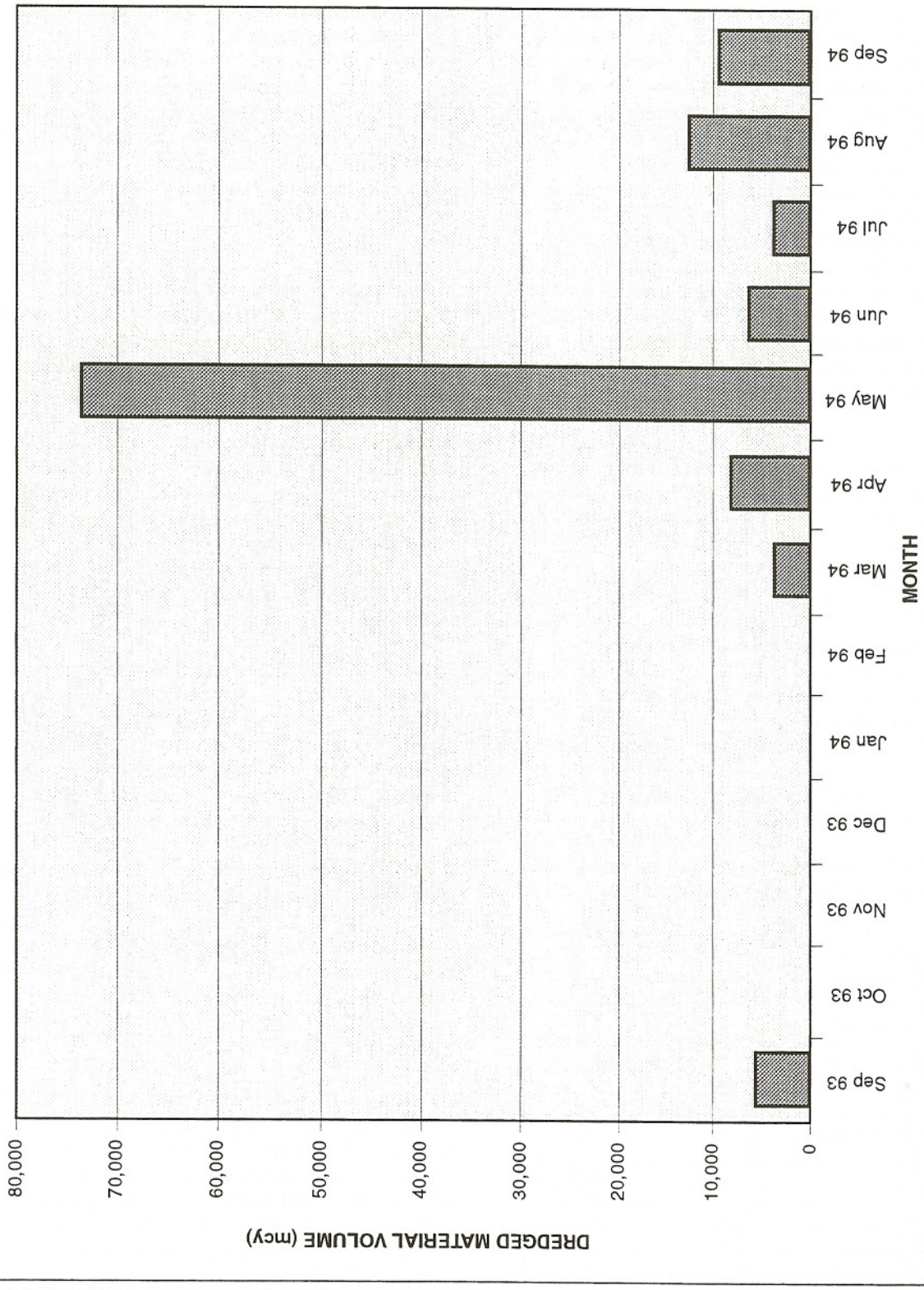



*Source:* COE Quarterly Reports

**Figure 4.3-15. Monthly Disposal Volumes at San Pablo Bay (September 1993 – September 1994)**

DISSOLVED OXYGEN. DO levels are generally high at this site. DO levels at a nearby monitoring station varied from 10 mg/l in March to 7 mg/l in September 1993. Short-term depressions in DO levels during disposal are expected to be similar to those found in waters immediately adjacent to the Carquinez Strait site (USACE 1976c). In that study, levels of DO near the Bay floor declined from 80 to 85 percent to 20 to 30 percent saturation within several minutes after material was released from the barge, but recovered to ambient levels within 10 minutes. Like the other in-Bay disposal sites, short-term changes in DO levels are expected to occur during disposal events at the San Pablo Bay site, but the overall effects would not be significant unless the frequency of disposal approached the amount of time it takes for DO levels to return to background after individual disposal events.

pH, UN-IONIZED AMMONIA AND POLLUTANTS. Water quality parameters measured in 1993 at a monitoring station near the San Pablo Bay site are summarized below in Table 4.3-8. The magnitude and extent of changes in pH, ammonia levels, and pollutant concentrations in the water column associated with dredged material disposal are not known for the San Pablo Bay site. Changes in these water quality parameters are expected to occur, but to be of short duration and primarily limited to the immediate vicinity of the disposal site except when associated with the near-bottom turbidity plume described below.

The primary factors controlling the bioavailability of contaminants will be the redox potential, pH, and salinity of water on-site. Oxygen levels in site water that are higher than in the disposed sediment would promote some oxidation of substances in disposed material, which would in turn promote the adsorption and desorption of chemical contaminants from particulates. The typically higher pH of San Pablo Bay waters compared to dredged material would also promote desorption of contaminants. However, higher salinity on occasion would serve to increase adsorption of contaminants onto particulates (U.S. Navy 1990).

**Table 4.3-8. Dissolved Water Quality Parameters near the San Pablo Bay Disposal Site**

| *Parameter* | *Dissolved Concentrations* | |
|---|---|---|
| PH | 7.6 - 7.8 | |
| Ammonia | 1.06 - 7.29 | µM |
| Ag | 1.34 - 4.76 | ng/l |
| As | 1.57 - 2.34 | µg/l |
| Cd | 29.23 - 91.63 | ng/l |
| Cr | 0.14 - 0.22 | µg/l |
| Cu | 1.3 - 2.54 | µg/l |
| Hg | 1.21 - 3.34 | ng/l |
| Ni | 1.35 - 3.73 | µg/l |
| Pb | 10.27 - 21.31 | ng/l |
| Se | 0.15 - 0.22 | µg/l |
| Zn | 0.41 - 0.78 | µg/l |
| PAHs | 2,783 | pg/l |
| PCBs | 171.78 | pg/l |
| Pesticides | 1,642 | pg/l |

*Source*: SFEI 1994.

Although there have been no detailed studies conducted on changes in water quality parameters at the San Pablo Bay site, it is expected that changes would be similar to those measured within Central Bay (see discussion of Pollutants under section 4.3.1.2), except that the tendency of saline waters to increase adsorption of trace metals to particulates would be lower because salinities within this embayment are lower. The overall impacts of short-term increases of pollutant levels in the water column would depend on background concentrations, whether water quality objectives are exceeded, and the extent of the volume of water within which concentrations are elevated above ambient levels.

SEDIMENT CHARACTERISTICS. The characteristics of the natural sediment at the San Pablo Bay disposal site vary seasonally, ranging from pockets of sand, to a mixture dominated by silt and clay (roughly 60 percent) and sand. Dredged material disposal affects these natural characteristics. However, at recent disposal volumes, most dredged material effectively disperses from this site each year, and no significant mounding problem has been observed like that found at the Alcatraz disposal site.

SEDIMENT QUALITY. Table 4.3-9 summarizes bulk chemistry data for sediment from the San Pablo disposal site, obtained from several recent permit applications (MEC and ABT 1994; ABT 1994a; ToxScan 1993; MEC 1993a).

