportation control measures. The CCAA focuses on attainment of the state ambient air quality standards (CAAQS), which, for certain pollutants and averaging periods, are more stringent than the comparable federal standards.

The CCAA requires designation of attainment and nonattainment areas with respect to CAAQS. The CCAA also requires that local and regional air districts expeditiously adopt and prepare an air quality attainment plan if the district violates state air quality standards for CO, SO_2, NO_2, or O_3. These Clean Air Plans are designed specifically to attain these standards and must be designed to achieve an annual 5% reduction in district-wide emissions of each nonattainment pollutant or its precursors. No locally prepared attainment plans are required for areas that violate the state PM10 standards.

The CCAA requires that the CAAQS be met as expeditiously as practicable but, unlike the federal CAA, does not set precise attainment deadlines. Instead, the act established increasingly stringent requirements for areas that will require more time to achieve the standards.

Local

The air quality management agencies of direct importance in the plan area are the EPA, ARB, and the BAAQMD. The EPA has established federal standards for which the ARB and BAAQMD have primary implementation responsibility. The ARB and BAAQMD are responsible for ensuring that state standards are met, implementing strategies for air quality improvement, and recommending mitigation measures for new growth and development. At the local level, air quality is managed through land use and development planning practices and is implemented in the counties through the general planning process. The BAAQMD is responsible for establishing and enforcing local air quality rules and regulations that address the requirements of federal and state air quality laws. The SMP may be subject to the air quality management district rules discussed below. In addition, the plan may be subject to additional rules.

Bay Area Air Quality Management District

The following discussion describes applicable air quality plans in the plan area within the BAAQMD's jurisdiction. The most recent versions of these plans are the 2001 Revised San Francisco Bay Area Ozone Attainment Plan for the 1-Hour National Ozone Standard (OAP), the Bay Area 2000 Clean Air Plan and Triennial Assessment (CAP), and the Bay Area 2005 Ozone Strategy (BAOS).

Ozone Attainment Plan

The OAP is the Bay Area's portion of California's SIP to achieve the national O_3 standard. In 1999, the BAAQMD, Association of Bay Area Governments (ABAG), and the Metropolitan Transportation Commission (MTC) adopted the 1999 OAP, which was submitted to the ARB in June 1999. The 1999 OAP was approved by the ARB in July 1999 and submitted to the EPA for approval. The EPA proposed to partially approve and partially disapprove portions of the 1999 OAP on March 30, 2001. The disapproved portions were the reasonably available control measures (RACMs) demonstration, attainment demonstration, and motor vehicle emissions budgets (MVEBs). This disapproval by the EPA started a sanctions clock, and the Bay Area became subject to the imposition of a 2:1 offset sanction.

In response, the BAAQMD, ABAG, and MTC began preparation of the 2001 OAP to correct the deficiencies in the 1999 OAP. On October 24, 2001, they adopted the 2001 OAP. The 2001 OAP was approved by the ARB on November 1, 2001, and submitted to the EPA for approval as a revision to the California SIP on November 30, 2001. The 2001 OAP included two commitments for further planning—a commitment to conduct a mid-course review of progress toward attaining the national 1-hour O_3 standard by December 2003 and a commitment to provide a revised O_3 attainment strategy to the EPA by April 2004. On April 22, 2004, the EPA approved the following elements of the 2001 OAP: emissions inventory; RACMs; commitments to adopt and implement specific control measures; MVEBs; and commitments for further study measures. The EPA's approval of RACMs and MVEBs in the 2001 OAP terminated the sanctions clock for those plan elements.

The EPA made a final finding in April 2004 that the BAAQMD had attained the federal 1-hour O_3 standard. As a result, certain planning commitments outlined in the 2001 OAP were no longer required. Although the EPA has prepared a finding of attainment for the region, the Bay Area has not been formally reclassified as an attainment area for the 1-hour standard. To be reclassified as an attainment area, the region must submit a redesignation request to the EPA.

Clean Air Plan

The CAP is a plan to reduce ground-level O_3 levels in the Bay Area and attain the state 1-hour O_3 standard. It was developed by the BAAQMD, in cooperation with ABAG and the MTC, in response to the CCAA, which requires all air districts exceeding the state O_3 standard to reduce pollutant emissions by 5% per year (calculated from 1987) or achieve emission reductions through all feasible measures. The CCAA further requires that the CAP be updated every 3 years. Because the Bay Area attained the state CO standard in 1993, the CCAA planning requirements for CO nonattainment areas no longer apply to the Bay Area. The first CAP prepared in 1991 includes a comprehensive strategy to reduce air pollutant emissions by focusing on control measures to be implemented from 1991 to 1994, 1995 through 2000, and beyond. The 1994 update to the CAP continued the comprehensive strategy established by the 1991 CAP and its goals of reducing health impacts from O_3 levels above the CAAQS to compliance with the CCAA. The 1994 CAP included eight new proposed control measures for stationary and mobile sources, in addition to changes in the organization and scheduling of some of the control measures from the 1991 CAP. The control measures proposed in the 1994 CAP constitute all feasible O_3-reducing measures in the Bay Area. In addition, the 1994 CAP projects pollutant trends and possible control activities beyond 1997.

The BAAQMD adopted the most recent update of the CAP on December 20, 2000. It is the third triennial update of the original CAP. The 2000 CAP includes a review of control strategies to ensure that “all feasible measures” to reduce O_3 are incorporated into the CAP. In addition, the 2000 CAP updates the BAAQMD’s emission inventory, estimates emission reductions resulting from the CAP, and assesses air quality trends in the region.

Bay Area 2005 Ozone Strategy

The BAAQMD has finalized the BAOS in cooperation with ABAG and the MTC. The BAOS is a comprehensive document that describes the Bay Area’s strategy for compliance with state 1-hour O_3 standard planning requirements.

O_3 conditions in the Bay Area have improved significantly, but there is still a need for continued improvement to meet the state 1-hour O_3 standard. The BAOS describes how the Bay Area will fulfill CCAA planning requirements for the state 1-hour O_3 standard and transport mitigation requirements through a proposed control strategy. The control strategy includes stationary source, mobile source, and transportation control measures to be implemented through BAAQMD regulations, incentive programs, and transportation programs, respectively.

Environmental Consequences

Assessment Methods

The activities required for the proposed tidal wetland restoration may generate significant air emissions from construction activities. Terrestrial construction-related emissions are generally short-term but still may cause adverse air quality impacts. PM10 is the pollutant of greatest concern with respect to terrestrial construction activities. PM10 emissions can result from a variety of construction activities, including excavation, grading, demolition, vehicle travel on paved and unpaved roads, and emission of vehicle and equipment exhaust. Terrestrial construction-related emissions of PM10 can vary greatly depending on the level of activity, the specific operations taking place, the equipment being operated, local soils, weather conditions, and other factors.

Particulate emissions from construction equipment exhaust can lead to adverse health effects, as well as nuisance concerns such as reduced visibility and soiling of exposed surfaces (Bay Area Air Quality Management District 1999).

The URBEMIS 2007 (version 9.2.4) model was used to estimate emissions associated with construction of the proposed project. To estimate construction emissions, URBEMIS 2007 analyzes the type of construction equipment used and the duration of the construction period associated with construction of each of the land uses. URBEMIS calculates unmitigated emissions, but also calculates mitigated emissions based on standard measures that are incorporated into the model. These measures include the following:

- Soil disturbance (apply soil stabilizers to inactive soil, replace ground cover in disturbed areas, water exposed surfaces, and equipment loading/unloading);
- Unpaved roads (reduce speed and manage haul road dust);
- Off-road equipment (use aqueous diesel fuel, diesel particulate filters, and diesel oxidation catalysts).

The soil disturbance mitigation measures, which are typically used to mitigate for fugitive dust, were not used. The project area consists of marsh land and because much of the ground would be wet, soil disturbing activity would not cause dust. The URBEMIS 2007 model calculates both PM10 and PM2.5 in terms of exhaust and dust. For the purposes of this analysis, the PM dust emissions were zeroed out because construction activity would not create PM dust during soil disturbing activities due to the marshy nature of the project site.

The BAAQMD has developed thresholds of significance and because both restoration and management activities could occur simultaneously, they were modeled as such to determine the maximum potential impact of SMP implementation on air quality. Because a detailed schedule of construction activity is not available, it is assumed that construction would take place primarily between June through September for 30 years for restoration activity, and June through September on any given year for management activity. However, dredging would be conducted from September through November as described in Chapter 2.

The Puget Sound Maritime Air Emissions Inventory methodology was used to estimate tugboat emissions. The tugboat emissions calculation spreadsheet is attached as Appendix B. In addition, the SCAQMD Final Methodology to Calculate Particulate Matter (PM) 2.5 and PM2.5 Significance Thresholds (South Coast Air Quality Management District 2006) was used to calculate PM 2.5 for tug emissions.

Significance Criteria

Because the plan has federal funding, general conformity significance criteria must be considered. Further, because of the location of the plan area, both CEQA and the BAAQMD must be considered. The most stringent significance criteria must be applied to implementing the plan.

Federal General Conformity

Under general conformity, the implementation of the plan would adversely affect air quality if construction emissions of O_3 precursors (ROG and NO_X) would exceed 100 tons per year and CO emissions would exceed 100 tons per year.

California Environmental Quality Act

Based on the State CEQA Guidelines and standard professional practice, implementation of the SMP would result in a significant impact on air quality if it would:

- conflict with or obstruct implementation of the applicable air quality management plan;
- violate any air quality standard or contribute substantially to an existing or projected air quality violation;
- result in a cumulatively considerable net increase of any criteria pollutant for which the plan region is nonattainment under an applicable NAAQS or CAAQS (including releasing emissions that exceed quantitative thresholds for O_3 precursors);
- expose sensitive receptors to substantial pollutant concentrations; or
- create objectionable odors affecting a substantial number of people.

The State CEQA Guidelines further state that the significance criteria established by the applicable air quality management or air pollution control district may be relied on to make the determinations above.

Operational emissions are not evaluated because activities associated with restoration and management are considered construction. Therefore, only the BAAQMD draft construction thresholds are used.

Construction

BAAQMD currently does not require quantification of construction emissions. Instead, it requires implementation of effective and comprehensive feasible control measures to reduce PM10 emissions (Bay Area Air Quality Management District 1999). PM10 emitted during construction activities varies greatly depending on the level of activity, the specific operations taking place, the equipment being operated, local soils, and weather conditions. Despite this variability in emissions, experience has shown that a number of feasible control measures can be reasonably implemented to reduce PM10 emissions during construction; these measures are summarized in Environmental Commitments in Chapter 2. According to BAAQMD, if all control measures listed in Chapter 2 are implemented (as appropriate, depending on the size of the plan area), air pollutant emissions from construction activities are to be considered less than significant (Bay Area Air Quality Management District 1999). However, quantification of emissions for large projects is useful as a means to provide information on the magnitude of emissions from construction.

Construction equipment also emits CO and O_3 precursors (ROG and NO_X). Construction-related emissions of these pollutants were not estimated, however, because they are already included in the emission inventory that forms the basis for BAAQMD's regional air quality plans and because those emissions are not expected to impede attainment or maintenance of O_3 and CO standards in the Bay Area (Bay Area Air Quality Management District 1999).

Bay Area Air Quality Management District Draft Construction Thresholds

The BAAQMD recently has released draft significance thresholds for construction-related emissions (Bay Area Air Quality Management District 2009). According to the draft thresholds, construction would result in a significant impact on the environment if it would generate criteria air pollutant emissions in excess of those shown below in Table 5.7-7.

Table 5.7-7. Thresholds of Significance for Project Construction

Pollutant	Lbs/day
ROG	54
NO_X	54
SO2	219
PM10	82
PM2.5	54

For the purposes of this plan area, the draft construction thresholds were used because they likely will be adopted in the future.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, a small amount of wetland restoration would occur and managed wetland activities are expected to decrease. As such, it is expected that there would be a reduction or no change in PM10, CO, O_3 precursors, or other pollutants, and there would be no impacts.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Impact AQ-1: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration

Temporary construction activity would involve the use of heavy equipment, which may generate emissions in excess of the draft BAAQMD construction thresholds. Construction impacts have been assessed in this analysis using the URBEMIS 2007 9.2.4 model and anticipated construction equipment that would be used during construction activities, which are based on typical restoration activity (Table 5.7-8). Construction would take place over a 30-year period in the form of small projects on parcels at an average of 300 acres.

Restoration projects generally are broken into three phases: site preparation, water management, and levee breaching. The site preparation phase entails grading, improving levees, and building channels and islands. The water management phase does not include the use of heavy equipment. Assumptions were made for the types of construction equipment that likely would be used for each phase, the total operating hours of each piece, and the horsepower of each piece to represent a worst-case scenario to demonstrate maximum emissions. These assumptions were based on what typically is used for restoration projects, information provided by the project proponent, and URBEMIS default values.

Table 5.7-8. Anticipated Construction Equipment for Restoration Activity

Equipment Pieces by Phase	Number of Equipment Pieces Used	Horsepower	Hours per Day
Site Preparation			
Tractor/loader/backhoe	1	180	8
Rubber-tired dozer	1	357	8
Excavator	1	168	8
Grader	1	174	8
Box scraper	1	313	8
Levee Breaching			
Excavator	1	168	8

Construction of the proposed project would result in the temporary increase in emissions of ROG, NO_X, CO, PM10, PM2.5, and CO_2. Total daily unmitigated and mitigated emissions resulting from construction of the proposed project are summarized in Table 5.7-9. As a worst-case scenario, site preparation and levee breaching emissions were combined into a total daily emissions value, because it is possible that two different projects could occur at the same time. Evaluating a worst-case scenario is necessary to compare emissions to the BAAQMD emission thresholds.

Table 5.7-9. Maximum 2009 Emissions from Restoration Activities for the Proposed Project Projects (lbs/day)

Project Phase	ROG	NO_X	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Unmitigated						
Site Preparation	6.54	54.63	29.87	2.71	2.49	5,072.67
Levee Breaching	0.72	5.45	3.55	0.32	0.30	572.66
Total Daily Unmitigated Emissions	7.26	60.08	33.42	3.03	2.79	5,645.33
Mitigated						
Site Preparation	6.54	46.45	29.87	0.41	0.38	5,072.67
Levee Breaching	0.72	4.63	3.55	0.05	0.04	572.66
Total Daily Mitigated Emissions	7.26	51.08	33.42	0.46	0.42	5,645.33
BAAQMD Draft Construction Threshold	54	54	N/A	82	54	N/A
Exceeds Threshold?	No	No	N/A	No	No	N/A

As shown above, unmitigated emissions from two projects (one in the site preparation phase and one in the levee breaching phase) exceed the BAAQMD draft construction thresholds of 54 pounds per day of NO_X, but mitigated emissions from two projects do not. In addition, if two projects began simultaneously and both were in the site preparation phase at the same time, NO_X emissions would exceed the BAAQMD threshold of 54 pounds per day. It should be noted that the proposed project is located in a rural setting and these activities would be spread out over the landscape of 50,000 acres in the middle of 27,000 acres of agricultural uplands and 30,000 acres of bays and sloughs, over a long period of time. Nevertheless, Mitigation Measures AQ-MM-1, AQ-MM-2, and AQ-MM-3 are required to reduce this impact to less than significant.

Conclusion: Less than significant with Mitigation Measures AQ-MM-1, AQ-MM-2, and AQ-MM-3 incorporated.

Mitigation Measure AQ-MM-1: Limit Construction Activity during Restoration

The project proponent will limit construction activity so that site preparation can occur on only one parcel at a time. This will ensure that construction emissions do not exceed the draft BAAQMD threshold for NO_X.

Mitigation Measure AQ-MM-2: Reduce Construction NO_X Emissions

The project proponent will ensure that construction emissions do not exceed the BAAQMD's draft construction threshold of 54 pounds per day for NO_X. Tables 5.7-8 (above) and 5.7-10 (below) show appropriate levels of construction equipment that can be operating at any given time in the marsh. Such measures include, but are not limited to, the following:

- Implement off road equipment mitigation, including installing 1st tier diesel particulate filters (DPFs), and installing diesel oxidation catalysts to reduce NO_x emissions by 40%.

