

3.2 WATER QUALITY

Water quality of the San Francisco Estuary, including the Bay and the surrounding flats and tidal marsh may be affected directly and indirectly by implementation of the *Spartina* Control Program. This section describes potential impacts, and defines mitigation measures that will reduce the impacts to water quality to less than significant levels.

3.2.1 Environmental Setting

This section describes existing water quality in the San Francisco Estuary and processes affecting it, and outlines the regulatory framework under which water quality is protected. Potential effects of treatment methods on water quality are evaluated, and mitigation measures are identified for potentially significant effects. The region of influence for impacts to water quality includes the tidal flats and marshes where treatment will occur, and the shallow tidal waters immediately adjacent to these areas.

Natural Processes Affecting Water Quality

Water quality within the San Francisco Estuary is connected to and affected by complex regional and local natural processes. Hydrologic relationships between the Pacific Ocean, the Estuary, and the many freshwater tributaries (including the Sacramento-San Joaquin River system) govern salinity levels in different portions of the Estuary and along the Bay margins. Variable natural factors such as tidal cycles, local winds, basin bathymetry, and salinity gradients interact with river flows and affect the circulation of Estuary waters through channels, Estuary margins, and bays, distributing nutrients, salt concentrations, and pollutants. Major processes affecting water quality are described below.

Tidal Cycles. The Estuary has two low tides and two high tides every 24.8 hours. During each tidal cycle, an average of about 1.3 million acre-feet of water, or 24 percent of the Bay and Delta's volume, moves in and out of the Golden Gate. On the flood (incoming) tide, ocean water moves through the Golden Gate and into the Estuary's southern and northern reaches, raising the water level at the end of the South Bay by more than eight feet, and raising the height of the Sacramento River at the upstream edge of the Estuary by about three feet. It takes about two hours for the flood tide to reach the end of the South Bay and eight hours to reach Sacramento.

Subregional Conditions. Suisun and North Bay subregions (see **Figure 2-1**) receive the majority of freshwater input from the Sacramento and San Joaquin River system. In the open bays, density-driven currents show ebb dominance of the surface water and flood dominance of the bottom water. Waters in these embayments are well oxygenated, with low- to moderate-salinity and high-suspended solids concentrations. Water residence time affects the abundance and distribution of many estuarine organisms, the amount of primary production by phytoplankton, and some of the chemical and physical processes that influence the distribution and fate of pollutants. During low flow periods of the year (late summer), the residence time of freshwater moving from the Delta to the ocean can be relatively long (on the order of months) compared to periods when outflow is very high (winter), when freshwater can move from the Delta to the ocean in days.

The Central Bay subregion is influenced by ocean waters that are cold, saline, and lower in total suspended sediment. Water quality parameters fluctuate less than in other sectors of the Bay due to

1 the predominance of ocean water. Net ex-
 2 changes of ocean and Bay waters depend on
 3 freshwater flow in the Bay, tidal amplitude,
 4 and longshore coastal currents.

5 The southern part of San Francisco Bay re-
 6 ceives less than 10 percent of the natural
 7 freshwater flow into the Bay, but the majority
 8 (>75 percent) of wastewater discharges. The
 9 largest flow is from San Jose, where approxi-
 10 mately 120 million gallons per day (MGD) of
 11 treated wastewater are released into Artesian
 12 Slough, a tributary to Coyote Creek (**Figure**
 13 **3.2-1**). This fresh water flow creates a local
 14 zone of brackish water in the otherwise saline
 15 tip of the South Bay. The rest of the South Bay,
 16 because it has so little freshwater input, is es-
 17 sentially a tidal lagoon with a relatively con-
 18 stant salinity (approximately the same as ocean
 19 water, 32 parts per thousand, ppt). South Bay
 20 waters are influenced by Delta outflow only
 21 during the winter months, when low-salinity
 22 water moves southward into the southern
 23 reach displacing the saline, denser water
 24 northward. In the summer months, however,
 25 South Bay currents are largely influenced by
 26 wind stress on the surface; northwest winds transport water in the direction of the wind, and the
 27 displaced water causes subsurface currents to flow in the opposite direction.

28 **Currents and Circulation.** Circulation patterns within the Bay are influenced by Delta inflows,
 29 gravitational currents, and tide- and wind-induced horizontal circulation. The cumulative effects of
 30 the latter three factors on net circulation within embayments tend to dominate over that of fresh-
 31 water inflows except during short periods after large storm events (Smith 1987). Exchanges be-
 32 tween embayments are influenced both by mixing patterns within embayments and by the magni-
 33 tude of freshwater inflows (Smith 1987).

34 Currents created by tides, freshwater inflows, and winds cause erosion and transport of sediments.
 35 Tidal currents are usually the dominant form of observed currents in the Bay. Tidal currents are
 36 stronger in the channels and weaker in the shallows (Cheng and Gartner 1984). These processes
 37 enhance exchange between shallows and channels during the tidal cycle, and contribute signifi-
 38 cantly to landward mixing of ocean water and seaward mixing of river water. Also, the South Bay
 39 begins flooding while San Pablo Bay is still ebbing, making it possible for the South Bay to receive
 40 water from the northern reach (Smith 1987).

41 Tides have a significant influence on sediment resuspension during the more energetic spring tide
 42 when sediment concentrations naturally increase, and particularly during the ebbs preceding lower
 43 low water when the current speeds are highest (Cheng and McDonald 1994). Powell *et al.* (1989),
 44 however, observed no correlation between tidal cycle and suspended sediment loads or distribution
 45 in the South Bay. Their conclusion was that winds are the most important factor in resuspending

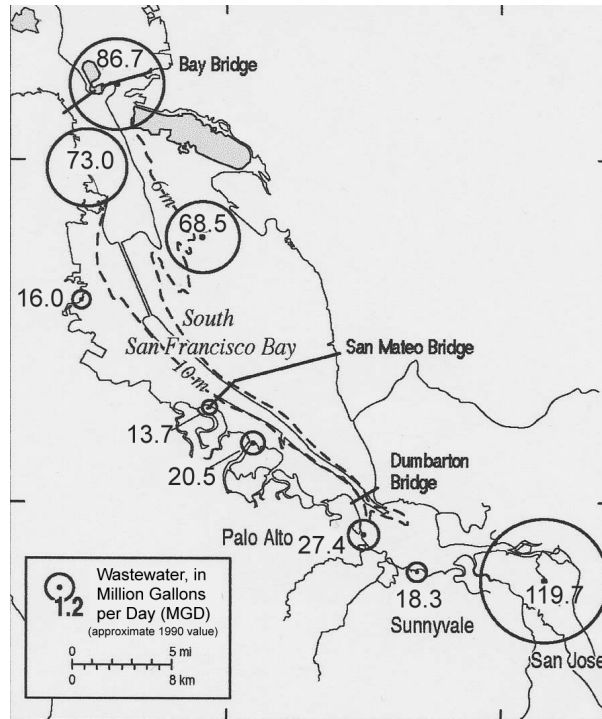


Figure 3.2-1. Locations and mean discharges for municipal wastewater treatment plants in South San Francisco Bay. Adapted from Schemel et al. 1999, based on Davis et al. 1991.

1 sediments in the South Bay, and that sources of sediments are more important than transport of
2 sediment resuspended from other parts of the Bay (Reilly *et al.* 1992).

3 Wind-induced currents have a significant effect on sediment transport by resuspending sediments
4 in shallow waters (Krone 1979; Cloern *et al.* 1989). An estimated 100 to 286 million cubic yards of
5 sediments are resuspended annually from shallow areas of the Bay by wind-generated waves
6 (Krone 1974; SFEP 1992b).