The average concentrations of pollutants observed in these San Pablo Bay disposal site samples are generally within ranges found throughout the main embayments in the Estuary. As in other areas, fine sediments at this site contain higher concentrations of pollutants (e.g., organotins, pesticides, and heavy metals) than coarser sediments. Average values across the four studies shown in Table 4.3-9 for arsenic, mercury, lead, nickel, and silver fell within the middle of background sediment quality levels

**Table 4.3-9. Summary of Bulk Chemistry in Sediments at the San Pablo Disposal Site**

| *Parameter* | *Source (1) Fine* | *Source (2)* | *Source (3) Sand* | *Source (4)* |
|---|---|---|---|---|
| **Grain Size (percent)** | | | | |
| Gravel | 1.2 | 4.5 | 0.9 | 0.2 |
| Sand | 30.8 | 57.8 | 37.8 | 95.0 |
| Silt | 29.7 | 14.3 | 28.1 | 1.5 |
| Clay | 38.3 | 23.4 | 33.2 | 3.3 |
| Total Organic Carbon (percent) | 1.0 | 0.673 | 0.92 | 0.19 |
| Solids (percent) (Dry wt.) | 52 | 64.6 | 58.5 | 76 |
| **Organic Contaminants (µg/kg)** | | | | |
| Tributyltin | 6 | <1.5 | <10 | ND |
| Dibutyltin | 8 | <1.5 | <10 | ND |
| Monobutyltin | ND | <1.5 | <10 | ND |
| Oil and Grease (mg/kg) | 140 | | | |
| TRPH (mg/kg) | 87 | 4.5 | <50 | ND |
| DDT and metabolites | 50 | ND | 4 | ND |
| Pesticides | ND | ND | ND | ND |
| total PCBs | ND | ND | ND | ND |
| total PAHs | ND | 103.1 | 393 | ND |
| total Phthalate Esters | ND | 188.9 | 400 | ND |
| **Metals (mg/kg)** | | | | |
| Arsenic | 10 | 7.12 | 8.5 | 5.7 |
| Mercury | 0.29 | 0.183 | 0.24 | 0.04 |
| Selenium | 0.2 | 0.443 | <0.5 | ND |
| Cadmium | 0.23 | 0.15 | 0.2 | 0.06 |
| Chromium | 150 | 58.8 | 75.6 | 44.3 |
| Copper | 42 | 26.3 | 35.9 | 11.7 |
| Lead | 25 | 13.8 | 22.7 | 13.7 |
| Nickel | 66 | 56.3 | 70.6 | 63.6 |
| Silver | 0.2 | <0.124 | 0.2 | 0.05 |
| Zinc | 100 | 67.2 | 93.4 | 53.9 |

*Notes:* All chemical concentrations are in dry weight unless noted.
Averages calculated assuming value was 1/2 of detection limit where reported.
*Sources:* (1) Pinole Shoal Maintenance Dredging Study from ToxScan (1993)
(2) San Rafael Rock Quarry Dredging Study from ABT (1994)
(3) Larkspur Ferry Terminal Dredging Study from MEC and ABT (1994)
(4) Bahia Lagoon Dredging Study from MEC (1993)

reported throughout the Estuary. Average cadmium and chromium concentrations fell near the high end of the same distribution.

TOTAL SUSPENDED SOLIDS AND TURBIDITY. Turbidity levels at the San Pablo Bay disposal site vary considerably depending on season and are often much higher that TSS levels in the Central Bay. TSS concentrations measured at a nearby monitoring station in 1993 ranged from a low of 7.2 mg/l during a period of high riverine flow to a high of 190.7 mg/l during the summer months when wind-generated currents resuspend significant amounts of material in the embayment.

AQUATIC RESOURCES. The primary aquatic resources within the boundaries of the San Pablo Bay disposal site that could potentially be affected by dredged material disposal are those associated with the benthic community. Other resources such as phytoplankton, zooplankton, pelagic fish, and wildlife are more appropriately considered in the following section addressing the broader context of the embayment.

*Environmental Characteristics of San Pablo 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 boundaries of the disposal site. Water quality within San Pablo Bay is expected to only be marginally affected by disposal, presuming disposal events are much less frequent than the time it takes a disposal sediment plume to fully diffuse (less than 1.5 hours).

SEDIMENT CHARACTERISTICS. San Pablo Bay is a very shallow embayment where the substrate is predominantly Bay mud. This material is cut by channels, the deepest of which runs from the western edge of Carquinez Strait to the southern boundary of the embayment. The substrate in the main channel is predominantly sand, surrounded by a broader band of silt and clay extending northwest and southeast into the lower energy mudflat reaches. The character of the surficial sediments in the vicinity of the channel also varies according to season.

SEDIMENT DYNAMICS. Transport of suspended material in the shallow areas and channels of San Pablo Bay is governed by two different sets of factors. Within the channels, tidal currents and gravitational circulation dominate the movement of suspended material. In the shallow areas, wind-driven currents dominate material suspension and movement. Also, during periods of high riverine flow, fine-grained material is resuspended from Suisun Bay and deposited in San Pablo Bay. As flows decline, this material is gradually resuspended and transported away from San Pablo Bay (Nichols and Pamatmat 1988).

Sedimentation rates in San Pablo Bay have varied substantially over the years, largely due to the varying rate of water flow from the Delta. For example, as a direct result of gold mining in the Sierra foothills in the second half of the 1800s, approximately 300 million cy of debris was deposited in San Pablo Bay, filling the Bay by, on average, 1 meter. Sedimentation continued, but at a much slower rate, until the middle of this century. Beginning in 1951, the Bay lost sediment, possibly as a result of upstream flood control and water distribution projects that reduced peak flows (conditions when the most sediment is transported) which, in turn, decreased the sediment supply. Tidal mudflats grew due to the sedimentation, but they eroded with the reduced influx of debris. In the years that the Bay experienced a net loss in sedimentation, the mudflats eroded at a rate of approximately 90 acres per year. Therefore, the changes in sedimentation have directly affected the creation and erosion of tidal mudflats (USGS 1997).

SEDIMENT QUALITY. Representative sediment quality data from two years of monitoring at two sites in San Pablo Bay is presented in Table 4.3-10. Generally, contaminant concentrations in these sediments are similar to those observed at the San Pablo disposal site with the exception of zinc and total PAHs, which are frequently higher at the monitoring sites than at the disposal site.

**Table 4.3-10. Summary of Bulk Chemistry in Sediments from Monitoring Stations in San Pablo Bay (1993-1994)**

| *Parameter* | *BD22* | *BD31* |
|---|---|---|
| Fines (percent) | 30 | 66 |
| Total Organic Carbon (percent) | 1.2-1.3 | 1.3-1.9 |
| **Organic Contaminants (µg/kg)** | | |
| DDT and metabolites | 0.9-2.6 | 2.0-5.3 |
| Total Pesticides | 2.8-3.2 | 5.0-5.8 |
| total PCBs | 7.1-9.9 | 18-26 |
| total PAHs | 3,100-7,461 | 646-1,080 |
| **Metals (mg/kg)** | | |
| Arsenic | 10-19 | 10-20 |
| Mercury | 0.4 | 0.2-0.4 |
| Selenium | 0.1-0.9 | 0.2-0.9 |
| Cadmium | 0.2-0.3 | 0.3-0.4 |
| Chromium | 69-80 | 83-100 |
| Copper | 48-53 | 49-62 |
| Lead | 16-30 | 25-36 |
| Nickel | 67-92 | 80-110 |
| Silver | 0.2-0.3 | 0.3-0.5 |
| Zinc | 111-121 | 120-148 |

*Note*: * Data not reported due to QA problem.
*Sources*: SFEI 1994 and 1995

TOTAL SUSPENDED SOLIDS AND TURBIDITY. TSS levels in San Pablo Bay are naturally often greater than those of the Central Bay. Recent data on suspended solids taken off Point San Pablo indicate mean TSS concentrations of 90.9 mg/l near the bay floor (65.3 mg/l median; 31.5 mg/l lower quartile, 121 mg/l upper quartile) and 87.9 mg/l at 13 feet above the Bay floor (70.4 mg/l median; 37.4 mg/l lower quartile; 114 mg/l upper quartile) (Buchanan and Schoellhamer 1994).