Mitigation Measure AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures

The project proponent will implement BAAQMD standard mitigation measures where appropriate and feasible. These measures include:

- Cover all haul trucks transporting soil, sand, or other loose material off-site.
- Remove all visible mud or dirt track-out onto adjacent public roads.
- Minimize idling times either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations[CCR]). Clear signage shall be provided for construction workers at all access points.
- Maintain all construction equipment in accordance with manufacturer's specifications. All equipment shall be checked by a certified mechanic and determined to be running in proper condition prior to operation.

- Post a publicly visible sign with the telephone number and person to contact at the Lead Agency regarding dust complaints. This person shall respond and take corrective action within 48 hours. The Air District's phone number shall also be visible to ensure compliance with applicable regulations.

Impact AQ-2: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Current Management Activities

Various types of management activity, such as constructing ditches, coring and repairing levees, repairing and replacing structures, etc., currently occur in the Marsh. These activities would increase in frequency under the SMP. Temporary construction activity would involve the use of heavy equipment, which may generate emissions in excess of the draft BAAQMD construction thresholds.

Construction impacts regarding existing management activity that would increase in frequency have been assessed in this analysis using the URBEMIS 2007 9.2.4 model and anticipated construction equipment that would be used during construction activities, which are based on typical wetland management activity. Because it is unknown how much these activities would be increased, the maximum allowable mitigated emissions were modeled to find the appropriate number of pieces of construction equipment that would be permitted to operate at any given time in the Marsh. It was assumed that management projects would take place from June through September on parcels averaging 300 acres in size. Estimated construction equipment that would be used for these projects is shown in Table 5.7-10.

Table 5.7-10. Estimated Construction Equipment for Management Activity That Would Increase in Frequency

Equipment Pieces Used for Management Activities	Number of Equipment Pieces Used	Horsepower	Hours per Day
Excavator	2	168	8
Tractor/loader/backhoe	3	108	8
Grader	3	174	8
Rubber tired dozer	3	357	8

Increased frequency of management activities would result in the temporary increase in emissions of ROG, NO_X, CO, PM10, PM2.5, and CO_2. Total daily unmitigated and mitigated project emissions resulting from operations of the proposed project are summarized in Table 5.7-11.

Table 5.7-11. Maximum 2009 Emissions from Management Activity That Would Increase in Frequency under the Proposed Action (lbs/day)

Management Activity That Would Increase in Frequency	ROG	NO_X	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Unmitigated	11.11	88.28	52.73	4.75	4.37	8,041.40
Mitigated	11.11	53.73	52.73	0.72	0.66	8,041.40
BAAQMD Draft Construction Threshold	54	54	N/A	82	54	N/A
Exceeds Threshold?						
Unmitigated	No	Yes	N/A	No	No	N/A
Mitigated	No	No	N/A	No	No	N/A

As illustrated in Table 5.7-11, emissions associated with increased frequency of management activities would be below the BAAQMD draft construction thresholds for all pollutants, if the equipment used does not exceed the anticipated construction equipment in Table 5.7-10. Mitigation Measures AQ-MM-2 and AQ-MM-3 will be implemented to reduce this impact to less-than-significant. In addition, environmental commitments, including annual monitoring of equipment and use of basic control measures to manage fugitive dust, would be implemented as part of the proposed action (see Chapter 2, environmental commitments section). The modeling in Table 5.7-11 is based on the anticipated construction equipment in Table 5.7-10.

Conclusion: Less than significant with Mitigation Measures AQ-MM-2 and AQ-MM-3 incorporated.

Impact AQ-3: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with New Management Activities

New management activities, including dredging tidal sloughs, interior levee construction, and replacing riprap, would occur under the SMP. Temporary construction activity would involve the use of heavy equipment that may generate emissions in excess of the draft BAAQMD construction thresholds.

Construction impacts regarding management activities have been assessed in this analysis using the URBEMIS 2007 9.2.4 model and anticipated construction equipment that would be used during construction activities, based on typical wetland management activity. The quantification of tug emissions was performed using emission factors provided by NONROAD2005 (U.S. Environmental Protection Agency 2005), entered into an Excel spreadsheet model.

To assess whether activity associated with the proposed action would exceed significance thresholds, the maximum placement per year was modeled by estimating a total of 100,000 cubic yards of dredge spoils. The analysis assumed a boxscraper, backhoe/loader, and pickup would be used from August through November for dredge spoil and riprap placement, and that 9,700 cubic yards would be moved per day. The calculated emissions, based on these assumptions, are presented in Table 5.7-12 and compared to the draft BAAQMD construction thresholds.

Table 5.7-12. Calculated Emissions Associated with New Management Activities

Activity	Emissions (lbs/day)					
	ROG	NO_X	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Tug Activity	0.12	4.82	0.88	0.39	0.36	302.42
Dredging/Interior Levee Construction/Placement of Riprap, Unmitigated	3.91	34.23	15.13	1.52	1.40	3,590.34
Dredging/Interior Levee Construction/Placement of Riprap, Mitigated	3.91	20.56	15.13	0.23	0.21	3,590.34
Total Unmitigated	4.03	39.05	16.01	1.91	1.76	3,892.76
Total Mitigated	4.03	25.38	16.01	0.62	0.57	3,892.76
BAAQMD Draft Construction Significance Thresholds (lbs/day)	54	54	N/A	82	54	N/A
Exceeds Threshold?	No	No	N/A	No	No	N/A

As illustrated in Table 5.7-12, unmitigated emissions associated with implementing the marsh management activities would be below the BAAQMD draft construction thresholds for all pollutants. In addition, environmental commitments, including annual monitoring of equipment and use of PM10 control measures, would be implemented as part of the proposed action.

Conclusion: Less than significant. No mitigation required.

Impact AQ-4: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration and Management Activities Combined

Construction activity associated with restoration and management activity potentially could occur simultaneously. Tables 5.7-13 and 5.7-14 summarize the combined emissions associated with restoration activity, management activity that would increase in frequency, and new management activity.

Table 5.7-13. Combined Unmitigated Emissions from Restoration and Management Activities

Activity	ROG	NO_x	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Restoration	7.26	60.08	33.42	3.03	2.79	5,645.33
Management Activity That Would Increase in Frequency	11.11	88.28	52.73	4.75	4.37	8,041.40
New Management	4.03	39.05	16.01	1.91	1.76	3,892.76
Emission Totals	22.40	**187.41**	102.16	9.69	8.92	17,579.49
BAAQMD Draft Construction Threshold	54	54	N/A	82	54	N/A
Exceeds Threshold?	No	Yes	N/A	No	No	N/A

Table 5.8-14. Combined Mitigated Emissions from Restoration and Management Activities

Activity	ROG	NO_x	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Restoration	7.26	51.08	33.42	0.46	0.42	5,645.33
Management Activity That Would Increase in Frequency	11.11	53.73	52.73	0.72	0.66	8,041.40
New Management	4.03	25.38	16.01	0.62	0.57	3,892.76
Emission Totals	22.67	**130.19**	102.16	1.8	1.65	17,579.49
BAAQMD Draft Construction Threshold	54	54	N/A	82	54	N/A
Exceeds Threshold?	No	Yes	N/A	No	No	N/A

The modeling shown in Tables 5.7-13 and 5.7-14 is based on the anticipated construction equipment in Tables 5.7-8 and 5.7-10. Therefore, if the construction equipment in Tables 5.7-8 and 5.7-10 changes, then the results in Tables 5.7-13 and 5.7-14 will change as well. As shown above in Table 5.7-14, the worst-case scenario mitigated emissions would exceed the BAAQMD draft construction thresholds for NO_X if all of the various restoration activity, new management activity that would increase in frequency, and new management activity were to all happen concurrently. While multiple phases of construction can overlap, the pieces of equipment being used on the marsh at any given time should not exceed the list of equipment described in Tables 5.7-8 and 5.7-10 so as not to exceed the BAAQMD threshold of 54 pounds per day of NO_X. Therefore, in addition to mitigation measures MM-AQ-1, MM-AQ-2, and MM-AQ-3, Mitigation Measure AQ-MM-4 is required to reduce this impact to less than significant.

Mitigation Measure AQ-MM-4: Limit Restoration and Management Activity

The project proponent will limit restoration and management activity so that the equipment being used in the SMP area does not exceed equipment described in

Tables 5.7-8 an 5.7-10. This will ensure that construction emissions do not exceed the draft BAAQMD threshold for NO_X.

Conclusion: Less than significant with Mitigation Measures AQ-MM-1, AQ-MM-2, AQ-MM-3 and AQ-MM-4 incorporated.

Impact AQ-5: Construction-Related Diesel Health Risk Associated with Restoration

Construction activities associated with restoration activity would involve the operation of diesel-powered equipment. In October 2000, the ARB identified diesel exhaust as a TAC. As described above, construction activities would occur in June through September over 30 construction seasons. The assessment of cancer health risks associated with exposure to diesel exhaust typically is associated with chronic exposure (70-year exposure period is often assumed). Although cancer can result from exposure periods of less than 70 years, acute exposure periods (2 to 3 years) to diesel exhaust are not anticipated to result in an increased health risk. Health impacts associated with exposure to diesel exhaust from implementing activities are anticipated to be less than significant because diesel particulate emission rates would be low, the emissions would be distributed over a large geographic area rather than clustered near any individual sensitive receptors, and construction activities would occur sporadically over a 30-year period and would not result in long-term emissions of diesel exhaust at the project sites. It also is anticipated that concentrations of diesel exhaust would attenuate to levels well below acceptable exposure limits because of the distances of sensitive receptors from construction activities. In addition, the environmental commitments described in Chapter 2 will be implemented.

Conclusion: Less than significant. No mitigation required.

Impact AQ-6: Construction-Related Diesel Health Risk Associated with Current Management Activities

Management activities, including dredging, would involve the operation of diesel-powered equipment. Health impacts associated with exposure to diesel exhaust from marsh management activities are anticipated to be less than significant because diesel particulate emission rates would be low, the emissions would be distributed over a large geographic area rather than clustered near any individual sensitive receptors, and construction activities would occur sporadically and would not result in long-term emissions of diesel exhaust at the project sites. It also is anticipated that concentrations of diesel exhaust would attenuate to levels well below acceptable exposure limits because of the distances of sensitive receptors from construction activities.

Conclusion: Less than significant. No mitigation required.

Impact AQ-7: Construction-Related Diesel Health Risk Associated with New Management Activities

Impacts from new management activities would be similar to those described above under Management Activities That Would Increase in Frequency.

Conclusion: Less than significant. No mitigation required.

Impact AQ-8: Construction-Related Diesel Health Risk Associated with Restoration and Management Activity Combined

Impacts from restoration and management activity combined would be similar to those described above under Restoration and Management Activities That Would Increase in Frequency.

Conclusion: Less than significant. No mitigation required.

Impact AQ-9: Increase in Construction Emissions in Excess of Federal *de Minimis* Thresholds

Table 5.7-15 summarizes annual emissions resulting from activities associated with both restoration and management activity combined. This represents worst-case scenario emissions that are not anticipated to exceed the *de minimis* thresholds of significance.

Table 5.7-15. Calculated Unmitigated Emissions Compared to Federal *de Minimis* Thresholds

	Pollutant Emissions (tons/year)					
Activity	ROG	NO_X	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Restoration	0.35	2.10	1.55	0.02	0.02	276.24
Management Activities That Would Increase in Frequency	0.20	1.16	0.90	0.03	0.03	151.22
New Management Activities	0.18	1.30	0.70	0.03	0.03	171.28
Emission Totals	0.72	4.56	3.16	0.08	0.07	598.74
Federal *de Minimis* Significance Thresholds	50	100	100	100	N/A	N/A
Exceeds Thresholds?	No	No	No	No	N/A	N/A

Source: 2008 Estimated annual Average Emissions-San Francisco Bay Area Air Basin. <http://www.arb.ca.gov/ei/maps/basins/absfmap.htm>.

As shown in Table 5.7-15 above, even if all activities are running concurrently, federal *de minimis* thresholds would not be exceeded.

Conclusion: Less than significant. No mitigation required.

Impact AQ-10: Increase in Construction-Related Odor

The proposed action may generate odors during ground-disturbing activities, and disposal and settling of dredged material. However, the environmental commitments outlined in Chapter 2, for restoration activities, including dust management, would minimize the potential for odor generation. Furthermore, it is anticipated that any odors generated from the dredging spoils would not be any more objectionable than the naturally occurring odors around the Marsh.

Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Under Alternative B, approximately 2,000–4,000 acres of tidal wetland would be restored, which is less than what would be restored under Alternative A. More management activity would occur under Alternative B than would occur under Alternative A. Although more projects related to Marsh management would occur annually under Alternative B, more would not occur on a daily basis. Thus daily emissions would not exceed those summarized above under Alternative A.

Alternative C: Restore 7,000–9,000 Acres

Under Alternative C, approximately 7,000–9,000 acres of tidal wetland would be restored, which is more than would be restored under Alternative A. Less management activity would occur under Alternative C than would occur under Alternative A. Although more restoration projects would occur annually under Alternative C, more would not occur on a daily basis. Thus daily emissions would not exceed those summarized above under Alternative A.

Section 5.8
Noise

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on noise.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts. For example, the setting identifies how noise would change as a result of construction and maintenance activities.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 5.8-1 summarizes noise impacts from implementing the SMP alternatives. There would be no significant impacts on noise from implementing the SMP alternatives.

Table 5.8-1. Summary of Noise Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
NZ-1: Temporary Increases in Ambient Noise during Construction Activities Associated with Restoration	A, B, C	Less than significant	None required	–
NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
NZ-3: Permanent Increases in Ambient Noise	A, B, C	Less than significant	None required	–
NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities	A, B, C	Less than significant	None required	–
NZ-3: Permanent Increases in Ambient Noise	A, B, C	Less than significant	None required	–
NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations	A, B, C	Less than significant	None required	–
NZ-5: Temporary Increases in Ambient Noise during Construction Activities Associated with Management Activities	A, B, C	Less than significant	None required	–
NZ-6: Exposure of Noise-Sensitive Land Uses to Noise from Portable Pump Operations	A, B, C	Significant	NZ-MM-1: Limit Noise from Pump Operations	Less than significant

Affected Environment

The plan area is located in Solano County. The following discussion provides background information on noise terminology and describes the existing environment in terms of sensitive receptors, existing noise levels, and regulatory requirements.

Noise Terminology

Following are brief definitions of acoustic and vibration terminology used in this section:

- **Sound.** A vibratory disturbance created by a vibrating object, which, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear or a microphone.
- **Noise.** Sound that is loud, unpleasant, unexpected, or otherwise undesirable.

- **Decibel (dB).** A unitless measure of sound on a logarithmic scale, which indicates the squared ratio of sound pressure amplitude to a reference sound pressure amplitude. The reference pressure is 20 micro-pascals.
- **A-Weighted Decibel (dBA).** An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.
- **Maximum Sound Level (L_{max}).** The maximum sound level measured during the measurement period.
- **Minimum Sound Level (L_{min}).** The minimum sound level measured during the measurement period.
- **Equivalent Sound Level (L_{eq}).** The equivalent steady state sound level that in a stated period of time would contain the same acoustical energy.
- **Percentile-Exceeded Sound Level (L_{xx}).** The sound level exceeded x% of a specific time period. L_{10} is the sound level exceeded 10% of the time.
- **Day-Night Level (L_{dn}).** The energy average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m.
- **Community Noise Equivalent Level (CNEL).** The energy average of the A-weighted sound levels occurring during a 24-hour period with 5 dB added to the A-weighted sound levels occurring during the period from 7:00 p.m. to 10:00 p.m. and 10 dB added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m.
- **Peak Particle Velocity (PPV).** The maximum velocity of a particle in vibrating medium such as soil. PPV is usually expressed in inches/sec.

L_{dn} and CNEL values rarely differ by more than 1 dB. As a matter of practice, L_{dn} and CNEL values are considered to be equivalent and are treated as such in this assessment. In general, human sound perception is such that a change in sound level of 3 dB is just noticeable, a change of 5 dB is clearly noticeable, and a change of 10 dB is perceived as doubling or halving the sound level.

