that could potentially be affected by dredged material disposal are those associated with the benthic community. This and other resources such as phytoplankton, zooplankton, pelagic fish, and wildlife are considered in the context of the embayment.

Environmental Characteristics of Suisun Bay Outside the Disposal Site Potentially Affected By Dredged Material Disposal

WATER QUALITY. In general, water quality parameters such as pH, DO, ammonia, salinity, and pollutant levels are affected by disposal of dredged material, but these changes are only expected to be short-term and localized within a limited volume of water generally located within the disposal site. Water quality within Suisun Bay is expected to be marginally affected by disposal, assuming disposal events are spaced to allow each plume to diffuse prior to beginning another event.

SEDIMENT CHARACTERISTICS. Suisun Bay is a shallow, brackish water embayment with a floor that is predominantly fine silt and clay, crossed by channels scoured by tidal and riverine flows. The surficial sediments around these channels change according to season. High riverine flows winnow the fine sediment of Suisun Bay and transport it downstream into San Pablo Bay. As a result, the ercentage of surficial sediments that are coarse-grained material in this embayment increases from roughly 5-10 percent to roughly 35 percent. As riverine flows decrease, silt again is deposited in Suisun Bay and the surficial sediments again become fine silt and clay (Nichols and Pamatmat 1988).

SEDIMENT DYNAMICS. Suspended sediment dynamics in Suisun Bay is governed by a complex series of factors. Riverine flows move suspended sediment westward and during high flow periods scour the substrate. Eastward flow of saline waters near the bottom of the Bay move descending particles back upstream. Continued disposal of sand material dredged from the main channel is not expected to affect either the sediment characteristics in Suisun Bay or the sediment dynamic patterns within the embayment.

SEDIMENT QUALITY. Representative physical and chemical data for various monitoring and dredging sites in Suisun Bay (both coarse and fine material) are presented below in Table 4.3-16. With the exception of chromium and nickel, contaminant concentrations in the finer sediments of Grizzly and Honker Bays is higher than in the sandy sediments of the navigation channel (Kohn et al. 1994).

PHYTOPLANKTON AND ZOOPLANKTON. Historically, the opossum shrimp have been abundant in the Suisun Bay; however, populations appear to have been impacted by altered flow and salinity conditions. *Acartia* is the most abundant copepod species in Suisun Bay. Generally, copepod and rotifer populations have drastically declined in this embayment, although water flea populations appear to be healthy (SFEP 1992a).

BENTHOS. Common benthic species in this area are those that are well-adapted to changing salinities. The asian clam, *Potamocorbula*, has reached its highest population densities in Suisun Bay and has caused significant changes in the structure of the benthic community. The situation appears not to have stabilized, and currently it is difficult to determine the nature of the benthic community in this body of water. Other common species include the following: the mollusks, *Macoma balthica*, *Mya arenaria*, and occasionally *Corbicula fluminea* when river flows are high; the amphipods, *Nereis succinea*, *Limnodrilus hoffmeisteri,* and occasionally *Ampelisca abdita*; and the polychaete, *Streblospio benedicti* that migrates upstream from more saline waters during periods of unusually low riverine flow (Nichols and Pamatmat 1988).

FISH AND SHELLFISH RESOURCES. The fish assemblage of Suisun Bay is markedly different from San Pablo Bay as a result of decreased salinity and different habitat structure. Changing salinity levels resulting from changes in freshwater outflow may alter the fish assemblage due to the differing salinity tolerance of the various species (Meng, Moyle and Herbold 1994). Typically, reduced salinity results in a decrease in the abundance and diversity of marine species such as northern anchovy, Pacific herring, white croaker, and jacksmelt which comprise a substantial portion of the fish assemblage. Species characteristic of Suisun Bay are striped bass, longfin smelt, yellowfin and chameleon goby and the northern anchovy. The abundance of many species have declined in recent years, including the striped bass, American shad, longfin smelt, delta smelt and starry flounder. Declines and changes in fish assemblages have been attributed to reduced Delta outflow and other anthropogenic impacts (Meng and Kanim 1994).

Table 4.3-16. Sediment Quality in Suisun Bay

Parameters	*Source (1) fine*	*Source (2) fine*	*Source (3) coarse*
Grain Size (percent)			
Gravel	0	0	0-1
Sand	1-2	1-3	80-97
Silt	31-36	28-31	0-12
Clay	62-68	66-72	2-8
Total Organic Carbon (percent)	1.4-1.5	1.6	0.11-0.3
Organic Contaminants (μg/kg)			
Tributyltin	NA	NA	ND
Dibutyltin	NA	NA	ND
Monobutyltin	NA	NA	ND
TRPH (mg/kg)	NA	NA	0-14
DDT and metabolites	3.9-10.4	4.4-7.0	ND
Pesticides	4-14	4-9	ND
total PCBs	8.1-17.8	8.0-13.0	ND
total PAHs	545-3,089	441-1,825	4-47
Metals (mg/kg)			
Arsenic	12.1-20.6	11.1-13.7	6.2-8.8
Mercury	0.2-0.4	0.3-0.4	0.01-0.03
Selenium	0.2-3.3	0.3-1.0	0.1-0.2
Cadmium	0.3	0.3-0.4	0.1
Chromium	70-105	107-125	230-334
Copper	52-67	68-72	17-29
Lead	20-27	23-24	7-12
Nickel	85-115	113-124	83-106
Silver	0.3	0.3-0.4	0.3-0.4
Zinc	124-151	131-164	72-77

Notes:
* Grain size data expressed as percent fines.
** Data not reported due to QA problem.
NA Not analyzed
ND Not Detected

Sources:
(1) Grizzly Bay (BF21) from SFEI (1994 and 1995)
(2) Honker Bay (BF40) from SFEI (1995)
(3) Sandy stations in Bulls Head Channel from Kohn et al. (1994)

Important crustacean species of Suisun Bay include two species of bay shrimp. California bay shrimp prefer the lower salinities that are common to Suisun Bay and blacktail shrimp are common and important food for striped bass, American shad, sturgeon and white catfish. Abundant and particular to Suisun Bay is the introduced shrimp *Palaemon macrodactylus* (SFEP 1992a); Nichols and Pamatmat 1988). Dungeness crab enter Suisun Bay when salinities are greater than about 10 ppt.

WILDLIFE RESOURCES. Birds common on the Suisun Bay are the wading birds, the great blue heron, great egret, snowy egret, American coot and Virginia rail. Migratory water fowl are the northern pintail, mallard, American widgeon, northern shovelers, Canada geese and cinnamon teal. The western sandpiper, dunlin, and long-billed dowitcher are abundant during spring migration. Marine mammals are generally not found in Suisun Bay.

SPECIES OF SPECIAL CONCERN. The species of special concern identified in Suisun Bay include the winter-run chinook salmon, delta smelt, Sacramento splittail, and the longfin smelt. Disposal in Suisun Bay is not expected to affect most migrating fish species because the site can be easily avoided. Species found in shallow channels are not expected to be affected because water quality changes are limited to an area immediately adjacent to the disposal site. Longfin smelt larvae cannot easily avoid specific areas such as the disposal site, and therefore may be affected by short-term changes in water quality on site and in the deeper channels.

Other special concern species that occur in Suisun Bay include brown pelican, California clapper rail, California least tern, and salt marsh harvest mouse.

Summary of Environmental Characteristics of Suisun Bay Potentially Affected by Dredged Material Disposal

Table 4.3-17 summarizes the resources within Suisun Bay that may reasonably be affected by dredged material disposal at the Suisun Bay disposal site, SF-9 or other dispersive sites within or near this water body segment. The magnitude of potential impacts depends on the overall amount of material directed to the Suisun Bay disposal site or to other nearby dispersive sites over the course of the next 50 years, and on the development and implementation of policies that will limit the adverse environmental effects of disposal.

Table 4.3-17. Summary of Resources of Concern for Suisun Bay Dredged Material Disposal Site and Suisun Bay

Resource	*On Site*	*Embayment*
Water Quality		
Dissolved oxygen	X	
Ammonia	X	
Pollutant levels	X	
Toxicity	X	
Sediment		
Characteristics		
Bathymetry/dynamics		
Quality	X	X
Total Suspended Solids/Turbidity	X	X
Aquatic Resources		
Habitats		
Benthos	X	
Fish		
Longfin smelt	X	X

4.3.2.5 South Bay

South San Francisco Bay includes all Bay waters south of the Oakland-San Francisco Bay bridge. The largest of the embayments, the South Bay covers 214 square miles and has a mean depth of 11 feet (SFEP 1992b). Salinites remain at near-ocean concentrations during much of the year although flushing of South Bay waters occurs during periods of high riverine flow. Consequently, the aquatic resources of the area are adapted to saline conditions.

The extreme southern edge of the South Bay south of the Dumbarton Bridge has historically been an area where water quality and associated beneficial uses have been impacted by sewage treatment facilities and industrial sources. Thus, while nutrient concentrations in other parts of the estuary vary seasonally, levels in the South Bay are relatively constant, being primarily a result of imputs from sewage treatment plants.

Material dredged from the ship channels and port facilities around the margin of the South Bay was historically disposed at many sites around the embayment. In 1972, the COE proposed using two sites, one off Hunter's Point and one just off the San Mateo Bridge, for material disposal. In 1975, however, these sites were de-designated because monitoring information showed they were not dispersive and thus had a very limited capacity. Since that time, there has been no disposal of dredged material from the projects described in this analysis within this embayment. Material from South Bay dredging projects is instead taken to Alcatraz or upland disposal sites.

Currently, there are no plans to designate any multi-user disposal sites within the South Bay. Although the COE has included a generic consideration of the "Bay Farm Borrow Pit" site as a location for a potential confined aquatic disposal (CAD) site for NUAD material in several recent EIS documents — Oakland Harbor SEIR/S (USACE and Port of Oakland 1994), Richmond Harbor SEIS/EIR (USACE and Port of Richmond 1995), and the John F. Baldwin Ship Channel (USACE and Contra Costa County 1995) — no formal proposal has yet been made to designate this site. Any proposal to designate a new site would require a complete, site-specific environmental review (see section 5.1.3.3).

The following section describes the resources of the South Bay that could potentially be affected by designation of a new site and/or by material transported from a Central Bay disposal site(s). However, it is important to emphasize that this programmatic EIS/EIR does not propose or anticipate the designation of a new South Bay site.

On-Site Environmental Impacts that Should Be Addressed in the Event a South Bay Disposal Site is Considered

The following discussion is based on a hypothetical unconfined South Bay site located within the main embayment at a site where the currents are the strongest within this portion of the Estuary. The on-site impacts of unconfined diposal at shallower sites and/or those sites located in lower energy areas would generally be greater.

WATER QUALITY. The water quality characteristics within a South Bay site that would be potentially affected by dredged material disposal are the same as those affected by disposal at existing in-Bay sites. These impacts include short-term depressions in DO and changes in the DO depth gradient on site; short-term changes in pH, ammonia, and salinity within the plume; and associated changes in gradients of these parameters in ambient waters. In general, water quality characteristics within 1 to 2 meters of the Bay floor are most likely to be affected.

SEDIMENT. The disposal of dredged material at a hypothetical new South Bay site could significantly alter sediment characertistics, particularly if the site were located in a region of shellfish beds or in a location characterized by coarser material such as found in the main navigation channels.

TOTAL SUSPENDED SOLIDS AND TURBIDITY. As was the case at the other designated disposal sites, turbidity levels in waters at a hypothetical South Bay site would be affected by dredged material disposal. Impacts would include short-term increases in turbidity, particularly in water near the bay floor. The rate with which this turbidity plume would dissipate would depend largely on current strength and the composition of the material disposed.

AQUATIC RESOURCES. The aquatic benthic resources would be most affected by the designation of a hypothetical South Bay disposal site. Disposal of material would bury benthic organisms. This impact is unavoidable and would likely result in colonization of the site by opportunistic species, thereby marking a significant change to the community composition.

Environmental Characteristics of South Bay Potentially Affected by Dredged Material Disposal

WATER QUALITY. Short-term increases in metal levels (particularly cadmium, copper, nickel, and lead) associated with the increase in suspended particulate material near the Bay bottom are also likely. Of particular concern within the South Bay are water column concentrations of copper and nickel. Ambient concentrations of these two metals have historically exceeded water quality critieria. Although discharge of these metals is gradually being reduced by the implementation of widespread point and nonpoint source control measures, past discharges have resulted in sediments acting as both a sink and source for these metals to the overlying water. Thus, even small increases in copper and nickel concentrations associated with dredged material disposal in an already affected system could potentially cause adverse effects in the water column. In contrast, similar discharges in other areas of the Estuary would be expected to have a less of an impact on water quality due to lower ambient concentrations of these metals.