BENTHOS. San Pablo Bay possesses an invertebrate fauna somewhat different from other regions of the Bay. The native Baltic clam (*Macoma balthica*) predominates in the intertidal mudflats of San Pablo Bay. Mollusks such as the soft shell clam *Mya arenaria* and *Gemma gemma* prefer the fine silt and clay bottoms of San Pablo Bay, but are sensitive to variations in salinity. The snail *Ilyanassa obsoleta*, a number of amphipods, and many polychaete worms that are found in other North American estuaries are also abundant. The Asian clam *Potamocorbula amurensis* has quickly become abundant in San Pablo Bay. As noted earlier, with the possible exception of *Macoma balthica*, all the species listed above were introduced.

Important crustacean species of San Pablo Bay include the Dungeness crab and several species of bay shrimp (*Crangon* spp.). These crustaceans are native species. Red rock crab (*Cancer productus*) and brown rock crab (*Cancer antennarius*) are found throughout San Pablo Bay during their entire life cycles, inhabiting rocky, nearshore habitats. Grass shrimp, California bay shrimp, blacktailed shrimp populations respond predominately to outflow and salinity (SFEP 1992a). During late winter to July, larval and post-larval stages of Franciscan bay shrimp are found in San Pablo Bay, while juveniles are most abundant from April to August.

EELGRASS HABITATS. Eelgrass (*Zostera*) beds are found only in the shallow areas in the southern portions of San Pablo Bay near Central Bay (where the substrate is mud or mixed mud and sand). The eelgrass grows in low-energy areas and serves to stabilize sediment, providing a substrate for epiphytes, producing organic matter, exporting detritus, and attracting crabs, shrimp, and skates. Eelgrass also provides forage, spawning, and nursery substrate for numerous species of fish. A 1987 aerial survey found a single bed of 50 ha directly north of Point San Pablo (Echeverria and Rutten 1989).

FISH AND SHELLFISH RESOURCES. The fish assemblage of San Pablo Bay varies seasonally as a result of reproductive cycles and the volume of freshwater inflow. The most abundant species in the embayment is the northern anchovy. The abundance of other marine fishes (e.g., white croaker, bay goby, jacksmelt, and the shiner perch) appears to be restricted to summer months, when salinities are highest in the extensive shallow areas in this embayment. Estuarine species include starry flounder, longfin smelt, staghorn sculpin, and the striped bass. Other species found in San Pablo Bay include the Pacific herring, yellowfin goby, and the English sole. Saltponds of San Pablo Bay support species such as topsmelt, yellowfin goby, threespine stickleback, and Pacific staghorn sculpin. (SFEP 1992a).

Because San Pablo Bay is located between the ocean and the San Joaquin and Sacramento rivers, it is used as a seasonal migration corridor for several species of anadromous fish such as the striped bass, chinook salmon, steelhead trout, American shad, and the white and green sturgeon. These species may utilize San Pablo Bay as seasonal habitat and/or a migration route during upstream spawning or downstream migrations of adults or juveniles. The abundances of many of the estuarine species that inhabit San Pablo Bay (striped bass, sturgeon, longfin smelt, starry flounder, and staghorn sculpin) have decreased substantially in recent years, apparently as a result of reduced freshwater inflow. This decrease in estuarine species has coincided with increases in some marine species, such as white croaker and queenfish.

The primary concerns regarding disposal of dredged material at the Carquinez or San Pablo Bay designated sites and aquatic species are related to migrating special status species and a sensitive life stage of Dungeness crabs.

WILDLIFE RESOURCES. Important shore- and waterbirds in San Pablo Bay include black-necked stilts, dowicher, dunlin, eared grebes, egrets, greater yellowlegs, lesser yellowlegs, herons, northern pintail, canvasback, scoters, scaups, long-billed curlew, American avocet, western and least sandpiper, killdeer, the marbled godwit, northern shovelers, red necked phalaropes, terns, and the western medowlark. Rocky shore habitat also supports the black turnstone, brown pelican, cormorants and western gulls.

Marine mammals of the open water and rocky shore habitat include the California sea lion and the harbor seal. The seal uses the mudflats to haul out during low tide.

SPECIES OF SPECIAL CONCERN. The species of special concern identified in San Pablo Bay include the chinook salmon, Sacramento splittail, coho salmon, longfin smelt, Dungeness crab, and recreational marine fishes. Generally, disposal could result in direct effects to chinook salmon adults and juveniles due to disruption of migration patterns and degradation of water quality. Coho salmon, if present, would also be susceptible to the same direct effects. Disposal may also degrade the habitat of marine recreational fishes in the area. However, these species are expected to be able to avoid effects from disposal operations provided that the disposal site is located in a broad water body and disposal events do not occur at high frequences over extended periods. Thus, disposal at the San Pablo Bay site is not expected to result in direct effects on these species of special concern.

Other special concern species that occur in San Pablo Bay include the peregrine falcon, brown pelican, western snowy plover, California clapper rail, California least tern, and salt marsh harvest mouse.

*Existing Monitoring Programs*

Existing monitoring programs of dredging and dredged material disposal that occur in the San Pablo Bay are discussed above in section 4.3.2.1.

*Summary of Environmental Characteristics of San Pablo Bay Potentially Affected by Dredged Material Disposal*

Table 4.3-11 summarizes the resources at the San Pablo Bay disposal site (SF-10) and within San Pablo Bay embayment that may be affected by dredged material disposal. The magnitude of potential impacts depends on the overall amount of material directed to San Pablo Bay over the course of the next 50 years and on the development and implementation of policies that will serve to limit adverse environmental effects of disposal.

**Table 4.3-11. Summary of Resources of Concern at San Pablo Bay Dredged Material Disposal Site and San Pablo Bay**

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

### 4.3.2.3 Carquinez Strait

The narrow, 12-mile long Carquinez Strait joins San Pablo Bay with Suisun Bay. The Strait is characterized by primarily deep water habitat and a variable salinity regime resulting from fluctuations in fresh water flow from the Sacramento-San Joaquin river system. The mean depth of the Strait is 29 feet (SFEP 1992a). In periods of high Delta outflow, the most landward zone of gravitational circulation (the null zone) is located in the vicinity of Carquinez Strait. While San Pablo Bay is the deposition site for many of the fine-grained sediments carried out of the Delta, the deeper Carquinez Strait is characterized by strong currents and consequently most of the bottom is a sandy substrate.

This section first describes the environmental conditions at the Carquinez disposal site itself, followed by a discussion of environmental parameters within the broader Strait that may be affected by dredged material disposal at the Carquinez site.

*Environmental Characteristics of the Carquinez Strait Disposal Site*

The Carquinez Strait disposal site (known as "SF-9") is a 1,000-foot by 3,000-foot rectangle located 0.9 miles west of the entrance to Mare Island Strait in eastern San Pablo Bay (see Figure 2.2-1 and Figure 4.3-16). The bulk of the material disposed at this site has been dredged from the Mare Island Ship Channel. The COE and BCDC records indicate historic disposal quantities ranged from a low of approximately 200,000 cy in 1977 to a high of over 2.5 mcy in 1986 (Figure 4.3-17). The current disposal volume limitation on this site is 2 to 3 mcy/yr, depending on whether the year is a "normal or "wet" year, respectively. Monthly information on disposal volumes at this site is presented in Figure 4.3-18.

The Carquinez site acts as a disperal site for the dredged sediments disposed there. A large-scale tracer study was performed at the site in the mid-1970s to examine the fate of dredged materials. The results of this study showed that approximately 10 percent of iridium-tagged sediment disposed at the site recycled back into Mare Island Strait and the rest settled across a large portion of San Pablo and Suisun bays (USACE 1976b).