Sources of Information

The following key sources of information were used in the preparation of this section:

- Solano County General Plan (Solano County 2008).
- *Noise Control Engineering Journal* article, “Construction noise control program and mitigation strategy at the Central Artery/Tunnel project” (Thalheimer 2000).
- Federal Transit Administration’s (FTA’s) transit noise and vibration impact assessment (Federal Transit Administration 2006).

- Clamshell dredge noise measurements taken in 1997 in support of the Oakland Harbor Navigation Improvement Project EIS (Geier & Geier Consulting 1997).
- Hoover and Keith's *Noise control for buildings, manufacturing plants, equipment and products* (Hoover and Keith 2000).

Regulatory Setting

In general, the federal government sets noise standards for transportation noise sources that are related to interstate commerce. These typically include aircraft, trains, and trucks. State governments establish noise standards for those sources not regulated by federal standards, such as automobiles, light trucks, motorboats and motorcycles. Other noise sources associated with construction and industrial and commercial activities are usually regulated by noise ordinances and general plan policies, which are established by local jurisdictions.

Federal

Federal Noise Control Act of 1972

The federal Noise Control Act of 1972 (Public Law 92-574) established a requirement that all federal agencies administer their programs to promote an environment free of noise that would jeopardize public health or welfare. The EPA was given the responsibility for:

- providing information to the public regarding identifiable effects of noise on public health and welfare,
- publishing information on the levels of environmental noise that will protect the public health and welfare with an adequate margin of safety,
- coordinating federal research and activities related to noise control, and
- establishing federal noise emission standards for selected products distributed in interstate commerce.

The Noise Control Act also directed that all federal agencies comply with applicable federal, state, interstate, and local noise control regulations.

U.S. Environmental Protection Agency

In 1974, in response to the requirements of the federal Noise Control Act, EPA identified indoor and outdoor noise limits to protect public health and welfare (communication disruption, sleep disturbance, and hearing damage). Outdoor L_{dn} limits of 55 dB and indoor L_{dn} limits of 45 dB are identified as desirable to protect against speech interference and sleep disturbance for residential, educational, and healthcare areas. Sound-level criteria to protect against hearing damage in commercial and industrial areas are identified as 24-hour L_{eq} values of 70 dB (both outdoors and indoors).

State

California Department of Health Services Guidelines

In 1987, the California Department of Health Services published guidelines for the noise elements of local general plans. These guidelines include a sound level/land use compatibility chart that categorizes various outdoor L_{dn} ranges by land use. These guidelines identify the normally acceptable range for low-density residential uses as less than 65 dB and conditionally acceptable levels as 55–70 dB.

Local

Solano County General Plan, Noise Element

Solano County has established policies and regulations concerning the generation and control of noise that could adversely affect its citizens and noise-sensitive land uses.

The County's General Plan is a document required by state law that serves as the County's guidance document for land use and development. The General Plan sets an overall framework for development in Solano County and protection of its natural and cultural resources; it is a comprehensive, long-term document that provides details for the physical development, sets policies, and identifies ways to put the policies into action. The noise element of the County General Plan contains planning guidelines relating to noise and identifies goals and policies to support achievement of those goals. Noise element guidelines relate primarily to land use compatibility with noise sources that are not regulated at the local level, such as traffic, aircraft, and trains. (Solano County 2008.)

The County's noise ordinance is the primary enforcement tool for operation of locally regulated noise sources such as mechanical equipment and construction activity.

The Solano County General Plan includes noise thresholds for permanent facilities and construction-related activities. The maximum allowable noise levels from construction equipment typically is 75 dBA at 50 feet. (Solano County 2008.) Solano County's Land Use Noise Compatibility Guidelines, Table 5.8-2, indicates that <70 CNEL is the normally acceptable standard for water-based recreational uses, and that <60 CNEL is the normally acceptable standard for residential uses.

Table 5.8-2. Land Use Noise Compatibility Guidelines

Land Use Category	Community Noise Exposure (L_{dn} or CNEL, dBA) Normally Acceptable[1]	Conditionally Acceptable[2]	Normally Unacceptable[3]	Clearly Unacceptable[4]
All residential, lodging, schools, libraries, places of worship, nursing homes	<60	60–65	65–75	75+
Auditoriums, concert halls, amphitheaters	–	<70	70+	–
Sports arena, outdoor spectator sports	–<75	70+	–	
Playgrounds, neighborhood parks	<67.5	–	67.5–75	75+
Golf courses, riding stables, water recreation, cemeteries	<70	–	70–80	80+
Retail, movie theaters, restaurants	<65	65–75	75–80	80+
Office building, business commercial and professional	<67.5	67.5–77.5	77.5+	–
Industrial, manufacturing, utilities, agriculture	<75	70–80	75+	–
Noise-sensitive manufacturing and communications	<55	55–70	70–80	80+

Notes:

CNEL = community noise equivalent level; dBA = A-weighted decibel; Ldn = day-night average noise level.

[1] Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

[2] New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

[3] New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design. Outdoor areas must be shielded.

[4] New construction or development should generally not be undertaken.

[5] These standards are not applicable for development within the airport compatibility review area. Development in the airport compatibility review areas are subject to standards in the applicable airport land use plan.

Source: Solano County 2008 Draft General Plan (Solano County 2008).

Physical Setting

Noise-Sensitive Land Uses

Noise-sensitive land uses generally are defined as locations where people reside or where the presence of unwanted sound could adversely affect the use of the land. Noise-sensitive land uses typically include residences, hospitals, schools, guest lodging, libraries, and certain types of recreational uses. A noise-sensitive land use also can be defined as an area of frequent human use that would benefit from a lowered noise level. In general, an area of frequent human use is an area where people spend at least 1 hour on a regular basis.

Noise-sensitive uses in the plan area include scattered single-family residences and waterfowl hunting areas with associated clubhouses.

Existing Noise Environment

Although portions of Solano County are urbanized, most of the county is generally considered rural. Ambient noise levels in urban areas typically range from approximately 60 to 70 dBA, and in rural areas from approximately 40 to 50 dBA.

Ambient sound levels associated with noise-sensitive land uses in the vicinity of the project site vary depending on the proximity of major existing noise sources such as traffic, aircraft, and industrial uses. Ambient sound levels in similar suburban/rural settings are typically in the range of 40 to 60 dBA.

Environmental Consequences

Assessment Methods

Potential construction noise impacts were determined using methodology developed by the FTA (Federal Transit Administration 2006). The types of construction equipment used for each proposed activity have been developed based on the description of the proposed activity. Reference noise levels for each piece of equipment were taken from FTA (2006). Utilization factors were estimated from factors provided in Thalheimer (2000). Impacts were determined based on the assumption that no major site-specific projects would be implemented at the same time in the same vicinity.

Significance Criteria

The State CEQA Guidelines, county standards, and standard professional practice were used to determine whether constructing and operating the SMP alternatives would result in a significant noise impact. Noise impacts would be considered significant if constructing or operating the alternatives would:

- expose persons to or generate noise levels in excess of standards established in a local general plan or noise ordinance or applicable standards of other agencies;
- expose persons to or generate excessive groundborne vibration or groundborne noise levels;
- result in a substantial permanent increase in ambient noise levels in the vicinity above levels existing without the plan; or

- result in a substantial temporary or periodic increase in ambient noise levels in the vicinity above levels existing without the plan.

Solano County has a list of maximum allowable noise levels from construction equipment. Maximum noise levels for most construction equipment is 75 dBA at 50 feet but is up to 95 dBA for pile drivers.

For the purposes of this analysis, construction noise would be considered significant if it would exceed 75 dBA L_{max} at the outdoor use area of a residence or would occur within 1,000 feet of a residence during evening/nighttime hours (6:00 p.m. to 7:00 a.m.). Noise from trucking activities would be considered significant if it would exceed 60 dBA-L_{eq} at the outdoor use area of a residence.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, some construction would occur. As such, there could be minor, localized increases in noise levels during construction of the restoration areas. Noise generated by managed wetland activities is expected to decrease, but could continue to affect their associated sensitive receptors. Overall, a reduction in noise is expected as a result in a reduction in activities in the Marsh. Therefore, there would be no impact.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact NZ-1: Temporary Increases in Ambient Noise during Construction Activities Associated with Restoration

Most noise associated with construction activities would be highly localized. However, noise from trucks would not be localized and would occur on roads throughout the plan area and on roads used to access specific project sites. Because noise-sensitive land uses are sparsely located throughout the plan area, it is unlikely that noise from these activities would have a substantial impact on any sensitive receptors. However, as described above, noise impacts exceeding 75 dBA L_{max} at the outdoor use area of a residence or would occur within 1,000 feet of a residence during evening/nighttime hours (6:00 p.m. to 7:00 a.m.) would be considered significant. Truck noise would be considered significant if it would exceed 60 dBA L_{eq} at the outdoor use area of a residence. To ensure that there would be no significant impact associated with these temporary increases in ambient noise during construction, construction hours would be limited when occurring near residences and noise reduction practices would be implemented as described in the Environmental Commitments section of Chapter 2.

Conclusion: Less than significant. No mitigation required.

Impact NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities

Noise-sensitive land uses could be exposed to vibration resulting from heavy equipment operation. Vibration produced by grading activities has been assessed using an analysis method recommended by FTA (Federal Transit Administration 2006). A reasonable worst-case assumption is that a bulldozer would generate the highest vibration of any heavy equipment used. The recommended reference vibration amplitude or reference PPV for a large bulldozer is 0.089 inch per second at 25 feet. The estimated vibration amplitude at various distances has been calculated and is summarized in Table 5.8-3.

Table 5.8-3. Estimated Vibration Amplitude from a Large Bulldozer

Distance (feet)	Peak Particle Velocity (inch/second)
25	0.089
50	0.031
100	0.011
200	0.0039

Source: California Department of Transportation 2004.

The threshold of perception for groundborne vibration is about 0.02 inch/second (California Department of Transportation 2004). Accordingly, perceptible vibration from the operation of heavy equipment is expected to be limited to an area within about 75 feet of the activity. Because residences are not anticipated to be located within 75 feet of heavy equipment operation, this impact is considered to be less than significant.

Conclusion: Less than significant. No mitigation required.

Impact NZ-3: Permanent Increases in Ambient Noise

Noise generated from individual site-specific projects would occur sporadically over the 30-year implementation period. This could result in slight, isolated occurrences of increased noise (described above under Impact NZ-1) that together would represent an overall permanent (30-year) increase in the ambient noise in Suisun Marsh. However, specific projects would occur throughout the plan area over time. As such, it is not expected that overlaps in substantial noise generation would occur in the same areas of the Marsh that would affect the same sensitive receptors at the same time in a manner that would be considered permanent.

Conclusion: Less than significant. No mitigation required.

Impact NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations

Truck traffic would increase temporarily to remove and import levee materials and import riprap and other construction materials. A description of anticipated trucking activity is provided in Section 5.7, Transportation and Navigation. It is not possible at this time to determine specific truck volumes on specific roadways. However, a reasonable worst-case assumption is that up to 20 heavy trucks per hour could use any given roadway. Using the Federal Highway Administration Traffic Noise Model (TNM) Version 2.5 and a nominal speed of 45 mph, 20 trucks per hour would produce the following hourly sound levels:

- 54 dBA at 100 feet
- 50 dBA at 200 feet
- 45 dBA at 400 feet

Because noise from project-related trucking operations is not predicted to exceed 60 dBA L_{eq} within about 100 feet of the trucking activity, it is unlikely that trucking noise would exceed 60 dBA L_{eq} at the outdoor use areas of any residences.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities

This impact would be similar to that described for restoration activities. Noise-sensitive land uses could be exposed to vibration resulting from heavy equipment operation. Perceptible vibration from the operation of heavy equipment is expected to be limited to an area within about 75 feet of the activity. Because residences are not anticipated to be located within 75 feet of heavy equipment operation, this impact would be considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact NZ-3: Permanent Increases in Ambient Noise

This impact would be similar to that described for restoration activities. Noise generated from individual site-specific projects would occur sporadically over the 30-year implementation period, which could result in slight, isolated occurrences of increased noise (described below under Impact NZ-5) that together would represent an overall permanent (30-year) increase in the ambient noise in Suisun Marsh. However, specific projects would occur throughout the plan area over time. Therefore, it is not expected that overlaps in substantial noise generation would occur in the same areas of the Marsh that would affect the same sensitive receptors at the same time in a manner that would be considered permanent.

Conclusion: Less than significant. No mitigation required.

Impact NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations

This impact would be similar to that described for restoration activities. Truck traffic would increase temporarily to remove and import levee materials and import riprap and other construction materials. Because noise from project-related trucking operations is not predicted to exceed 60 dBA L_{eq} within about 100 feet of the trucking activity, it is unlikely that trucking noise would exceed 60 dBA L_{eq} at the outdoor use areas of any residences.

Conclusion: Less than significant. No mitigation required.

Impact NZ-5: Temporary Increases in Ambient Noise during Construction Activities Associated with Management Activities

Some of the managed wetland activities would involve the use of heavy construction equipment. These activities include dredging equipment, box scrapers, dozers, and trucks. Table 5.8-4 summarizes typical noise levels produced by construction equipment commonly used for managed wetland activities. As indicated, equipment involved in construction is expected to generate noise levels ranging from 55 dB to 95 dB at a distance of 50 feet. Noise produced by construction equipment would be reduced at a rate of about 6 dB per doubling of distance.

Table 5.8-4. Construction Equipment Inventory and Noise Emission Levels and Utilization Factor

Equipment	Typical Noise Level (dBA) 50 ft from Source[1]	Utilization Factor[5]
Long-reach excavator	85 [1]	0.4
Diesel-powered barges	85 [2]	0.5
Small to medium bulldozers	85	0.4
Dump trucks	84	0.4
Small clamshell dredge	80 [3]	0.4
Crane	88	0.2
Front-end loader	85	0.4
Small boat	55 [4]	–

[1] Assumed same as excavator.
[2] Assumed same as dump truck.
[3] Geier & Geier Consulting 1997.
[4] Assumed same as pickup truck.
[5] Thalheimer 2000.

A reasonable worst-case assumption is that the three loudest pieces of equipment (crane, excavator, and bulldozer) would be operated simultaneously and continuously over a period of at least 1 hour within the same area. Table 5.8-4 shows the noise levels produced by each piece of equipment described above along with a related utilization factor (Thalheimer 2000). The predicted 1-hour L_{eq} value is calculated from the maximum noise level and the utilization factor. The combined noise level, assuming simultaneous operation of each piece of equipment, is provided along with predicted noise levels at various distances from the source. The predicted noise levels at various distances take into account geometric point-source attenuation (6 dB per doubling of distance) and ground absorption (1 to 2 dB per doubling of distance). The results in Table 5.8-5 indicate that construction operations could result in noise that exceeds 75 dBA within about 200 feet of construction operations.

Table 5.8-5. Construction Noise

Source Data	Maximum Sound Level (dBA)	Utilization Factor	L_{eq} Sound Level (dBA)
Construction Condition: Suisun Marsh Restoration			
Source 1: Crane—Sound level (dBA) at 50 feet	88	0.2	81.0
Source 2: Excavator—Sound level (dBA) at 50 feet	85	0.4	81.0
Source 3: Bulldozer—Sound level (dBA) at 50 feet	85	0.4	81.0
Average Height of Sources—Hs (feet)			10
Average Height of Receiver—Hr (feet)			5
Ground Type (soft or hard)			soft
Calculated Data:			
All Sources Combined—L_{max} sound level (dBA) at 50 feet			91
All Sources Combined—L_{eq} sound level (dBA) at 50 feet			86
Effective Height (Hs+Hr)/2			7.5
Ground Factor (G)			0.62

Distance between Source and Receiver (feet)	Geometric Attenuation (dB)	Ground Effect Attenuation (dB)	Calculated L_{max} Sound Level (dBA)	Calculated L_{eq} Sound Level (dBA)
50	0	0	91	86
100	-6	-2	83	78
200	-12	-4	75	70
300	-16	-5	71	65
400	-18	-6	67	62
500	-20	-6	65	60
600	-22	-7	63	58
700	-23	-7	61	56
800	-24	-7	60	54
900	-25	-8	58	53
1,000	-26	-8	57	52
1,200	-28	-9	55	50
1,400	-29	-9	53	48
1,600	-30	-9	52	46
1,800	-31	-10	50	45

Distance between Source and Receiver (feet)	Geometric Attenuation (dB)	Ground Effect Attenuation (dB)	Calculated L_{max} Sound Level (dBA)	Calculated L_{eq} Sound Level (dBA)
2,000	-32	-10	49	44
2,500	-34	-10	47	41
3,000	-36	-11	44	39

Source: Calculations based on Federal Transit Administration 2006.