7 **Water Quality**

8 Water quality in the San Francisco Estuary has improved significantly since the enactment of the
9 California Water Quality Control Act (Porter-Cologne) in 1969 and the Clean Water Act in 1972.
10 Nevertheless, the Estuary waters still carry significant loads of pollutants from human sources. Under
11 Section 303(d) of the Clean Water Act, states were required to develop a list of water bodies that do
12 not meet water quality standards; this list is referred to as the “303(d) list.” This list defines low, me-
13 dium, and high priority pollutants that require immediate attention by State and Federal agencies.
14 Portions of the Estuary have high-priority 303(d) listings for a number of pollutants, including dioxin
15 compounds, furan compounds, PCBs, mercury, copper, nickel, and exotic (plant and animal) species.

16 The most comprehensive information describing water quality in the Estuary comes from the Re-
17 gional Monitoring Program managed by the San Francisco Estuary Institute (SFEI) and ongoing
18 studies by the Interagency Ecological Program (IEP). In addition, numerous short-term studies
19 that focus on specific sites, resources, or pollutants are conducted on a regular basis by researchers
20 and entities conducting permit-specified monitoring of waste discharges. The primary water quality
21 parameters discussed below are: temperature, salinity, dissolved oxygen (DO), pH, total suspended
22 solids (TSS), turbidity, and pollutants.

23 **Temperature.** Water temperatures in the Estuary range from approximately 10°C to 22°C (50°F to
24 71.6°F). Temperatures are influenced by seasonal solar cycles and variable inputs of river and
25 coastal ocean waters. Temperatures are typically at the higher end of this range along the Estuary
26 margin during daylight hours as the influence of solar energy warms the water.

27 **Salinity.** The salinity of the Estuary varies spatially and temporally. Along the northern reach the
28 salinity increases from the Delta to the Central Bay. At the mouth of the Sacramento River, for
29 example, the mean annual salinity averages slightly less than 2 ppt; in Suisun Bay it averages about
30 7 ppt; and at the Presidio in Central Bay it averages about 30 ppt. In the South Bay, salinities remain
31 at near-ocean concentrations (32 ppt) during much of the year, except in the vicinity of the San Jose
32 wastewater outfall at Artesian Slough, where salinities are lessened. During summer months in dry
33 years, high evaporation rates may cause salinity in South Bay to exceed that of ocean water.

34 Seasonal changes in the salinity distribution within the Estuary are controlled mainly by the ex-
35 change of ocean and Estuary water, and by river inflow. River inflow has the greater influence on
36 salinity distribution throughout most of the Estuary because inflow varies widely, while variations
37 in ocean inputs are relatively small. In winter, high flows of freshwater from the Delta lower the
38 salinity throughout the Estuary’s northern reach. High Delta flows also intrude into South Bay,
39 lowering salinity there for extended periods. In contrast, during the summer, when freshwater in-
40 flow is low, saline water from the Bay intrudes into the Delta. The inland limit of salinity intrusion
41 varies greatly from year to year. In addition, channel dredging can increase gravitational circulation
42 and enhance salinity intrusion (Nichols and Pamatmat 1988).

43 **Dissolved Oxygen.** Oxygen concentrations in estuarine waters are increased by the mixing action of
44 wind, waves, and tides; photosynthesis of phytoplankton and other aquatic plants; and high DO in

1 freshwater inflow. DO concentrations are lowered by plant and animal respiration, chemical oxidation,
2 and bacterial decomposition of organic matter.

3 The Estuary's waters are generally well oxygenated, except during summer in the extreme southern
4 end of the South Bay where concentrations are reduced by poor tidal mixing and high water tem-
5 perature. Typical concentrations of DO range from 9 to 10 milligrams per liter (mg/l) throughout
6 the Estuary during periods of high river flow, 7 to 9 mg/l during moderate river flow, and 6 to 9
7 mg/l during the late summer months when flows are the lowest. Unlike the 1950s and 1960s, when
8 inadequately treated sewage and processing plant wastes depleted oxygen in parts of the Bay and
9 Delta, today there are few reports of places in the Estuary where low oxygen concentrations ad-
10 versely affect beneficial uses. Today, the lowest concentrations in the Estuary are typically ob-
11 served in the extreme South Bay but, in some instances, DO levels in semi-enclosed embayments
12 such as Richardson Bay can be much lower than in the main water body (SFEI 1994).

13 **pH.** The pH of the water in San Francisco Bay is relatively constant and typically ranges from 7.8
14 to 8.2¹.

15 **Total Suspended Solids (TSS) and Turbidity.** Turbidity and TSS are generally used as measures
16 of the quantity of suspended particles. The distinction between the two terms lies mainly in the
17 method of measurement. In general, higher TSS results in more turbid water.

18 Regions of maximum suspended solids occur in the North Bay in the null zone² (generally 50 to
19 200 mg/l, but as high as 600 mg/l TSS). The specific location of the null zone changes depending
20 upon freshwater discharge from the Delta. TSS levels in the Estuary vary greatly depending on the
21 season, ranging from 200 mg/l in the winter to 50 mg/l in the summer (Nichols and Pamatmat
22 1988; Buchanan and Schoellhamer 1995). TSS also varies with tidal stage and depth (Buchanan and
23 Schoellhamer 1995). Shallow areas and channels adjacent to shallow areas have the highest sus-
24 pended sediment concentrations. The Central Bay generally has the lowest TSS concentrations;
25 however, wind-driven wave action and tidal currents, as well as dredged material disposal and sand
26 mining operations cause elevations in suspended solids concentrations throughout the water column.

27 **Pollutants.** Pollutant loading to San Francisco Bay has long been recognized as one of many fac-
28 tors that has historically stressed aquatic resources. Pollutants enter the aquatic system through at-
29 mospheric deposition, runoff from agricultural and urbanized land, and direct discharge of waste
30 to sewers and from industrial activity.

31 The Bay's sediment can be both a source and a sink for pollutants in the overlying water column.
32 The overall influx of pollutants from the surrounding land and waste discharges can cause in-
33 creases in sediment pollutant levels. Natural resuspension processes, biological processes, other
34 mechanical disturbances, dredging, and sediment disposal can remobilize particulate-bound pollut-
35 ants.

¹ Water or solutions that are acidic have a pH of less than 7.0, and basic or alkaline water have a pH greater than 7.0. A pH of 7.0 is considered neutral.

² The null zone is area or region of an estuary where the bottom, high-density and surface, low-density currents have equal and opposite effects. It is defined as the zone where the mean near-bottom speed is zero. The actual location of the null zone migrates in response to changes in river discharge. It is important because it is typically characterized by high concentrations of suspended particulate matter and rapid sediment accumulation.

Table 3.2-1. Dissolved Concentrations of Trace Metals in Water Samples (SFEI 1998)

	Ag µg/L	As µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Hg µg/L	Ni µg/L	Pb µg/L	Se µg/L	Zn µg/L
Minimum	0.0002	0.83	0.003	0.09	0.37	0.0003	0.56	0.002	ND	0.07
Maximum	0.006	4.8	0.09	3.8	3.5	0.015	7.2	0.40	6.1	22.5
WQ Criteria 1-hour	1.9	69	42	1100	5		74	210		90
WQ Criteria 4-day		36	9.3	50	3.1		8.2	8.1		81

ND – Not detectable at laboratory limits

1 Metals. Ten trace metals in the aquatic system and in waste discharged to the Bay are monitored on
 2 a regular basis. Total and dissolved fractions are sampled three times a year at Regional Monitoring
 3 Program (RMP) stations throughout the Estuary. **Tables 3.2-1** and **3.2-2** present dissolved and total
 4 trace metal concentration ranges in Bay waters during 1998 (SFEI 1998).