TOTAL SUSPENDED SOLIDS AND TURBIDITY. Recent data on TSS concentrations in the waters of the South Bay is available for three monitoring stations: one located on the San Mateo Bridge on the eastern edge of the ship channel; one at Pier 23 off the Dumbarton Bridge; and one at Coast Guard Channel marker 17 in the central portion of the embayment south of the Dumbarton Bridge. Suspended solids levels were highest in the southernmost end of the embayment and varied from 52.8 mg/l to 153 mg/l at mid-depth and 67.1 to 197 mg/l at near-bottom. Average concentrations decreased northward, moving closer to the marine-influenced Central Bay. At a site at the boundary between Central and South bays (the Bay Bridge), the average suspended solid concentration was 36 mg/l near the bottom and 29 mg/l at mid-depth (Buchanan and Schoellhamer 1994).

SEDIMENT CHARACTERISTICS AND DYNAMICS. Sediment grain size in the northern part of the South Bay averages around 60-70 percent silt and clay, with higher concentrations of coarser sediments observable in early summer (Nichols and Pamatmat 1988). One distinguishing feature of sediments in the South Bay are the high concentration of shell fragments and remnants of shellfish beds found in mud along the eastern margin of the embayment. Sediment in the South Bay is resuspended two to five times before final burial, with the highest resuspension rates occurring during summer when wind-generated currents move across the embayment.

SEDIMENT QUALITY. Representative physical and chemical data from 1993-94 for three monitoring stations in the South Bay are presented below in Table 4.3-18.

Table 4.3-18. Sediment Quality in the South Bay

Parameters	*Oyster Point*	*Dumbarton Bridge*	*Extreme South Bay*
Grain Size			
Percent fines	34-36	74-77	72-76
Total Organic Carbon (percent)	0.7-1.4	0.7-1.4	0.8-1.5
Organic Contaminants (μg/kg)			
DDT and metabolites	1-3	2-6	2-3
Pesticides	2-7	2-9	4-12
total PCBs	9.9-24.8	2.6-36.5	16.7-32.4
total PAHs	1,407-4,022	2,095-4,232	1,707-7,632
Metals (mg/kg)			
Arsenic	9.7-14.2	9.7-13.1	9.8-12
Mercury	0.2-0.3	0.3-0.5	0.3-0.5
Selenium	0.3-0.7	0.2-0.5	0.3-1.3
Cadmium	0.05-0.3	0.04-0.2	0.04-0.2
Chromium	57-91	65-99	78-99
Copper	29-38	32-46	40-54
Lead	14-22	15-35	23-41
Nickel	60-86	48-103	70-100
Silver	0.3-0.5	0.3-0.5	0.4-0.6
Zinc	85-101	91-137	118-144

Notes: ** Data not reported due to QA problem.
Source: SFEI (1994 and 1995)

PHYTOPLANKTON AND ZOOPLANKTON. Phytoplankton productivity in the South Bay is high, contributing a significant amount of organic carbon to the Bay food chain. Productivity tends to increase with annual Delta discharges as higher outflows promotes stratification. Stratification then leads to higher growth rates and lower losses to suspension-feeding benthic macroinvertebrates. Conversely, decreased outflow from the Delta depresses phytoplankton productivity in the SF Bay. (SFEP 1992a). *Synchaeta* is the most common rotifer in the South Bay. Generally, rotifers are abundant in areas where there are high levels of chlorophyll *a*. Abundances of two copepod species, *Acartia californicus* and *Acartia calussi* vary seasonally (SFEP 1992a).

BENTHOS. Most of the South Bay is characterized by shallow water habitat. South Bay substrates are predominantly either soft mud or masses of shell fragments remaining from a previous commercial oyster industry. Shallow soft sediments are dominated by the large tube dwelling polychaete *Asychis elongata*. Other species present include large numbers of small clams (*Gemma gemma* and *Potamocorbula amurensis*), a tube-dwelling amphipod (*Ampelisca abdita)*, and the polychaete *Streblospio benedicti*. The molluscs *Mya arenaria* and *Macoma balthica* and the omnivorous mudsnail *Ilyanassa obsoleta* also are common on soft sediments. Shell deposits and areas with boulders, broken concrete, and cobbles, found particularly along the eastern and western margins of central South Bay, provide habitat for limpets (*Crepidula* spp.), predatory snails (*Urosalpinx cinerea*), ascidians (*Mogula manhattensis*), and molluscs (*Musculista* and *Tapes japonica*) (Nichols and Pamatmat 1988).

Several different kinds of crustaceans are found in the South Bay including Bay shrimp (*Crangon nigricauda* and *C. nigromaculata*) and brine shrimp, *Artemia salina*. The recently introduced green crab (*Carcinus maenas)* has also been observed in the South Bay.

Of the species listed above, only *Macoma balthica* may be native. The recently introduced Asian clam (*Potamocorbula amurensi)s* and green crab (*Carcinus maenas)* are changing the benthic community through their activities, as previously did other invasive species. The effects of *Potamocorbula* appear to be related to rapid population growth and its ability to filter large volumes of water as it feeds on suspended particles that include not only large numbers of phytoplankton, but the larvae of other invertebrates. *Potamocorbula* are tolerate salinities ranging from 1 to 33ppt (SFEP 1992a).

FISH. Northern anchovy, Pacific herring, shiner perch, jacksmelt and topsmelt dominate the species in the South Bay, however abundance is variable. The fishes of the South Bay are characteristic of a lagoon-type estuary where the salinity ranges are small. One area in the South Bay provides one of the few Pacific herring spawning sites in the Bay (LTMS 1994b). Longfin smelt, bat rays, walleye surfperch, brown smoothhound, and adult white croaker are also common in the South Bay.

Seasonal migration of marine fishes such as chinook salmon and American shad alter the composition of species in the South Bay. Bay gobies are often found in the South Bay on a seasonal basis (SFEP 1992a). Speckled sand dab, English sole, and staghorn sculpin vary in abundance. Fishes characteristic of shallow waters are less predictable in abundance than those found in the channels. In recent years, the species composition and overall fish abundance have remained fairly consistent except for an increase in the abundance of white croaker and plain midshipman that may be attributable to increased salinities.

WILDLIFE. The South Bay provides habitat for 60 percent of the shorebirds in San Francisco Bay (SFEP 1992b). Common birds in the South Bay include the western meadowlark, western sandpiper, and killdeer, dowitcher, and northern shoveler, white pelicans during their winter migration, and colonial waterbirds such as herons, terns, gulls, egrets and cormorants. Also found in the South Bay are scaups, scoters, northern shovelers, eared grebes, terns, red necked phalaropes, black-necked stilts, greater yellowlegs, lesser yellowlegs, and American avocets.

Harbor seals and the California sea lions haul out on the mudflats and intertidal salt marshes of the South Bay. Raccoons and striped skunks can be found in the mudflats areas. Red fox have also been observed in the South Bay.

SPECIES OF SPECIAL CONCERN. Species of special concern in the South Bay include the brown pelican, American peregrine falcon, California clapper rail, California least tern, western snowy plover, and salt marsh harvest mouse. Nesting colonies of the California least tern have been established at Alameda Naval Air station and the Oakland Airport. Federal species of concern in the South Bay are the Alameda song sparrow and the saltmarsh common yellowthroat. The San Francisco-Oakland Bay Bridge is an important nesting site to the double crested cormorants who are listed under CDFG species of special concern (SFEP 1992a). Alameda Naval Air Station provides a major roost for the endangered California brown pelicans.

The salt marsh wandering shrew, another federal species of concern, is limited to an small area in the southern part of the Bay. The endangered salt marsh harvest mouse also lives in the South Bay. Two varieties of bats that are species of concern (not endangered) and found in this area are the Pacific western big-eared bat and the greater western mastiff bat.

Summary of Environmental Characteristics of the South Bay Potentially Affected by Dredged Material Disposal

Table 4.3-19 presents the resources within the South Bay that may reasonably be affected by dredged material disposal at a theoretical disposal site or other dispersive sites outside this water body.

Table 4.3-19. Summary of Resources of Concern for the South Bay

Resource	*On Site*	*Embayment*
Water Quality		
Dissolved oxygen	X	X
Ammonia	X	
Pollutant levels	X	X
Toxicity	X	
Sediment		
Characteristics	X	X
Bathymetry/dynamics	X	X
Quality	X	X
Total Suspended Solids/Turbidity	X	X
Aquatic Resources		
Plankton		X
Habitats		
Benthos	X	X
Eelgrass		X

4.3.2.6 Delta

There are no aquatic dredged material disposal sites in the Delta and currently there are no plans to designated any aquatic disposal sites. However, dredged material disposal and reuse, primarily for levee stabilization projects, does occur in the Delta and may be expanded in the future. The Delta environment and resources at risk from dredged material placement are discussed below in section 4.4.

4.4 UPLAND/WETLAND REUSE ENVIRONMENT

The Estuary is one of the largest estuaries in North America and is comprised of two distinct regions: the San Francisco Bay region and the Sacramento- San Joaquin Delta region. The Estuary supports a variety of natural habitats (see Figure 4.4-1), of which wetlands are among the most valuable.

However, the Estuary today bears little resemblance to its historic past. The Delta and large land areas along the margins of the Bay have been greatly modified by human activity. The Delta, once an area of expansive freshwater wetlands, is now comprised of 57 diked low-lying islands and higher lands, most of which is in agricultural use (SFEP 1992b).

The Estuary shoreline downstream of the Delta supports only a fraction of its former natural uses. Urban land use predominates along the edges of the Bay in all but a few areas of the South Bay, San Pablo Bay, and Suisun Bay, where remnants of tidal wetlands remain. Nearly 30 percent of the upland areas in the LTMS Planning Area is urbanized (SFEP 1992b).

This section discusses the placement/beneficial reuse of dredged material in the upland (diked) and wetland areas surrounding the margins of the Bay/Delta. Dredged material placement in the upland/wetland reuse environments includes confined disposal facilities (CDFs), rehandling facilities, and beneficial reuse sites. The COE's manual on beneficial reuse of dredged material (EM 1110-2-5026) identifies 11 broad categories of beneficial reuse: wetland habitats; upland habitats; island habitats; aquatic habitats; beaches and beach nourishment; aquaculture; parks and recreation; agriculture, forestry and horticulture; strip mine reclamation and solid waste landfill; multi-purpose uses and other land use concepts; and construction and industrial/commercial use. Previous LTMS studies have identified the following beneficial reuses appropriate for the Bay Area that are worthy of further consideration:

- Tidal wetland restoration (habitat development);
- Rehandling facilities for landfill cover and other end uses;
- Levee rehabilitation;
- Beach nourishment; and,
- Construction fill.

For the purposes of this EIS/EIR, four of the above five LTMS identified beneficial reuses are considered appropriate for the Bay Area and have been categorized into three principal upland/wetland dredged material reuse classifications: (1) habitat restoration; (2) levee maintenance and stabilization; and (3) rehandling facilities. Beach renourishment is not included in this list as it is a specific type of reuse, having a limited application as a disposal option within the Estuary.

There are many opportunities for the reuse of dredged material for habitat restoration. One of the primary uses of dredged material for habitat restoration is the placement of dredged material along the margins of diked subsided areas. This can sufficiently elevate these sites so that tidal marsh habitat is developed once the perimeter levees are breached. Dredged materials could also be used to create elevated areas within tidal wetland restoration sites that, after the reintroduction of tidal action, would be inundated only during maximum high tides, thereby ponding water from infrequent tidal inundation and rainfall. These areas would be considered saline/brackish seasonal wetlands that would provide additional habitat diversity in restored tidal wetland areas.

Other habitat restoration uses of dredged material include constructing berms, separating tidal and seasonal wetlands within individual sites, or creating areas for ponding and drainage control on wetland sites not influenced by tidal action. Dredged material could also be used for filling low areas where undesirable salt pans form (i.e., at duck clubs, within managed wetland areas).

Dredged material can be used to create or restore seasonal wetland habitats by raising and modifying topography and thus improving wetland hydrology. Seasonal wetlands in the Estuary include diked salt and brackish marshes, vernal pools, other emergent freshwater habitats, farmed wetlands, and abandoned salt ponds.

The levee maintenance and stabilization category primarily addresses the beneficial reuse of dredged material for repair and bolstering (stabilization) of levees in the Delta region of the Planning Area. This regional focus results from preliminary estimates by the DWR which indicate that in excess of 50 mcy of material will be needed to upgrade levees to flood control and seismic standards. Three existing Delta island levee upgrading and repair projects have demonstrated that some of the needed fill can be met through the use of dredged material.

The category of rehandling facilities principally refers to the facilities themselves and the associated end product uses of the processed material (once sorted and dried) such as landfills, construction fill material, and limited levee maintenance and stabilization uses. The resources of concern for CDFs are also discussed under this category since potential impacts from CDF construction and use are similar to those of rehandling facilities and landfills.

4.4.1 The Upland/Wetland Reuse Environment Setting

All uses of the Estuary depend, to varying degrees, on the quality and health of its water and wetlands. While many uses in the Estuary region co-exist with and enhance the Estuary, others can conflict with or degrade the value and beneficial uses of the Estuary. A leading cause of degradation and fundamental threat to the present and future benefits of the Estuary is the loss of open water areas, wetlands, and stream environments through modification or conversion to other uses. However, human activities within the region also impact the Estuary through the contribution of pollutants, through direct and indirect inputs.