Note: This calculation does not include the effects, if any, of local shielding from walls, topography or other barriers that may reduce sound levels further.

Although highly unlikely, management activities could take place within 200 feet of residences. Noise-reducing practices, as described in the Environmental Commitments section of Chapter 2, would be implemented if noise levels adjacent to a sensitive receptor are anticipated to exceed standards.

Conclusion: Less than significant. No mitigation required.

Impact NZ-6: Exposure of Noise-Sensitive Land Uses to Noise from Portable Pump Operations

Pumps would be used to dewater managed wetlands to augment flood and drain practices. It is reasonable to assume the pumps used for dewatering would be diesel-powered, and approximately 75 horsepower (Hp). It is anticipated that up to eight dewatering pumps may be used at any one time but would be spread throughout the plan area.

Noise levels from operation of dewatering pumps were calculated based on information provided by the project engineers, methodology developed by the FTA, and methodology developed by Hoover and Keith (Hoover and Keith 2000). A single 75-Hp dewatering pump is anticipated to generate a noise level of 80dBA at a distance of 50 feet.

A reasonable worst-case assumption is that eight pumps would operate simultaneously and continuously over a 24-hour day. Simultaneous operation of eight dewatering pumps would result in a combined source level of 89 dBA at 50 feet. For a sound source that operates continuously over a 24-hour period, the CNEL value is about 7 dB greater than the 1-hour L_{eq} value. In this case the CNEL value would be 96 CNEL at 50 feet. Table 5.8-6 calculates estimated sound levels from the operation of dewatering pumps as a function of distance. The predicted noise levels at various distances takes into account geometric point-source attenuation (6 dB per doubling of distance) and ground absorption (1 to 2 dB per doubling of distance).

The results in Table 5.8-6 indicate that pumping noise may exceed 70 CNEL within 275 feet of the pump. Noise-sensitive land uses may be located within 275 feet of the pump locations.

Table 5.8-6. Pump Operation Noise

Source Data	Maximum Sound Level (dBA)	Utilization Factor	L_{eq} Sound Level (dBA)
Condition: pump operation			
Source 1: 8 pumps - Sound level (dBA) at 50 feet =	96	0.4	92.0
Average Height of Sources - Hs (feet) =			2
Average Height of Receiver - Hr (feet) =			5
Ground Type (soft or hard) =			soft
Calculated Data:			
All Sources Combined - L_{eq} sound level (dBA) at 50 feet =			94
Effective Height (Hs+Hr)/2 =			3.5
Ground factor (G) =			0.66

Distance Between Source and Receiver (feet)	Geometric Attenuation (dB)	Ground Effect Attenuation (dB)	Calculated L_{eq} Sound Level (dBA)
50	0	0	94
100	-6	-2	86
200	-12	-4	78
300	-16	-5	73
400	-18	-6	70
500	-20	-7	67
600	-22	-7	65
700	-23	-8	63
800	-24	-8	62
900	-25	-8	60
1,000	-26	-9	59
1,200	-28	-9	57
1,400	-29	-10	55
1,600	-30	-10	54
1,800	-31	-10	52
2,000	-32	-11	51
2,500	-34	-11	48
3,000	-36	-12	46

Source: Calculations based on Federal Transit Administration 2006.

Note: This calculation does not include the effects, if any, of local shielding from walls, topography or other barriers which may reduce sound levels further.

In instances where the operation of portable pumps is occurring under the existing condition, there would be no impact unless additional pumps are used, it is placed in an area that increases the noise at sensitive land uses, or it generates additional noise. Otherwise, a significant impact could occur.

Conclusion: Less than significant with Mitigation Measure NZ-MM-1 incorporated.

Mitigation Measure NZ-MM-1: Limit Noise from Pump Operations
The specific project proponent will limit noise from pump operations, where feasible, such that noise from pump operations does not exceed 70 CNEL in the surrounding areas. Noise control measures that can be implemented to reduce noise from pumps on adjacent land uses include those following.

- All internal combustion engine–driven equipment will be equipped with intake and exhaust mufflers that are in good condition and appropriate for the equipment.
- Unnecessary idling of internal combustion engines will be strictly prohibited.

Staging of pump equipment within 275 feet of residences will be avoided. Where equipment must be located within 275 feet of residences, enclosures or barriers will be provided around pumps to reduce noise to acceptable levels.

Alternative B: Restore 2,000–4,000 acres

Impacts for Alternative B are the same as for Alternative A.

Alternative C: Restore 7,000–9,000 acres

Impacts for Alternative C are the same as for Alternative A.

Section 5.9
Climate Change

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives and how climate change may affect future restoration sites.

The Affected Environment discussion below describes the current setting of the plan area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the plan. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary. Adaptation refers to actions that are taken (separate from a specific project) to prepare for the effects of ongoing climate change. This section identifies mitigation measures, not adaptation measures, for addressing the effects of implementing the SMP in light of climate change through the 30-year planning horizon. However, indirect effects of implementation of the SMP itself can be considered a form of climate adaptation as restored wetlands would be more resilient to sea level rise effects.

Summary of Impacts

Table 5.9-1 summarizes climate change impacts from implementing the SMP alternatives. There would be no significant impacts on climate change from implementing the SMP action alternatives.

Table 5.9-1. Summary of Climate Change Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
CC-1: Construction-Related Changes in Greenhouse Gas Emissions	A, B, C	Less than significant	None required	–
CC-2: Permanent Changes in Greenhouse Gas Sources and Sinks	A, B, C	Beneficial	None required	–
CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated with Sea Level Rise	No Action Alternative	–	–	–
CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated with Sea Level Rise	A, B, C	Beneficial	None required	–

Affected Environment

Regulatory Setting

Federal

There are no federal standards for greenhouse gas (GHG) emissions or contributions to climate change and no requirements to address climate change in NEPA analysis. However, recent activity suggests that regulation may be forthcoming, with the EPA serving in a leadership role to implement such a program. However, EPA regulation may be preempted by congressional action should a cap and trade bill be passed prior to adoption of EPA regulation.

This section summarizes recent legal cases, legislation, and policy related to climate change and GHG regulation.

Massachusetts et al. v. *Environmental Protection Agency* (2007)

Twelve U.S. states and cities including California, in conjunction with several environmental organizations, sued to force the EPA to regulate GHGs as a pollutant pursuant to the Clean Air Act (CAA) in *Massachusetts* et al. v. *Environmental Protection Agency*. On April 2, 2007, the U.S. Supreme Court held that EPA has the authority to regulate GHG emissions as a pollutant pursuant to the CAA. However, the court did not decide whether EPA is required to regulate GHG emissions at this time, or may exercise discretion to not regulate at this time.

Despite the Supreme Court ruling and the EPA proposal, there are no promulgated federal regulations to date limiting GHG emissions that are applicable to the project.

EPA Finding of Endangerment (2007)

On April 17, 2009, the EPA issued a Proposed Endangerment and Cause or Contribute Finding for Greenhouse Gases under the CAA. Through this Finding of Endangerment, the EPA Administrator proposed that current and projected concentrations of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6) threaten the public health and welfare of current and future generations. Additionally, the Administrator proposed that combined emissions of CO_2, CH_4, N_2O and HFCs from motor vehicles contribute to the atmospheric concentrations and thus to the threat of climate change. Although the Endangerment Finding in itself does not place requirements on industry, it is an important step in the EPA's process to develop regulation.

Environmental Protection Agency Advance Notice of Proposed Rulemaking 2008

In June 2008, the EPA issued an Advance Notice of Proposed Rulemaking (ANPR) inviting comments on options and questions regarding regulation of GHGs under the CAA but has not yet proposed or adopted regulations in response to the Massachusetts case decision.

Environmental Protection Agency Rule: Mandatory Reporting of Greenhouse Gases (2009)

On September 22, 2009, the EPA Administrator signed a rule requiring mandatory reporting of emissions of GHGs from large sources within the United States. The rule was published in the *Federal Register* on October 30, 2009, and goes into effect December 29, 2010. The rule includes emissions of CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, nitrogen trifluoride (NF_3), hydrofluorinated ethers (HFE), and select other fluorinated compounds. Under the rule, suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions are required to report annual emissions to the EPA. The first annual reports for the largest emitting facilities, covering calendar year 2010, will be submitted to the EPA in 2011.

State

California Global Climate Change Solutions Act of 2006

In Assembly Bill 32 (AB32) (California Global Warming Solutions Act of 2006), the Legislature recognized California's vulnerability to weather events triggered by global warming. The Legislature found that global warming will "have detrimental effects on some of California's largest industries." Residents likely will be affected by many of these climate change effects, given the importance of agriculture, tourism, and recreation to Solano County (Yolo-Solano Air Quality Management District 2007).

AB32 mandates that emissions of GHGs be reduced to 1990 levels by 2020. Considering that 40% of GHG emissions come from motor vehicles, projects that generate new vehicle trips can conflict with AB32 goals.

Senate Bill 97 Chapter 185, Statutes of 2007

Senate Bill (SB) 97 requires that the Office of Planning and Research (OPR) prepare guidelines to submit to the California Resources Agency regarding feasible mitigation of GHG emissions or the effects of GHG emissions as required by CEQA. The Resources Agency is required to certify and adopt these revisions to the State CEQA Guidelines by January 1, 2010. The Guidelines will apply retroactively to any incomplete environmental impact report, negative declaration, mitigated negative declaration, or other related document.

Executive Order S-03-05 (2005)

California Executive Order S-03-05, issued by Governor Arnold Schwarzenegger, established the following GHG emission reduction targets for California's state agencies:

- By 2010, reduce GHG emissions to 2000 levels;
- By 2020, reduce GHG emissions to 1990 levels; and
- By 2050, reduce GHG emissions to 80% below 1990 levels.

The order also required that the Secretary of the California Environmental Protection Agency (CalEPA) oversee and coordinate emission reduction efforts with the Secretary of the Business, Transportation and Housing Agency, Secretary of the Department of Food and Agriculture, Secretary of the Resources Agency, Chairperson of the CARB, Chairperson of the CEC, and the President of the Public Utilities Commission (PUC). The Secretary of CalEPA is required to report to the governor and state legislature biannually on the impacts of global warming on California, mitigation and adaptation plans, and progress made toward reducing GHG emissions to meet the targets established in this executive order.

Executive Orders are directives to state agencies from the Governor of California. They do not govern local agency actions nor do they affect the state legislature. While S-03-05 is an indicator of state policy as interpreted by the governor, it may or may not reflect the view of the legislature. It is, however, one of the factors being considered by state agencies such as the CARB, CEC, and the Building Standards Commission in formulating their GHG reduction strategies.

Executive Order S-13-08 (2008)

California Executive Order S-13-08, issued by Governor Arnold Schwarzenegger, directed the California Resources Agency to develop a state Climate Adaptation Strategy by June 30, 2009, and complete the first California Sea Level Rise Assessment Report by December 1, 2010. The assessment report must advise how California should plan for future sea level rise and should account for California-specific sea level rise projections; scientific uncertainty; impacts on state infrastructure, natural areas, and coastal/marine ecosystems; and a discussion of future research needs. The Executive order also requires that state agencies must address, for construction projects in areas vulnerable to sea level rise, project vulnerability to sea level rise, and as feasible, reduce risks and increase resiliency to sea level rise.

The 2009 California Climate Adaptation Strategy was released in December, 2009, and summarizes the best known science on climate change impacts in seven specific sectors and provides recommendations on how to manage against those threats. This strategy discusses adaptation strategies related to sea level rise, biodiversity, and ocean and coastal resources. It calls for the creation of statewide guidance and regional planning forums to help local governments update local plans and make planning decisions in light of sea level rise. Strategies include:

- Management of Watersheds, Habitat, and Vulnerable Species
- Establish State Policy to Avoid Future Hazards and Protect Critical Habitat
- Provide Statewide Guidance for Protecting Existing Critical Ecosystems, Existing Coastal Development, and Future Investments
- State Agencies Should Prepare Sea Level–Rise and Climate Adaptation Plans
- Support Regional and Local Planning for Addressing Sea Level–Rise Impacts
- Complete a Statewide Sea Level–Rise Vulnerability Assessment Every Five Years

Senate Bill 1107, Chapter 230, Statutes of 2004

This bill, approved August 16, 2004, includes a provision requiring that the Secretary of CalEPA coordinate GHG emission reductions and climate change efforts in the state government (California Energy Commission 2005).

Senate Bill 812, Chapter 423, Statutes of 2002

SB 812 requires the California Climate Action Registry to cooperate with the CARB to develop and adopt protocols for reporting and certification of GHG emissions reductions from forestry conservation and conservation-based management projects. This bill also requires the registry to develop protocols for reporting and certifying GHG reduction projects of participants.

Senate Bill 527, Chapter 769, Statutes of 2001

SB 527, approved October 11, 2001, requires the California Climate Action Registry to coordinate with the State Energy Resources Conservation and Development Commission to adopt industry-specific GHG reporting metrics. The bill requires separate reporting of direct and indirect emissions of participants in the California Climate Action Registry and requires the registry to periodically report the number of participating organizations and the percentage of total state emissions represented by participants as well as any GHG reductions achieved by participating organizations. Under SB 527, the responsibilities of the California Climate Action Registry are adjusted to meet state goals to promote voluntary reporting and reduction of GHG emissions. The bill defines the terms *annual emissions results, baseline, certification, emissions, emissions inventory, greenhouse gases, material,* and *de minimis emissions* as they pertain to climate change and the California Climate Action Registry and CARB.

Senate Bill 1771, Chapter 1018, Statues of 2000

SB 1771 (Chapter 1018, Statutes of 2000) established the California Climate Action Registry (CCAR) in 2000. In 2001 SB 527 (Chapter 769, Statutes of 2001) modified CCAR as a nonprofit voluntary registry for GHG emissions. (SB 1771 enacted Sections 42800–42870 of the California Health and Safety Code and Public Resources Code Section 25730; SB 527 amended Sections 42810, 42821–42824, 42840–42843, 42860, and 42870 of the Health and Safety Code.) The purpose of CCAR is to help companies and organizations with operations in the state establish GHG emissions baselines against which future GHG emissions reduction requirements may be applied. CCAR has developed general protocols and additional industry-specific protocols that provide guidance on how to inventory GHG emissions for participation in the registry.

Local

Solano County General Plan

The Solano County General Plan (Solano County 2008) recognizes AB32 and its goal of reducing GHG emissions. The County's goal is to reduce GHG emissions by 20% below 1990 levels by 2020. The general plan integrates the reduction throughout different resource areas such as Land Use, Public Facilities and Services, Transportation and Circulation, Health and Safety, Economic Development, Resources, and Agriculture. One of the first strategies will be to develop and adopt the Solano County Climate Action Plan (CAP) by June 30, 2010. The CAP will address both GHG emissions from activity within the county (residential, commercial, industrial, transportation, and agricultural sectors) and emissions specifically from county operations. The CAP first will create a GHG emissions inventory for the base year 1990 and forecast GHG emissions for the year 2020. The CAP will determine the quantity of emissions to be reduced in order to meet the reduction target of 20% below 1990 levels. The CAP's third step will be to establish additional policies and programs necessary to achieve the county's reduction target. The fourth step of the CAP will describe strategies, policies, and measures that will be used to protect the county from and facilitate adaptation to the potential effects of climate change. Finally, the CAP will identify benchmarks, monitoring procedures, and other steps needed to ensure the county achieves its GHG reduction, protection, and adaptation goals. The following emission reduction benchmarks will be included (Solano County 2008: HS-102–109):

- overall emissions reductions of at least10% below 1990 levels by 2015,
- overall emissions reductions of at least 20% below 1990 levels by 2020, and
- reductions of total countywide energy consumption of at least 2% per year to achieve a minimum 20% reduction by 2020.

