SCH. No. 91053082

Draft Environmental Impact Report for Consideration of a New Lease for the Operation of a Crude Oil and Petroleum Product Marine Terminal on State Tide and Submerged Lands at Unocal's San Francisco Refinery Oleum, Contra Costa County

prepared for:

STATE OF CALIFORNIA
STATE LANDS COMMISSION
Sacramento, California

prepared by:

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Notice of Completion/Public Hearing

on a Draft Environmental Impact Report

Pursuant to Section 15085 (d), Title 14, California Administrative Code, this is to advise that the State Lands Commission (SLC) has completed a Draft Environmental Impact Report for the proposed project described below:

Project Title:	Consideration of a New Lease for the Operation of a Crude Oil and Petroleum Product Marine Terminal
Project Location:	State Tide and Submerged Lands at Oleum, Contra Costa County
Project Description:	Continued Operation of a Crude Oil and Petroleum Product Marine Terminal by Unocal Corporation
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The document is identified as SLC EIR 636, State Clearinghouse Number 91053082. A copy of the document may be obtained from:

State Lands Commission
Division of Environmental
  Planning and Management
1807 13th Street
Sacramento, CA 95814

Comments should be received no later than May 2, 1994.

DRAFT ENVIRONMENTAL IMPACT REPORT FOR CONSIDERATION OF A NEW LEASE FOR THE OPERATION OF A CRUDE OIL AND PETROLEUM PRODUCT MARINE TERMINAL ON STATE TIDE AND SUBMERGED LANDS AT UNOCAL'S SAN FRANCISCO REFINERY OLEUM, CONTRA COSTA COUNTY

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S.1 INTRODUCTION

This document is a Draft Environmental Impact Report (EIR) that has been prepared for the California State Lands Commission (SLC) for its review of environmental impacts associated with issuing a new lease of state tidelands to Unocal Corporation (Unocal). The lease would allow Unocal to continue operating its San Francisco Marine Terminal that has been in operation at its present location at Oleum since 1955. This project involves the continuation of current operations and any future foreseeable increases in uses and throughputs for a period of up to 40 years.

Unocal is presently operating through an interim lease that has been authorized by the SLC pending the completion of this EIR and its consideration of Unocal's application for a new lease.

The EIR addresses the project-specific impacts related to normal operations and for accident conditions resulting in spills at the Marine Terminal, in the San Francisco Bay shipping lanes, and along the northern outer coast of California from Santa Cruz north to the Oregon border. Oil spill impacts along shipping routes from San Francisco Bay south have previously been addressed in the GTC Gaviota Marine Terminal Project Final Supplemental EIR/Environmental Impact Statement (EIS) (Aspen 1992).

The EIR also addresses cumulative impacts focusing on cumulative tankering actions within the Bay and outer coast, as well as alternatives to the Proposed Project.

S.2 PROPOSED PROJECT

S.2.1 Project Action and Location

The Proposed Project involves granting a new lease by the SLC for continuation of operations at the Unocal Marine Terminal and for approximately 3.6 acres of filled state lands near the Terminal that Unocal uses for butane storage. The Marine Terminal is located on the east side of San Pablo Bay, Contra Costa County, between the Cities of Rodeo and Crockett on San Pablo Avenue (U.S. Highway 40), 1.8 miles west of the Carquinez Strait Bridge. The Unocal Refinery has been in Rodeo since 1896. A Marine Terminal has been located at the site since 1928. The present Marine Terminal has been operating since 1955.

S.2.2 Description of Marine Terminal and Its Operation

The Marine Terminal is a pier consisting of a tee-head ship and barge-berthing structure, a mooring breasting dolphin, and a shore-connecting trestle-pipelineway. The ship-berthing structure is 1,250 feet long and 136 feet wide. The mooring breasting dolphin measures 51 by 32 feet and is located 74 feet from the west end of the tee. The trestle pipelineway connecting the Terminal to shore is 1,730 feet long and 77 feet wide.

The waterward side of the Terminal wharf has two ship-berthing areas and three manifold areas, while the shoreside of the wharf has three barge berths. Both berthing areas have hose risers with loading hoses. The pier pipeline trestle supports one ballast water pipeline, two 16-inch crude oil pipelines, and 17 petroleum product pipelines. No submerged pipelines service the Terminal.