SALINITY. Salinity levels at the Carquinez Strait disposal site vary considerably according to season. Data from a nearby monitoring station at Davis Point show levels ranging from 8.43 to 19.98 ppt with higher salinities during periods of low riverine flow. There is also a significant salinity gradient with depth at this site that also varies by season. Sampling during 1993 showed the strongest gradient during periods of high riverine flow and low surficial salinities (levels increased from roughly 2 ppt to 25 ppt with increasing depth). The gradient was much less pronounced during periods of low riverine flow when salinities rnaged from approximately 12 ppt at the surface to 20 ppt near-bottom.

Disposal of sediment dredged from channels in the Estuary may cause short-term, localized changes in

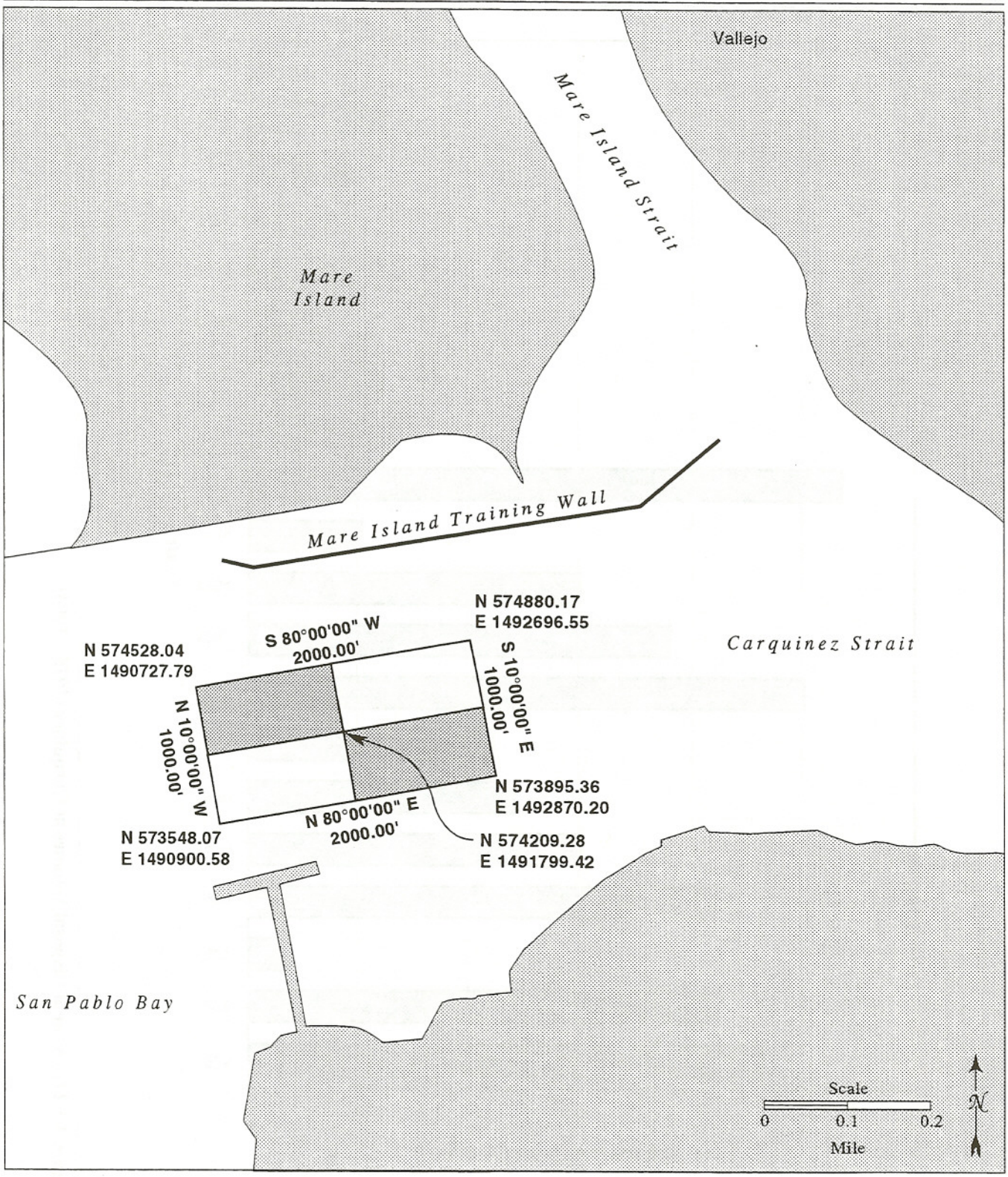



**Figure 4.3-16. Carquinez Strait Open Water Disposal Site SF-9**

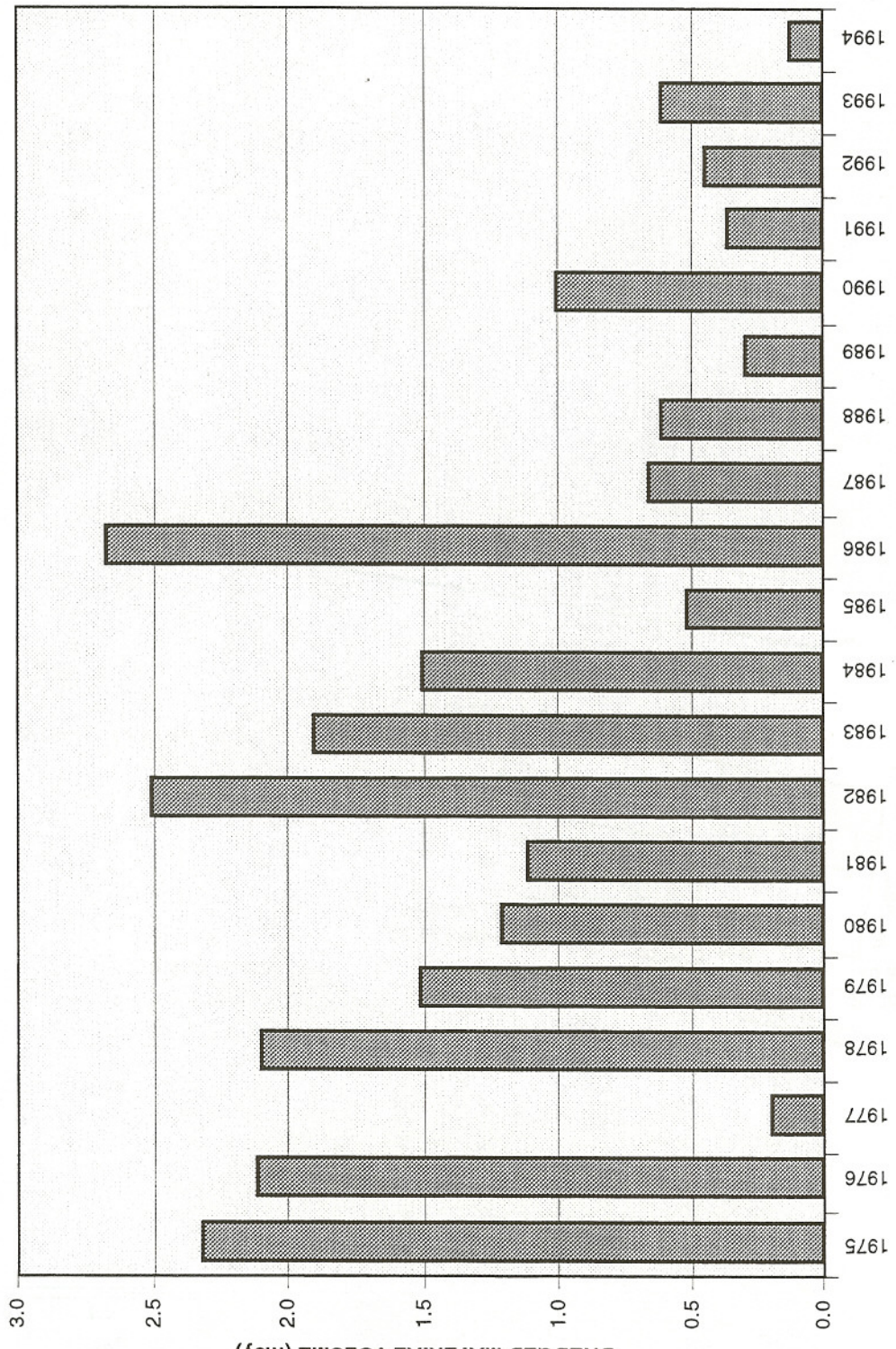



**Figure 4.3-17. Annual Disposal Volumes at Carquinez (1975 – 1994)**

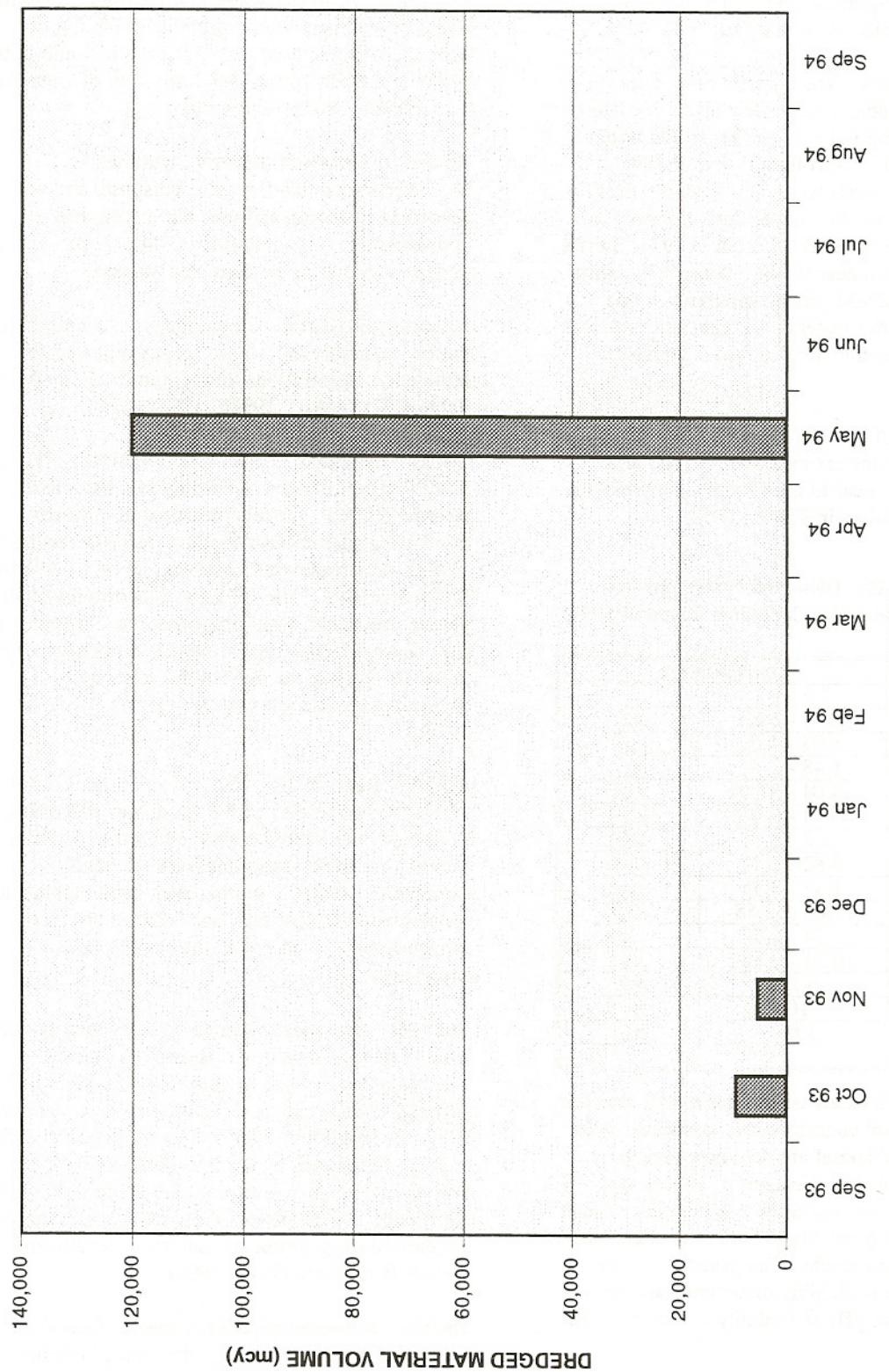



**Figure 4.3-18. Monthly Disposal Volumes at Carquinez (September 1993 – September 1994)**

salinity at the Carquinez disposal site, but these changes are expected to be marginal.

DISSOLVED OXYGEN. The disposal of dredged sediment has the potential to affect levels of dissolved oxygen at each disposal site, particularly in waters near the Bay floor. Short-term depressions in dissolved oxygen levels were measured in waters immediately adjacent to this site during disposal of material from the Mare Island Strait in 1973. Levels of dissolved oxygen near the Bay floor declined from 80-85 percent to 20-30 percent saturation within several minutes after material was released from the barge, but recovered to ambient levels within 10 minutes.

PH, UN-IONIZED AMMONIA, AND POLLUTANTS. Water quality parameters measured in 1993 at a monitoring station near to the Carquinez disposal site are summarized below in Table 4.3-12.

**Table 4.3-12. Dissolved Water Quality Parameters near the Carquinez Disposal Site**

| *Parameter* | *Concentrations* | |