As discussed in section 4.2, the Estuary has been modified greatly from its historical state. Where once wetlands and mudflats ringed the Bay, large portions of these former baylands (approximately 90 percent) have been converted, by means of fill and diking, to upland uses. Other formally open-water areas of the Bay were also filled for upland uses. Although some of the areas diked off from the Bay are presently used for managed wildlife habitat (e.g., managed wetlands in the Suisun Bay region, and seasonal habitat in the San Pablo Bay region — see discussion under respective sections below) or remain under agricultural cultivation (e.g., the diked baylands of San Pablo Bay), much of the created upland areas have been converted to urban uses such as homes or shopping centers. Additionally, large areas in the north and south reaches of the Bay were diked off for the creation of salts ponds (see Section 4.3).

This modification of the Estuary has greatly impacted its ecosystem. For example, the reduction of wetlands has deprived the Estuary of one of its organic parts, resulting in a patchwork of wetlands that have reduced value to wildlife, a greatly reduced ability to filter and absorb pollutants, and a significantly reduced regional biodiversity. Modified wetlands adversely alter the natural hydrologic conditions and role of wetlands in providing habitat for wildlife, assimilating pollutants, and trapping sediments.

As the population continues to grow, and current agricultural and rural lands are converted to urban uses, the Estuary will be further adversely impacted by the elimination or modification of wetlands, modification of stream environments, and additional pollutant loading from urban runoff. Within the upland areas of the Planning Area (created by fill or otherwise previously existing), 896,498 acres (14 percent) are in residential, commercial/light industrial, and heavy industrial uses. Of that amount, 582,444 acres (9 percent) are residential use; 150,081 acres (2 percent) are in commercial/light industrial use; and 163,973 acres (3 percent) are in heavy industrial use. Intensive agriculture and rural land amounts to 3,847,767 acres (59 percent) (SFEP 1992b).

Pollutants enter the Estuary from a variety of sources: conveyed by riverine inflow from upstream sources; urban runoff (storm water and other runoff from urban areas); non-urban runoff (water from agricultural lands, forests, range lands, and irrigation return flow as surface runoff or subsurface drain water); point sources (publicly-owned treatment facilities and industrial discharges); dredging and dredged material disposal; petroleum, chemical, and other material spills; and atmospheric deposition (fallout, or settling of pollutants transported by the wind). An estimate of the range and magnitude of the Estuary's pollutant loadings is shown in Figure 4.4-2 (SWRCB 1990).

This section describes the current environmental settings found within the upland/non-aquatic environments of the Planning Area. These environments include the following: (1) the ecosystems of the diked baylands (seasonal wetlands, palustrine wetlands, and seasonal ponds); (2) managed wetlands; (3) riparian woodlands; (4) Delta levees; and (5) urbanized areas. As described below, each of these settings is individually important to the function of the Estuary as a whole, and each has experienced the impacts associated with the modification of the Estuary.

4.4.1.1 Upland/Wetland Reuse Environment Parameters

The Estuary consists primarily of the open tidal, brackish, and fresh water system of the San Francisco Bay and Sacramento-San Joaquin Delta, their adjacent wetlands, and tributary streams. However, the upland areas surrounding the Estuary, the diked former bayland

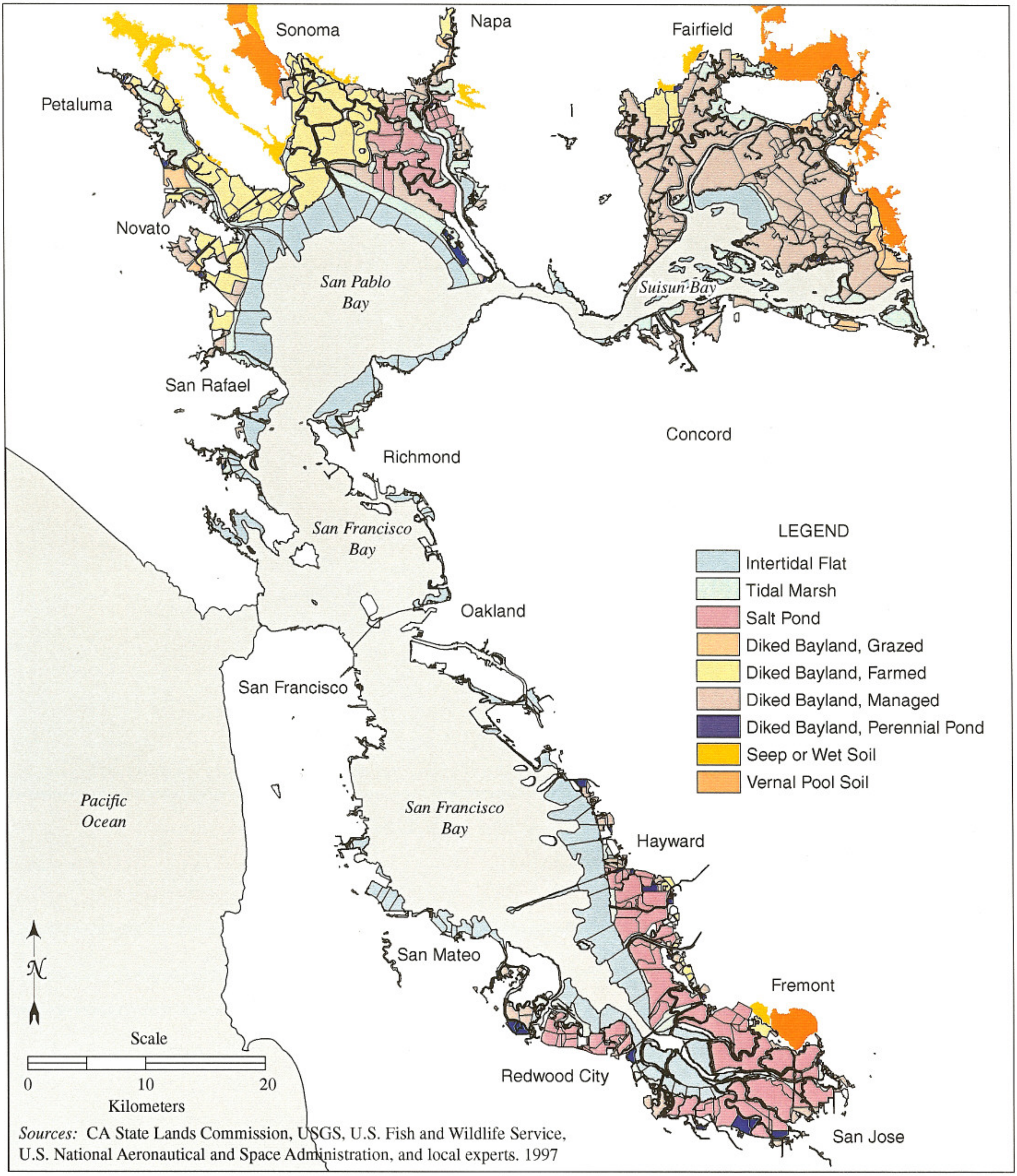
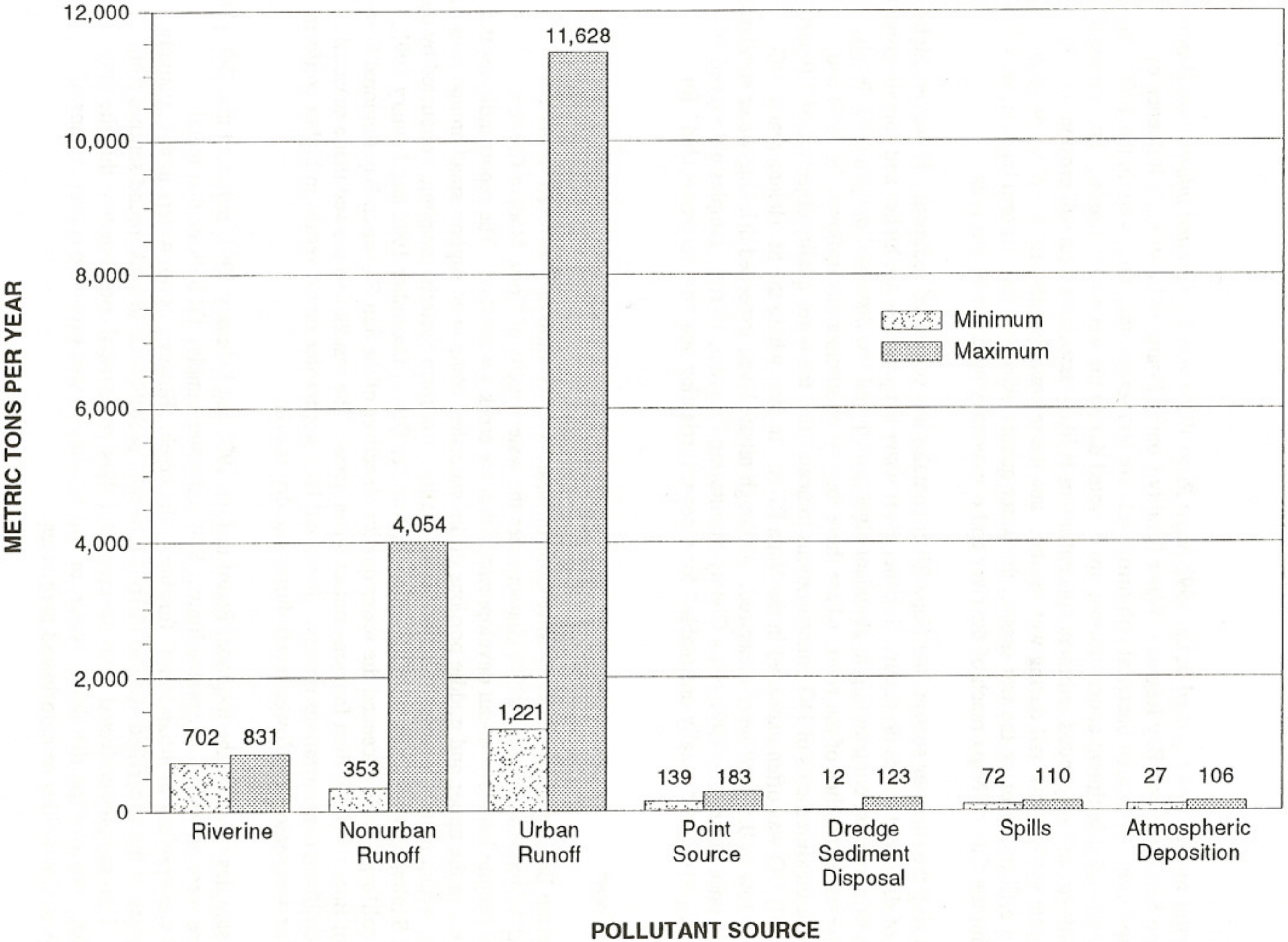


Figure 4.4-1. Modern View of Baylands (ca. 1985-1996)



Note: Bars represent tonnes per year of calculated pollutant loads from identified sources. It should be noted however, that because of inadequate data the loads for some important categories of pollutants were not calculated for the sources shown and are therefore not included in this figure. Due to the varying toxicity of different pollutants, bar heights do not reflect either the toxicity of the pollutants or their impacts on beneficial uses.
Source: SWRCB (1990)

Figure 4.4-2. Combined Pollutant Loadings to the Bay/Delta by Source Type

Water Quality Monitoring Data Summaries for Napa River and Corte Madera Creek

Napa River

Napa River water quality was reported in the 1992 *Napa River Watershed Background Information Report*, prepared by the San Francisco Bay Regional Water Quality Control Board, to be strongly influence by seasonal precipitation. Although bacterial coliform levels are less serious than they were in the 1960s, both coliform and suspended sediment concentrations are elevated during the wet winter season. This seasonal increase in coliform and suspended sediment concentrations is likely associated with soil erosion, poorly constructed septic systems that fail during wet weather, and the seasonal (winter) release of wastewater treatment plant effluent. During the wet season, the water quality objectives for coliform bacteria are often exceeded within the City of Napa reach of the river and occasionally upstream of this area.

In contrast, during the summer season, the Napa River contains less suspended sediment. However, higher concentration of dissolved solids do occur. Summer river water temperatures are higher and contain greater concentrations of nutrients, contributing to abundant algal growth and low dissolved oxygen (DO) levels, especially in the upper reaches of the river, where there may be no summer streamflows. In 1984 and 1985, dry season measurements of DO concentrations indicated that the water quality objective of 7.0 parts per million (mg/l) DO was often exceeded in the Napa River. In fact, within the St. Helena reach, DO concentration as low as 0.5 mg/l were measured. Although nitrate levels exceeded drinking water standards of 45 mg/l only once during the 1991 Napa County Monitoring Program, 15 river samples did exceed 30 mg/l; this is categorized as "usually unsuitable" for vineyard irrigation and "not recommended" for industrial uses.