5 Organic Pollutants. Three general types of trace organic contaminants, polycyclic aromatic hydro-
 6 carbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides, are measured in San Francisco
 7 Bay water on a regular basis.

8 Water column concentrations of dissolved and total PAHs in 1998 ranged from 2.1 to 46 parts per
 9 trillion (ppt) and from 20 to 300 ppt, respectively (SFEI 1998). Total PCB concentrations in Bay
 10 waters during 1998 ranged from 70 to 7,000 parts per quadrillion (ppq), and were below the U.S.
 11 Environmental Protection Agency (U.S. EPA) 4-day (chronic toxicity) water quality criteria (30
 12 ppt) (SFEI 1998). Dissolved PCB concentrations ranged from 12 to 930 ppq. Bay waters also
 13 contained measurable concentrations of chlorinated pesticides, including chlordanes and DDTs.
 14 Total chlordane concentrations ranged from 21 to 5,700 ppq, while total DDT concentrations
 15 ranged from 190 to 9,900 ppq (SFEI 1998).

16 A recent review of historical data from several sources found several previously unidentified or-
 17 ganic contaminants in the San Francisco Estuary (SFEI 2002). In this study, p-nonylphenol, a
 18 common constituent in detergents and other household products, agricultural surfactants, and
 19 many industrial products, was identified in Sacramento and San Joaquin River water (at 19 ng/L
 20 and 5 ng/L, respectively), but it was not detected in Estuary water.

21 **Sediment Quality**

Sediment quality in the Estuary varies greatly according to the physical characteristics of the sediment, proximity to historical waste discharges, the physical and chemical condition of the sediment, and sediment dynamics that change with location and season. Generally, the level of sediment contamination at a given location will vary depending on the rate of sediment deposition, which varies with seasons and tides (Luoma *et al.* 1990). Chemical contaminant dynamics in an estuary are closely associated with the behavior of suspended and deposited sediments. The physical and chemical characteristics of sediments, and the bioavailability and toxicity of sediment-associated chemicals to aquatic organisms, are particularly important in determining their potential impact on environmental quality.

While pollutant loading to the Estuary from point and non-point sources has declined dramatically over the past two decades, and surface sediment contamination may be declining from historical highs, Bay sediments are still an important source and sink of pollutants. Much of the data documenting concentrations of trace metals and organics in Bay sediments are found in the historical summary of Long and Markel (1992) and in the more recent monitoring efforts by the State’s Bay Protection and Toxic Cleanup Program (BPTCP) (SFBRWQCB 1994) and Regional Monitoring Program (SFEI 1994 and 1998).

Concentrations of Metals and Organic Pollutants in Sediments. Mean concentrations of trace metals and organics in sediments vary according to grain size, organic carbon content, and seasonal changes associated with riverine flow, flushing, sediment dynamics, and anthropogenic inputs. Anthropogenic inputs appear to have the greatest effect on sediment levels of copper, silver, cadmium, and zinc, as well as several chlorinated and petroleum hydrocarbons (SFBRWQCB 1994). Ranges in sediment metals and trace organic concentrations during 1998 are listed in **Table 3.2-3**. The table also compares measured concentrations to effects range-low (ER-L) and effects range-

Table 3.2-3. Ranges of Trace Pollutants in San Francisco Bay Sediments (SFEI 1998)

	SEDIMENT SAMPLES (MG/KG)		EFFECTS LEVELS (MG/KG)	
	Minimum	Maximum	ER-L	ER-M
Arsenic	3.1	19	8.2	70
Cadmium	0.1	2.1	1.2	9.6
Chromium	63	216	81	370

Table 3.2-2. Total Concentrations of Trace Metals in Water Samples (SFEI 1998)

	Ag µg/L	As µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Hg µg/L	Ni µg/L	Pb µg/L	Se µg/L	Zn µg/L
Minimum	0.002	ND	0.009	0.29	0.42	0.0006	0.63	0.05	ND	0.77
Maximum	0.20	9.4	0.36	101	20	0.73	49.0	15.8	6.8	98.6
WQ Criteria 1-hour	2.3	69	43	1100		2.1		140		58
WQ Criteria 4-day		36	9.3	50		0.025	7.1	5.6		

ND – Not detectable at laboratory limits

Total Chlordanes	ND	<u>0.0099</u>	0.0005	0.006
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Key: Concentrations bolded exceed the Lowest Observable Effects Level (ER-L)
 Concentrations bolded and underlined exceed the Median Observable Effects Level (ER-M)
 ND – Not detectable at laboratory limits

1 median (ER-M) values, which are levels that are rarely associated with adverse effects to benthic
 2 organisms from exposures to sediment-associated contaminants and levels that are frequently as-
 3 sociated with adverse impacts, respectively (Long *et al.*, 1995). For most pollutants, ranges in meas-
 4 ured concentrations exceed the respective ER-L values but are below the corresponding ER-M
 5 values. The exceptions are mercury, nickel, total PCBs, and total chlordanes, which exceed the ER-
 6 M values at one or more locations in the Bay. Some sites within San Francisco Bay, such as Lau-
 7 ritzen Canal, the Port of Oakland near San Leandro Bay, and Richmond Harbor, which have been
 8 greatly affected by historical contamination, contain sediment pollutant levels which are considera-
 9 bly higher than those measured by the Regional Monitoring Program.

10 3.2.3 Analysis of Potential Effects

11 Significance Criteria

12 The San Francisco Bay Area Regional Water Quality Control Board and the Central Valley Re-
 13 gional Water Quality Control Board (Water Boards) are the primary agencies responsible for pro-
 14 tecting water quality in natural waters (“waters of the State”). The Water Boards’ Basin Plans³ des-
 15 ignate beneficial uses for each water body (including wetlands and marshes) in the San Francisco
 16 Bay and Sacramento Regions (Table 3.2-4), and set water quality objectives to protect the present
 17 and potential beneficial uses. In addition, the Basin Plans identify a number of numerical and nar-
 18 rative objectives for surface waters that apply to all waters within the Regions. The surface water
 19 objectives include goals for a wide range of factors, including DO, pH, sediment, toxicity, and bi-
 20 ota population and community ecology. The Basin Plan includes an implementation plan for
 21 achieving the water quality objectives for each of the Regions’ water bodies. The designated bene-

Table 3.2-4. Beneficial Uses of Waters of the San Francisco Estuary as Defined by the San Fran-
 cisco Bay Area Regional Water Quality Control Board

	<i>Central San Francisco Bay</i>	<i>Lower San Francisco Bay</i>	<i>South San Francisco Bay</i>	<i>San Pablo Bay</i>	<i>Suisun Bay</i>
Industrial Service Supply	E	E	E	E	E
Industrial Process Supply	E				
Navigation	E	E	E	E	E
Commercial and Sport Fishing	E	E	E	E	E
Shellfish Harvesting	E	E	E	E	
Contact Recreation	E	E	E	E	E
Non-contact Recreation	E	E	E	E	E
Fish Spawning	E		P		E
Fish Migration	E	E	E	E	E
Estuarine Habitat	E	E	E	E	E
Rare and Endangered Wildlife Habitat	E	E	E	E	E
Wildlife Habitat	E	E	E	E	E

Key: E = Existing, P = Potential

3 San Francisco Regional Water Quality Control Board (Region 2) Water Quality Control Plan (1995) and Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Region 5; 1998)

1 ficial uses, combined with the narrative and numerical water quality objectives and the implemen-
 2 tation plan constitute water quality standards for the San Francisco Bay and Central Valley Re-
 3 gions. The Water Boards have also been designated as the State agencies responsible for imple-
 4 menting the Federal National Pollutant Discharge Elimination System (NPDES) under Section
 5 401 of the Clean Water Act.