Solano County also will develop and adopt a Sea Level Rise Strategic Program (SLRSP). The SLRSP will have three primary objectives—(1) investigate the potential effects of sea level rise on Solano County, (2) identify properties and resources susceptible to sea level rise in order to prioritize management strategies, and (3) develop protection and adaptation strategies to meet the county's and region's goals. The program will encompass all areas identified within a sea level–rise planning area and will be coordinated with San Francisco BCDC, CBDA, and other relevant agencies (Solano County 2008: HS-13).

San Francisco Bay Conservation and Development Commission

The BCDC has developed a Climate Change Planning Project with the following goals:

1. identify and report on the impacts of climate change on San Francisco Bay;

2. identify strategies for adapting to climate change;
3. develop a regional task force to inform and coordinate local governments, stakeholders, and land use planning bodies in the Bay Area regarding the potential bay-related impacts of and approaches for adapting to global climate change;
4. identify the findings and policies in the San Francisco Bay Plan pertaining to climate change, such as the findings and policies on sea level rise, and update other relevant Bay Plan policies to incorporate new information about the impacts of climate change (San Francisco Bay Conservation and Development Commission 2006).

Current Climate Change Predictions

Global Warming and Greenhouse Gases

Global warming is the name given to the increase in the average temperature of the earth's near-surface air and oceans since the mid-20th century and its projected continuation. Warming of the climate system now is considered to be unequivocal (Intergovernmental Panel on Climate Change 2007) with global surface temperature increasing approximately 1.33°F over the last 100 years. Continued warming is projected to increase global average temperature between 2 and 11°F over the next 100 years.

The causes of this warming have been identified as both natural processes and as the result of human actions. The Intergovernmental Panel on Climate Change (IPCC) concludes that variations in natural phenomena such as solar radiation and volcanoes produced most of the warming from pre-industrial times to 1950 and had a small cooling effect afterward. However, after 1950, increasing atmospheric GHG concentrations resulting from human activity such as fossil-fuel burning and deforestation have been responsible for most of the observed temperature increase. These basic conclusions have been endorsed by more than 45 scientific societies and academies of science, including all of the national academies of science of the major industrialized countries. Since 2007, no scientific body of national or international standing has maintained a dissenting opinion.

Increases in GHG concentrations in the earth's atmosphere are thought to be the main cause of human-induced climate change. Greenhouse gases are gases that naturally trap heat by impeding the exit of solar radiation that has hit the earth and is being reflected back into space. Some greenhouse gases occur naturally and are necessary for keeping the earth's surface inhabitable. However, increases in the concentrations of these gases in the atmosphere during the last hundred years have decreased the amount of solar radiation that is reflected back into space, intensifying the natural greenhouse effect and resulting in the increase of global average temperature.

The principal greenhouse gases are CO_2, CH_4, N_2O, SF_6, PFCs, HFCs, and water vapor (U.S. Environmental Protection Agency 2009a). Each of the principal greenhouse gases has a long atmospheric lifetime (1 year to several thousand years). In addition, the potential heat-trapping abilities of each of these gases vary significantly from one another.

CH_4 is 21 times as potent as carbon dioxide, while SF_6 is 22,200 times more potent than CO_2. Conventionally, GHGs have been reported as carbon dioxide equivalents (CO_2e). CO_2e takes into account the relative potency of non-CO_2 GHGs and converts their quantities to an equivalent amount of CO_2 so that all emissions can be reported as a single quantity.

The primary human-made processes that release these gases are: burning of fossil fuels for transportation, heating and electricity generation; agricultural practices such as livestock grazing and crop residue decomposition that release CH_4; and industrial processes that release smaller amounts of high global warming–potential gases such as SF_6, PFCs, and HFCs. Deforestation and land cover conversion also have been identified as contributing to global warming by reducing the earth's capacity to remove CO_2 from the air and altering the earth's albedo or surface reflectance, allowing more solar radiation to be absorbed.

Although the international, national, state, and regional community is beginning to address GHGs and the potential effects of climate change, it is expected that worldwide GHG emissions will continue to rise over the next several years.

In the plan area, most GHG emissions are generated from vehicle use, industrial activities, and residential uses.

Greenhouse Gases and Wetlands

Analysis of GHG fluxes from wetlands has received a considerable amount of study in the last two decades. However, given that carbon cycling, CH_4 production, and nitrogen cycling vary substantially in different wetlands at different times of the year and because of highly site-specific chemical and biological characteristics, there is a substantial amount of uncertainty in estimating potential changes in GHG emissions and sequestration in such dynamic environments. The values below should be considered an illustrative evaluation of the potential changes in carbon sequestration and CH_4 production associated with the proposed project, but given the level of uncertainty in the underlying supporting research, the values derived below should not be considered predictive. However, as described below, the evidence does allow for concluding the direction of change in carbon sequestration and CH_4 production, but not for the precise determination of the extent of such change.

Water salinity plays a major role in wetland carbon cycling, CH_4 production, and nitrogen cycling. Wetlands with higher salinity tend to sequester more carbon and emit less CH_4 than wetlands with lower salinity. The concentration of salts (salinity) in ocean water is approximately 33 parts sea salt per thousand parts of water (ppt, or grams per liter [g/L]) (psu), while the salinity of fresh water is near zero (U.S. Geological Survey 2007). Salinity measurements taken at the Suisun wetlands between 2002 and 2003 are presented in Section 5.2, Water Quality. Figure 5.2-3 shows the variation in salinity within Suisun Bay from Martinez to Collinsville. Salinity in the Marsh varies with Delta outflow. Figure 5.2-4 indicates that salinity averages about 15 milliSiemens per centimeter (mS/cm) in the western Marsh and about 5 mS/cm in the eastern portion of the Marsh.

Carbon Dioxide Sequestration

Through the process of photosynthesis, plants take up CO_2 from the atmosphere. Along with water, nutrients, and minerals, CO_2 is incorporated into the living tissue of plants to allow for development, growth, and reproduction of the plant. This is the process through which carbon is sequestered into plants and stored as carbon stock. Some portion of the carbon removed from the atmosphere is returned to the atmosphere through several processes, including respiration, decay, and disturbance. CO_2 emissions from respiration can be as much as 25% of "gross primary productivity," or the net rate at which plants fix and store carbon as energy.

Like other plant matter, vegetation in wetlands can capture carbon by taking in atmospheric CO_2, converting it to plant mass through photosynthesis and then sequestering the carbon in the inundated soils that form as plant matter decomposes. Pilot studies being undertaken in tule marshes on Twitchell Island (approximately 15 miles east of Suisun Marsh) have found a very high primary productivity (carbon fixation) and sequestration (C-immobilization, or long-term "storage") of belowground carbon that would remain stable if continuously inundated. When coupled with the CO_2 emissions reduction associated with preservation of historic peat deposits, as much as 25 metric tons of carbon per acre per year may be sequestered by freshwater marshes in the Delta according to indications in these studies. The results vary widely depending on many factors such as temperature, inundation regime, and plant species (U.S. Geological Survey 2007, 2008).

Saline and freshwater wetlands can represent net sinks of CO_2. Because tidal marshes are extremely productive, they are one of the most effective environments for carbon sequestration (Chmura et al. 2003; Trulio 2007; Mitsch and Gosselink 2000). Recent research estimates the carbon sequestration potential of saline marshes to range between 0.8 and 5.7 metric tons per acre per year (54 g/m^2 and 385 g/m^2/year) (U.S. Climate Change Science Program 2007; Trulio 2007). Freshwater mineral soil wetlands also sequester CO_2. The first State of the Carbon Cycle Report (SOCCR) estimates the sequestration potential of freshwater wetlands to be 0.3 metric ton per acre per year (21 g/m^2/year) (U.S. Climate Change Science Program 2007). These values represent the net, long-term storage of carbon in the system, after accounting for losses attributable to respiration. Research on sequestration in brackish wetlands is limited. Because the salinity in these environments is lower than in a salt marsh, but higher than in a freshwater marsh, it can be theorized that the carbon sequestration potential of brackish wetlands likely would fall somewhere between the range of a freshwater wetland and the range of a saltwater wetland.

Methane Emissions

While freshwater, saltwater, and brackish wetlands sequester amounts of CO_2, they also produce CH_4 through anaerobic decomposition of biomass; CH_4 is a more potent GHG than CO_2.[1] Approximately 76% of global naturally produced CH_4 comes from wetlands (U.S. Environmental Protection Agency 2009b). CH_4 is naturally produced and emitted from wetlands by CH_4-producing bacteria that need anoxic conditions combined with labile organic matter.

Saline marshes, in general, often are thought to release less CH_4 than freshwater environments, but the absolute differences depend on site characteristics (Trulio 2007; U.S. Climate Change Science Program 2007). Sulfates can suppress CH_4 production from CO_2 respiration (Chmura et al. 2003). Research suggests that tidal brackish wetlands release 6.4 g/m^1 to 22.4 g/m^2 of CH_4 per year, or 0.5 to 1.9 metric tons of CO_2e per acre per year (U.S. Climate Change Science Program 2007; Bartlett et al. 1987), while freshwater wetlands release 18.7 to 91.4 g/m^2 of CH_4, or 1.6 to 7.8 metric tons of CO_2e per acre per year (U.S. Climate Change Science Program 2007).[2] As mentioned above, the salinity in Suisun Marsh ranges from 3 to 10 psu, which corresponds to the high range of CH_4 emissions for tidal brackish wetlands presented above, or 1.6 to 1.9 metric tons of CO_2e per acre per year (Bartlett et al. 1987). Because CH_4 is a far more potent GHG on a pound-for-pound basis than CO_2, in freshwater wetlands CH_4 production may overwhelm the benefits obtained from carbon sequestration (U.S. Climate Change Science Program 2007). Recent work on wetland mesocosms[3] and restored wetlands (Altor 2009) has shown that the soils that originally formed under flooded or saturated conditions and are continually inundated with water release higher levels of CH_4 than periodically inundated soils.

CH_4 flux out of the marsh is controlled by numerous environmental factors, one of which is evapotranspiration. Evapotranspiration is the transport of water from soil or surfaces (evaporation) and from the open stomata of plants (transpiration) to the atmosphere. Other gases, such as CH_4 or N_2O discussed below, follow physical paths similar to water vapor as they move from an ecosystem to the atmosphere; thus, the evapotranspiration potential (ETP) of an ecosystem and its GHG flux are related. In Suisun Marsh, the ETP is estimated to increase

[1] Different GHGs are compared using their global warming potential (GWP) over a 100-year period. On this basis, CH_4 is approximately 21 times more powerful on a pound for pound comparison to CO_2 and thus has a GWP of 21. N_2O has a GWP of 310.

[2] The highest CH_4 values for brackish and freshwater marshes, 97 and 213 g/m^2 respectively, were assumed to be outliers and excluded from the calculations. In addition, higher CH_4 values were reported for non-tidal marshes. Uncertainty associated with these statistics can be as high as 100%.

[3] A mesocosm is any system larger than a microcosm (a smaller system which is representative of or analogous to a larger one) but smaller than a macrocosm (a complex structure, such as a society, considered as a single entity that contains numerous similar, smaller-scale structures). In the research cited above, mesocosm refers to a small study area within the marsh that was examined and assumed to be representative of conditions throughout a larger area

dramatically from the western to eastern portions of the Marsh. This gradient, together with numerous other mediating factors, ultimately determines the amount and patterns of CH_4 released in the Marsh.

Nitrous Oxide Emissions

Natural emissions of N_2O result primarily from bacterial breakdown of nitrogen in soils and in the earth's oceans. Globally, tropical soils (primarily wet forest soils, but also savannas and agricultural systems) are estimated to produce 6.3 million tons (Tg) of N_2O annually, and oceans are thought to add around 4.7 Tg of N_2O annually to the atmosphere (Intergovernmental Panel on Climate Change 2001; U.S. Environmental Protection Agency 2009c). Together, these two sources account for more than 70% of the natural sources. Similar microbial processes in temperate-region soils produce smaller quantities of N_2O. In some ocean areas, large areas of surface water can become oxygen-depleted, allowing active denitrification in open water. Large amounts of oceanic N_2O also can arise from denitrification in marine sediments, particularly in nutrient-rich areas such as those of estuaries.

All wetlands produce N_2O through nitrification and denitrification processes, which are the generation and diagenesis of nitrate (NO_3), respectively. However, research on N_2O production rates from wetlands is limited. In addition, the research that has been conducted has an extremely high degree of uncertainty because of the compound's complex chemistry and unknown strength of nitrifying and denitrifying processes in certain environments. As such, depending on biogeochemical characteristics of a wetland (e.g., labile carbon availability, nitrate availability, redox potential), N_2O production could vary significantly. Given the current research limitations, N_2O production was not included in this analysis.

It is important in studies of N_2O emissions to account for the various interactions between natural processes and human influences in the nitrogen cycle, because human impacts can significantly enhance the natural processes that lead to N_2O formation. For example, the nitrogen nutrient loading in water bodies attributable to fertilization and runoff to streams can enhance N_2O emissions from these natural sources. Human-related ammonia emissions also have been shown to cause N_2O emissions in the atmosphere through ammonia oxidation.

Peat Soil Subsidence and Oxidation

Globally, peat oxidation accounts for 2–3 gigatons (Gt) per year of CO_2 equivalents (one tenth of fossil-fuel emissions) with rates ~tenfold greater in temperate and tropical soils than in boreal soils (Intergovernmental Panel on Climate Change 2007). In addition, global emissions of CO_2 from drained peatlands amounted to 1.4 Gt in 2008 (Wetlands International 2009).

Subsidence of organic soil in drained wetlands can produce CO_2 through microbial oxidation of the carbon in the organic component of the soil. Subsidence also can produce CH_4 and N_2O. Subsidence of organic soils is common in the Delta region. According to multiple studies, subsidence is caused primarily by microbial oxidation of soil organic carbon, which produces emissions of CO_2. Subsidence also can occur through anaerobic decomposition; consolidation; shrinkage; wind erosion; gas, water, and oil withdrawal; wetting and drying of the soil; and dissolution of organic matter (Deverel 2008). Peat soil lands in the Delta region are subsiding significantly, with an estimated subsidence rate between 0.2 and 2.5 inches per year that results primarily from the oxidation of the peat soil (Deverel and Rojstaczer 1996). However, research on peat soil oxidation rates from the Suisun area is limited. Much subsidence and peat soil oxidation in the Delta occur from agricultural practices on drained wetlands, and such practices are not occurring at Suisun. Consequently, subsidence at Suisun marsh is significantly less than subsidence in other Delta regions. In addition, oxidation and subsidence rates depend on soil organic content, carbon content, temperature, and other factors. Understanding these characteristics at Suisun improves the ability to predict net effects of hydrologic changes on peat oxidation.

Sea Level Rise

With respect to Suisun Marsh, the most critical climate change problem is the potential for significant increase in mean sea level. Such a rise may result from a combination of (a) the volumetric expansion of existing seawater as water temperatures rise significantly and (b) the increase in total (liquid) sea water as large ice deposits on land (e.g., in Antarctica, in Greenland, and worldwide in large glaciers) melt into the sea. Local sea level rise may be affected by both global sea level rise and geotectonic land mass movements and subsidence. Subsidence has the potential to affect local regional sea level to the same extent as climate change.

Atmospheric pressure, ocean currents, and local ocean temperatures also affect local rates of sea level rise. The sea level has risen approximately 4,800 inches (400 feet) since the peak of the last ice age about 18,000 years ago, but the bulk of that occurred before 6,000 years ago (Axelrod 1981). From 3,000 years ago to the late 1800s, the rate of sea level rise held almost constant (average rate of 0.0 to 0.2 millimeter per year, or 0.0 to 0.8 inch per century [Intergovernmental Panel on Climate Change 2007]); however, it appeared to increase worldwide in the twentieth century (e.g., 8.4 inches/century or 4.2 inches/50 years near San Francisco).