|---|---|---|
| pH | 7.7 - 8.0 | |
| ammonia | 2.43 - 6.89 | µM |
| Ag | 1.09 - 4.00 | ng/l |
| As | 1.48 - 2.41 | µg/l |
| Cd | 33.04 - 97.03 | ng/l |
| Cr | 0.14 - 0.36 | µg/l |
| Cu | 1.82 - 2.36 | µg/l |
| Hg | 0.82 - 2.45 | ng/l |
| Ni | 1.43 - 3.75 | µg/l |
| Pb | 8.49 - 62.88 | ng/l |
| Se | 0.14 - 0.27 | µg/l |
| Zn | 0.51 - 0.98 | µg/l |
| PAHs | 6,269 | pg/l |
| PCBs | 100 | pg/l |
| Pesticides | 3,684 | pg/l |

*Source*: SFEI 1994.

The magnitude and extent of changes in pH, ammonia levels, and pollutant concentrations, associated with dredged material disposal are not known for the Carquinez disposal site. Changes in these water quality parameters are expected to occur, but to be of short duration and primarily limited to the immediate vicinity of the disposal site. The primary factors controlling the bioavailability of contaminants will be the redox potential, pH, and salinity of water on-site.

Oxygen levels in site water that are higher than in the disposed sediment would promote oxidation of substances in disposed material, which would in turn, promote the adsorption and desorption of chemical contaminants from particulates.

SEDIMENT CHARACTERISTICS. Sediment characteristics at the Carquinez disposal site vary according to season and use, but are on average approximately 7 percent gravel, 44 percent sand, 21 percent silt, and 28 percent clay material.

SEDIMENT QUALITY. Contaminant levels measured at the site generally fall within ranges reported for sediment concentrations throughout the Estuary (see Table 4.3-13) (ABT 1994b, 1994c, 1995).

TOTAL SUSPENDED SOLIDS AND TURBIDITY. Levels of TSS at the site vary according to season and riverine outflow. Levels measured at a nearby monitoring station (near-surface) in 1993 ranged from 13.2 to 40.7 mg/l with increasing levels as riverine flows decreased. The COE has monitored turbidity plumes associated with disposal at the Carquinez Strait site. Turbidity was highest immediately after disposal in waters close to the bottom but returned to background levels after 10-25 minutes (USACE 1976c).