6 **The California Toxics Rule (CTR).** In May 2000, U.S. EPA promulgated water quality criteria for
 7 priority toxic pollutants for California’s inland surface waters and enclosed bays and estuaries. In-
 8 cluded are both human health and aquatic life protective criteria. The CTR criteria, along with the
 9 beneficial use designations in the Basin Plans, are directly applicable water quality standards for
 10 these toxic pollutants in these waters. Implementation provisions for these standards are provided
 11 in the Policy for *Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries*
 12 *of California* (SWRCB Resolution No. 2000-015). The CTR and other criteria for selected pollutants
 13 are listed in **Table 3.2-5**.

Table 3.2-5. Water Quality Criteria for Selected Constituents

Constituent	California Toxics Rule Criteria ^a Saltwater		California Ocean Plan ^b Marine Aquatic Life		Drinking Water ^c State & US
	CMC ^e µg/L	CCC ^e µg/L	Daily Maximum µg/L	Instantaneous Max µg/L	MCL µg/L
Copper^d	4.8	3.1	12	30	1,300
Lead^d	210	8.1	8	20	15
Mercury^d	Reserved ^f	Reserved ^f	0.16	0.4	2
Selenium^d	290	71	60	150	50
PCBs	NA	0.03	NA	NA	0.5
Glyphosate	NA	NA	NA	NA	700

- a. Enclosed Bays and Estuaries criteria are the same as CTR criteria for all listed constituents.
 - b. California Ocean Plan criteria provided for comparison.
 - c. State and USEPA drinking water maximum contamination levels (MCLs) are provided for comparison only.
 - d. Criteria apply to California waters except for those waters subject to objectives in Tables III-2A and III-2B of the San Francisco Regional Water Quality Control Board’s (SFRWQCB) 1986 Basin Plan, that were adopted by the SFRWQCB and the State Water Resources Control Board, approved by EPA, and which continue to apply.
 - e. Criteria Maximum Concentration (CMC) equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time without deleterious effects. Criteria Continuous Concentration (CCC) equals the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. µg/L equals micrograms per liter.
 - f. U.S. EPA did not establish a standard at time of promulgation, but may do so at a future time.
- NA – Criteria not available.

14 U.S. EPA also published recommended water quality criteria for nonylphenols for protection of
 15 saltwater aquatic life. The recommended criteria for continuous concentration (4-day) average and
 16 maximum concentration (1-hour average) are 1.6 µg/L and 6.2 µg/L, respectively. For the purposes
 17 of this evaluation, significant impacts to water quality would be determined to occur if the project
 18 would:

- Violate any Federal, State, regional, or local water quality standard, or any waste discharge requirement or NPDES permit condition;

- 1 • Discharge any toxic substances into the water in concentrations that are lethal to or that
- 2 produce significant alterations in population or community ecology or receiving water biota;
- 3 • Degrade the existing high quality of water in any waters of the State; or
- 4 • Otherwise degrade water quality and adversely affect beneficial uses.

5 This section primarily evaluates possible impacts that would directly affect water quality and result
6 in a violation of a numerical water quality standard or permit condition. Other, more subtle poten-
7 tial impacts, such as alteration of community ecology or adverse impact to a beneficial use of wet-
8 land or estuarine habitat, are evaluated in Section 3.3, *Biological Resources*.

9 The primary water quality impacts associated with the treatment of non-native cordgrass are sum-
10 marized in **Table 3.2-7**. Each impact is described below, followed by an assessment of the signifi-
11 cance of the impact. Mitigation measures that would be applied are identified in the text and sum-
12 marized in **Table 3.2-8**.

13 **Sediment Quality Criteria.** There currently are no Basin Plan objectives or other regulatory crite-
14 ria for sediment quality. However, there are sediment quality guidelines that may be used as
15 screening tools. The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) has
16 developed sediment screening and testing guidelines for determining the general suitability of
17 dredged material for beneficial reuse (wetland restoration) projects (SFRWQCB 2000). The guide-
18 lines include sediment chemistry, acute toxicity, contaminant mobility, and elutriate chemistry and
19 toxicity.

20 Chemistry. The guidelines for sediment chemistry are shown in Table 3.2-8. The sediment chemis-
21 try guidelines are divided into two levels, one for material that will be placed at or near the wetland
22 surface (“surface material”) and one for material that will be placed at a minimum specified dis-
23 tance below the wetland surface (“foundation material”).

24 Toxicity. The recommended acute toxicity screening guideline for surface material is “no signifi-
25 cant toxicity” for benthic bioassays. Benthic tests are to be interpreted following guidelines in
26 SFBRWQCB Public Notice 93-3. For benthic bioassays, mortality in a test sediment that is statisti-
27 cally significant and 10 percentage points greater (20 percentage points for amphipods) than that in
28 the reference is considered to be indicative of acute toxicity.

29 Contaminant Mobility. There are no screening levels for contaminant mobility for wetland surface
30 material because toxicity and chemistry screening for this material will result in concentrations for
31 which mobility is not considered of concern. The screening levels for wetland foundation material
32 are based on Water Quality Objectives found in the Basin Plan. While the foundation material is
33 not expected to be in direct contact with biological receptors, levels of contaminants in effluent
34 discharged during placement of material or in leachate produced after placement of material must
35 be below levels of concern.

36 Elutriate Chemistry and Toxicity. If dewatering will occur as part of material placement, discharge
37 water must meet screening guidelines for both chemistry and toxicity. The screening guidelines for
38 discharged water chemistry are the Water Quality Objectives listed in the Basin Plan. The screening
39 guideline for toxicity is no significant toxicity. For the elutriate bioassay, this is met when the sur-
40 vival of organisms in effluent has a median value of not less than 90% and a 90th percentile value
41 of not less than 70% survival.

1 These guidelines will be used as screening criteria in situations where sediment will be dredged or
2 excavated, to evaluate beneficial reuse options for dredged material and the potential adverse ef-
3 fects of these and other sediment disturbing activities. The guideline approach will also be used to
4 evaluate effects of herbicide and surfactant residue in sediment. These criteria will be reviewed by
5 the SFRWQCB as part of the NPDES Water Quality Monitoring Plan, and other criteria may be
6 established by the SFRWQCB at that time. The SFRWQCB may also require different or addi-
7 tional criteria for specific sites as part of CWA Section 401 review.

1 **Table 3.2-6** Sediment Chemistry Screening Guidelines (from Beneficial Reuse of Dredged Mate-
 2 rials: Sediment Screening and Testing Guidelines [SFBRWQCB 2000])