Four ships owned by Unocal Oil Company of California and operated by West Coast Shipping Company (WCSC) call at the Unocal Marine Terminal at an average of 2.3 calls per ship per month (averaged over 4 years). The Blue Ridge, Coast Range, and the Sierra Madre vessels are double-bottom, single-hull vessels capable of carrying 300,000 barrels (bbl) of oil. Only the Blue Ridge is used exclusively for Alaskan crude import. The others are used mainly for product export; only on occasion do they deliver crude to the Terminal. A fourth ship, the Cornucopia, is an ammonia tanker that stops to refuel at the Terminal on its return trip from offloading ammonia in Stockton on route to Cook Inlet, Alaska.

Tankers owned by other companies have averaged between 13 and 15 calls per year over the past 5 years. Tank barges, owned by local Bay Area operators, also call at the Terminal at an average of about 4.5 calls per month, primarily to load products but also to deliver gas oil.

Alaskan crude has been the primary crude oil transported by ships to the Refinery. Since 1985, approximately 7.5 to 9.2 million bbl of crude have been transported per year. Lightering of Alaskan crude by Unocal has been conducted in the past at Anchorage 9 in the Bay, is not currently performed; ships are loaded lighter to avoid this procedure.

The quantity of product loaded onto ships is approximately 14 million bbl per year. Typical types of product include low-sulfur fuel oil, diesel, fuel oil for ships, various octane unleaded gasolines, aviation fuel oil, lube oil blending stocks, catalytic gas oil, medium and light unicrackate, heavy coker gasoline oil, sidecut from prefractionator, and reformate.

Vessels follow established shipping routes along the outer coast that range from approximately 15 to 20 miles offshore for vessels transporting product from the Unocal Refinery to ports in the northwest United States, to those that are more than 50 miles offshore for crude oil transfer between California and Alaska.

In addition to the Marine Terminal, the Refinery is served by Unocal's Oleum Pipeline, a 16-inch unheated line extending from Coalinga in the San Joaquin Valley to the Refinery; it parallels Interstate Highway 5. This line has a capacity of 68,400 bbl per day and is normally used to 94 percent of its capacity.

Products are shipped from the Refinery via three pipelines to Concord, Brisbane, and Unocal Richmond. The Refinery also has a direct connection to transfer product to the Wickland Oil Selby Terminal, a nearby product receiving, storage, and shipping terminal, that has only been used occasionally by Unocal to transfer product into Wickland storage tanks. Unocal products are also transported by truck and rail.

S.3 DESCRIPTION OF ALTERNATIVES

S.3.1 Alternatives Considered in Detail in EIR

Alternatives considered in detail in the EIR include the No Project Alternative and consolidation of the Unocal and Pacific Refining Company Marine Terminals into one located at the Unocal Marine Terminal (Consolidation Alternative). The Pacific Refining Company Terminal is located about 1,000 feet west of the Unocal Marine Terminal.

S.3.1.1 No Project Alternative

If no new lease is granted, Unocal would not be able to operate the Marine Terminal and its wharf for Refinery support. The consequences of the No Project Alternative include several ramifications as described below.

<u>Pier Structure Scenarios</u>

Without use of the wharf, one of two scenarios would result: the pier would either be (1) abandoned and dismantled, or (2) abandoned and left in place.

If the Marine Terminal is not used, Unocal could either leave the pier in place or dismantle it. In any case, the SLC would likely require that Unocal remove the pipelines and pumping facilities from the pier.

The wharf was also considered regarding its use for other purposes, such as a fishing pier. This alternative was considered to be infeasible due to public safety because access would have to be through the Refinery.

<u>Refinery Scenarios</u>

Not having the wharf to support the Refinery could result in the possibility that the Refinery could (1) continue to operate at current levels, (2) operate at reduced levels, or (3) be shut down. If the Refinery continues operating at current capacity, it would require that Alaskan crude be replaced by equal amounts of Central Valley crude via modifications to Unocal's Oleum pipeline or by connection to a common carrier pipeline. Another option would involve continued importation of Alaskan crude via a Unocal pipeline connection to another area marine terminal, which would involve new pipeline construction. The most likely candidate would be the Wickland Oil Selby Terminal located 1 mile east of Unocal's Marine Terminal. Similarly, product transport may be accommodated through pipelines to other marine terminals or the Selby Storage Terminal for export by water. Increased truck and rail transport may also be used for a portion of product from the Unocal Refinery.

The second refinery scenario would involve continued Refinery operation at reduced levels. This assumes no Alaskan crude replacement. The Refinery would continue to operate with Central Valley crude only. It is estimated that approximately 7 out of 30 refinery lube processing units would be shut down.