Corte Madera Creek

The San Francisco Bay Regional Water Quality Control Board's *Corte Madera Watershed Resources Evaluation and Information Report* (1994) characterizes the water quality of Corte Madera Creek as generally good despite intensive urban development within the creek's watershed. The report indicates that tributary streams in the upper and middle portions of the watershed continue to support small annual runs of steelhead trout, which require reasonably good water quality. Coliform bacteria sampling, conducted by the Central Marin Sanitation District and Sanitary District Number One in December 1992 and January 1993, indicated that coliform levels exceeded the water quality objectives of the San Francisco Bay Regional Water Quality Control Board's Basin Plan for non-contact water areas. The results also showed that a seasonal fluctuation of coliform concentrations occurs. Street and land stormwater runoff results in higher coliform levels during the wet season and lower levels during the dry season.

Water quality samples taken by the Regional Board in June 1992 and February 1993, indicated that DO, pH, and temperature were all within acceptable limits. Soil and water samples did indicate that metal concentrations were present in urban runoff flowing to the creek. However, even waters in the relatively undeveloped areas of the watershed showed dissolved metals, probably due to background sources from local geology. Fish samples collected from the creek did show some metal constituents within the fatty tissue of the fish. None of the fish tissue, water, or soil samples showed excessive concentrations of organophosphorous pesticides or chlorinated herbicides.

areas along its margins, and the Delta island system are also integral components of the overall ecosystem.

Each of the natural components of the larger Estuary system are also individually important. As discussed in section 4.3, the Estuary's tidal wetlands play a major role in the function of the overall system by providing habitat and serving as nursery grounds for fish and wildlife, while also serving as a natural mechanism for pollutant and sediment assimilation. However, the seasonal wetlands, present within subsided areas of the diked baylands, as well as other upland habitat areas (i.e., away from the Bay), such as riverine and stream systems and associated riparian corridors, comprise important wildlife habitat elements of the overall Estuary (SFEP 1992b).

Parameters that are described for the upland/wetland reuse environmental setting are separated into three broad categories: (1)water quality, including: surface and ground water quality, pollutant loading, drinking water standards, and salinity; (2) hydrologic features, including: hydrology, tidal plain elevation, flood protection, and subsidence; and (3) land uses, including: diversity of habitat type, agricultural lands, and coastal zone management and local zoning.

Water Quality

SURFACE AND GROUND WATER QUALITY

The quality of water that flows to the Bay through the rivers, creeks, lakes, and drainage channels in the Planning Area is highly variable, ranging from water containing high concentrations of pesticides, metals, and organics typical of highly degraded creek systems, to those low concentrations found near pristine cold-water streams. There is no comprehensive water quality monitoring program of the upland surface waters in the Planning Area. However, periodic water quality monitoring of Corte Madera Creek and Napa River illustrates the range of water quality in the upland environments around the Estuary. A summary of this monitoring is presented in the text box above.

San Francisco Bay is the principal receiving water body for the majority of all urban, non-urban, and wastewater discharges from the upland/non-aquatic environments of the Planning Area. These runoff and wastewater inputs have a profound impact on nearly every aspect of the aquatic ecosystem, including upland surface and ground water systems. Regulatory standards for water quality in the Estuary are promulgated by a number of agencies under various legislative acts. The EPA establishes federal criteria for drinking water quality as mandated by the Safe Drinking Water Act (as amended in 1987) and, for freshwater and saltwater aquatic life water quality, the Water Pollution Control Act (also known as the Clean Water Act [CWA]) (see Appendix H.1). Under provisions of the state Porter-Cologne Water Quality Control Act and the CWA, the SFBRWQCB and the CVRWQCB regulate water quality in the Estuary (see regulatory discussion [section 4.8] and Appendix H.2 and H.3). The regional boards are authorized to monitor ground and surface water quality and to require permits for the discharge of wastewater to all navigable waters.

Any placement of dredged material within the upland environment of the Planning Area that could result in the discharge of wastewater or the degradation of groundwater would be subject to the review and approval of the appropriate jurisdictional regional board, in accordance with the appropriate Basin Plan. These plans contain water quality standards for the Delta and San Francisco Bay that conform to the SWRCB policies for water quality control (see Appendix H.4). The federal and state water quality criteria/objectives are presented in Appendix H.

POLLUTANT LOADING

A Pollutant Policy Document (PPD), prepared by the SWRCB in 1990, identifies and characterizes pollutant of concern in the Bay and Sacramento-San Joaquin Delta Estuary. The pollutants of concern were identified based on their frequency of occurrence and their potential to cause adverse impacts on beneficial uses. These pollutants include the following: arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc, tributyltin (TBT), organochlorines, chlorinated dibenzodioxins and dibenzofurans, and hydrocarbons. Five sources have been identified in the PPD, including point sources, urban runoff, non-urban runoff, riverine sources, and others. Scientists estimate that urban runoff may contribute the greatest pollutant loads to the Estuary. Non-urban runoff (e.g., from agricultural land) and riverine sources also contribute substantial pollutant loads to the Estuary (SWRCB 1990).

DRINKING WATER STANDARDS

Drinking water standards are established by both state and federal agencies. Based on guidelines developed by the EPA and the California Department of Health Services, there are established primary and secondary drinking water standards that must be met by public water systems. Federal standards are established pursuant to the Public Health Service Act, as amended by the Safe Drinking Water Act and other federal regulations related to public water supply. Under the National Interim Primary Drinking Water Regulations promulgated by the EPA (40 CFR parts 141 and 143), maximum contaminant levels (MCLs) have been developed for a number of micro-biological, inorganic chemicals, organic chemicals, and radionuclide pollutants (see Appendix H.1).

In addition to the MCLs, water quality objectives for domestic or municipal supplies are designated in the SFBRWQCB (Appendix H.2) and the CVRWQCB Basin Plans (Appendix H.3). Such waters must not contain concentrations of chemicals greater than those specified in Title 22 of the California Administrative Code (CAC), Chapter 15, Article 4.

In 1986 the Safe Drinking Water and Toxic Enforcement Act was approved by the California voters as Proposition 65. The purpose of this Act is to prohibit the discharge, into sources of drinking water, of chemicals that have been listed by the Governor as causing cancer or reproductive toxicity. However, the Safe Drinking Water and Toxic Enforcement Act may not be applied to a discharge that does not contribute "significant concentration" of a chemical, relative to a concentration level, as determined by the State Health and Welfare Agency.

Federal and state drinking water standards are applicable to the placement or reuse of dredged material in the upland environment of the Planning Area, pursuant to the SWRCB's Resolution Number 88-63 (Sources of Drinking Water). This resolution established that all ground and surface waters of the state are considered suitable or potentially suitable for municipal or domestic water supply with the exception of those waters that are hydrologically, biologically, economically, or practicably unsuited for public use. Specifically exempted are ground and surface waters where (1) the total dissolved solids exceed 3,000 mg/l and are not reasonably expected by Regional Boards to supply a public water system; or (2) there is contamination either by natural processes or by human activity (unrelated to a specific pollution incident) that cannot reasonably be treated for domestic use using either Best Management Practices (BMPs) or best economically achievable treatment practices; or (3) the water source does not provide sufficient water to supply a single well capable of producing an average sustained yield of 200 gallons per day. Pursuant to this resolution, the discharge of water from the beneficial reuse/placement of dredged material within the Delta region would be subject to compliance with drinking water standards, regardless of whether such discharge occurred within or outside individual Delta islands.

Salinity

Salinity issues related to the beneficial reuse of dredged material in the upland/non-aquatic environment range from critical to insignificant depending on the placement environment. Within tidal wetland environments, the salinity of the overlying water and marsh sediments is considered a dominant factor influencing productivity and species distribution. For example, in the North Bay, freshwater and brackish water-adapted plants dominate northern Suisun Bay, while saltwater-adapted plants occur throughout most of the remaining lower, more ocean influenced, areas of the Bay.

The potential placement of saline dredged material in the existing freshwater environment is also of critical concern. The Sacramento and San Joaquin Delta region contains over 700 miles of interconnected waterways and is recognized by state and federal agencies as a highly sensitive fish and wildlife ecosystem. Water quality standards within the Delta are also established for the protection of fish and wildlife, as well as municipal, industrial, and agricultural water uses. These standards include provisions that minimize saline inputs to the aquatic environment.

As with hydrology issues for landfills and CDFs, salinity concerns at these environments are minimal. Surface and ground water at such facilities are collected by surface and subsurface drain/leachate systems. Any discharge of drainage water from these facilities is required to meet the standards set by state and federal law, including standards for salinity. In some cases, however, processing (washing) of dredged material may be necessary to reduce salt content prior to reuse.

Hydrologic Features

Hydrology

Hydrology within the environment of existing levees, landfills, and CDFs is ostensibly controlled by man. The use of dredged material at such sites is not expected to significantly alter local hydrology. In wetland restoration, however, hydrology is considered to be the single most important factor for the establishment and maintenance of specific wetland habitat types (Mitsch and Grosselink 1986). Even small changes to a wetland's hydrology can result in significant changes to its productivity and species diversity. Water sources for the Estuary's wetlands are derived from the Bay, local drainages surrounding the Bay and Delta, and larger rivers draining the Central Valley. Within the diked baylands, however, seasonal precipitation is the single most important factor affecting the development and support of seasonal wetlands. Overall, Delta outflow from the Sacramento and San Joaquin rivers determines the tidal mixing, salinity ranges, and transport of materials through the Estuary.

Variable tidal ranges, time of submergence, exposure and tidal flushing, influence the vertical extent of wetland vegetation and the distribution of different wetland types.

TIDAL PLAIN ELEVATIONS

Tidal marshlands are not flat. The average elevation of the marsh surface relative to an absolute datum decreases with distance upstream of the tidal inlet(s) to the marsh. Elevation plays an important role in the physiology (geomorphology) of tidal wetlands. The occurrence and productivity of vascular plants of tidal marshes tends to correspond to tidal elevations, where changes in elevation result in substantial changes in habitat conditions (LTMS 1994d).

An LTMS-sponsored study examining tidal wetland restoration using dredged material found that the elevation of the marsh plain after placement of dredged material is critical to provide the successful physical conditions for tidal marsh evolution. This includes developing slough channels as natural sedimentation occurs on the marsh plain and vegetation is established (LTMS 1994g).

The results of the field investigations by ENTRIX and Philip Williams & Associates (LTMS 1994d) at Muzzi Marsh in Marin County and Faber Tract in San Mateo County provide the following important physical design implications for developing tidal wetland restoration projects using dredged (fill) material:

- No slough channels will develop when material is placed at an elevation higher that approximately 0.5 feet below mean higher high water (MHHW). Tidal marsh vegetation, dominated by pickleweed (*Salicornia virginica*), will colonize the higher elevations, but these plants will not be as vigorous as those that colonize areas with a well-developed tidal slough channel system.
- Relatively few channels form when dredged material is placed at an elevation ranging from 0.5 to 1.0 feet below MHHW.
- Abundant slough channels form when dredged material is placed at an elevation less than 1.0 feet below MHHW.

FLOOD PROTECTION

Flood protection is a principal concern for the lower lying areas along the margins of the Estuary. Nowhere, however, are flooding issues more of a concern than for the reclaimed islands and other low-lying areas of the Sacramento and San Joaquin River Delta region.

The California Legislature passed the Delta Flood Protection Act, Senate Bill 34 (SB 34), in 1988 which recognized the importance of the Sacramento-San Joaquin Delta region and appropriated $12 million annually for the implementation of the Delta Levee Subvention Flood Protection Program for 10 years, beginning in July 1988. In addition to the subvention program, SB 34 directed the California Department of Water Resources to develop and implement flood protection projects on the following eight western Delta islands: Sherman, Twitchell, Bradford, Webb, Bethel, and Jersey islands, and the Hotchkiss and Holland tracts. The primary purpose of these western island projects is to protect the federal Central Valley Project and the State Water Project's freshwater supply. The program also provides protection for public highways and roads, utility lines, private and public land uses, recreational areas, and environmentally sensitive habitat. This was considered achievable by means of flood and levee failure protection for the western Delta island region.

The State's Delta Flood Hazard Mitigation Plan outlines the following levee rehabilitation standards: (1) 1 foot of freeboard above the 100-year flood frequency elevation as determined by the COE; (2) minimum crown widths of 16 feet; (3) water-slide levee slopes of 1.5-to-1, with revetment where problematic erosion is recognized; (4) land-side levee slopes of at least 2-to-1, with flatter slopes in the lower portions of the levee in areas where problematic soil stability and seepage is recognized; and all-weather access roads. The Federal Emergency Management Agency (FEMA) determined in 1994 that 39 reclamation districts in the Primary Flood Control Zone did not fully comply with the Flood Hazard Mitigation Plan.