ANALYTE	WetlandSurfaceMaterial		WetlandFoundationMaterial	
	Concentration	Decision Basis	Concentration	Decision Basis
METALS (mg/kg)				
Arsenic	15.3	Ambient Values	70	ER-M
Cadmium	0.33	Ambient Values	9.6	ER-M
Chromium	112	Ambient Values	370	ER-M
Copper	68.1	Ambient Values	270	ER-M
Lead	43.2	Ambient Values	218	ER-M
Mercury	0.43	Ambient Values	0.7	ER-M
Nickel	112	Ambient Values	120	ER-M
Selenium	0.64	Ambient Values		
Silver	0.58	Ambient Values	3.7	ER-M
Zinc	158	Ambient Values	410	ER-M
ORGANOCHLORINE PESTICIDES/PCBS (mg/kg)				
DDTS, sum	7.0	Ambient Values	46.1	ER-M
Chlordanes, sum	2.3	TEL	4.8	PEL
Dieldrin	0.72	TEL	4.3	PEL
Hexachlorocyclohexane, sum	0.78	Ambient Values		
Hexachlorobenzene	0.485	Ambient Values		
PCBs, sum	22.7	ER-L	180	ER-M
POLYCYCLIC AROMATIC HYDROCARBONS (mg/kg)				
PAHs, total	3,390	Ambient Values	44,792	ER-M
Low molecular weight PAHs, sum	434	Ambient Values	3,160	ER-M
High molecular weight PAHs, sum	3,060	Ambient Values	9,600	ER-M
1-Methylnaphthalene	12.1	Ambient Values		
1-Methylphenanthrene	31.7	Ambient Values		
2,3,5-Trimethylnaphthalene	9.8	Ambient Values		
2,6-Dimethylnaphthalene	12.1	Ambient Values		
2-Methylnaphthalene	19.4	Ambient Values	670	ER-M
2-Methylphenanthrene		Ambient Values		
3-Methylphenanthrene		Ambient Values		
Acenaphthene	26.0	Ambient Values	500	ER-M
Acenaphthylene	88.0	Ambient Values	640	ER-M
Anthracene	88.0	Ambient Values	1,100	ER-M
Benz(a)anthracene	412	Ambient Values	1,600	ER-M
Benzo(a)pyrene	371	Ambient Values	1,600	ER-M
Benzo(e)pyrene	294	Ambient Values		
Benzo(b)fluoranthene	371	Ambient Values		
Benzo(g,h,i)perylene	310	Ambient Values		
Benzo(k)fluoranthene	258	Ambient Values		
Biphenyl	12.9	Ambient Values		
Chrysene	289	Ambient Values	2,800	ER-M
Dibenz(a,h)anthracene	32.7	Ambient Values	260	ER-M
Fluoranthene	514	Ambient Values	5,100	ER-M
Fluorene	25.3	Ambient Values	540	ER-M
Indeno(1,2,3-c,d)pyrene	382	Ambient Values		
Naphthalene	55.8	Ambient Values	2,100	ER-M
Perylene	145	Ambient Values		
Phenanthrene	237	Ambient Values	1,500	ER-M
Pyrene	665	Ambient Values	2,600	ER-M

3 Ambient Values – Ambient or “background” concentration statistically derived by the SFBRWQCB from data collected by the Regional Monitoring
 4 Program for Trace Substances (SFEI 1999) and the Bay Protection and Toxic Substances Cleanup Program Reference Study (SWRCB 1998)

5 TEL, PEL – Threshold Effects Level and Probable Effects Level - Sediment chemistry values developed by the Florida Department of Environ-
 6 mental Protection (FDEP 1994) as those below which biological effects are unlikely (TEL), and above which biological effects are likely (PEL).

7 ER-L, ER-M – Effects Range-Low and Effects Range-Median – Sediment chemistry values developed by Long et al. (1995) using the sediment
 8 chemistry and toxicity database of the National Oceanographic and Atmospheric Administration as those below which biological effects are unlikely
 9 (ER-L) and above which biological effects are likely (ER-M).

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ALTERNATIVE 1: Proposed Action/Proposed Project – Regional Eradication Using All Available Control Methods

Impacts to water quality from physical and chemical treatment methods could be associated with application of herbicides, remobilization of sediment contaminants, spills of petroleum products (required for machinery, vehicles, and boats) or herbicides, and erosion of marsh sediments in the vicinity of structures.

IMPACT WQ-1: Degradation of Water Quality Due to Herbicide Application

Treatment methods involving the use of herbicides may degrade water quality and subsequently affect beneficial uses of waters of the Bay.

Only one herbicide, glyphosate, has been approved for use by the U.S. EPA in estuarine environments. The commercial glyphosate products that will be used by the Control Program are Rodeo and Aquamaster. Glyphosate must be combined with a suitable surfactant and colorant, as described in Chapter 2, *Program Alternatives*. The following presentation of empirical information on water quality impacts from herbicide applications is focused on Rodeo or Aquamaster, the active ingredient (glyphosate), its breakdown products, the surfactants R-11, LI 700, and Agri-dex, and the colorant, Blazon Blue.

There are four signal words on US EPA registration labels describing the toxicity of the compounds: Caution, Warning, Danger, and Danger-Poison. Caution means the product is slightly toxic if eaten, absorbed through the skin, or inhaled, or it causes slight eye or skin irritation. Warning indicates that the product is moderately toxic if eaten, absorbed through the skin, or inhaled, or it may cause moderate eye or skin irritation. Danger means that the product is highly toxic, corrosive, or causes severe burning to the eyes or skin. Danger-Poison means that the pesticide product is highly toxic only if eaten, absorbed through the skin, or inhaled. These products have a “skull and crossbones” symbol on the label.

Glyphosate. Rodeo and Aquamaster are simple aqueous solutions of isopropylamine salt, and contain no inert ingredients other than water. The primary decomposition product of glyphosate is aminophosphoric acid (AMPA), and the commercial product contains an impurity, N-nitrosoglyphosate (NNG). The potential effects of AMPA and NNG are encompassed by the available toxicity data on glyphosate and glyphosate formulations (SERA 1996). Glyphosate is water-soluble and may be transported by surface waters. It is stable in water and sunlight, but is degraded rapidly by bacteria. Specific degradation rates in water depend on temperature and pH, and are usually within days to weeks. It is considered moderately persistent in soils with an estimated half-life of 47 days. Because glyphosate adheres strongly to particles, it does not readily leach to waters (Sprankle *et al.*, 1977 cited in Albertson, 1998), and potential movement of glyphosate to groundwater is unlikely. Information concerning the mobility, persistence, and toxicity of glyphosate in estuarine environments is compiled in **Appendix E-1**.

Surfactants. Pursuant to the U.S. EPA registration label for glyphosate, a non-ionic surfactant is required whenever glyphosate is used in aquatic systems. Several non-ionic surfactant formulations are registered by the U.S. EPA and the California Department of Pesticide Regulation for use in aquatic systems. Agridex, R-11, and LI-700 have been selected for use by the Control Program as among the least toxic of the approved surfactants. These three surfactants are described briefly below. Product labels and additional information are provided in **Appendix E-2**.

1 Agri-dex (Helena Chemical Company) is a non-ionic surfactant consisting of a paraffin base pe-
2 troleum oil, polyol fatty acid esters, and polyethoxylated derivatives of the fatty acid esters. The
3 pesticide label identifies a toxicity category of 3-4 (CAUTION)⁴. This surfactant improves pesticide
4 application by modifying the wetting and deposition characteristics of the spray solution resulting
5 in a more even and uniform coverage. The ingredients in this surfactant break down within several
6 days.

7 R-11 Spreader Activator (Wilbur-Ellis Company) consists of a non-ionic alkylphenol ethoxylate.
8 The pesticide label identifies a toxicity category of 3-4 (CAUTION). This surfactant increases the
9 efficacy of herbicides by facilitating wetting and uniform coverage over the target surface.

10 Alkylphenol ethoxylates are widely used as detergents, emulsifiers, solubilizers, wetting agents, and
11 dispersants, and are introduced into the aquatic environment primarily through industrial and mu-
12 nicipal wastewater discharges (Heinis *et al.* 1999). Depending on the environment, alkylphenol
13 ethoxylates may break down into a variety of metabolites, some of which may persist in the water
14 column for several weeks and in sediments for many years (Ferguson *et al.* 2001). One of the
15 break-down products, nonylphenol, has been found to bioaccumulate (Ferguson *et al.* 2001) and to
16 have estrogenic effects on some organisms (Dreze *et al.* 2000, Meregalli *et al.* 2001).