AQUATIC RESOURCES. The primary aquatic resources within the boundaries of the Carquinez disposal site that could potentially be affected by dredged material disposal are those associated with the benthic community. Other resources such as phytoplankton, zooplankton, pelagic fish, and wildlife are more appropriately considered in the context of the embayment.

BENTHOS. The most abundant species found in the vicinity of the Carquinez disposal site in soft sediments were amphipods *Ampelisca abdida* and *Grandidierlla japonica* and the clam *Mya arenaria*. In 1989, the soft-bottom benthic community had shifted to being dominated by the introduced Asian clam, *Potamocorbula amurensis* and the polychaete worm, *Tharyx* sp. Abundance of these two species typically increases during spring and summer recruitment periods (Chambers Group 1994).

The most abundant epiphaunal species found near the Carquinez disposal site (near the Unocal marine

**Table 4.3-13. Physical and Chemical Parameters Measured in Sediments from the Carquinez Disposal Site**

| *Parameter* | *Source (1)* | *Source (2)* | *Source (3)* |
|---|---|---|---|
| **Grain Size (percent)** | | | |
| Gravel | 4 | 1.8 | 7.9 |
| Sand | 42.2 | 56.3 | 69.9 |
| Silt | 22.1 | 18.9 | 6.9 |
| Clay | 31.7 | 23.0 | 15.3 |
| Total Organic Carbon (percent) | 0.94 | 0.5 | 0.495 |
| Solids (percent) (Dry wt.) | 50.1 | 63.6 | 59.4 |
| **Organic Contaminants (µg/kg)** | | | |
| Tributyltin | <2.0 | <1.6 | <1.7 |
| Dibutyltin | <2.0 | <1.6 | <1.7 |
| Monobutyltin | <2.0 | <1.6 | <1.7 |
| TRPH (mg/kg) | 33.1 | 10.1 | 98.5 |
| DDT and metabolites | ND | ND | ND |
| Pesticides | ND | ND | ND |
| total PCBs | ND | ND | ND |
| total PAHs | ND | ND | 569.6 |
| total Phthalate Esters | 180.5 | ND | 961 |
| **Metals (mg/kg)** | | | |
| Arsenic | 8.58 | 10.3 | 6.06 |
| Mercury | 0.303 | 0.162 | 0.343 |
| Selenium | <1.99 | <0.78 | <0.84 |
| Cadmium | <0.31 | 0.212 | 0.215 |
| Chromium | 70.7 | 67.6 | 51.9 |
| Copper | 46.3 | 34.9 | 35.0 |
| Lead | 19.2 | 39.9 | 12.1 |
| Nickel | 77.0 | 70.1 | 64.0 |
| Silver | 0.798 | <0.06 | <0.14 |
| Zinc | 103 | 81.8 | 75.1 |

*Notes:* All chemical concentrations are in dry weight unless noted.
*Sources:* (1) ABT 1994b (Benicia Industries).
(2) ABT 1995 (Exxon Loading terminal study).
(3) ABT 1994c (Wickland Oil study).

terminal) were cranganid shrimp, commonly known as bay or grass shrimp. Dungeness crab was also abundant throughout the sampling area, accounting for nearly 8 percent of the crustacean catch in 1989. The same sample also included several rock crabs such as *Cancer productus and C. antennarius* (Keegan et al. 1989).

The coarse shifting sand at the edge of the J.F. Baldwin ship channel contained only a few individuals of two amphipod species, *Ampelisca abdida* and *Sinelobus sanfordi*, both of which are adapted to invading disturbed areas and persisting in stressful environments (Chambers Group 1994).

*Environmental Characteristics of Carquinez Strait Outside the Disposal Site Potentially Affected by Material Disposal*

The Carquinez Strait disposal site is characteristically highly dispersive; disposed material has been shown to disperse rapidly into a widespread area both upsteam and downstream of the site (Sustar 1982). The environmental resources in both San Pablo and Suisun bays therefore have the potential to be affected by dispersed sediment from the Carquinez site (see sections 4.3.2.2 and 4.3.2.4). This section focuses on environmental resources potentially affected within the Carquinez Strait.

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 mixing zone. That zone is generally located within the disposal site. Water quality within the Carquinez Strait is expected to only be marginally affected by disposal, presuming disposal events are much less frequent than the time it takes the plume to diffuse.

SEDIMENT CHARACTERISTICS. Carquinez Strait is a narrow channel that is scoured by strong tidal currents and riverine flows. The sediment is predominantly rock and sand with fine silt and clay forming classic Bay mud in the lower energy areas off the main channel (such as Southhampton Bay). The deep channel shoreline is characterized by rocky shores and developed waterfront areas, consisting of intertidal riprap, gravel beaches, and subtidal fine sand (ENTRIX 1991; Robilliard et al. 1989).

SEDIMENT DYNAMICS. Sediment dynamics within the Strait are dominated by riverine outflow and gravitational circulation. Sediment transported through the Strait appears to enter the overall sediment cycle in the Bay, and can ultimately distribute widely throughout the Estuary. See Chapter 3 (section 3.2.2 and Figure 3.2-3) for a more detailed discussion of general patterns of sediment movement in the Bay.

SEDIMENT QUALITY. Representative sediment quality data from two years of monitoring at one site at the edge of Carquinez Strait as well as data from stations associated with recent COE studies are presented in Table 4.3-14. Generally, contaminant concentrations in overall Carquinez Strait sediments are similar to, if

**Table 4.3-14. Sediment Quality in Carquinez Strait**

| *Parameter* | *Source (1)* | *Source (2)* | *Source (3)* |
|---|---|---|---|
| **Grain Size (percent)** | | | |
| Gravel | 2-3 | NR | 0-4 |
| Sand | 73-81 | NR | 4-94 |
| Silt | 6-9 | NR | 3-51 |
| Clay | 10-17 | NR | 3-52 |
| Total Organic Carbon (percent) | 0.2-0.5 | NR | 0.4-2.2 |
| **Organic Contaminants (µg/kg)** | | | |
| Tributyltin | NA | NR | 0.6-29 |
| Dibutyltin | NA | NR | 1-12 |
| Monobutyltin | NA | NR | 0.7-4 |
| Oil and Grease (mg/kg) | | NR | 9-111 |
| TRPH (mg/kg) | | NR | 12-62 |
| DDT and metabolites | 0.7-1.2 | 23 | ND |
| Pesticides | 0.7-1.6 | NR | ND |
| total PCBs | 1.2-4.4 | 29 | ND |
| total PAHs | 116-389 | 1,100 | 26-392 |
| **Metals (mg/kg)** | | | |
| Arsenic | 5.7-7.4 | NR | 8.4-21 |
| Mercury | 0.1-0.2 | 0.13 | 0.06-0.45 |
| Selenium | 0.1-0.7 | -- | 0.8-1.0 |
| Cadmium | 0.1 | 0.5 | 0.1-0.6 |
| Chromium | 67-81 | 193 | 164-269 |
| Copper | 18-29 | 63 | 17-67 |
| Lead | 13-16 | 23 | 10-34 |
| Nickel | 62-74 | -- | 81-120 |
| Silver | 0.05-0.1 | 0.2 | 0.03-0.3 |
| Zinc | 73-87 | -- | 71-147 |

*Notes:* * Grain size data expressed as percent fines.
NA = not analyzed
NR = not reported

*Sources:* (1) Davis Point (BD40 and BD41) from SFEI (1994 and 1995)
(2) Sample Point from Long et al. (1988)
(3) Range of Carquinez Strait samples from Word and Kohn (1990)

not occasionally higher than, those observed in the vicinity of the disposal site (Word and Kohn 1990).

TOTAL SUSPENDED SOLIDS AND TURBIDITY (TSS). Levels of TSS in the Carquinez Strait vary according to season and riverine outflow. TSS concentrations measured at the surface at the western edge of the trait ranged from 13.2 to 40.7 mg/l while levels at the eastern edge of the Strait varied from 81.8 to 45.9 mg/l over the same time period. In special studies of disposal at Carquinez Strait site, the COE collected samples at four down-current stations prior to disposal. Maximum concentrations of suspended solids at these stations were up to 100 times higher in waters close to the bottom than in near-surface water. Elevated suspended solids concentrations were measured as far as 1,400 m down-current from the disposal site, but only lasted approximately 10 minutes (USACE 1976b).