Flood control in the Central Valley is managed jointly by the state, through the Reclamation Board, and by the federal government, through the COE. The Reclamation Board was created by the Legislature in 1911 to carry out a comprehensive flood control plan for the Sacramento and San Joaquin rivers, covering 1.7 million acres in 14 counties. The Board uses both structural and non-structural measures for flood control. Structural facilities include the following: (1) reservoirs to store flood waters for later release; (2) levees to contain flood flows within a defined area; (3) leveed bypasses to carry floodwater that stream channels cannot hold; and (4) channel improvements to enable a stream to carry higher flows while maintaining the same water elevation. Although two of these structural controls do not involve levees, the Delta levee system remains an integral part of the Central Valley flood control program.

Although not addressed by SB 34, the levee system and stormwater retention basins located in the lower reaches of the Estuary are equally important physical flood control measures for much of the low lying urbanized and agricultural areas surrounding the north, central, and south portions of San Francisco Bay.

SUBSIDENCE

Subsidence of the land surface is a principal issue affecting habitat restoration, levee maintenance, and stabilization within the diked historic baylands and the reclaimed Delta islands. Waters in these reclaimed Estuary areas no longer interact with the Bay or Delta waters. The sediment previously deposited from this interaction is now effectively blocked by constructed levees. For the diked historic baylands, the age of the marsh when it was diked is a major factor in the determination of its eventual elevation, which in turn strongly influences the ecological functions of a site. Due to the oxidation of formerly saturated (and therefore anoxic) sediments, between 4 and 6 feet of land surface subsidence has occurred at many diked bayland sites. The more recently diked marshes located in the northern San Pablo Bay region experienced even greater subsidence. These historic marsh areas were formed from sediment deposition associated with the up-stream hydraulic mining that occurred during the late 1800s. Marshes created by the rapid siltation of the Bay during this time had not yet settled and consolidated when diking occurred, leading to subsidence that exceeded other sites by as much as 4 to 6 feet (BCDC 1983a).

The diked Delta islands are equally susceptible to subsidence. The soils of the Delta islands are primarily peats. Agricultural activities on the islands result in substantial differential subsidence due to the compaction and oxidation of the peat soils.

Land Uses

DIVERSITY OF HABITAT TYPES

The quality and quantity of wildlife habitat is one of the most important factors determining the size and health of the Estuary's wildlife populations. There are many types of wildlife habitat within the Planning Area, ranging from those occurring in the upland areas to the aquatic environment. The functions and value provided by different habitat types can vary significantly throughout the Estuary. Some of the habitat types provide local benefits while others may provide benefits on a regional, national, or an international level. For example, habitats of international importance include those that provide a life cycle function for individuals of a migratory species that reside during some part of the year in another country. A habitat can be of regional importance if it provides refugia or other important functions for a state listed species. An example of a nationally important habitat is one that provides habitat functions for federally listed species.

A range of habitat types is needed to provide for the overall health of the Estuary's ecosystem. For example, tidal wetlands provide habitat for many shorebirds and migratory bird species, but upland habitat areas including the diked baylands are an important refugia habitat for these bird species during storm events and periods of high tide. Additionally, an animal species' habitat requirements can vary throughout the stages of its life cycle. Such variation can be generalized to specialized, depending on the species, population density, and other factors such as nutrient levels and/or other limiting features of the ecosystem. Specialized habitat type requirements can limit the range of species and directly affect their survival (e.g., salt marshes and the California clapper rail [*Rallus longirostris absoletus*], and brackish marshes and the Suisun shrew [*Sorex ornatus sinuosus*]).

AGRICULTURAL LANDS

The majority of the lands under agricultural cultivation or pasture within the Planning Area, many of which are diked, occur in areas that would develop extensive stands of wetland plants if they were not cultivated and drained. Most of the farmed historic baylands around the Estuary occur near the northern edge of San Pablo Bay. Common cultivated crops include pasture forage and small grains such as oat hay. In the Delta, where most of the cultivated lands occur on diked reclaimed islands, crops such as asparagus, tomatoes, and sugar beets are grown. Corn and sorghum are also planted within the Delta region for commercial markets and by hunting clubs and farmers for wildlife feed and cover. Agricultural lands that were located in the South Bay have been replaced to a large extent by urban development (SFEP 1992b).

COASTAL ZONE MANAGEMENT AND LOCAL ZONING

State and local land use planning and regulations are the principal tools for managing land use and the effects of land use change on the Estuary systems. Until 1970, land use regulation generally consisted of local zoning. A number of regulatory changes concerning land use planning occurred in the 1970s, dramatically increasing the direct role of the state in land use planning and regulation. Additionally, in 1972, the federal Coastal Zone Management Act was enacted which provided grants to coastal states to develop and implement management plans and programs for the nation's coastal zones. Since 1965, BCDC has implemented comprehensive planning for the Bay and shoreline when the Commission was established and the Bay Plan prepared (see text box). This action was followed in 1978 by the Department's certification of the California Coastal Commission's management plan for the coastal segment of the California coastal zone. However, the Sacramento/San Joaquin Delta region was not included within this approved Coastal Zone Management Plan (SFEP 1992b).

Land use management concepts of the Bay Vision 2020 Commission were applied to the San Francisco Bay Area in the 1980s. Such regional and growth management efforts are intended to enable existing institutions to have a more comprehensive, greater-than-local decision-making structure, providing for rational economic and population growth while preserving and enhancing the region's natural environments, including the Estuary. Nonetheless, decisions regarding zoning, building permits, infrastructure financing, housing subdivisions, and related development projects are currently made largely by local governments without effective regional or state-level review (SFEP 1992d). The BCDC's shoreline band of regulatory jurisdiction surrounding San Francisco Bay is an exception.

Within California, land use planning and regulation is concentrated at the local government level. Under state law, each city and county must prepare a comprehensive General Plan containing nine state-specified elements. However, these provisions are oriented primarily toward addressing local goals and needs. The General Plans are not required to deal with adjacent communities or regional and state goals and objectives. This structure could pose a serious problem for regional wetland restoration efforts.

Under the California Environmental Quality Act (CEQA), each jurisdiction must undertake the process of environmental review and prepare an environmental impact report whenever a proposed project may cause significant adverse impacts on the environment. Within the state planning process, however, there is no provision to resolve conflicts or inconsistencies among local, state, or regional plans. City or county governments can approve a specific new development even if that project is inconsistent with regional plans or goals, such as Estuary protection or habitat restoration.

Currently, there is no region-wide enforceable plan that manages lands containing significant natural resources, such as the Estuary. BCDC's San Francisco Bay Plan and the Suisun Marsh Protection Plan only apply to the portions of the Estuary within the agency's jurisdiction, including the Suisun Marsh, salt ponds, the 100-foot shoreline band and certain contributing waterways and sloughs. Regional goals, such as the protection and enhancement of the Estuary's wetlands, are not consistently addressed by law or agency regulation. Given this regulatory environment, the implementation and ultimate success of the LTMS will depend, in part, on the ability of local planning efforts to incorporate established goals and policies discussed within this document and the Proposed LTMS Comprehensive Management Plan.

Regional planning efforts, such as the North Bay Initiative (North Bay Wetlands Protection Program [NBWPP]) and the U.S. Fish and Wildlife Service's (USFWS) Habitat Goals Process are currently being developed. Funded by grants through the EPA, the NBWPP is a voluntary partnership between the BCDC and local governments to develop a comprehensive wetlands protection plan for the North Bay. The goal of the program is to ensure the protection, enhancement, and restoration of North Bay wetlands, while allowing uses such as agriculture that are consistent with wetland values and functions to continue, and limiting other incompatible uses to upland locations.

The Bay faces development pressures and land use changes that could seriously compromise the vast mosaic of wetlands, diked historic baylands, and agricultural lands. Urbanization may eliminate some of the best and last remaining opportunities to increase the abundance and diversity of wildlife through the restoration of diked historic baylands. Population growth, new development, and related infrastructure improvements within the Bay watershed may result in the direct loss of wetlands, riparian habitat, and agricultural lands. The planning efforts of the NBWPP focus on reducing conflict, uncertainty, and delays in the wetlands regulatory process by integrating habitat-based natural resource planning, wetland studies, wetland restoration planning (such as the Habitat Goals Process), and state and federal regulatory requirements with local land use planning and zoning. The NBWPP will provide participating local governments with technical assistance, resource mapping, and baseline information needed to identify and develop comprehensive wetland protection programs.

4.4.2 Upland Habitats and Resources

For the purposes of this EIS/EIR, the upland and non-aquatic environment is defined as those areas that may be determined appropriate for the beneficial reuse of dredged material after site-specific environmental analyses are conducted and a dredged material management alternative is chosen. This secion describes the habitats and resources within these upland areas. The upland portions of the Planning Area are described below and are organized by potential dredged material reuse applications. These upland environments include (1) diked historic baylands; (2) managed wetlands; (3) Delta levees; and (4) urbanized areas.

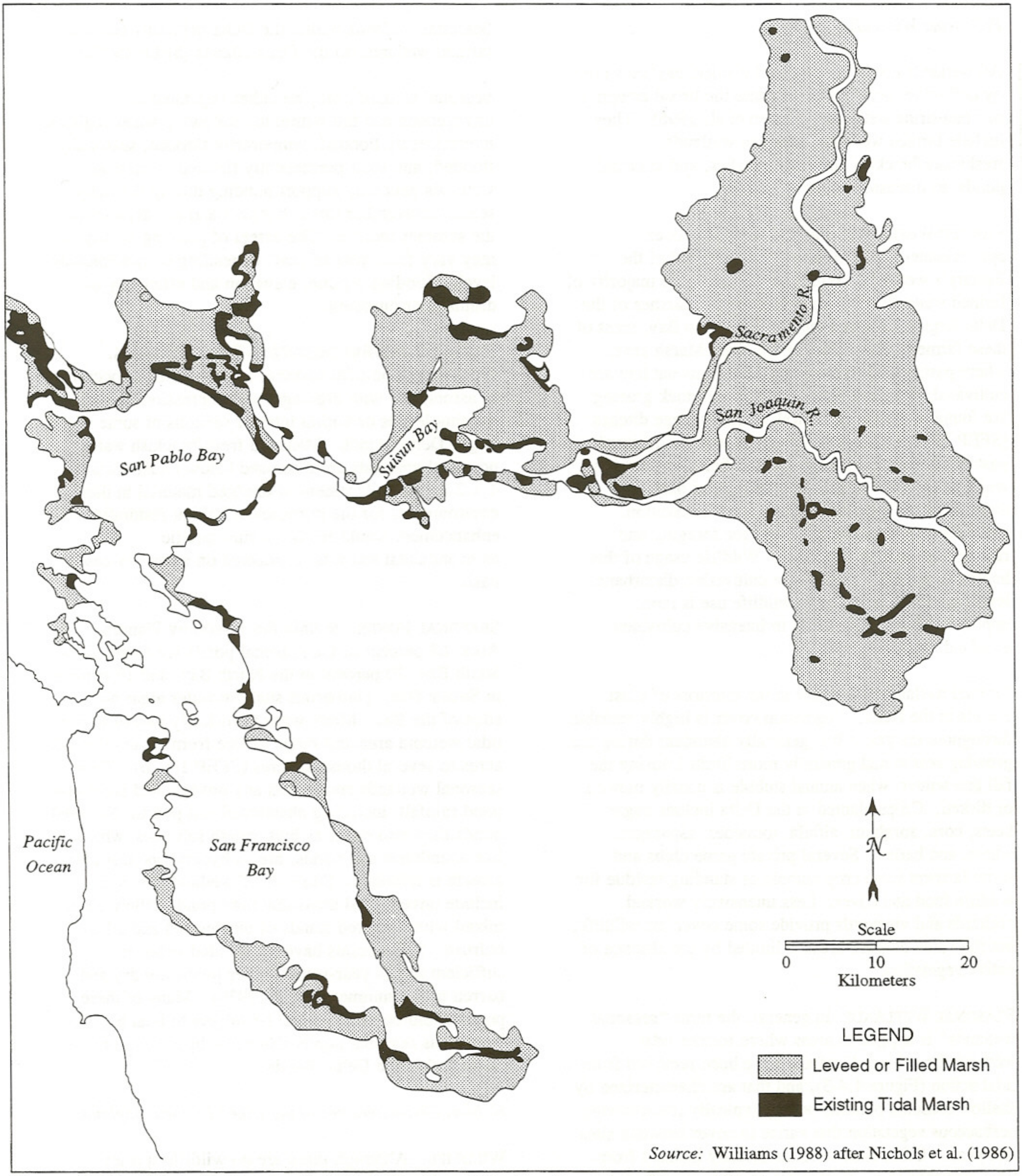
4.4.2.1 Diked Historic Baylands

The historic baylands have no tidal interaction along the margins of the Bay. They function, however, as an integral part of the overall estuarine ecosystem. In the late 19th century, broad expanses of marsh land, particularly in rural areas of Marin, Sonoma, and Napa counties, and most of the Delta, were diked off from the Bay, then ditched and drained for dryland farming. Most of these lands have soil characteristics of wetlands. Additionally, large areas of the South Bay were diked from the Bay to produce salt (Figure 4.4-3). Some of these reclaimed lands had been previously established tidal marshes. Others had formed more recently, created by the deposition of hydraulic mining sediments within the watersheds of the Sacramento and other Delta rivers.