17 Because the primary contributors of nonylphenol to the environment are wastewater sources, most
18 of the available information on the persistence and effects of these substances is focused on
19 wastewater processes. Several studies have concluded that nonylphenol does not tend to be per-
20 sistent (i.e., it breaks down further to inert products) under aerobic conditions (J. Maguire 1999,
21 Staples *et al.* 1998).

22 LI-700 Penetrating Surfactant (Loveland Industries), contains phosphatidylcholine (lecithin), which
23 is a naturally occurring lipid that biodegrades readily. It also contains methylacetic acid and alkyl
24 polyoxyethylene ether. The pesticide label identifies a toxicity category of 1 (DANGER). This sur-
25 factant facilitates uniform coverage of the spray solution and aids in penetration of the herbicide.
26 The ingredients in this surfactant break down within several days.

27 **Colorant.** Blazon Spray Pattern Indicator (Milliken Chemical) is a water-soluble polymeric color-
28 ant. As with most colorant products, the active ingredients are proprietary; the Material Safety Data
29 Sheet indicates that it is non-hazardous and non-toxic. The product information sheet reports that
30 the product is non-staining to the skin or clothing. A literature survey on the toxicity of color indi-
31 cators done for the U.S. Department of Agriculture reports “most commercial indicators are blue
32 ... and most often a form of Acid Blue 9...” (McClintock 1997 and Zullig 1997 cited in SERA
33 1997b). Acid Blue 9 is a disodium salt classed chemically as a triphenylmethane color (SERA
34 1997b). The Cosmetic, Toiletry, and Fragrance Association (CTFA) name for certified batches of
35 Acid Blue 9 is FD&C blue No. 1. Product information for Blazon Spray Pattern Indicator is pro-
36 vided in **Appendix E-2**.

37 **Herbicide mixtures.** The glyphosate/surfactant/colorant mixture is a chemical formulation, and
38 the toxicological characteristic may vary from that of its constituents. While information about the
39 constituents may be instructive, it is desirable to consider the characteristics of the combined mix-
40 ture to accurately assess possible toxicity. There is a wide range of possible interactions between
41 the glyphosate mixture constituents, and the effects are difficult to predict based on structural,
42 mechanistic, or theoretical considerations (SERA 1997b). The application of data from general

⁴ Toxicity categories are determined by the U.S. EPA for human health affects. See <http://www.epa.gov/oppfead1/labeling/lrm/chap-08.htm> for more information on pesticide label requirements.

1 aquatic studies to the estuarine environment is unreliable for determining possible effects. An im-
2 portant exception to the general lack of estuarine data is the recent research on glyphosate toxicity
3 to Pacific estuarine organisms of Willapa Bay, cited in the EIR literature (Paveglio et al. 1996, Kil-
4 bride and Paveglio 2001, Killbride et al. 1995). These recent Pacific coast data and analyses are
5 considered up to date, highly relevant, and scientifically reliable. They also are the closest and most
6 similar estuarine systems to the San Francisco Estuary for comparative study of glyphosate im-
7 pacts. Overall, they indicate that energetic, turbid conditions in tidal mudflats rapidly dissipate gly-
8 phosate between tides, resulting in rapid reduction to undetectible levels, and rapid inactivation
9 (adsorption) by clay sediments, as well as low aquatic toxicity. The Control Program will perform
10 studies, including bioassays, during the early phases of the Program to determine if there are addi-
11 tional toxic effects of the herbicide mixtures.

12 **Herbicide application.** Impacts to water quality from herbicide application depend on environ-
13 mental fate, degradation rates of active agents and decomposition products of the herbicides. The
14 primary route by which herbicide solution may contact water is by overspray directly onto the wa-
15 ter surface, or by washing off from plants due to precipitation or tidal inundation. The proposed
16 herbicide is formulated and approved for use in aquatic environments.

17 Glyphosate mixtures may be applied as sprays to plant surfaces, pastes applied to cut stems, or so-
18 lutions wiped or painted on foliage. Spray mixtures may be administered from manually trans-
19 ported tanks (backpack sprayers) or spray equipment mounted on trucks, track vehicles, boats, or
20 helicopters (broadcast sprayers; see Chapter 2, *Program Alternatives, Alternative 1* for a complete de-
21 scription of application methods and restrictions). Manual application would entail workers walk-
22 ing through the marsh and applying herbicide directly to target plants, with limited overspray to
23 surrounding plants or water surfaces. Application from a boat would also result in direct applica-
24 tion of herbicide to target plants, with limited overspray. Application from trucks and track vehi-
25 cles would entail vehicles moving through the marsh, either on roadways and levees or tracking
26 over marsh vegetation, respectively applying herbicide more broadly to vegetation in the immediate
27 area. Aerial application would be by helicopter with either a boom sprayer (a horizontal pipe with
28 spray nozzles along its length, mounted to the bottom of the helicopter) or a spray ball (a hollow
29 ball with perforations suspended from the bottom of the helicopter). Aerial application would re-
30 sult in a wider dispersion of herbicides, with greater potential for overspray onto non-target areas
31 or the water surface. Aerial application is would be used infrequently, and primarily at large areas
32 of dense cordgrass infestations, particularly in locations where little native cordgrass and other
33 non-target plants are nearby. The rate of application for each type of treatment was provided in
34 **Table 2-2.**

35 Herbicide mixtures may be indirectly discharged to surface waters by tidal action or rainfall that
36 rinses the herbicide solution from the plants. Rainfall is unlikely to occur during the planned appli-
37 cation season (late summer), and herbicide applications would be postponed if rainfall were pre-
38 dicted, but tidal inundation is inevitable in many locations on a regular cycle.

39 Energetic tidal cycles and tidal currents effectively disperse bound (adsorbed) glyphosate and sur-
40 factants and dilute them in microbially active suspended sediment. Studies of the fate of glyphosate
41 and surfactants applied in tidal marshes and mudflats have reported that concentrations of both
42 substances dropped below detection levels as soon as two tidal cycles (one day) to seven days
43 (Kroll 1991, Paveglio *et al.* 1996) after application. The initial tidal submergence of sprayed surfaces
44 disperses a large fraction of applied glyphosate and surfactant.

1 Research in Willapa Bay, Washington, found that the highest average maximum concentrations of
2 glyphosate and X-77 Spreader surfactant in water dispersed from sprayed estuarine mud with the
3 first flooding tide were 26 µg/L and 16 µg/L, respectively. These conditions represent the highest
4 expected concentrations for exposure for aquatic invertebrates or fish swimming into freshly
5 sprayed sites. The solution of Rodeo (3.8 pts/acre) and X-77 Spreader (0.9 pts/acre) was applied
6 aerially (Paveglia *et al.* 1996). This “worst case” concentration of glyphosate and surfactants is in-
7 herently short-lived in high-energy tidal environments, and would not be pertinent to potential
8 chronic, low-level effects. The same study found that concentration of glyphosate and surfactants
9 were below analytic detection limits (0.5 ppb) during the first high tide after treatment. Kroll
10 (1991) found that glyphosate concentrations in seawater were below the detection limit of 5 ppb
11 within 7 days after treatment by Rodeo (0.75% solution) and Arborchem Aquatic surfactant (0.5%
12 solution) by a hand-held sprayer.