The third refinery scenario assumes that, without a sufficient quantity of crude, the Refinery would be in an economic situation that would require it to shut down. Direct and indirect jobs would be lost locally, as well as regionally. Unocal's three West Coast refineries (Los Angeles, Santa Maria, and San Francisco) have an integrated operation in which each refinery is dependent on the other for intermediate feed stocks.

S.3.1.2 Consolidation Alternative

Consolidation of the Pacific Refining Company's Terminal with the Unocal Marine Terminal at Unocal and elimination of the Pacific Refining Terminal was considered because the proximity of the refineries would allow accommodation of necessary additional pipelines between the Unocal Marine Terminal and Pacific Refining's Refinery. The Unocal Marine Terminal is considered large enough to accommodate tankers porting for both refineries. Of various consolidation alternatives considered, this Unocal/Pacific Refining consolidation was deemed to be the most feasible alternative. It was examined regarding its possible benefits in eliminating oil spill potential and accidents.

S.3.2 <u>Alternatives Eliminated from Consideration</u>

Several additional alternatives were eliminated from detailed consideration in the Draft EIR through a screening process. These include the following:

- **Consolidation of Unocal and Pacific Refining Terminals at Pacific Refining Terminal** -The Pacific Refining Terminal, located about 1,000 feet west of the Unocal wharf, is a nonland-connected terminal served by subsea pipelines. Subsea pipelines are harder to maintain and inspect than those connected directly to shore above the water line. This alternative would require additional subsea lines. Also, the Pacific Refining Terminal could create more congestion and safety implications because there are fewer berths than at the Unocal Terminal. Being a nonland-connected wharf also poses increasing problems of access in the event of an accident.

- **Consolidation of Unocal with Pacific Refining and Wickland Oil Terminals at Wickland Terminal** - The Wickland Oil Selby Terminal, located about 1 mile east of the Unocal wharf, was also considered. However, the Wickland Terminal is much smaller than either Pacific Refining or Unocal's Terminals, and the logistics of its use without major modification to the pier structure itself, as well as pipeline integration to the refineries, made this alternative infeasible.

- **Single Facility and Deep Water Port Consolidation** - The concept of consolidating Unocal and all other Bay Area terminals into a single Bay port was considered as infeasible at this time due to the logistics that would be involved in implementation. Similarly, the concept of a single offshore port was considered. Because of the complexity of these concepts, their feasibility, and timeframe for implementation, both concepts were eliminated from further consideration.

- **Limitations on Terminal Use** - This review included limitations on use of the Marine Terminal to import crude only or export product only. Reduced use of the Terminal would decrease overall risk, but not necessarily proportionately to the decrease in vessel calls or throughput. The wharf and pipelines would still present a continuous potential for spill release. Because it is unlikely that the Terminal would be able to operate efficiently in this manner, this alternative was considered infeasible.

- **Lease Options and Other Uses** - Also considered was granting a short-term lease, which was determined not to be an alternative, but a ramification of phase-out of the Terminal if that option was implemented. Consideration was given to lease of the Marine Terminal by another operator. However, problems with logistics of ownership of pier and infrastructure, and the necessity of new pipelines make this alternative infeasible. In addition, impacts similar to those of the Proposed Project would occur from this alternative.

S.4 APPROACH TO PROJECT ANALYSIS

The study area for this project involves the Marine Terminal, the San Francisco-San Pablo Bay region, the lower Sacramento-San Joaquin Delta, and the shipping lanes that accommodate tankering along the north coast of California from Santa Cruz to the Oregon border. This area is rich in natural and other public resources that could be severely impacted by oil spills.

Because of the numerous sizes, types, and locations of possible oil spills; vast natural and public resources; and seasonal variations in hydrodynamic flow conditions in San Francisco Bay, the possible consequences of a spill could vary greatly. The methodology used in this Draft EIR combined hydrodynamic and oil spill modeling with a Geographic Information System (GIS) to analyze and assess the potential for resource damage for a range of spill scenarios.