The Bay's diked historic baylands provide extensive and diverse wildlife habitats around the Bay periphery with a wide variety of water regimes and associated vegetative colonization. The diked bayland environments add substantially to the total habitat diversity of the Estuary, serving as buffers between urban and tidal areas and reducing the development impacts on wildlife. Many historic baylands serve as corridors for wildlife movement, connecting otherwise separate wetland areas (BCDC 1983a). The diked baylands also contribute to improved Bay water quality by filtering pollutants in urban runoff and wastewater, and often act as interim storage basins for stormwater runoff storage basins that provide urban flood control benefits.

Diked baylands have wetland soils that formed through deposition and accumulation of fine sediments on tidal marshes. Because of their low elevation relative to both the Bay and upland areas (averaging -4 to -9 feet MHHW), the diked bayland areas tend to collect rainwater and drain slowly, functioning as seasonal wetlands that can remain ponded for extensive periods during winter through spring, the duration depending on annual rainfall and whether they are regularly drained and/or pumped. In addition, Bay water seepage through levees is not uncommon. Vegetation and wildlife uses thus directly depend on the way surface water is managed by landowners. Areas that are regularly pumped support terrestrial species, and those that are seasonally wet support wintering/migratory waterfowl and shorebirds and are important to shorebirds during high tides and storm events. Diked seasonal wetlands adjacent to tidal marshes and mudflats provide resting and foraging areas for shorebirds at high tide.

Some diked former bayland areas support valuable wildlife habitat. Examples include diked salt marshes that support the endangered salt marsh harvest mouse, and diked salt ponds that provide foraging habitat for the endangered California least tern. There is, however, an increasing recognition of the importance of the Estuary's tidal wetland systems has encouraged restoration of wetlands especially at the margins of San Pablo Bay and within the Delta. Restoration of historically diked areas requires either extensive natural sedimentation to occur or the placement of soil/sediment material at a site to raise the site's surface elevation sufficient for vegetative colonization. The reuse of dredged material is one way to raise a site's surface elevation.



Source: Williams (1988) after Nichols et al. (1986)

Figure 4.4-3. Historic Changes in Tidal Marshes of the San Francisco Bay and Delta

Palustrine Wetlands

All wetlands occurring on diked historic baylands are, by definition, non-tidal and fit into the broad category of "palustrine wetlands" (Ferren et al. 1996). They include farmed wetlands, seasonal wetlands, freshwater/brackish non-tidal marshes, and seasonal ponds, as discussed below.

FARMED WETLANDS. Farmed wetlands cover approximately 385,000 acres or 61 percent of the Estuary's wetlands. Within the Estuary, the majority of farmed wetlands are former freshwater marshes of the Delta Region. Around the San Francisco Bay, most of these farmed wetlands are in the Napa Marsh area, where pastureland or small grains such as oat hay are cultivated. Wetland vegetation and livestock grazing are found in untilled low swales and drainage ditches (SFEP 1992b). These pasturelands include irrigated pasture and hay fields (e.g., alfalfa fields and oat-hay), which are mowed or grazed on a regular basis throughout the growing season. Such cultivation practices provide abundant cover for foraging and resting birds during migration. Wildlife usage of this habitat is generally high where cultivation disturbance levels are low. In contrast, wildlife use is more opportunistic and short-term in intensive cultivated cropland.

Farmed wetlands also occur in the interiors of most islands in the Delta. Vegetation cover is highly variable throughout the year. It is generally abundant during the growing season and generally more limited during the fall and winter, when annual stubble is usually mowed or disked. Crops planted in the Delta include sugar beets, corn, sorghum, alfalfa, tomatoes, asparagus, wheat, and barley. Several private game clubs and some farmers leave crop stubble or standing residue for wildlife food and cover. Less intensively worked orchards and vineyards provide some cover for wildlife, but the value of these areas is limited by the absence of native vegetation.

SEASONAL WETLANDS. In general, the term "seasonal wetlands" is applied to areas where former tidal wetlands have been diked and have been removed from tidal action (Figure 4.4-3), and that are characterized by shallow seasonal ponding and by typically low-growing herbaceous vegetation that varies in cover between sites and years. Other sites were historically isolated from tidal influence (e.g., freshwater marshes inland of the Bay). Additionally, there are over 57,000 acres of seasonal diked wetlands managed for migratory waterfowl in Suisun Marsh (see section 4.4.2.2, below). Seasonal wetlands within the Delta primarily occur as farmed wetlands on the Delta islands (SFEP 1992b).

Seasonal wetlands may be either vegetated or unvegetated and fall within the following water regimes: intermittently flooded, temporarily flooded, seasonally flooded, and semi-permanently flooded. Seasonal wetlands generally support ponding during the rainy season (November through April) and are dry during the summer months. The extent of ponding on any site may vary from year to year, depending on precipitation levels, flooding regime, elevation and efficiency of drainage or pumping.

FRESH WATER/BRACKISH NON-TIDAL MARSHES. Freshwater non-tidal marshes are described as occurring in association with drainages and depressions behind existing levees or within interior sections of some of the larger Delta islands. Managed fresh/brackish water non-tidal wetlands are discussed below under section 4.4.2.2. Any placement of dredged material in these environments for the purposes of habitat restoration or enhancement would require a site-specific environmental analysis, conducted on a case-by-case basis.

SEASONAL PONDS. Within the 11-county Planning Area, 64 percent of the seasonal ponds are found in the South Bay, 20 percent in the North Bay, and 16 percent in Suisun Bay. Numerous shallow-water areas dot the edge of the Bay. Many were historically part of larger tidal wetland area and range in size from about 40 to 50 acres to several thousand acres (SFEP 1992b). These seasonal wetlands encompass any unvegetated areas that pond rainfall, including abandoned salt ponds. Seasonal ponds may also occur as high marsh salt pans, which, like abandoned salt ponds, are so hypersaline that plant growth is inhibited. Some diked wetland sites also include unvegetated areas that may pond shallow water mixed with scattered stands of pickleweed and alkali bulrush. Some ponds have impounded volumes sufficient to last year-round; other ponds are dry and barren in the summer (SFEP 1992b). Many of these ponds could be restored and be subject to tidal action. Numerous seasonal ponds also exist throughout the Delta within the Delta islands.

Habitat Characteristics of the Diked Historic Baylands

WILDLIFE. Although there are no wildlife species restricted to the seasonal wetland habitats of the Planning Area, this dramatically altered habitat type plays an extremely important role in the maintenance of the wetland-dependent wildlife. The variety of seasonal wetland habitats within the Planning Area provides important habitat for migratory birds. The importance of seasonal wetlands lies in their ability to provide essential feeding and resting habitat at a time of year when California's limited wetland acreage must support a much larger bird population (SFEP 1992c).

In addition to providing supplemental foraging habitat for waterfowl, San Francisco Bay's seasonal wetlands play a critical role in supporting migratory shorebirds, particularly the small species such as the western sandpiper, dunlin, dowitchers, marbled godwit, and least sandpiper. During the winter when high tides cover intertidal mudflats, seasonal wetlands adjacent to the Bay provide alternate refugia sites and foraging habitat. Seasonal wetlands also provide roosting habitat for larger shorebirds during high tides and shelter for waterfowl as well as shorebirds during storms (SFEP 1992c).

Within the Delta, farmed wetlands provide valuable wintering habitat for many migratory bird species where harvesting inefficiencies result in surplus grain for scavenging birds, including the sandhill crane, tundra swan, Canada goose, and other water birds. A list of the wildlife species of the Estuary is presented in Appendix I.

INVERTEBRATE COMMUNITY. The invertebrate community living in ditches and other standing waters classified as seasonal wetland habitats is influenced by salinity and the extent of habitat inundation. Common invertebrate species in these habitats include the introduced red swamp crayfish (*Procambarus clarkii)*, and many species of seed shrimp (*Ostracoda* spp.), water fleas (*Cladocera* spp.), copepods (*Copepoda* spp.), and aquatic insects such as dragonflies (*Anisoptera* spp.), damselflies (*Zygoptera* spp.), water scavenger beetles (*Hydrophilidae* spp.), water boatman (*Corixidae* spp.), midges (*Chironomidae* spp.), mosquitoes (*Culicidae* spp.), and shore flies (*Ephydridae* spp.).

FISH. Fish populations in seasonal wetlands are typically limited due to intermittent desiccation or periods of harsh environmental conditions (SFEP 1991b). Hence, these habitats are of negligible value to sportfish and special status species. The introduced mosquitofish is normally the dominant species. These habitats are generally not connected to the Estuary by water, so estuarine fishes are not normally found in them (SFEP 1994).

SPECIAL STATUS SPECIES. Within the Planning Area, several types of seasonal wetlands have been identified, including freshwater non-tidal marsh, diked wetlands, seasonal ponds, and farmed wetlands. The following is a brief description of the special status species associated with these habitats. The LTMS agencies requested an informal consultation with the USFWS as part of EIS/EIR preparation. Subsequently, the USFWS provided a list of important and special status species that could potentially be affected by implementation of any of the LTMS EIS/EIR alternatives. Special status species that occur within the upland portions of the Planning Area are presented in Table 4.4-1. Among the species that occur in diked salt marshes is the endangered salt marsh harvest mouse. The USFWS list, in its entirety (including Latin nomenclature), is presented in Appendix J. Brief descriptions of the federally listed special status species found in the upland portions of the Planning Area are contained in Appendix J.

Freshwater non-tidal marshes in the Planning Area are known to provide foraging habitat and nesting sites for the following special status bird species: the tricolored blackbird, double-crested cormorant, western least bittern, white-faced ibis, and yellow rail. In addition, western pond turtles are common residents to these habitats. Seasonal ponds may also support the western pond turtle and California tiger salamander (SFEP 1992c).

Diked wetlands and seasonal ponds provide nesting and/or foraging habitat for several special status bird species, including the California gull, American white pelican, elegant tern, California least tern, and double-crested cormorants that use these habitats for roosting and foraging during the fall (SFEP 1992c).

Farmed wetlands in the Planning Area provide foraging habitat for several special status species that nest and roost in adjacent habitats. These species include the tricolored blackbird, California gull, long-billed curlew, and short-eared owl (SFEP 1991b; SFEP 1992c).

Special status invertebrate species that may occur within the diked bayland habitat areas include the San Francisco forktail damselfly, Ricksecker's water scavenger beetle, and the curved-foot hygrotus diving beetle. No special status fishes are known to use the bayland habitats.

Special status plant species in the Planning Area are not associated with farmed wetlands, due to the high levels of disturbance associated with these areas. Seasonal

Table 4.4-1. Special Status Species within the Upland Environment of the EIS/EIR Planning Area

(page 1 of 3)