13 Research conducted for the California Department of Food and Agriculture (Trumbo 2002) stud-
14 ied the environmental fate and aquatic toxicity of Rodeo and R-11 in three locations, including a
15 Sacramento-San Joaquin Delta slough, a riverine area, and a no-outlet pond. This study measured
16 glyphosate, amino methyl phosphonic acid (AMPA; glyphosate’s primary metabolite), nonylphenol
17 ethoxylate, and nonylphenol at treated sites one hour, two days, and eight days after application.
18 The study also tested for toxicity using 96-hour toxicity tests with the fish species fathead minnow
19 *Pimephales promelas*. The study found that concentrations of the tested constituents at slough and
20 river sites (with moving water) was below detectible levels for all tests, and that there was no sig-
21 nificant mortality of test fishes. The pond site, however, showed detectable residues of glyphosate,
22 nonylphenol ethoxylate, and nonylphenol at one hour and two days after treatment, but all con-
23 stituents were below detection limits by day eight. The one-hour pond samples experienced 30%
24 mortality of test fishes, which, because of the relatively low concentrations of glyphosate (which is
25 known to be non-toxic at the detected level), was attributed to effects caused by nonylphenol
26 ethoxylate and nonylphenol. The two- and eight-day tests showed no significant mortality to test
27 fishes.

28 Kilbride *et al.* (2001) conducted another study in Willapa Bay to evaluate the fate of a more con-
29 centrated glyphosate mixture (5% Rodeo solution and 2% LI-700 solution) in sediments. This con-
30 centration is above that permitted for manual application to cordgrass. Both mudflat plots and
31 cordgrass plots were treated. Sediment samples were collected at 1 and 21 days, and at one year
32 after treatment, and geometric mean concentrations ranged from 0.090 mg/kg to 2.30 mg/kg.

33 Patten (2002) compiled data on the fate of glyphosate in water and sediment following applications
34 in estuarine environments. Data are presented as geometric means for immediate maximum con-
35 centration (<3hrs after application) and short-term concentration (between 24 hrs and 48 hrs after
36 application). For use rates between 8 and 16 kg/ha (7-15 lbs/acre), the immediate maximum geo-
37 metric mean glyphosate concentrations were 0.174 mg/L (174 µg/L) in water and 2 mg/kg in
38 sediment. The short-term geometric mean glyphosate concentrations were 0.003 mg/L (3 µg/L) in
39 water and 1.9 mg/kg in sediment.

40 These independent lines of research in the fate of glyphosate and surfactants in tidal (and other)
41 habitats suggest that potential impacts to water quality and beneficial uses of waters of the State
42 caused by spraying glyphosate mixtures in intertidal environments are likely to be small and tem-
43 porary. Therefore, controlled applications (i.e., following label instructions) of registered herbicides
44 are not expected to degrade water quality, except for limited temporal and spatial extent.

1 Herbicides adsorbed by soils also degrade rapidly in the environment. Glyphosate has little poten-
2 tial for affecting groundwater because of its strong affinity for soil particles, which results in low
3 mobility in soils. Following herbicide application and eventual decay of affected plant roots, local
4 soils may be somewhat destabilized and subject to erosion prior to recolonization, but this would
5 not facilitate transfer of glyphosate adsorbed to soil particles to the underlying groundwater aquifer.

6 In summary, the use of glyphosate and surfactants to treat infestations of non-native cordgrass
7 would result in less than significant impacts on water quality due to the rapid degradation rate and
8 controlled application of herbicides only on target plants. Since application of herbicides would
9 take place during low tide and low wind conditions, the herbicide would likely be absorbed by
10 plants for a minimum of several hours (up to several weeks or months in high marsh) following ap-
11 plication resulting in less than significant quantities of glyphosate or surfactants entering the water.

12 **MITIGATION WQ-1:** Herbicides shall be applied directly to plants and at low or receding tide to
13 minimize the potential application of herbicide directly on the water surface. Herbicides shall be
14 applied by a certified applicator and in accordance with application guidelines and the manufac-
15 turer label.

16 The Control Program shall obtain coverage under the State NPDES Permit for the Use of Aquatic
17 Herbicides and any necessary local permits. A monitoring program shall be implemented as part of
18 the NPDES permit, and shall include appropriate toxicological studies to determine toxicity levels
19 of the herbicide solutions being used. The Control Program shall use adaptive management strate-
20 gies to refine herbicide application methods to increase control effectiveness and reduce impacts.
21 The Control Program shall continue to investigate improved herbicide formulations with lower
22 ecological risk.

23 **IMPACT WQ-2: Herbicide Spills**

24 Large volumes of herbicide or surfactant, spilled or misapplied, could degrade water quality and
25 cause temporary toxicity. As described for Impact WQ-1, above, controlled applications (i.e., fol-
26 lowing label instructions) of registered herbicides are not expected to degrade water quality because
27 these materials degrade rapidly in the environment and do not represent high potentials for toxicity
28 or bioaccumulation in marine or terrestrial organisms. However, if large volumes of herbicide or
29 surfactant (adjuvant) are to be spilled near the treatment site in an undiluted (neat) form, or misap-
30 plied, these events would degrade water quality and cause temporary toxicity. Thus, impacts to
31 water quality associated with large volume spills would be potentially significant.

32 **MITIGATION WQ-2:** Herbicides shall be applied by or under the direct supervision of trained,
33 certified or licensed applicators. Storage of herbicides and adjuvants/surfactants on-site shall be
34 allowed only in accordance with an approved spill prevention and containment plan; on-site mix-
35 ing and filling operations shall be confined to areas appropriately bermed or otherwise protected to
36 minimize spread or dispersion of spilled herbicide or surfactants into surface waters.

37 **IMPACT WQ-3: Fuel or Petroleum Spills**

38 Spills of gasoline or other petroleum products, required for operation of motorized equipment,
39 into or near open water could degrade water quality, with potential for toxicity or contaminant bio-
40 accumulation.

41 Gasoline or other petroleum products, such as oil and hydraulic fluids, required for operation of
42 motorized equipment, could spill into or near open water. Large spill volumes could degrade water
43 quality, with potentials for toxicity and contaminant bioaccumulation in marsh organisms. Water

1 quality impacts also may occur if ignition fluids such as gasoline used for burning were inadver-
2 tently sprayed or spilled to surface waters. Gasoline, diesel, and other distilled petroleum products
3 are more water-soluble than crude oils and heavier distillate fractions. However, they are also more
4 volatile and therefore lost rapidly from water to the atmosphere. The lower molecular weight aro-
5 matic hydrocarbon compounds in petroleum products can be toxic to marine organisms at low
6 exposure concentrations. Consequently, some toxicity to marine organisms could occur in the im-
7 mediate vicinity of a spill, whereas environmental weathering processes reduce the toxicity of the
8 spill with time.

9 This impact to water quality is potentially significant, but would be localized to the general vicinity
10 of the spill and temporary. Impacts related to spills generally can be reduced to less-than-significant
11 levels by implementing specific mitigation measures and best management practices.

12 **MITIGATION WQ-3:** Fueling operations or storage of petroleum products shall be maintained
13 off-site, and a spill prevention and management plan shall be developed and implemented to con-
14 tain and clean up spills. Transport vessels and vehicles, and other equipment (e.g., mowers, pumps,
15 etc.) shall not be serviced or fueled in the field except under emergency conditions; hand-held gas-
16 powered equipment shall be fueled in the field using precautions to minimize or avoid fuel spills
17 within the marsh. Other, specific best management practices shall be specified as appropriate in
18 project-specific Waste Discharge Requirements.

19 **IMPACT WQ-4: Contaminant Remobilization**

20 Treatment methods that include dredging or excavation of anaerobic bay mud may expose buried
21 sediments with higher levels, or more biologically available forms of heavy metals (e.g., mercury,
22 nickel, and zinc) or other contaminants such as polychlorinated biphenyls (PCBs). As shown in
23 **Table 3.2-3**, heavy metals, including mercury, are present in bay muds from natural and artificial
24 sources. Background levels in the San Francisco Bay are very high for some of these constituents
25 compared to most estuaries nationally. If dredging or excavation is done in areas with high con-
26 centrations of metals or pollutants, it could degrade water quality and contribute to exposure of
27 marsh organisms. Remobilization of contaminant would not be likely to occur from treatment
28 methods that do not directly disturb sediments. Treatment methods that entail constructing levees
29 or projects that require constructing roads for access could expose contaminants and create a mi-
30 nor risk to water quality.