Most climate scientists agree that anthropogenically induced global warming will cause the rate of sea level rise to increase further. In 2001, the IPCC released a report with projections of global sea level rise over the next century. More recent studies project different rates of sea level rise for specific regions of the globe. These regional projections are considered more reliable on a region-by-region basis than the IPCC projections. To provide a comprehensive discussion of sea level rise, both IPCC and regional projections are presented below.

IPCC projections of sea level rise vary depending on several different GHG emissions scenarios analyzed in the IPCC Special Report on Emissions Scenarios. As such, the IPCC estimates sea level rise to be between 3.6 and 34.8 inches between years 1990 and 2100 (Intergovernmental Panel on Climate Change 2001). The IPCC model range of estimates for global sea level average rise by 2060 is predicted to be between 2.4 and 15.6 inches. However, the models used by the IPCC do not predict uniform global sea level rise, and there are substantial regional variations. The IPCC model predictions for the eastern Pacific indicate a range of sea level rise of 3.6 to 19.2 inches by 2100, which is on the lower end of the global range noted above. Most of the sea level rise predictions on the top end of the global range are for the top and bottom of the world (i.e., the polar latitudes), not the middle latitudes. Assuming net rise between 1990 and 2060 to be half of the net rise between 1990 and 2100, the geographic prediction for 2060 from the IPCC models for the eastern Pacific would be 1.8 to 9.6 inches.

While IPCC assessments of climate change and associated sea level rise rely on global models, adapting to climate change and associated sea level rise requires an understanding of how climate change will affect specific regions so that planning can take place at the state and regional levels. The California Climate Action Team relies on the IPCC Special Report on Emissions Scenarios for assessing primary impacts of climate change, namely changes in the frequency and intensity of precipitation and temperature increases, on a regional level (Cayan et al. 2006; Cayan et al. 2008). IPCC-projected temperature increases range from 2.5°F for the lowest emissions scenario to 10.4°F for the highest emissions scenario. However, the California Climate Action Team uses Rahmstorf's methodology for projecting sea level rise.

In 2007, German scientist, Stefan Rahmstorf, developed an empirical approach to projecting future sea level rise that entails calculating the relationship between sea level rise and global mean surface temperature. Rahmstorf first determined the historical trend in this relationship and then projected that trend into the future using IPCC's projected temperature increases associated with Special Report on Emissions Scenarios, which range from 2.5°F for the lowest emissions scenario to 10.4°F for the highest emissions scenario (Rahmstorf 2007). Rahmstorf's corresponding estimates of sea level rise by 2100 range from 10 inches to 55 inches.

IPCC's and Rahmstorf's sea level rise estimates did not include the effects of dams on sea level rise (Cayan et al. 2008). Dams constructed primarily during the 1950s to 1970s may have stored enough water worldwide to mask acceleration in the rate of sea level rise prior to the notable acceleration detected in 1993. As building of dams for additional upland water storage has slowed, sea level rise now may be accelerating faster than the IPCC and scientists such as Rahmstorf have predicted (Chao 2008).

The Delta Vision Blue Ribbon Task Force established by Governor Schwarzenegger to develop a strategic management plan for the Delta employed an Independent Science Board to review literature and provide recommendations on sea level rise. The Independent Science Board found that: (1) current IPCC projections are conservative and underestimate recently measured sea level rise; (2) empirical models, such as Rahmstorf's empirical method, yield significantly higher estimates of sea level over next few decades and are better for short- to mid-term planning; and (3) neither the IPCC nor Rahmstorf accounts for accelerating contributions from ice sheet melting, which likely will contribute significantly to future sea level rise with the potential for very rapid increases of up to 39 inches by 2100. Based on these findings, the Independent Science Board recommended adopting an estimated rise in sea level of 55 inches by 2100 and recommended adopting a sea level rise estimate for 2050 as well.

Therefore, even though the California Climate Action Team still relies on IPCC-projected temperature increases and Rahmstorf's methodology for projecting sea level rise, the team goes further to account for effects of dams and accelerated ice sheet melting on sea level rise. As a result, California Climate Action Team–funded research for a 2009 report (the 2009 California Climate Adaptation Strategy) to Governor Schwarzenegger estimates that sea level rise will increase in California between 12 and 17 inches by 2050 and between 20 and 55 inches by 2099 (San Francisco Bay Conservation and Development Commission 2009b). In addition, DWR supports a range in sea level rise of 7 to 55 inches along California's Coast by 2100 (California Department of Water Resources 2008). The most recent climate science report, the 2009 Copenhagen Diagnosis, estimates that global sea level rise will increase up to approximately 78.7 inches by 2100 (Allison et al. 2009). Based on these predictions, sea level rise would likely cause flooding in the urbanized areas of Suisun City and Fairfield.

The 2009 California Climate Adaptation Strategy includes many adaptation actions to respond to changes in sea level rise. Some of these actions are summarized below:

- identify and strategically prioritize for protection lands at the boundaries of the San Francisco Bay and the Delta that will provide the habitat range for tidal wetlands to adapt to sea level rise;
- minimize the adverse effects of sea level rise and storm activities by carefully consider new development within areas vulnerable to inundation;
- prepare agency-specific adaptation plans, guidance, and criteria, as appropriate (state agencies responsible for the management and regulation of resources and infrastructure subject to potential sea level rise); and
- identify and protect key habitats that may require more protection as a result of climate change impacts, including sea level rise.

See Chapter 2 of this EIS/EIR for further discussion of ways to respond to predicted sea level rise.

Water Quality

Trace elements such as copper can be present in wetland sediments, and copper toxicity to wildlife is a current water quality concern in the western Suisun Marsh. The increase in atmospheric CO_2 associated with climate change results in a decrease of ocean pH, because of carbonic acid increase associated with the ocean's increased absorption of CO_2. As copper desorption in aqueous environments is sensitive to changes in pH, copper toxicity is susceptible to increase as a result of climate changes. A change of 1 pH unit can result in a hundredfold increase in availability coming from copper bound in sediments (Sparks 1995). It is estimated that surface ocean pH will drop by up to 0.5 pH units by 2100, as the oceans absorb more CO_2. However, copper toxicity effects related to climate change would not change with implementation of the proposed project, as these copper toxicity effects would occur regardless of whether the proposed project is implemented. For more impact discussion related to wetland restoration and water quality, see Section 5.2, Water Quality.

Disease Vectors

There have been positive human test results for the West Nile virus across the United States, including the Bay Area, specifically Contra Costa County (U.S. Geological Survey 2009). Coccidioidomycosis (valley fever) also is located in the southwestern U.S. where temperatures are high and the soils are dry. With more severe, frequent, and lasting heat events associated with climate change, there could be a greater chance of infectious disease such as West Nile spread by insects (e.g., mosquitoes) or valley fever spread by fungi (e.g., *Coccidioides immitis*). This would be attributable to an increased range of warmer temperatures in the region that could lead to a wider ecosystem in which such insects and fungi thrive (U.S. Global Change Research Program 2000). Infectious disease effects related to climate change would not change with implementation of the proposed project, as the expansion of disease vectors would occur regardless of whether the proposed project is implemented. For more impact discussion related to wetland restoration and infectious diseases, see Section 7.8, Public Health and Environmental Hazards.

Temperature, Ecology, and Other Changes

Climate change impacts will substantially alter the bay ecosystem through erosion and loss of wetland habitat, changing sediment demand, altered species composition, changing freshwater inflow and salinity, altered food web, and impaired water quality. Warmer water temperatures and reducing amounts of tidal marsh may make it harder to recover the diverse range of threatened and endangered species living in the Bay and may increase the number of species considered threatened and endangered. These changes have the potential to overwhelm the bay ecosystem's ability to rebound and continue functioning (San Francisco Bay Conservation and Development Commission 2009a).

One predicted outcome of climate change is an increase in rainfall during the winter and spring months, and a decrease in snowmelt runoff in spring and summer months, making downstream areas more flood-prone in the winter and drier in the summer. Managed wetland draining within the bay could be more difficult because of the difference in water levels between the managed wetland interior and the exterior channels.

Climate change also may affect storm frequency and intensity, which can increase flooding when coupled with sea level rise. From 1993 to 2003, there was an increase in the number of storm surge events and high tides exceeding previously observed extremes. Increasing storm activity and more frequent extreme tides are projected to occur over time. If state water reservoirs lack the capacity to handle increased rainfall and earlier snowmelt, water managers may need to release flows through the Delta during winter months, resulting in even higher water levels (San Francisco Bay Conservation and Development Commission 2009a).

The combined effects of sea level rise, storm surge, and river flooding may result in water levels elevated as high as 51 inches for a period of 10 to 12 hours in the Delta and Suisun Marsh region, an area already below mean tide elevation surrounded by fragile levees (San Francisco Bay Conservation and Development Commission 2009a). Consequently, flooding impacts from sea level rise can be expected during the first half of this century as a result of winter storms and sea level rise.

Increased flows also would result in increased erosion, which may alter sediment loading, affecting the bay ecosystem by changing the dynamics of sedimentation over time. Decreased summertime flows may affect aquatic habitats by reducing the amount of open water and channel habitat, and by increasing the frequency of water quality issues related to temperature, salinity, and DO. These changes in how water is distributed throughout the year also will affect soil moisture. It is expected that climate change could result in drier soils in the summer and wetter soils in the winter. Reduced flows also could result in an increase in salinity, especially during the summer and fall months. Changing salinity affects fish, wildlife, and other aquatic organisms in intertidal and subtidal habitats.

Climate change may encourage new and existing invasive species to become established in the bay, causing biodiversity loss. Increasing temperatures and changes in salinity may result in conditions that better suit such invasive species or diseases that native species are not currently able to combat.

Environmental Consequences

Assessment Methods

This analysis discloses both the SMP's contribution to climate change and the effects that climate change may have on implementation of the SMP alternatives.

The only contributions to climate change that the SMP may make are related to construction activities that would be implemented as part of the plan and the potential sequestration of carbon and emissions of CH_4 as a result of creating tidal wetlands. These potential contributions are described here and in Chapter 10, "Cumulative Impacts," of this EIS/EIR.

Several assumptions were made to estimate the impacts implementation of the proposed project would have on carbon sequestration and CH_4 production in the Suisun wetlands. First, based on the salinity values from Section 5.2, it can be assumed that the western portion of the wetlands function more on the saline end of the brackish environment spectrum. Conditions in the eastern portion, on the other hand, function more on the fresh end of the brackish environment spectrum.[4] Second, because both areas of the wetland are flooded and drained seasonally such that they are saturated with water for about 9 months of the year, they are producing CH_4 only for these 9 months. When organic soil wetlands are dried, in general, they release more soil carbon through oxidation than taken up by photosynthesis, but also stop producing significant amounts of CH_4.[5]

Peat soil subsidence and organic matter oxidation also were analyzed because these processes release CO_2. It is likely that the soil is oxidized continuously when not submerged and that the oxidation rate would be reduced entirely if converted to tidal wetlands, thereby reducing CO_2 emissions. For purposes of this analysis, a potential range of peat soil oxidation reduction for the plan is presented below. However, it should be noted that quantifying the amount of released carbon is difficult and depends on the unique biology of the environment.

Carbon sequestration and CH_4 production in the Suisun wetlands were estimated for all plan conditions using values obtained from multiple literature sources (U.S. Climate Change Science Program 2007; Trulio 2007; Bartlett et al. 1987; Chmura et al. 2003; Deverel 2008). Potential net carbon fluxes resulting from these processes were estimated for both a brackish and freshwater wetland to better represent the actual conditions in the wetlands. It was assumed that under existing conditions, carbon flux in the wetlands while drained was zero or positive (as a result of carbon oxidation). Therefore, implementation of the proposed project would result in a 100% decrease in carbon oxidation and a 33% increase in CH_4 production (most CH_4 production occurs when the wetland is wet) relative to existing conditions because the wetlands no longer would be drained for 3 months of the year. As the values used to calculate CH_4 production, sequestration, and oxidation were obtained from different sources, there is a high degree of uncertainty in estimating the net CO_2e balance, considering the

[4] No specific boundary separates the eastern and western portions of the wetland. Assumptions were made using monitoring values for stations that are located in these regions. Water salinity between the monitoring stations will fall somewhere between the observed values, with salinity decreasing the farther east. Given this, sequestration potentials and methane production were estimated for both brackish and freshwater environments using the entire project acreage in each calculation.

[5] Regarding CH_4, during the dry period, anaerobic decay may continue in wetland vegetation, and thus there may be some methane production that will occur in buried vegetation, but aerobic exposure is expected to suppress methane production in general.

offsetting influences of carbon sequestration and CH_4 production. Therefore, the results of this analysis have been used to illustrate the carbon flux and CH_4 production changes, but the magnitude of the net change (considering the combined effect of carbon sequestration and CH_4 production) should be considered relatively uncertain.

The analysis does not assume that the restored marsh will be 100% vegetated. The amount of vegetation in wetlands is correlated with the CO_2 sequestration capacity of the wetland because sequestration is driven largely by photosynthesis of vegetation. The analysis assumes that the restored marsh would sequester carbon at a rate similar to other North American and Delta region marshes with similar salinity and characteristics as Suisun. These marshes include both vegetated areas and open water areas. It is currently unknown what percentage of the restored marsh would revegetate and what percentage would be open water. It is possible that the project would result in more open water or subtidal habitat than other North American or Delta marshes, potentially resulting in lower carbon sequestration rates than these marshes. To provide a conservative estimate of sequestration for the project, a relatively low range of sequestration values for similar wetlands was used in this analysis.

The sections below describe the potential sea level rise impacts of climate change on the study area and on the SMP alternatives. The sea level–rise impact of global climate change on Suisun Marsh is described as a quantitative range because local and regional projections of specific climate change impacts have high uncertainty. Scientific findings are summarized and discussed in terms of broad implications for the Bay-Delta, which encompasses Suisun Marsh.

Significance Criteria

The SMP alternatives' contributions to GHGs are assessed for significance. The following significance criterion applies only to the plan's emission and sequestration of GHGs: An impact would be considered significant if the alternative's GHG emissions would impede compliance with the GHG emissions reduction goals mandated in AB32.

With respect to the analysis of climate change impacts on the SMP alternatives (sea level rise, in this case), climate change effects on an alternative are compared to the climate change effects on the future no action scenario. The reasonably foreseeable affected environment, described under the No Action Alternative analysis, serves as the basis for evaluating and comparing the incremental effects of the SMP alternatives.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, some restoration activities would occur. Similar to Alternative A as described below, a temporary increase in GHG emissions could occur as a result of the construction activities, but it is not expected that substantial GHG emissions would be generated. Also, increased inundation caused by sea level rise likely would reduce current carbon sequestration rates.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Impact CC-1: Construction-Related Changes in Greenhouse Gas Emissions

Construction activities associated with tidal restoration and managed wetland activities would result in temporary increased emissions over the 30-year SMP implementation period. These activities would occur intermittently over time, and it is not expected that substantial GHG emissions would be generated during construction of any of the proposed project activities.

GHG emissions from construction activity are described in Section 5.7, Air Quality. According to this analysis, implementing the SMP alternatives would generate approximately 598.7 tons of CO_2 per year, of which 276.3 tons are from restoration activities and 322.5 tons are from management activities. Over the 30-year construction timeline, this is equivalent to 17,962 tons of CO_2, or 16,295 metric tons of CO_2. CO_2 emissions associated with management activities would occur beyond the 30-year construction timeline in the amount of 292.6 metric tons per year.

Because the activities are temporary and localized, it is not expected that implementation of the proposed project would result in a permanent or substantial increase in GHG emissions. In addition, construction emissions likely would be offset though changes in net GHG sources and sinks as a result of the proposed project described in Impact CC-2 below.

Conclusion: Less than significant. No mitigation required.