BENTHOS. The benthic community in the main channel of the Strait is characterized by low diversity, dominated by opportunistic species such as the amphipods, *Ampelisca abdida* and *Sinelobus sanfordi*. Salinity of the area west of Carquinez Strait rarely falls below 5 ppt and the benthic community there is therefore dominated by salt-tolerant species and is more diverse than the benthic community of the eastern Strait and Suisun Bay. While Dungeness crab are primary found in the shallower areas of central and San Pablo Bay, they can are also found upstream depending on waterflows (Tasto 1983).

FISH AND SHELLFISH RESOURCES. Carquinez Strait is an important migratory corridor for many pelagic fish species. Striped bass, chinook salmon, American shad, Pacific herring, northern anchovy, white sturgeon and longfin smelt migrate through the area surrounding the vicinity of the Carquinez disposal site during one or more life stages. The starry flounder is a resident in the Carquinez Strait.

WILDLIFE RESOURCES. Shorebirds in Carquinez Strait include dunlin, northern pintail, canvasback, scoters, scaups, long billed curlew, American avocet, western and least sandpiper, killdeer, and the marbled godwit. The Carquinez Strait also supports the black turnstone, brown pelican, cormorants and western gulls.

SPECIES OF SPECIAL CONCERN. Resource agencies have identified the chinook salmon, delta smelt, longfin smelt, and Pacific herring as species of special concern along Carquinez Strait. Chinook salmon pass through Carquinez Strait on their migratory route. Both adults and juveniles may be directly affected by disposal at the Carquinez disposal site through interference with migration and the degradation of water quality. Juveniles may be affected by suspended sediment associated with the disposal of sediments interfering with their ability to forage in the Strait. Delta smelt primarily inhabit the shallow brackish sloughs and marshes of the Delta and Suisun Bay, but also occur downstream in the Carquinez Strait and elsewhere in the estuary, including the Napa River, where salinities are reduced by freshwater inflow. Longfin smelt are widely distributed in the northern part of the estuary from San Pablo Bay through the Carquinez Strait to Suisun Bay and the Delta. In addition, adult steelhead congregating at the mouth of the Napa River before high flow periods may also be affected by disposal at the Carquinez site.

Other special concern species that occur along the Carquinez Strait include brown pelican, California clapper rail, California least tern (which has nested at Port Chicago), and salt marsh harvest mouse.

*Existing Monitoring Programs*

Existing monitoring programs of dredging and dredged material disposal that occur in the Carquinez Strait are discussed above in section 4.3.2.1.

*Summary of Environmental Characteristics of Carquinez Strait Potentially Affected by Dredged Material Disposal*

Table 4.3-15 summarizes the resources within the Carquinez Strait that may be affected by dredged material disposal at SF-9 or other dispersive sites within or near this water body. The magnitude of potential impacts depends on the overall amount of material directed to SF-9 over the course of the next 50 years and on the development and implementation of policies that will serve to limit adverse environmental effects of disposal.

**Table 4.3-15. Summary of Resources of Concern at Carquinez Strait Dredged Material Disposal Site and Carquinez Strait**

| *Resource* | *On Site* | *Embayment* |
|---|---|---|
| **Water Quality** | | |
| Dissolved oxygen | X | |
| Ammonia | X | |
| Pollutant levels | X | |
| Toxicity | X | |
| **Sediment** | | |
| Characteristics | X | |
| Bathymetry/dynamics | X | X |
| Quality | X | X |
| Total Suspended Solids/Turbidity | X | |
| **Aquatic Resources** | | |
| Habitats | | |
| Benthos | X | |
| Migratory corridor | X | X |
| Fish | | |
| Steelhead | | X |
| **Special Status Species** | | |
| Chinook salmon | | X |

### 4.3.2.4 Suisun Bay

Suisun Bay is a shallow embayment between Chipps Island, at the western boundary of the Delta, and the Benicia-Martinez Bridge. Adjacent to this embayment is Suisun Marsh, the largest brackish marsh in the United States. Suisun Bay covers approximately 36 square miles, has a mean depth of 14 feet, and a mean salinity of approximately 7 ppt. Fresh water flowing from the Delta usually meets salt water from the ocean in the vicinity of Suisun Bay. Under moderate Delta outflow conditions, the location of the null zone is at the upstream end of Suisun Bay. The bottom of this embayment is primarily comprised of mud. During high flows, these fine sediments are deposited to San Pablo Bay. Under low-flow conditions, fine materials are deposited in Suisun Bay.

This section first describes the environmental conditions at the Suisun Bay disposal site. This is followed by a discussion of environmental parameters within the broader Suisun Bay embayment that may be affected by dredged material disposal at the Suisun Bay site.

*Environmental Characteristics of the Suisun Bay Disposal Site*

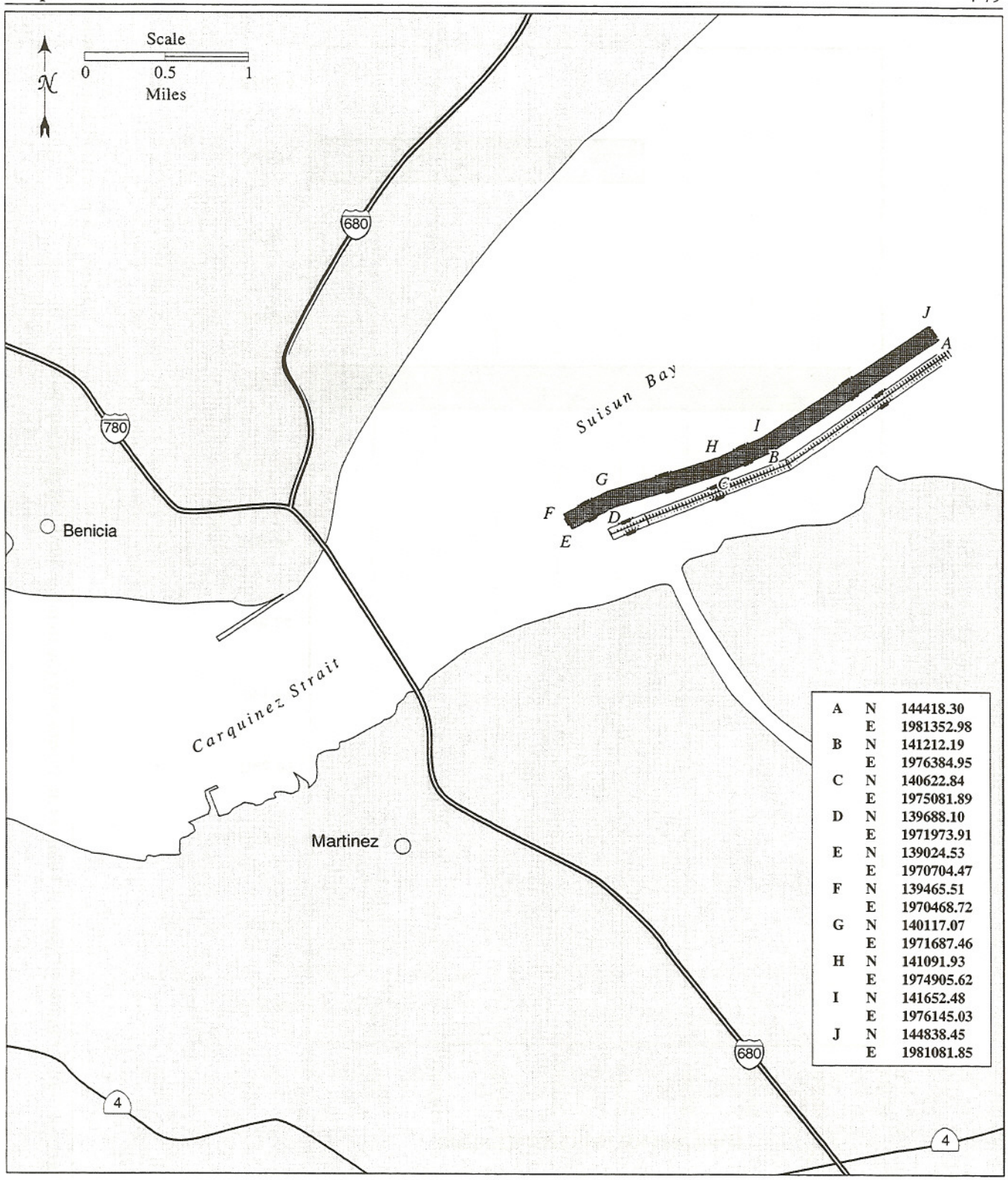
The Suisun Bay disposal site (known as "SF-8") is a 500-foot by 11,200-foot rectangle located along the northern side of the Suisun Bay Channel (see Figure 2.2-1 and Figure 4.3-19). This site is currently limited to federal project use for materials that are at least 95 percent sand from the COE maintenance dredging of the Suisun Bay Channel. The COE and BCDC records indicate recent disposal quantities ranged from a low of 33,000 cy in 1992 and 1993 to a high of 125,000 cy in 1990. The site was not used in 1989 or 1991. Monthly information on disposal volumes at this site is presented in Figure 4.3-20. The current disposal volume limitation at the Suisun Site is 0.2 mcy/yr.