31 **MITIGATION WQ-4:** For projects where dredging or excavation methods are used, a prelimi-
32 nary assessment shall be performed to determine the potential for contamination in sediments
33 prior to initiating treatment. The preliminary assessment shall include (1) review of existing site
34 data (e.g., from Regional Monitoring Program) and (2) evaluation of historical site use and/or
35 proximity to possible contaminant sources. If the preliminary assessment finds a potential for his-
36 toric sediment contamination, an appropriate sediment sampling and analysis plan shall be devel-
37 oped and implemented. If contaminants are present at levels of possible concern (but below levels
38 that might trigger site cleanup), an alternative treatment method (that shall not disturb sediment)
39 will be implemented, or the project shall apply to the Regional Water Board for site-specific Waste
40 Discharge Requirements. If significant contamination that warrants site cleanup is found, sampling
41 information shall be turned over to the U.S. Environmental Protection Agency or other appropri-
42 ate authority.

43 **ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods**

44 *Impacts*

1 Impacts to water quality from individual treatment methods and combinations of methods gener-
2 ally would be the same as those described for Alternative 1, with the exception that potential im-
3 pacts associated with herbicide application and spills would be replaced by increased contaminant
4 remobilization and erosion due to repeated application of physical or mechanical methods and
5 ground disturbance. Overall, impacts to water quality are considered less than significant and sub-
6 ject to feasible mitigation.

7 *Mitigation Measures*

8 Mitigation measures WQ-3 and WQ-4 also apply to this alternative.

9 **ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated**
10 **Treatment**

11 Under Alternative 3, all types of control methods would continue to be used in the Estuary as
12 needed by individual landowners, without benefit of training and standardization provided by the
13 *Spartina* Control Program. Water quality impacts from herbicide application and resuspension of
14 contaminants would still occur. Water quality impacts from herbicide and fuel spills might occur
15 with disproportional frequency as a result of a lack of training and application standards.

16 *Mitigation Measures*

17 Mitigation measures WQ1, WQ-2, WQ-3 and WQ-4 would apply to this alternative.

18 **Impact WQ-5: Water Quality Effects Resulting from Sediment Accretion**

19 Colonization by invasive cordgrass can directly and indirectly affect water quality by trapping
20 marsh sediments (Daehler and Strong, 1996). This process filters suspended particles from marsh
21 waters, thereby increasing water clarity and light penetration, and promoting further deposition and
22 accumulation of sediment and possible changes in sediment texture (Daehler and Strong, 1996).
23 Accretion rates vary but appear to be related to stem density and sediment supply, and inversely
24 related to wind and wave action (Chung, 1985 cited in Ebasco 1997). Sediment accretion and sta-
25 bilization may eventually alter local topography and habitats relative to tidal elevation, promote
26 changes in tidal drainage channels, and change topography from gentle slope to steep slopes in
27 tidal channels. Changes in marsh circulation can, in turn, decrease the frequency of tidal inundation
28 or exchange, and lead to stagnation and localized degradation of water quality. *Spartina* colonization
29 of flood control channels may also increase flooding potential of residential and commercial prop-
30 erties (see also Section 3.1-*Geomorphology and Hydrology*). These indirect effects would result in po-
31 tentially significant impacts to water quality.

32 This alternative is not expected to affect water quality standards although some beneficial uses as-
33 sociated with fish and wildlife habitat may be adversely affected. Other, local control programs,
34 independent of the proposed regional eradication program, could generate waste discharges and
35 affect local water quality conditions; however evaluation of local control programs is outside the
36 scope of this EIS/EIR.

37 **MITIGATION WQ-5:** No feasible mitigation has been identified to address this impact. Moreo-
38 ver, mitigation measures associated with treatment methods would not be implemented by the
39 Conservancy or the Service or required under this alternative. Locally sponsored control programs
40 may incorporate mitigation measures to reduce potential impacts on water quality and sediment
41 accretion. Mitigation would not be needed or appropriate at marsh locations where sediment accretion is a
42 beneficial or neutral impact.

1 *Residual Impacts*

- 2 Because no mitigation measures would be implemented, residual impacts would be as described
3 above. These residual impacts are considered potentially significant.

Table 3.2-6: Summary of Potential Water Quality Effects

Impact	Manual Removal (Hand pulling and manual excavation)	Mechanical Removal (Excavation, dredging, and shredding)	Pruning, Hand- mowing, and Smothering	Flooding (Diking, drowning, and salinity variation)	Burning	Herbicide Application	Beneficial Effects
WQ-1: Degradation of Water Quality due to Herbicide Application	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	Alternatives 1 & 3: Minor impact Alternative 2: No impact.	N/A
WQ-2: Degradation of Water Quality due to Herbicide Spills	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	Alternatives 1 & 3: Potentially signifi- cant and mitigable impact Alternative 2: No impact.	N/A
WQ-3: Degradation of Water Quality due to Fuel or Petroleum Spills	All Alternatives: No impact.	All Alternatives: Small potential for spill.	All Alternatives: Small potential for spill.	All Alternatives: Small potential for spill.	All Alternatives: Small potential for spill.	All Alternatives: Small potential for spill.	N/A
WQ-4: Degradation of Water Quality due to Contaminant Remobilization	Alternative 1-2: Small potential Alternative 3: No significant im- pact.	Alternative 1: Small potential Alternative 2: Potentially significant Alternative 3: No significant effect	All Alternatives: No adverse impacts.	Alternative 1: Small potential Alternative 2: Potentially significant Alternative 3: No significant effect	All Alternatives: No adverse impacts.	All Alternatives: No adverse impacts.	N/A
WQ-5: Water Quality Effects Resulting from Sediment Accretion	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Clarification of the water column may benefit some spe- cies

Table 3.2-7: Summary of Mitigation Measures for Water Quality

Mitigation	Manual Removal (Hand pulling and manual excavation)	Mechanical Removal (Excavation, dredging, and shredding)	Pruning, Hand-mowing, and Smothering	Flooding (Diking, drowning, and salinity variation)	Burning	Herbicide Application
Mitigation WQ-1: Degradation due to herbicide application. Herbicides shall be applied under NPDES Permit from the State. Herbicides shall be applied directly to plants and at low tide to minimize the potential application of herbicide directly on the water surface, and shall be applied in accordance with application guidelines and the manufacturer label. Best management practices shall be applied at all times. The SCP shall monitor and evaluate projects.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Applicable
Mitigation WQ-2: Herbicide spills. Herbicides shall be applied under NPDES Permit from the State, and by or under the direct supervision of a trained, certified or licensed applicator. Spill prevention and containment plan shall be developed and implemented.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Applicable
Mitigation WQ-3: Fuel or petroleum spills. Fueling and storage of fuels will be maintained onsite. A spill prevention and containment plan shall be developed and implemented.	Not Applicable	Applicable	Not Applicable	Applicable	Applicable	Applicable
Mitigation WQ-4: Contaminant remobilization. Site sediments will be researched and sampled (if needed) prior to initiating treatment of any site where there may be contamination. Waste Discharge Requirements shall be obtained for operations in a site where contamination is present.	Applicable	Applicable	Not Applicable	Usually Not Applicable	Not Applicable	Not Applicable

Note: There may be textual differences between the measures in this summary table and the text in the section. The actual mitigation measure is in the text.

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