Common Name	Scientific Name	Status	Abundance	Habitat Type: Tidal Wetland(a)	Habitat Type: Other Wetland(b)	Habitat Type: Adjacent Upland	Habitat Type: Delta Islands(c)	General Location of Habitat: Suisun Bay	General Location of Habitat: Carquinez Strait	General Location of Habitat: San Pablo Bay	General Location of Habitat: Central Bay	General Location of Habitat: Alcatraz	General Location of Habitat: South Bay
San Francisco Bay Mammals													
Alameda Island mole	*Scapanus latimanus parvus*	FSC	rare			X					X		
Badger	*Taxidea taxus*	SSC	uncommon			X		X	X	X	X		X
Riparian brush rabbit	*Sylvilagus bachmani riparius*	FPE, SSC	rare			X		X					
Salt marsh harvest mouse	*Reithrodontomys raviventris*	FE, SE	rare	X	X	X		X	X	X			X
Salt marsh vagrant shrew	*Sorex vagrans halicoetes*	FSC, SSC	rare	X	X	X		X	X	X			X
San Joaquin kit fox	*Vulpes macrotis mutica*	FE, ST	rare		X	X							X
San Joaquin Valley woodrat	*Neotoma fuscipes riparia*	FPE, SSC	rare			X							
San Pablo vole (California vole)	*Microtus californicus*	SSC	uncommon	X					X				
Suisun ornate shrew	*Sorex ornatus sinuosis*	FSC, SSC	rare			X	X	X	X	X			
San Francisco Bay Reptiles													
Alameda whipsnake (striped racer)	*Masticophis lateralis euryzanthus*	FPE, ST	common			X							
California horned lizard	*Phrynosoma coronatum frontale*	FSC, SSC	uncommon			X							
Giant garter snake	*Thamnophis gigas*	FT, ST	uncommon	X	X	X	X	X	X				
Northwestern pond turtle	*Clemmys marmorata pallida*	FSC, SSC	uncommon	X		X	X						
San Francisco garter snake	*Thamnophis sirtalis tetrataenia*	FE, SE	common	X		X	X				X		X
San Francisco Bay Reptiles													
California red-legged frog	*Rana aurora draytoni*	FT, SSC	rare	X	X	X	X						
California tiger salamander	*Ambystoma californiense*	FC	Uncommon	X	X	X	X	X	X	X			
San Francisco Bay Birds													
Alameda (South Bay) song sparrow	*Melospiza melodia pusilla*	FSC, SSC	Uncommon	X		X							X
Aleutian Canada goose	*Branta canadensis leucopareia*	FT	rare	X	X	X			X				
American bittern	*Botaurus lentiginosus*	AB	uncommon		X		X						
American peregrine falcon	*Falco peregrinus anatum*	FE, SE	rare	X		X		X		X	X		X
Bald eagle	*Haliaeetus leucocephalus*	FT, SE	rare	X			X						
Barrow's goldeneye	*Bucephala islandica*	SSC	uncommon	X				X	X	X	X		
Black rail	*Laterallus jamaicensis*	FSC, ST	rare	X	X		X						
California brown pelican	*Pelecanus occidentalis californicus*	FE, SE	uncommon	X				X	X	X	X	X	X
California clapper rail	*Rallus longirostris obsoletus*	FE, SE	rare	X	X	X		X	X	X			X
California least tern	*Sterna antillarum brownii*	FE, SE	rare	X	X	X	X	X	X	X	X		X
Double-crested cormorant	*Phalacrocorax auritus*	SSC	common	X	X		X	X	X	X	X	X	
Fulvous whistling duck	*Dendrocygna bicolor*	SSC, SBS	rare	X				X	X	X			
Greater white-fronted goose	*Anser albifrons*	SBS	uncommon	X	X		X	X	X	X			X
Horned grebe	*Podiceps auritus*	AB	common	X	X		X	X	X	X	X		
Saltmarsh common yellowthroat	*Geothylpis trichas sinuosa*	FSC, SSC	uncommon	X	X		X	X	X	X	X		X
San Pablo (Suisun) song sparrow	*Melospiza melodia samuelis*	FSC, SSC	uncommon	X	X		X	X	X	X			
Tricolored blackbird	*Agelaius tricolor*	FSC, SSC	uncommon		X	X	X	X	X	X	X		X

Table 4.4-1. Special Status Species within the Upland Environment of the EIS/EIR Planning Area
(page 2 of 3)

Common Name	Scientific Name	Status	Abundance	HABITAT TYPE: Tidal Wetland(a)	HABITAT TYPE: Other Wetland(b)	HABITAT TYPE: Adjacent Upland	HABITAT TYPE: Delta Islands(c)	GENERAL LOCATION OF HABITAT: Suisun Bay	GENERAL LOCATION OF HABITAT: Carquinez Strait	GENERAL LOCATION OF HABITAT: San Pablo Bay	GENERAL LOCATION OF HABITAT: Central Bay	GENERAL LOCATION OF HABITAT: Alcatraz	GENERAL LOCATION OF HABITAT: South Bay
San Francisco Bay Birds													
Western burrowing owl	*Athene cunicalria hypugea*	FSC, SSC	uncommon			X	X		X		X	X	X
Western snowy plover	*Charadrius alexandrinus nivosus*	FT, SSC	uncommon	X		X	X				X		
White-faced ibis	*Plegadis chihi*	FSC, SSC	rare		X		X						
San Francisco Bay Invertebrates													
California freshwater shrimp	*Syncaris pacifica*	FE, SE	rare		X			X	X	X			
Ciervo aegialian scarab beetle	*Aegialia concinna*	FSC	rare	X									
Conservancy fairy shrimp	*Branchinecta conservatio*	FE, SE	rare	X	X								
Curved-foot hygrotus diving beetle	*Hygrotus curvipes*	FSC	rare	X	X		X	X					
Delta green ground beetle	*Elaphrus viridis*	FT, ST	rare		X	X	X	X	X	X			
Lange's metalmark butterfly	*Apodemia mormo langei*	FE, SE	rare		X	X		X					
Marin elfin butterfly	*Incisalia mossii*	FSC	rare						X	X			
Middledauf's shieldback katydid	*Idiostatus middlekaufi*	FSC	rare		X			X					
Myrtle's silverspot butterfly	*Speyeria zerene myrtleae*	FE, SE	rare										
Longhorn moth	*Adela oplerella*	FSC	rare										
Ricksecker's water scavenger beetle	*Hydrochara rickseckeri*	FSC	rare		X			X					
Sacramento anthicid	*Anthicus sacramento*	FSC	rare				X	X					
San Francisco lacewing	*Nothochrysa californica*	FSC	rare										
San Joaquin dune beetle	*Coelus gracilis*	FSC	rare				X						
Sonoma arctic skipper	*Carterocephalus palaemon* ssp.	FSC	rare										
Vernal pool tadpole shrimp	*Lepidurus packardi*	FE, SE	rare		X								
Vernal pool fairy shrimp	*Branchinecta lynchi*	FT	rare		X			X					
San Francisco Bay Plants													
Adobe lily	*Fritillaria pluriflora*	FSC	rare										
Alkali milkvetch	*Astragalus tener* var. *tener*	FSC	rare			X			X	X	X		X
Antioch Dunes evening primrose	*Oenothera deltoides* ssp. *howellii*	FE, SE	rare			X	X	X					
Baker's stickyseed (Sonoma sunshine)	*Blennosperma bakeri*	FE, SE	rare		X					X			
Brittlescale	*Atriplex depressa*	FSC	rare	X			X	X					
California sea blite	*Suaeda californica*	FE, SE	rare	X							X		X
Caper-fruited tropidocarpum	*Tropidocarpum capparideu*	FSC	rare				X						
Carquinez goldenbush	*Isocoma arguta*	FSC	rare	X			X	X					
Colusa grass	*Neostapfia colusana*	FT	rare		X								
Congdon's tarplant (Pappose spikeweed)	*Hemozonia parryi* ssp. *congdonii*	FSC	rare			X		X					
Contra Costa goldfields	*Lasthenia cojugens*	FE	rare		X			X					
Contra Costa wallflower	*Erysimum capitatum* ssp. *angustatum*	FE, SE	rare										
Delta tule pea	*Lathyrus jepsonii* var. *jepsonii*	FSC	rare	X	X		X	X	X				
Diamond-petaled poppy	*Eshscholzia rhombipetala*	FSC	rare						X				

Table 4.4-1. Special Status Species within the Upland Environment of the EIS/EIR Planning Area

(page 3 of 3)

				Habitat Type				General Location of Habitat					
Common Name	*Scientific Name*	*Status*	*Abundance*	*Tidal Wetland(a)*	*Other Wetland(b)*	*Adjacent Upland*	*Delta Islands(c)*	*Suisun Bay*	*Carquinez Strait*	*San Pablo Bay*	*Central Bay*	*Alcatraz*	*South Bay*
San Francisco Bay Plants (continued)													
Ferris's milkvetch	*Astragalus tener* var. *ferrisiae*	FSC	rare		X								
Fragrant fritillary	*Fritillaria liliacea*	FSC	rare			X				X	X		
Gairdner's yampah	*Perideridia gairdneri* ssp. *gairdneri*	FSC	rare										
Heartscale	*Atriplex cordulata*	FSC	rare	X	X			X					
Hispid's bird's beak	*Cordylanthus mollis* ssp. *hispidus*	FSC	rare	X	X	X		X					
Hoover's button celery	*Eryngium artistulatum* var. *hooveri*	FSC	rare										X
Legenere	*Legenere limosa*	FSC	rare		X	X				X			
Marin knotweed	*Polygonum marinense*	FSC	rare			X			X	X			
Marsh sandwort	*Arenaria paludicola*	FE	rare	X	X						X		
Mason's lilaeopsis	*Lilaeopsis masonii*	FSC, ST	rare	X		X	X	X	X	X			
Mt. Diablo bird's beak	*Cordylanthus nidularius*	FSC	rare										
Northcoast (Pt. Reyes) bird's beak	*Cordylanthus maritumus* ssp. *palustris*	FSC	rare	X	X	X				X	X		X
San Francisco Bay spineflower	*Chorizanthe cuspidata* var. *cuspidata*	FSC	rare										
San Mateo tree lupine	*Lupinus arboreus* var. *eximius*	FSC	rare										
Soft bird's beak	*Cordylanthus mollis* ssp. *mollis*	FE	rare	X				X		X			
Solano grass	*Tuctoria mucronata*	FE, SE	rare			X							
Suisun Marsh aster	*Aster lentus*	FSC	rare	X	X		X	X					
Suisun thistle	*Cirsium hydrophilum* var. *hydrophilum*	FE	rare	X			X	X					
Tiburon mariposa lily	*Calochortus tiburonensis*	FT	rare			X				X	X		
Tiburon paintbrush	*Castilleja affinis* ssp. *neglecta*	FSC	rare			X		X	X	X	X		
Tiburon tarweed	*Hemizonia multicaulis* ssp. *vernalis*	FSC	rare										

Notes:
- a. Mudflats or marshes.
- b. Seasonal wetlands, vernal pools, diked salt marshes, and other non-tidal wetlands
- c. Levees.
- FE: Federally listed as endangered.
- FT: Federally listed as threatened.
- FPE: Federally proposed for listing as endangered.
- FC: Federal candidate for listing.
- SE: Stated listed as endangered.
- ST: State listed as threatened.
- FSC: Federal Species of Concern.
- SSC: California Department of Fish and Game Species of Special Concern.
- SBS: Federally-listed sensitive bird species.
- AB: Audubon blue list.

wetlands within these areas, however, may support a variety of special status plant species, including Contra Costa goldfields, heart-leaf saltbush, San Joaquin spearscale, alkali milk-vetch, brittlescale, dwarf downingia, fragrant fritillary, and Carquinez goldenbush.

PLANT COMMUNITY. During most of the year, the plant community of the diked baylands is primarily influenced by farming activities. Oat hay is the predominant crop that is cultivated. Plant height is spatially variable due to the patchy nature of productive soils. Within the diked baylands, lower lying depressions that retain water year-round support perennial aquatic vegetation, especially bulrush (*Scirpus* spp.). Saline ditches support pickleweed (*Salicornia virginica*) and salt grass (*Distichlis spicata*). Ditch banks, levee sides, and fallow fields tend to support a sparse cover of ruderal (weedy) species of grasses and forbes (LTMS 1994h).

The grazed baylands of the North Bay area typically support small patches of seasonal wetlands that are scattered within a matrix of introduced annual grasses. Small stands of willow and eucalyptus may be present, especially within baylands that adjoin upland areas (LTMS 1994h).

The plant community of the Delta island freshwater marsh systems includes two species of cattails, common reed, four species of tule or bulrush, barnyard grass, and nutgrass. Pretty water smartweed and yellow water weed crowd between the emergent plants and float partially submerged. Shrubs are commonly established on the higher margins of non-tidal marshes in the Delta, including dogwood, buttonbush, and various types of willows (SFEP 1992b).

POLLUTANTS AND WATER QUALITY. Pollutants and water quality in the diked historic baylands is primarily influenced by human activities. The combination of hydrologic influences including: seasonal fluctuations in groundwater elevations, artificial drainage, pumping of subsided sites, stormwater runoff from the limited watersheds of the sites, and directed runoff for areas outside existing watersheds, as well as the agricultural practices on individual sites is the primary factor that affects the overall water quality and pollutant load within diked bayland parcels.

Issues regarding pollutants and water quality within the non-tidal fresh water wetlands of the Delta region are discussed below in section 4.4.2.4.

SALINITY. The salinity of seasonal wetlands and ponds varies depending on exposure to runoff, groundwater, season, water volume, evaporation, soil salinity, rainfall, and other factors. Within the diked baylands, salinity regimes can vary greatly depending on field drainage, groundwater pumping, and induced leaching management practices.

Issues regarding salinity within the non-tidal fresh water wetland of the Delta region are discussed below under section 4.4.2.4.

4.4.2.2 Managed Wetlands

Approximately 46 percent of the diked salt and brackish marsh habitat occurs in Suisun Bay, 14 percent occurs in the North Bay, and 8 percent occurs in the South Bay. These diked wetlands are formerly tidal areas that are managed to partially limit or totally exclude tidal action. They typically support salt and brackish wetland vegetation. Some have ponded water in old tidal sloughs most of the year that may become hypersaline in the dry season. Brackish conditions occur due to dilution by freshwater runoff. Some sites may support a mosaic of moisture-tolerant upland species mixed with brackish wetland vegetation (SFEP 1992b).