Three levels of modeling were conducted. Spill trajectory modeling was used to estimate the probability of spills and fate of spilled material (e.g., where the oil would go if a spill occurred) both within the Bay and the outer coast. Probabilistic/conditional models that show the general flow of high, medium, and light volumes of oil during seasonal variations were run to indicate the relative risk to areas oiled during a spill from Unocal tankering and Terminal operations, and cumulative tankering and cumulative Terminal operations for all Bay Terminal operators. Receptor mode modeling was also run to assess the vulnerability of 20 selected sensitive resource locations within the Bay. Spill scenario modeling was run for 14 representative spill events and seasonal variations for spill sizes ranging from 500 bbl at the Terminal to 100,000 bbl of crude in the Precautionary Zone near Alcatraz, and two along the outer coast. These 14 runs are representative of the extent of oiling and the trajectory that these spills would take given seasonal conditions.

GIS mapping was conducted for marine biological resources, fisheries, land use/access, and recreational resources in the Bay and outer coast segments of the study area. Oil spill modeling results were overlaid with the GIS databases to create a synthesized map coverage that displayed the interaction between oil spill scenarios and vulnerable resources. Tables were produced presenting acreages and/or percentages of resources affected by each scenario. In this manner, the potential impacts resulting from the various types of spills that could occur could be described.

S.5 IMPACTS AND MITIGATION MEASURES SUMMARY

Discussion of all impacts associated with the Proposed Project and each of the alternatives is presented below. A summary of all impacts for the Proposed Project and each of the alternatives is presented in tabular form at the end of this section as Table S-1.

Because the Proposed Project is the granting of a new lease for continued operations, the project is, for the near term, the continuation of conditions as they presently exist. Therefore, the discussion in resource sections, as appropriate, has been organized to focus on the continuation of existing conditions as a separate discussion from future conditions.

Where feasible, projected future impacts over a 40-year period are addressed. However, during the next 40 years, substantial unforeseen changes can be expected to occur in terminal operations, the San Francisco Bay environment, and the regulations and technology involved in oil spill prevention and cleanup, air quality control, water quality control, fisheries regulations, and other environmental areas. Because of such unforeseen changes, little reliable data are available upon which to base assumptions of future conditions. One of the major driving forces of the future is the long-term energy perspective. The California Energy Commission projects a 1.1-percent-per-year increase in demand for petroleum products over the next 20 years. Based on this figure, future conditions for many analyses in the EIR assumed a 20-year future projection. In addition, it is assumed that sources of San Joaquin heavy crude (SJHC) and other domestic crude, including Alaskan crude, will decline. More reliance will be placed on crude imports from foreign sources. Because of this greater reliance on foreign tankering, this analysis assumes an increase in Unocal tankering of crude by 60 percent and an increase in product tankering by 30 percent.

The continuation of existing operations under normal operations is also presented as a separate discussion from that of impacts from accident conditions for resources directly affected by oil or product spills. This delineation has been provided to focus on appropriate mitigation for those resources impacted from spills.

For the impacts discussion, significance has been classified according to the following definitions:

- Class I - A significant adverse impact that cannot be mitigated to a level of nonsignificance.
- Class II - A significant adverse impact that can be mitigated to a level of nonsignificance.
- Class III - An impact that is adverse, but nonsignificant.
- Class IV - A beneficial impact.

S.5.1 Proposed Project

S.5.1.1 Operational Safety/Risk of Accidents

Continuation of Current Operations

Routine Operations

The various components of the Marine Terminal and its operations were evaluated. The evaluation of structural integrity of the wharf identified corrosion of steel batter piles and beams that, if allowed to continue to deteriorate, will result in a potentially significant (Class II) impact to wharf integrity that can be mitigated through repair of the wharf.

The most current versions of piping and instrumentation diagrams (P&IDs) and operations and training manuals were reviewed. P&IDs were found to be outdated, resulting in a Class II impact. Mitigation includes updating to meet the Office of Oil Spill and Prevention Response (OSPR) requirements. Six spills have occurred at the Terminal since 1986 due to pipeline corrosion or erosion. The proposed OSPR regulations also require that a hazard and operability (HAZOP) study be conducted to identify hazards. This hazard (corrosion and erosion) is considered to be a significant (Class II) impact that can be mitigated by development and implementation of a Risk Management Audit Program and a planned maintenance program.

An annual inspection of the Terminal in December 1992 found that a detonation arrester near the Berth M-1 vapor connection had been removed from its original approved location and now represents a potential safety hazard (Class II impact). Resolution of this issue will require both SLC and U.S. Coast Guard (USCG) review as to the detonation arrester's effectiveness and relocation or placement of additional arresters. Due to this detonation arrester being moved, a 1991 HAZOP study on the vapor control system (VCS) is no longer valid.