Impact CC-2: Permanent Changes in Greenhouse Gas Sources and Sinks

The proposed project would restore approximately 5,000 to 7,000 acres of tidal wetlands. Improved recreational access may result in a slight increase in the number of users and the associated vehicle use, but it is not expected that this increase would result in a substantial increase in permanent or short-term GHG emissions. Changes in the types of wetlands and the total area of tidal wetlands could result in changes in carbon sequestration. However, the existing wetlands cover a range of conditions—the entire marsh is a brackish environment, but the western portion is generally saltier, whereas the eastern portion of the wetlands is generally fresher. In addition, the wetlands are subject to drought-wet cycles that can create wide swings in salinity. For the purposes of this analysis to provide a conservative estimate of carbon sequestration and CH_4 emissions, the eastern portion of the marsh was assumed to be more similar to a freshwater environment. While both brackish and freshwater wetlands sequester, or act as a sink for, carbon (peat soil formation), brackish wetlands generally sequester more carbon per unit area than freshwater wetlands (U.S. Climate Change Science Program 2007; Trulio 2007).

Over the long term, changing managed wetlands to permanent tidal wetlands, where the potential for anoxic conditions and abundant organic matter is higher, has the potential to result in an increase in CH_4 production. As discussed above, wetlands produce CH_4 through anaerobic decomposition of biomass. While both brackish and freshwater tidal wetlands produce CH_4, brackish wetlands tend to produce less CH_4 per unit area than freshwater tidal wetlands (U.S. Climate Change Science Program 2007; Bartlett et al. 1987). Because CH_4 is a far more potent GHG than CO_2, in freshwater wetlands CH_4 production may overwhelm the benefits obtained from carbon sequestration (U.S. Climate Change Science Program 2007).

Table 5.9-2 presents the changes in carbon sequestration and CH_4 emissions associated with implementation of Alternative A, assuming that the restored wetlands fall within the widest possible range of carbon sequestration and CH_4 emission values for freshwater and brackish wetlands. Based on the information presented in Table 5.9-2, the following conclusions can be made:

1. Implementation of the plan alternatives would result in increased carbon storage in both brackish and freshwater environments for the restored wetlands relative to existing conditions. This increase in carbon storage would be roughly one-third the current potential.
2. Sequestration in the western, brackish portion of the wetlands would be higher than sequestration in the eastern, more freshwater environment.
3. Implementation of the plan alternatives would result in increased CH_4 production. This increase in CH_4 production would be roughly one-third the current production.
4. CH_4 production in the western, brackish portion of the wetlands would be lower than CH_4 production in the eastern, more freshwater environment.

The sequestration potential and CH_4 production of freshwater and brackish wetlands were combined to obtain net CO_2e production, as shown in Table 5.9-2. As stated previously, it should be noted that there is a high degree of uncertainty in the results, given the uncertainty in applying literature-based values from different studies of wetlands for carbon sequestration and CH_4 production to the plan area. The following conclusions are illustrated in Table 5.9-2, but should be considered a range of uncertainty for implementation of the SMP alternatives and are inconclusive with regard to the plan's net GHG impact.

1. Carbon benefits from sequestration in a brackish wetland may exceed emissions from CH_4 production. As such, implementation of the plan alternatives in the western portion of the Suisun wetlands could result in a net decrease in GHG emissions.
2. Carbon benefits from sequestration in a freshwater wetland may be overwhelmed by CH_4 production. As such, implementation of the plan alternatives in the eastern portion of the Suisun wetlands could result in a net increase in GHG emissions.

The analysis above shows the wide range of net GHG emissions from implementing Alternative A for wetlands ranging from pure fresh water to highly brackish. However, the plan activities would produce GHG emissions that fall between the high and low ranges. In addition to the broad analysis presented above, a more refined analysis using Suisun area–specific values was prepared to provide a smaller range of potential GHG emissions from the plan alternatives. This analysis was based on the following assumptions:

1. For the low range of CO_2 sequestration values (under the *low* category below), the restored wetlands are assumed to be freshwater, mineral soil wetlands.
2. For the high range of CO_2 sequestration values (under the *high* category below), the restored wetlands are assumed to be the average for tidal wetlands in the conterminous U.S.
3. For the high range of CH_4 emission values (under the *high* category below), the restored wetlands are assumed to be tidal brackish/fresh marsh with an average salinity of 5 ppt (characteristic of the eastern areas of Suisun Marsh).
4. For the low range of CH_4 emission values (under the *low* category below), the restored wetlands are assumed to be tidal brackish marsh with an average salinity of 10 ppt (characteristic of the western areas of Suisun Marsh).

These assumptions result in the low-high range of GHG emissions presented in Table 5.9-2, compared to the wider range of results presented above.

Table 5.9-2. Net Change over Baseline for Yearly Carbon Sequestration Benefits and Methane Production and Net CO_2e[1] Production for Alternative A

	Carbon Sequestration (metric tons CO_2)[1]		Methane Production (metric tons CO_2e)[1]		NET CO_2e Production (metric tons)[1]	
Scenario/Range[2]	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Freshwater (Yearly)						
Low	390	545	2,380	3,331	9,320	13,048
High	390	545	9,709	13,593	1,990	2,786

Scenario/Range[2]	Carbon Sequestration (metric tons CO_2)[1]		Methane Production (metric tons CO_2e)[1]		NET CO_2e Production (metric tons)[1]	
	Min	Max	Min	Max	Min	Max
Brackish (Yearly)						
Low	1,002	1,402	595	833	1,378	1,929
High	7,141	9,997	2,380	3,331	-6,546	-9,165
Suisun Proxy Range (Yearly)						
Low	390	545	1,933	2,707	1,990	2,786
High	4,081	5,713	2,380	3,331	-2,147	-3,006

Sources: Trulio 2007; Bartlett et al. 1987; U.S. Climate Change Science Program 2007.

Notes: Net CO_2e only includes carbon sequestration and CH_4production because of limited information regarding other GHGs such as N_2O.

[1] Values include acreage for the entire project area. Net CO_2e production represents *low* carbon sequestration plus *high* CH_4 emissions to estimate the widest possible range of GHG emissions.

[2] Values are a range of carbon sequestration and CH_4 production in fresh to saline wetlands. Low values represent the low end of the range of potential carbon sequestration and CH_4 production for fresh and saline wetlands, and high values represent the high end of the range.

The above results suggest that implementation of the proposed project could increase or decrease net GHG emissions related to the Suisun wetlands, depending on the specific location of the restored wetlands (i.e., west versus east). If the restoration occurs more to the east where the salinity of the wetlands is lower, the restored wetlands likely would be a source of GHGs as presented above under the *low* classification. However, if the restoration occurs more to the west where the salinity of the wetlands is higher, the restored wetlands likely would be a sink of GHGs as presented above under the *high* classification. These results are representative of the net annual CO_2e emissions, after the initial 3–4 years required to offset the one-time construction emissions.

Additionally, Choi et al. (2001) found that as sea levels rise, marsh plains continue to build up (accrete), and they continually store carbon in the process. Thus, tidal marshes continue to take carbon from the atmosphere as sea levels rise, as long as there is a large enough input of mineral sediments to build marsh soil and keep pace with sea level rise. Biomass accumulation also can occur without the accretion of mineral soils. Over time, it is expected that the combination of sea level rise and sediment accretion would increase carbon sequestration in the marsh. However, in areas without enough sediment input to keep pace with sea level rise, marshes can break up and be converted to open water (Patrick 1990). Specific research is needed to quantify the precise carbon sequestration capacity and CH_4 production of the Suisun wetlands as well as the sediment fluxes and potential effects of sea level rise on GHG emissions. In addition, the results presented in these studies are likely relevant only up to a certain sea level rise, after which wetlands would be inundated with water and no longer would function as wetlands.

As discussed above, direct emissions of CO_2 are known to be emitted from oxidation of peat soils when those soils are exposed to the atmosphere. For example, research shows that when wetlands are drained, anaerobic soils become exposed to the air, thus releasing stored carbon (Trulio 2007). This process would occur during the periods when the Suisun wetlands are drained. Restoring these areas to permanent marshes would eliminate a majority of peat soil oxidation emissions, resulting in an additional GHG emissions benefit. A number of studies of peat soil subsidence and carbon loss in the Sacramento/San Joaquin Valley region show that carbon losses range from 0.05 gram/cm^2 to 0.15 gram/cm^2 per year (Deverel 2008; Volk 1973; Deverel and Rojstaczer 1996). This range is equivalent to approximately 7.4 to 22.3 metric tons of CO_2 release per acre per year. Another study found that measured subsidence rates in the Delta from 1988 to 2006 range from 0.7 to 3.7 cm/year, and up to 1.7 cm/year in western areas of the Delta, where soil organic matter contents are lower (Deverel 2008).

As noted above, subsidence and peat soil oxidation in the Delta region results mainly from agricultural practices on drained wetlands; such practices are not occurring in Suisun. In addition, oxidation and subsidence rates depend on soil organic content, carbon content, temperature, and other factors. Consequently, subsidence at Suisun Marsh is significantly less than subsidence in other Delta regions. However, subsidence in Suisun was estimated using the lower end of Delta subsidence rates to provide a potential range of oxidation rates for Suisun. The organic soil content affects carbon loss; Suisun Marsh is composed of Joice, Tamba, and Suisun soils (see Section 5.3, Geology and Groundwater), which range 15–60% in organic matter content (National Cooperative Soil Survey 2001). This analysis assumes an average soil organic composition in Suisun Marsh of 40%, based on an average of the three soil types. Assuming a carbon fraction of the organic content of 40%, this range is equivalent to approximately 1.8 to 4.2 metric tons of CO_2 release per acre per year. This range is equivalent to a subsidence rate of approximately 0.7 to 1.5 cm/year and falls within the lower range of estimated subsidence rates in western Delta marshes, representing a conservative estimate of peat soil oxidation.

The Suisun Proxy Range in Table 5.9-3 shows the possible net GHG emissions from implementing Alternative A for Suisun-area specific values. The following assumptions were made:

1. The restored wetlands are assumed to have lowest rates of peat soil oxidation presented above because the Suisun wetland soils vary in organic carbon content and are not currently under agricultural practices.
2. The soil is oxidized continuously when not submerged, and the soil oxidation rate would be reduced by 90% when converted to wetlands.

Table 5.9-3. CO_2 Reductions from Reduced Peat Soil Oxidation as a Result of Project Implementation for Alternative A (Net Change over Baseline)

Scenario/Range[2]	CO_2 Reduction (metric tons)[1]	
	Min	**Max**
Suisun Proxy Range (Yearly)		
Low	-2,041	-2,857
High	-4,723	-6,612

Sources: Trulio 2007; Deverel 2008; Deverel and Rojstaczer 1996; National Cooperative Soil Survey 2001.

Notes:

[1] Values include acreage for the entire project area.

[2] Values are a range of carbon sequestration and CH_4 production in fresh to saline wetlands. Low values represent the low end of the range of potential carbon sequestration and CH_4 production for fresh and saline wetlands, and high values represent the high end of the range.

See limitations and discussion of uncertainty in text.

This analysis demonstrates that implementation of SMP alternatives could result in a large reduction in CO_2 emissions, if peat soil oxidation is taken into account. However, these results should be considered estimates based on the best available science because the amount of released carbon depends on the unique biology of the environment and has not been measured specifically for the site.

Regardless of the uncertainty associated with the GHG benefits of Alternative A, restoring tidal wetlands is recommended by the IPCC as an effective method for removing CO_2 from the atmosphere (Intergovernmental Panel on Climate Change 2001). Table 5.9-4 presents the net change over baseline for CO_2e production for Alternative A in comparison to construction and operational emissions using the results from Table 5.9-3 above. As the net change over baseline in CO_2e production likely would fall within this range, a mid value for the net CO_2e change for wetlands also was estimated. Using this mid value, Alternative A would offset one-time construction emissions within about 6–9 years. The net lifetime result of the proposed project is a net sink of CO_2e over existing conditions.

Table 5.9-4. Direct Construction Emissions, Wetland Emissions, and Net Change over Baseline for CO_2e Production for Alternative A (Metric Tons CO_2e)

Emissions Type/Range		
Direct Emissions		
Construction One-Time Emissions (30 Years)		16,295
Management (Yearly)		292.6
Wetland Emissions (Yearly)	**Min**	**Max**
Carbon Sequestration		
Low	-390	-545

Emissions Type/Range		
High	-4,081	-5,713
Methane Production		
Low	1,933	2,707
High	2,380	3,331
Peat Soil Oxidation		
Low	-2,041	-2,857
High	-4,723	-6,612
Net CO_2e Change for Wetlands[1]		
Low	-51	-71
Mid[2]	-2,119	-2,967
High	-6,870	-9,618
NET CO_2e Change (Yearly)[3]		
Low	242	221
Mid[2]	-1,827	-2,675
High	-6,578	-9,326

Notes: Net CO_2e includes only carbon sequestration and CH_4production because of limited information regarding other GHGs such as N_2O.

[1]Represents net CO_2e production; represents *low* carbon sequestration plus *high* CH_4 emissions plus *low* peat soil oxidation to estimate the widest possible range of GHG emissions.

[2] Represents mid range of carbon sequestration and CH_4 production combined with the low range of peat soil oxidation.

[3] Represents the net change from direct emissions from maintenance activities and wetland emissions. Direct emissions from construction were not included in the net CO_2e because these emissions occur on a different time scale. The plan's overall benefit is equivalent to the yearly accumulation of the net CO_2e change minus the one-time construction emissions.

See limitations and discussion of uncertainty in text.

Although the low range of values presented in Table 5.9-4 above for net CO_2e change over baseline resulting from Alternative A are positive, it is likely that the mid values presented for the net CO_2e change would more closely represent actual project conditions. Using this mid value, as stated above, Alternative A would offset one-time construction emissions within about 6–9 years such that the proposed project would result in a net GHG benefit.

Conclusion: Beneficial. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres, and Alternative C: Restore 7,000–9,000 Acres

Alternatives B and C would have the same restoration and managed wetland activities, only over a different acreage of land. Impacts of both alternatives would be similar to Alternative A. However, Alternative B has less restoration and more managed wetland activities, so the potential for carbon sequestration and CH_4 emissions is lower. Alternative C has more restoration, and therefore greater potential for carbon sequestration and CH_4 emissions. It is assumed that construction-related emissions would be similar for all three alternatives as wetlands would be either restored or enhanced, requiring construction equipment and worker vehicles.

The same analysis prepared for Alternative A was prepared for Alternatives B and C. In addition, the same conclusions described for Alternative A can be made for Alternatives B and C. Table 5.9-5 presents the changes in carbon sequestration, CH_4 emissions, and net CO_2e production associated with implementation of Alternatives B and C. Table 5.9-5 also presents the possible net GHG emissions from implementing Alternatives B and C with a more refined analysis using Suisun area–specific values (Suisun Proxy Range). Table 5.9-6 presents the possible net GHG reductions from reduced peat soil oxidation from implementing Alternatives B and C using Suisun area–specific values (Suisun Proxy Range).

It should be noted again that a high degree of uncertainty is associated with these numbers because of the number of sources used in this analysis and limited data on Suisun Marsh characteristics. The conclusions should be considered uncertain and inconclusive, given the uncertainty of using literature-based values from different studies of wetlands for carbon sequestration and CH_4 production. Regardless of the uncertainty associated with the GHG benefits of Alternatives B and C, restoring tidal wetlands is recommended by the IPCC as an effective method for removing CO_2 from the atmosphere (Intergovernmental Panel on Climate Change 2001).

Table 5.9-7 presents the net change over baseline for CO_2e production for Alternatives B and C in comparison to construction and operational emissions using the results from Tables 5.9-5 and 5.9-6 below. Because the net change over baseline in CO_2e production likely would fall within this range, a mid value was estimated to represent the most likely plan conditions. Using this mid value, Alternative B would offset one-time construction emissions within about 12–29 years, and Alternative C would offset one-time construction emissions within about 5–7 years. The net lifetime result of the proposed project is a net sink of CO_2e over existing conditions.