WATER QUALITY. The water quality characteristics at this disposal site resulting from the disposal of primarily sandy material are not expected to be significantly different than the immediate area. Studies conducted on the discharges from sand mining operations in Central Bay (MEC 1993b) demonstrated that unfiltered effluent from sand mining at Presidio Shoals and Point Knox had $LC_{50}$ values of 60 percent and 34 percent unfiltered effluent while filtered effluent caused no toxicity. Chemical analysis of overboard effluent showed fairly high levels of particulate-bound metals within the plume and some changes in the gradient of metal concentrations with depth. While water quality at the Suisun Bay site has the potential to be affected by disposal of dredged sandy material, the effects are expected to be short term and limited to the site under the scenarios being considered under this programmatic EIS/EIR.

SEDIMENT COMPOSITION AND QUALITY. At the present time, the restrictions on use of this site to sandy material effectively prevent modification of the native sediment. Significant changes in sediment characteristics, dynamics, and quality are not expected with continued use of this site. Sediment chemistry (aside from grainsize analysis) is not available for the Suisun Bay disposal site. Past testing has demonstrated consistently low levels of contaminants in highly sandy sediments, eliminating the need for extensive chemical characterization of sediments from this disposal site.

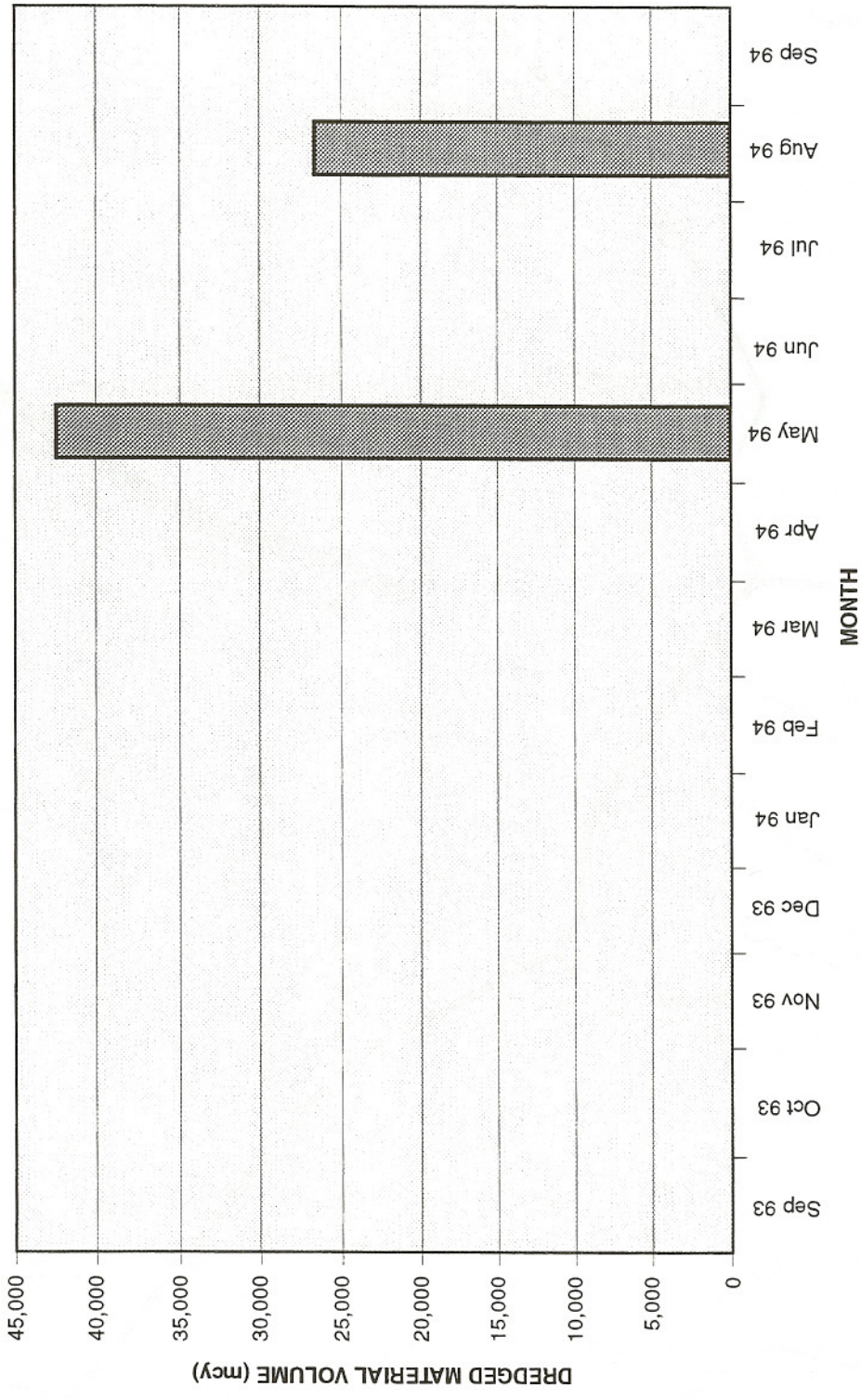
TOTAL SUSPENDED SOLIDS AND TURBIDITY. As with the other designated disposal sites, it is expected that turbidity levels at the site will increase for a short period of time after release of dredged material and the greatest increase will occur in waters near the bay floor.

AQUATIC RESOURCES. The primary aquatic resources within the boundaries of the Suisun Bay disposal site




| | | |
|---|---|---|
| A | N | 144418.30 |
| | E | 1981352.98 |
| B | N | 141212.19 |
| | E | 1976384.95 |
| C | N | 140622.84 |
| | E | 1975081.89 |
| D | N | 139688.10 |
| | E | 1971973.91 |
| E | N | 139024.53 |
| | E | 1970704.47 |
| F | N | 139465.51 |
| | E | 1970468.72 |
| G | N | 140117.07 |
| | E | 1971687.46 |
| H | N | 141091.93 |
| | E | 1974905.62 |
| I | N | 141652.48 |
| | E | 1976145.03 |
| J | N | 144838.45 |
| | E | 1981081.85 |

**Figure 4.3-19. Suisun Bay Open Water Disposal Site SF-8**




*Source:* COE Quarterly Reports

**Figure 4.3-20. Monthly Disposal Volumes at Suisun Bay (September 1993 – September 1994)**