Routine vessel traffic operations consist of traveling to/from the Marine Terminal and performing loading and unloading operations. No impacts are associated with the Unocal Marine Terminal vessel traffic routine operations. Because tankers and barges calling at the Unocal Marine Terminal use the designated vessel traffic channel and the vessel traffic separation (VTS) in place both inside and just outside the Bay, the vessel traffic associated with the Unocal Marine Terminal does not create an impact on other vessel traffic or recreational watercraft during routine operations.

Accident Conditions

The potential for spills at the Terminal was estimated based on published data for spills greater than 238 bbl and greater than 1,000 bbl. It was estimated that, over a 40-year life (lease term), there would be a 78-percent probability that a spill greater than 238 bbl would occur (2.7×10^{-4} per port call or a mean time of 27 years between spills) and a 20-percent probability that a spill over 1,000 bbl would occur (3.8×10^{-5} per port call or a mean time of 187 years between spills).

The potential for spills from vessels calling at the Terminal was estimated based primarily on data contained in the GTC Gaviota Marine Terminal Project Final Supplemental EIR/EIS (Aspen 1992) and the Port Needs Study (USCG 1991). Tankers calling at the Unocal Terminal normally operate between terminals in California, Oregon, Washington, Alaska, and Hawaii. Spills more than 50 nautical miles (nm) from the coast are not expected to impact the shoreline. Vessel traffic was analyzed out to the 50-nm limit. The estimated mean times between spills greater than 1,000 and 10,000 bbl for tankers in transit to/from the Terminal were estimated to be 390 years (1,450 years inside the Bay and 350 years outside the Bay) and 1,120 years (7,100 years inside the Bay and 1,330 years outside the Bay), respectively. While the probability of a spill from vessels at the Marine Terminal or vessels in transit lanes is low (once every

170 years for a spill greater than 1,000 bbl), a spill can still result in a significant (Class I) impact if sensitive/vulnerable resources are impacted. Sensitive resources are covered in other resource sections below.

Unocal has recently updated its Oil Spill Response Manual to meet the requirements of the Federal Oil Pollution Act of 1990 (OPA 90). In addition, it contracts for a vessel to stand by the Terminal whenever crude oil or a persistent product is being transferred. This standby vessel has the capability to deploy 600 feet of boom within 30 minutes. Unocal is a member of the Clean Bay oil spill cooperative and the Marine Spill Response Corporation (MSRC). These two organizations have a great deal of response capability in the Bay Area and can respond rapidly to a spill at the Unocal Terminal or from a vessel transitting to/from the Terminal.

In most cases, Unocal should be able to contain small spills at the Terminal; however, depending on currents, small spills may sometimes not be containable. It is unlikely that large spills could be contained and would, in most cases, be expected to reach shore. Thus, spills from the Terminal are considered to be significant (Class I) impacts.

Response to a spill from a tanker is the responsibility of the vessel owner/operator. Each vessel is required to have an oil spill response plan that identifies a worst-case spill and response measures. Response would consist of containment, recovery, and protection of sensitive resources. Clean Bay and MSRC would make their equipment available to member companies as would other cooperatives (Clean Seas, Clean Coastal Waters). WCSC is a member of both Clean Bay and MSRC. It is, however, unlikely that the response efforts could prevent a large spill from causing significant contamination to the shoreline. Spills are considered to be significant (Class I) impacts.

Fires and explosions are possible at the Terminal involving vessels and/or the Terminal itself. The requirement for inert gas systems (IGS) on tankers transporting volatile products greatly decreases the possibility of fires and explosions on tankers. Even so, a fire could result in the generation of radiant heat, and an explosion could create flying debris and blast overpressure. However, neither the radiant heat nor the flying debris would be expected to present a hazard to the general public (Class III impact).

Unocal maintains its own fire/emergency response department with full-time personnel trained in fighting petroleum fires and fires at the Terminal. No discussion or procedures for dealing with tank vessel fires were found in Unocal's manuals addressing fires or emergency response; however, measures were addressed in the West Coast Shipping Response Plan. Thus, there is a need for updating of the Unocal manuals for consistency (Class II impact).