Table 5.9-5. Net Change over Baseline for Yearly Carbon Sequestration Benefits and Methane Production and Net CO_2e Production for Alternatives B and C

	Carbon Sequestration (metric tons CO_2)[1]				Methane Production (metric tons CO_2e)[1]				NET CO_2e Production (metric tons)[1]			
	Alternative B		Alternative C		Alternative B		Alternative B		Alternative B		Alternative B	
Scenario/Range[2]	Min	Max	Min	Min	Min	Min	Min	Max	Min	Max	Min	Max
Freshwater (Yearly)												
Low	156	312	467	701	952	1,904	2,855	4,283	3,728	7,456	11,184	16,776
High	156	312	467	701	3,884	7,768	11,651	17,477	796	1,592	2,388	3,582
Brackish (Yearly)												
Low	401	801	1,202	1,803	238	476	714	1,071	551	1,102	1,654	2,480
High	2,856	5,713	8,569	12,854	952	1,904	2,855	4,283	-2,618	-5,237	-7,855	-11,783
Suisun Proxy Range (Yearly)												
Low	156	312	467	701	773	1,547	2,320	3,480	796	1,592	2,388	3,582
High	1,632	3,264	4,897	7,345	952	1,904	2,855	4,283	-859	-1,718	-2,577	-3,865

Sources: Trulio 2007; Bartlett et al. 1987; U.S. Climate Change Science Program 2007.

Notes: Net CO_2e includes only carbon sequestration and CH_4production because of limited information regarding other GHGs such as N_2O.

[1] Values include acreage for the entire project area. Net CO_2e production represents *low* carbon sequestration plus *high* CH_4 emissions to estimate the widest possible range of GHG emissions.

[2] Values are a range of carbon sequestration and CH_4 production in fresh to saline wetlands. Low values represent the low end of the range of potential carbon sequestration and CH_4 production for fresh and saline wetlands, and high values represent the high end of the range.

Table 5.9-6. CO_2 Reductions from Reduced Peat Soil Oxidation as a Result of Plan Implementation for Alternatives B and C (Net Change over Baseline)

	CO_2 Production (metric tons)[1]			
	Alternative B		Alternative C	
Scenario/Range[2]	**Min**	**Max**	**Min**	**Max**
Suisun Proxy (Yearly)				
Low	-816	-1,633	-2,449	-3,674
High	-1,889	-3,778	-5,668	-8,501

Sources: Trulio 2007; Deverel 2008; Deverel and Rojstaczer 1996; National Cooperative Soil Survey 2001.

Notes: Net CO_2e includes only carbon sequestration and CH_4production because of limited information regarding other GHGs such as N_2O.

[1] Values include acreage for the entire project area.

[2] Values are a range of carbon sequestration and CH_4 production in fresh to saline wetlands. Low values represent the low end of the range of potential carbon sequestration and CH_4 production for fresh and saline wetlands, and high values represent the high end of the range.

Table 5.9-7. Direct Construction Emissions, Wetland Emissions, and Net Change over Baseline for CO_2e Production for Alternatives B and C (Metric Tons CO_2e)

Emissions Type/Range	**Alternative B**		**Alternative C**	
Direct Emissions				
Construction One-Time Emission (30 years)	16,295		16,295	
Management (Yearly)	292.6		292.6	
Wetland Emissions (yearly)	**Min**	**Max**	**Min**	**Max**
Carbon Sequestration				
Low	-156	-312	-467	-701
High	-1,632	-3,264	-4,897	-7,345
Methane Production				
Low	773	1,547	2,320	3,480
High	952	1,904	2,855	4,283
Peat Soil Oxidation				
Low	-816	-1,633	-2,449	-3,674
High	-1,889	-3,778	-5,668	-8,501
Net CO_2e Change for Wetlands[1]				
Low	-20	-41	-61	-92
Mid[2]	-848	-1,696	-2,543	-3,815
High	-2,748	-5,496	-8,244	-12,366

Emissions Type/Range	Alternative B		Alternative C	
NET CO_2e Change (Yearly)[3]	**Min**	**Max**	**Min**	**Max**
Low	272	252	232	201
Mid[2]	-555	-1,403	-2,251	-3,522
High	-2,455	-5,204	-7,952	-12,074

Notes: Net CO_2e includes only carbon sequestration and CH_4production because of limited information regarding other GHGs such as N_2O.

[1]Represents net CO_2e production; represents *low* carbon sequestration plus *high* CH_4 emissions plus *low* peat soil oxidation to estimate the widest possible range of GHG emissions.

[2] Represents mid range of carbon sequestration and CH_4 production combined with the low range of peat soil oxidation.

[3] Represents the net change from direct emissions from maintenance activities and wetland emissions. Direct emissions from construction were not included in the net CO_2e because these emissions occur on a different time scale. The plan's overall benefit is equivalent to the yearly accumulation of the net CO_2e change minus the one-time construction emissions.

See limitations and discussion of uncertainty in text.

Although the low range of values presented in Table 5.9-7 above for net CO_2e change over baseline resulting from Alternative A are positive, it is likely that the mid values presented for the net CO_2e change would more closely represent actual project conditions. Using this mid value, as stated above, Alternative B would offset one-time construction emissions within about 12–24 years, and Alternative C would offset one-time construction emissions within about 5–7 years, such that the proposed project would result in a net GHG benefit.

Conclusion: Beneficial. No mitigation required.

Environmental Impacts in the Context of Climate Change

No Action Alternative

Impact CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated with Sea Level Rise

Global climate change has resulted and will continue to result in global mean sea level rise. Local mean sea level rise predictions for San Francisco Bay include up to 16 inches by 2050 and up to 55 inches by 2099 (San Francisco Bay Conservation and Development Commission 2009b). In addition, global sea level rise predictions include up to 78.7 inches by 2100 (Allison et al. 2009). The largest 2009 high-tide differential documented within Suisun Bay is 1.7 inches (National Oceanic and Atmospheric Administration 2009). Thus, sea level rise for the Suisun Bay area would equate to up to 17.7 inches at high tide in 2050 and up to 80.4 inches at high tide in 2099.

Under the No Action Alternative, major restoration would not occur in Suisun Marsh, and managed wetland activities would be substantially limited or suspended. As a result, levee integrity would continue to degrade. As the No Action Alternative would not result in levee improvements to protect against flood events, this analysis conservatively assumes that the existing, degraded levees would fail under the water force associated with predicted sea level rise. Based on the aforementioned sea level rise predictions and assuming the absence (because of failure) of existing levees and other shoreline protection, Suisun Marsh (including the sloping wetland/upland transition zone surfaces that would typically allow tidal wetland to shift upslope when floodwaters rise) would be inundated by the year 2050. Only the Potrero Hills and Kirby Hill areas of Suisun Marsh would not be inundated, because of their higher elevations.

The flood vulnerability of this area as a result of sea level rise and substandard levees is compounded by ongoing subsidence, the El Niño–Southern Oscillation effect, higher winter flows, and greater than 1-year tide or tributary flood events. The aforementioned BCDC local mean sea level rise predictions for San Francisco Bay, which are based on DWR 2006 to 2007 elevation data, do not take into account ongoing subsidence (Parris 2009). There is an ongoing 1 to 3 inches per year of subsidence in the region (U.S. Geological Survey 2000). However, it should be noted that if the levees fail in 2050 as predicted above, subsidence would cease. Based on this range of annual subsidence, relative sea level rise, which considers sea level rise and tidal and subsidence factors, in the Suisun Bay portion of the Bay-Delta is anticipated to be up to 140.7 inches (11.73 feet) at high tide in 2050 and up to 353.4 inches (29.45 feet) at high tide in 2099. El Niño–Southern Oscillation is a large, regional ocean current that moves water from one side of the Pacific to the other every 3 or 4 years, and during El Niño years warm water is pushed over to the eastern Pacific (and thus Suisun Bay), resulting in the ocean being up to 24 inches higher there. Thus, during El Niño years, relative sea level rise in the Suisun Bay portion of the Bay-Delta is anticipated to be up to 164.7 inches (13.73 feet) at high tide in 2050 and up to 377.4 inches (31.45 feet) at high tide in 2099. In addition, the anticipated 50% loss of the Sierra snowpack would lead to earlier runoff and increased winter storm peaks, resulting in temporary surges in Delta (and thus Suisun Bay) water volume even farther above this anticipated relative sea level rise (Knowles and Cayan 2002). Finally, the BCDC local mean sea level rise predictions for San Francisco Bay do not take into account greater than 1-year tide events[6] stacking on top of Bay water levels (Parris 2009). Thus, not only is the Suisun Marsh area susceptible to inundation as a result of large storm events, but under the No Project Alternative the Marsh also likely would become consistently inundated from the combined effect of increased sea level rise, levee degradation, subsidence, and loss of Sierra snowpack. This conclusion that coastal habitats,

[6] Refers to the level of high tide with a 100% chance (1 in 1) of occurring any 1 year. Does not account for the more extreme high tide events that are expected to occur on a more regular basis in the future as a result of rising sea levels. For example, these more extreme high tide events could occur10 or more times per year by 2050 instead of just once or twice per year.

such as wetlands, can become permanently inundated with water and eroded if sea level rises faster than these ecosystems can move inland is also reached in the California Climate Action Team 2009 report (the 2009 California Climate Adaptation Strategy) to Governor Schwarzenegger (California Climate Action Team 2009).

As previously mentioned, sea level rise associated with climate change could overwhelm levees to the point of breach, resulting in Marsh inundation. In addition, because Suisun Marsh primarily is surrounded by urban development and areas of greater elevation (specifically, the Montezuma Hills on the east, Suisun City and Travis Air Force Base on the north, and Benicia Hills on the west), there are no adequate areas for Suisun Marsh to retreat to if it were inundated. Thus, Marsh inundation would result in erosion and loss of wetland habitat, changing sediment demand, altered species composition, changing freshwater inflow and salinity, altered food web, and impaired water quality, all of which may overwhelm the system's ability to rebound and continue functioning (San Francisco Bay Conservation and Development Commission 2009a). Thus, Suisun Marsh habitat and ecosystem health would be adversely affected by climate change–induced sea level rise. Moreover, this loss of wetlands would increase the risk of shoreline flooding in the Suisun Bay area.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Impact CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated with Sea Level Rise

Within 30-Year Planning Horizon

Because Alternative A includes restoring 5,000 to 7,000 acres in Suisun Marsh to fully functioning, self-sustaining tidal wetland and improving the levee stability and flood and drain capabilities of the remaining 44,000 to 46,000 acres of managed wetland areas, this analysis assumes that, for at least 30 years, the improved levees would hold under the water force associated with predicted sea level rise. Based on the fact that sea level rise associated with climate change would be addressed throughout implementation of the SMP, sustainable vegetated tidal marshes are expected to develop in some of the tidally restored ponds within the plan's 30-year planning horizon.

As described under the No Action Alternative analysis, the flood vulnerability of this area as a result of sea level rise is compounded by ongoing subsidence, the El Niño-Southern Oscillation effect, and higher winter flows. Thus, the Suisun Marsh area is susceptible to inundation as a result of 100-year storm events, but under Alternative A, the Marsh would not likely become consistently inundated because of the proposed levee improvements and the ability of the tidally restored wetlands still to accrete sediment and eventually support vegetated tidal marsh, even if at a slower rate. In addition, under the proposed project, gradually sloping wetland/upland transition zone surfaces would provide an elevation gradient over which tidal wetland could shift upslope when floodwaters rise.

As a result, the system's ability to continue functioning and thrive would increase (San Francisco Bay Conservation and Development Commission 2009a). Thus, Suisun Marsh habitat and ecosystem health would not be adversely affected by climate change–induced sea level rise. Moreover, this restoration of wetland function would decrease the risk of shoreline flooding in the Suisun Bay area.

Alternative A would help maintain and restore natural wetland processes that enhance ecosystem function and protect marsh biodiversity. This would increase the capacity of Suisun Marsh to deal with uncertainty regarding climate change, and reduce stress on species resulting from events associated with climate change (i.e., increased sedimentation from flooding events). Alternative A therefore has the potential to increase the Marsh's ability to adapt to changes induced by climate change (i.e., by reducing subsidence, increasing biomass accumulation, and allowing natural tidal marsh functions to resume, etc.). Refer to the *Plan Response to Predicted Sea-Level Rise* section of Chapter 2 for more discussion regarding restoration efforts associated with Alternative A that support achieving long-term ecological functions and reduce impacts associated with climate change.

Within the 30-year planning horizon, the proposed project would result in a beneficial impact compared to the No Action Alternative related to loss of wetland habitat, ecosystem health, and flood risk associated with climate change–induced sea level rise.

Conclusion: Beneficial Impact. No mitigation required.

Beyond 30-Year Planning Horizon

The proposed project would result in some levee improvements, but beyond the 30-year planning horizon the improved levees could fail under the water force associated with predicted sea level rise. Based on the sea level rise predictions described under the No Action Alternative analysis and assuming the absence (because of failure) of existing levees and other shoreline protection, Suisun Marsh would be inundated by the year 2050. Only the Potrero Hills and Kirby Hill areas of Suisun Marsh would not be inundated, because of their higher elevations.

As described under the No Action Alternative analysis, the flood vulnerability of this area as a result of sea level rise and substandard levees is compounded by ongoing subsidence, the El Niño-Southern Oscillation effect, and higher winter flows. Thus, the Suisun Marsh area is not only susceptible to inundation as a result of 100-year storm events, but under Alternative A, the Marsh (including the sloping wetland/upland transition zone surfaces that would typically allow tidal wetland to shift upslope when floodwaters rise) likely would become consistently inundated from the combined effect of increased sea level rise, levee degradation, subsidence, and loss of Sierra snowpack. This outcome is likely even though some wetland restoration would occur, some new exterior levees would be built, and some levees would be maintained with dredging material, because there is not enough material authorized in the dredging program to improve all levees in the Marsh.

As a result, beyond the 30-year planning horizon, sea level rise associated with climate change could overwhelm levees to the point of breach, resulting in Marsh inundation. In addition, because Suisun Marsh primarily is surrounded by urban development and areas of greater elevation (specifically, the Montezuma Hills on the east, Suisun City and Travis Air Force Base on the north, and Benicia Hills on the west), there are no adequate areas for Suisun Marsh to retreat to if it were inundated. Thus, Marsh inundation would result in erosion and loss of wetland habitat, changing sediment demand, altered species composition, changing freshwater inflow and salinity, altered food web, and impaired water quality, all of which may overwhelm the system's ability to rebound and continue functioning (San Francisco Bay Conservation and Development Commission 2009a). Thus, Suisun Marsh habitat and ecosystem health would be adversely affected by climate change–induced sea level rise. Moreover, this loss of wetlands would increase the risk of shoreline flooding in the Suisun Bay area.

Alternative B: Restore 2,000–4,000 Acres, and Alternative C: Restore 7,000–9,000 Acres

Impact CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated with Sea Level Rise

Within 30-Year Planning Horizon

Alternatives B and C would have the same restoration and managed wetland activities, only over a different acreage of land. However, Alternative B has less restoration and more levee stability improvements, so the potential for habitat loss and degradation of ecosystem health associated with climate change–induced sea level rise would be lower. Thus, within the 30-year planning horizon, Alternatives B and C would result in a beneficial impact compared to the No Action Alternative related to loss of wetland habitat, ecosystem health, and flood risk associated with climate change–induced sea level rise, and with the incorporation of measures to improve levees to withstand sea level rise, this impact would be beneficial.

Conclusion: Beneficial Impact. No mitigation required.

Beyond 30-Year Planning Horizon

Alternatives B and C would have the same restoration and managed wetland activities, only over a different acreage of land. Alternatives B and C would result in some levee improvements (B more than C), but beyond the 30-year planning horizon the improved levees could fail under the water force associated with predicted sea level rise. Based on the sea level rise predictions described under the No Action Alternative analysis and assuming the absence (because of failure) of existing levees and other shoreline protection, Suisun Marsh would be inundated by the year 2050. This is likely even though some new exterior levees would be designed to protect against sea level rise and the dredging program would provide source materials for levee maintenance, because there is not enough material authorized in the dredging program to improve all levees in the Marsh.