Although the wetlands described in this section are primarily seasonal wetlands due to human management, they are discussed separately from diked historic baylands because of their concentrations in the Estuary. The Suisun Marsh comprises the largest diked seasonal wetland complex in the Estuary, extending over 58,000 acres. This marsh is located where the salt water of the Pacific Ocean and the fresh water of the Sacramento-San Joaquin River Delta meet and mix. In the late 1800s, much of the Suisun Marsh was diked and drained for agriculture, and later converted to private duck clubs. Because of its location and management, the marsh provides a transitional zone between salt and fresh water environments, creating a unique diversity of fish and wildlife habitats. These marshlands are managed both privately and by the state, and represent approximately 12 percent of California's remaining wetlands. Due to varying levels of water salinity, the Suisun Marsh has provided extremely variable habitat and supported over 25 percent of the central California waterfowl population in dry years (USFWS 1978).

Habitat Characteristics of the Managed Wetlands

FISH AND WILDLIFE. The managed wetlands of the Suisun Marsh provide an important wintering habitat for waterfowl of the Pacific Flyway, as well as critical habitat for other wildlife including such endangered, rare, or unique species as the peregrine falcon, white-tailed kite, golden eagle, California clapper rail, black rail, salt marsh harvest mouse, and Suisun shrew. These wetlands are managed for the purposes of hunting, fishing, and non-consumptive uses, such as nature study, photography, and similar passive wildlife activities. A list of the wildlife species of the Estuary is presented in Appendix I.

PLANT COMMUNITY. The plant community of the Suisun Bay's managed wetlands is primarily influenced by the salinity of the water used to seasonally flood the marsh fields. In areas of the marsh where salinity inputs are controlled, freshwater bulrush (*Scirpus acutus and Scirpus californicus*) predominates, although a complex mosaic of fresh and brackish marsh plant species can also be present. Under more saline conditions (Suisun Bay water source), the advanced successional state of managed seasonal wetlands tends to be dominated by rank pickleweed (*Salicornia virginica*), with alkali bulrush (*Scirpus robustus*), fat hen (*Atriplex* spp.), and pickleweed predominating under more brackish conditions.

SPECIAL STATUS SPECIES. The LTMS agencies requested an informal consultation with the USFWS during preparation of this EIS/EIR. Subsequently, the USFWS provided a list of the important and special status species that could potentially be affected by implementation of any of the LTMS EIS/EIR alternatives. Special status species that occur within the upland portions of the Planning Area are presented in Table 4.4-1. The USFWS list, in its entirety (including Latin nomenclature), is presented in Appendix J. Brief descriptions of the federally listed special status species found in the upland portions of the Planning Area are contained in Appendix J.

Federally listed special status species that could occur in the managed wetland areas of Suisun Bay include Aleutian Canada goose, American peregrine falcon, California black rail, California brown pelican, California least tern, giant garter snake, salt marsh harvest mouse, and Swainson's hawk. The following special status species (not listed as threatened or endangered) may also occur within the managed wetland areas of the Suisun Bay Region: tricolored blackbird, double-crested cormorant, western least bittern, white-faced ibis, yellow rail, California gull, American white pelican, elegant tern, and double-crested cormorants, long-billed curlew, short-eared owl, western pond turtles, and California tiger salamander (SFEP 1991b; SFEP 1992c).

SALINITY, POLLUTANTS, AND WATER QUALITY. The water quality of managed wetlands affects the use of these areas by resident and migratory waterfowl. Salinity in the soils and water of the managed wetlands can affect the habitat value for duck breeding and rearing. Minimizing adverse algal and bacterial growth also affects duck activity and reproduction in the habitat.

Pollutants other than salinity are not considered a major problem in the managed wetlands areas. Like other diked or managed Planning Area locations, areas of Suisun Bay wetlands are managed for the purposes of waterfowl production and are considered to have relatively low pollutant levels. Few water quality variables have been measured by area resource managers, however. Upstream agricultural and urban contaminants do enter the wetlands ecosystem, and are likely present in measurable concentrations.

4.4.2.3 Riparian Habitat

The Planning Area supports approximately 12,500 acres of riparian habitat, including scrub, woodland, and forest types that generally occur in narrow strips along freshwater waterways. Riparian habitats are composed of broad-leaved, winter deciduous trees and shrubs, with tree canopies that reach as high as 100 feet tall and include boxelder, Fremont cottonwood, black willow, Valley oak, and white alder. The understory typically includes elderberries, Himalayan blackberry, and several species of willow. The understory ranges from sparse to absent when the overstory tree canopy is dense. Soil moisture is almost always available, and flooding events occur irregularly (SFEP 1992c).

The largest concentrations of riparian habitats occur mostly in the northern and eastern Delta, along the Mokelumne River and the Snodgrass, Sevenmile, Trapper, and Whisky sloughs (Herbold and Moyle 1989).

Riparian habitats are considered valuable wildlife habitats, providing critical wildlife resources (water, food, movement corridors, and cover for escape, breeding, nesting, and foraging). The complexity of micro-habitats created by the layering of trees, shrubs, vines, and herbaceous and aquatic vegetation promotes high wildlife species diversity (SFEP 1992c).

Riparian habitat also enhances the value of adjacent fish and wildlife habitats. When adjacent to grasslands or agricultural land, riparian habitats provide nest sites for raptors and cover for upland species that use them for foraging. Riparian vegetation that extends over water shades the aquatic environment, thereby favorably reducing water temperatures. Dropping leaves and insects provide food and other essential nutrients to the aquatic ecosystem. Riparian habitat also provides nesting habitat for migratory, neo-tropical song birds (SFEP 1992c).

Widespread conversion of riparian habitat to cropland during the mid- to late-1800s reduced most of the region's riparian habitat resources. Current factors affecting riparian habitats in the Delta include levee rehabilitation projects, erosion, water exports, and agricultural practices. In addition, establishment of non-native plants has altered the habitat structure and species composition of some riparian habitat areas. Invasive plant species include giant reed, honey-locust, barnyard grass, poison hemlock, perennial peppergrass, acacia, almond, tree-of-heaven, and Himalayan blackberry (DWR 1993). These introduced, invasive species also support several non-native bird species that compete directly and indirectly with native songbird populations. These invasive birds include the European starling, English house sparrow, and brown-headed cowbird.

Approximately 75 local streams drain a total area of 3,464 square miles (8,974 km^2) within the Estuary (Leidy 1984). The majority of these streams are ephemeral (intermittent); however many support extensive riparian and emergent woodlands. Additionally, riparian wetlands may become established along local drainages, supported by seasonal flooding, and maintained through dry periods by hydrologic connection to groundwater.

Habitat Characteristics of the Riparian Corridors

FISH AND WILDLIFE. Fish do not use the upland areas of the riparian corridors, however, this environment does provide benefits to the aquatic environment used by fish. There is a great diversity of wildlife species in the riparian corridors. The shape of riparian zones (e.g., narrow corridors) maximizes the extent of edge habitat, thereby increasing species diversity. A number of species, such as hole-nesting or bark-gleaning birds, are completely dependent on this habitat type (SFEP 1991b). A list of the wildlife species of the Estuary is presented in Appendix I.

PLANT COMMUNITY. Riparian woodland vegetation covers approximately 12,513 acres of wetland habitat in the Estuary. Vegetation in the riparian woodlands is divided into three categories: (1) riparian forests; (2) riparian shrub-brush; and (3) brushy riprap. The category of riparian forest includes the riparian trees, shrubs, and herbs that are generally restricted to the banks of the perennial and intermittent stream and riverine tributaries of the Estuary. Riparian forest tree species include the following: California bay laurel (*Umbellularia californica*), cottonwood (*Populus fremontii*), western sycamore (*Platanus racemose*), white elder (*Alnus rhombifolia*), valley oak (*Quercus lobata*), and willow (*Salix* sp.). Riparian forest shrubs and herbs include the following species: blackberry (*Rubus procerus*), wild rose (*Rosa* sp.), mugwort (*Artemisia douglasii*), and wild grape (*Vitis californica*). Although riparian forests occur along the river and stream channels of the Bay Area, they flourish in the Delta region where stands occur along the numerous interconnecting channels and streams and on remnant isolated peninsulas (SFEP 1991b).

Riparian shrub-brush vegetation is characterized by broad-leaved woody growth that is for the most part less than 18 feet (6 meters) tall. The most common species are shrubs such as blackberry, wild rose, young alder, willows, and herbaceous species such as stinging nettle and mugwort. These shrub-brush communities occur on broad, earthen levees, on natural berms on the margins of some channel islands, and on naturalized dredged material disposal sites on some channel islands, such as the west end of Sherman Island (SFEP 1991b).

Bushy-riprap plant communities form on riprapped banks of levees and channels that are undisturbed by inspection and maintenance clearing activities, or where riprap is limited to the lower portions of the levee, allowing natural vegetation to remain on the upper part. Blackberry dominates this plant community in the Delta. Other common plant species include alder, stinging nettles, wild radish, milkweed, willows, and smartweed (Madrone Associates 1980).

SPECIAL STATUS SPECIES. The LTMS agencies requested an informal consultation with the USFWS during the preparation of this EIS/EIR. Subsequently, the USFWS provided a list of the important and special status species that could potentially be affected by implementation of any of the LTMS EIS/EIR alternatives. Special status species that occur within the upland portions of the Planning Area are presented in Table 4.4-1. The USFWS list, in its entirety (including Latin nomenclature), is presented in Appendix J. Brief descriptions of the federally listed special status species found in the upland portions of the Planning Area are contained in Appendix J.

Riparian habitats in the Planning Area are known to support rookery sites for several heron species and double-crested cormorants, nesting cover for colonies of tricolored blackbirds, basking sites for western pond turtles, and den habitat for ringtails. These species all forage in or adjacent to riverine habitat. Other special status species may utilize this habitat for migration corridors and/or perch sites, but are not generally dependent on riparian habitat.

WATER QUALITY AND POLLUTANTS. Water quality within the riparian corridor areas tend to reflect the characteristics of the individual watersheds. Approximately 30 percent of the upland areas around the Estuary are urbanized; the water quality within the riparian drainages is largely influenced by upstream urban inputs.

SALINITY. In general, salinity is not considered a potential significant impact on the majority of the region's riparian corridors. Vegetation and fish and wildlife use of the riparian corridors and woodlands tend to be segregated through natural estuarine salinity regime processes. An exception occurs where fresh water has been artificially diverted in the upper reaches of the Estuary. Such diversion has resulted in the displacement of fresh water species from the lower reaches of the tributary stream and associated riparian habitat areas. This effect is primarily seen during the summer dry season when the effects of water export are combined with lower riverine and stream flows.

4.4.2.4 Delta Levees

The Sacramento and San Joaquin Delta is a roughly triangular area of about 738,000 acres (1,150 square miles) comprised of a complex system of almost 60 major islands separated from water channels by levees. The Delta contains over 700 miles of interconnected waterways of which 550 are navigable. The total surface area of the Delta waterways is over 48,000 acres. Approximately 1,100 miles of levees protect 700,000 acres of reclaimed marshland and uplands (DWR 1994). The Delta receives water from the Sacramento River in the north and the San Joaquin River entering from the south, as well as minor tributaries to the east (Consumnes, Mokelumne, and Calaveras rivers). The rivers flowing to the Delta receive a combined runoff from approximately 40 percent of California's land area. The Delta discharges to Suisun Bay and San Francisco Bay, forming an interconnected estuary system.

Approximately one-quarter of the swamp and overflowed lands granted to California in the mid-to-late 1800s were located in the Sacramento-San Joaquin Delta. The vast marsh area of the historic Delta was made up of low-lying vegetated islands separated by many channels and sloughs. The thickly vegetated, natural levees of the Delta invited agricultural development; soon, small farmed plots appeared on higher ground. Reclamation of the Delta took place in two stages. The first stage of levee building occurred from the early 1880s to the early 1900s, primarily using Chinese laborers. Reclamation districts were formed in the late 1800s as a means to raise revenue for reclamation purposes through taxation and the issuance of bonds. The second phase of reclamation occurred from the 1950s to the early 1980s, using heavy equipment such as the clamshell dredge. Today, nearly 700,000 acres of land in the Delta are protected by levees.

The vast majority of the 1,100 miles of Delta levees were built and are maintained by adjacent landowners. Since the construction of the Delta levees, the region has become dependent on the levee system for flood control of the low-lying lands behind the structures. Standards for levee height, crown width, or slopes had not been developed when most levees were constructed. Due to great variation in levee construction and variation in soil types, geology, and other factors, levee maintenance requirements differ from site to site.

Throughout the Delta, islands reclaimed from historic wetlands are protected from flooding by levees. Since the reclamation of the Delta in the 1800s, the levees have increased from less than 5 feet tall to over 25 feet tall. Due to subsidence of the island interiors, it is necessary to continually add material to hold back the adjoining rivers and sloughs.

In the Delta, the levees not only protect the islands from flooding, but also protect the water quality in the Delta channels, which serve as an integral part of the state's water transfer system for approximately two-thirds of California's population. Degradation of the state's water supply by saline water could result from the failure of one or more Delta levees, making the water unsuitable for use.

Habitat Characteristics of the Delta Levees

WILDLIFE. The wildlife habitat of the Delta region is critical to both aquatic and terrestrial species. Because of the proposed dredged material reuse in the Delta Region will occur primarily on the in-board side of