A butane pressure vessel is located on the filled state lands that have been under the same lease as those for the Marine Terminal. SLC expects to continue leasing that parcel to Unocal regardless of the outcome of the Marine Terminal. While the probability of a major incident involving the butane vessel is extremely low (one release every 50,000 years), a worst-case catastrophic tank failure could result in a butane release with a flammable gas cloud calculated to extend about 4,900 feet downwind. If the butane is ignited, a radiant heat footprint could extend approximately 1,000 feet from the fire. An unconfined vapor cloud explosion (considered to be the worst type of event) would cause windows to be broken several miles away with heavy damage to other structures. Thus, while the probability of these events occurring is remote, a significant (Class I) impact would result if such an event were to occur, with substantial potential for injury to the general public.

Analysis of Future Conditions

Accidents at marine terminals have been shown to be approximately directly proportional to the number of vessel callings. Future conditions assume increases in tankering and barge activity due to a decrease in production of Central Valley crude and an increase in import of crude from Alaska and other sources. Thus, the probability of spills at the Terminal and along the shipping lanes will increase. Even though the risk increases, the impacts resulting from spills remain the same as for the continuation of current operations.

Cumulative Analysis

Twenty-four marine terminals operate within the Bay and contribute to the risk for accidents. The cumulative risk of accidents increases from these terminals, and significant (Class I) impacts would result from spills, especially if sensitive resources are present. Mitigation includes compliance with all regulations and specific mitigations for each terminal to be determined on a terminal-by-terminal basis. Even with mitigation, impacts would remain significant (Class I).

S.5.1.2 Water Quality

<u>Continuation of Current Operations</u>

Routine Operations

Unocal tankers unload product and take on ballast water at West Coast ports that may have higher levels of certain contaminants than San Pablo Bay. However, because the volume of water discharged would be extremely small and dispersion would be rapid, discharge of segregated ballast water at the Unocal Terminal is not expected to have an adverse significant (Class III) impact on water quality. It may, however, contribute to the significant cumulative impacts of pollutants in the Bay (Class I). Other wastewaters generated by docked vessels are not released into the Bay, but are fed into the process water feed to the wastewater treatment plant.

A small amount of trace metals and organotins may be introduced into Bay waters from antifouling paints and sacrificial anodes on ship hulls. Tributyltin (TBT) is the most toxic of substances. Unocal has suspended its use of TBT antifouling paints and now uses coal tar with epoxy overlay coatings. Thus, Unocal tankers do not contribute significantly (Class II) to elevated TBT levels in Bay waters. A prohibition in the lease stipulation against TBT use and mandatory SLC inspection would reduce any potential for impact to a level of nonsignificance.

Other sources of contamination of Bay waters may be from small leaks and spills from the Terminal facility as well as from tankers and barges at the Terminal. All of these sources of low-level chronic contamination would be expected to represent an adverse, but nonsignificant (Class III) impact. Because of the tidal flushing that occurs in the vicinity of the Terminal, these materials would be rapidly dispersed. Therefore, concentrations in Bay waters would not be expected to exceed standards. However, any impact of contaminants contributes to mass loadings in the Bay and would be regarded as a significant (Class I) cumulative impact.

Continued oil transport from the Marine Terminal would be expected to contribute to the volume of effluent discharged from the Refinery; however, the Refinery's fully treated effluent concentration remains constant due to the equalization system that allows the feed to stabilize prior to introduction into the treatment plant. The Terminal's contribution of discharge to Bay water is considered to be adverse but nonsignificant. All discharge would continue to meet National Pollutant Discharge Elimination System (NPDES) requirements. Impacts of Refinery discharges are considered to be adverse, but nonsignificant (Class III). Water sampled near the Marine Terminal has been shown to have concentrations of copper, lead, and zinc that exceed San Francisco Bay Plan objectives, which are considered to contribute to cumulative loading. The Terminal's contribution to contaminants in San Pablo Bay is small relative to other sources and is nonsignificant on a project-specific level, but would contribute to significant cumulative impacts.

Continued Terminal use would require continued maintenance dredging of approximately 90,000 cubic yards annually with dredged material disposed of at the Carquinez Strait Dredged Material Disposal Site (DMDS, SF-9). The conditions of the DMDS are such that material rapidly disperses. Sediments at the Marine Terminal are primarily coarse grained; thus, the amount and duration of turbidity generated by dredging operations are considered to be minimal. Also, Marine Terminal sediments have tested clean with no organic pesticides, polychlorinated biphenyls (PCBs), phenols, polycyclic aromatic hydrocarbons (PAHs), or phthalates detected and trace metals and organotins detected at low levels. Nickel was the only trace metal detected at elevated levels in the sediment but is at the low end of the concentration range at which biological effects have been observed. Continued dredging of sediments at the Terminal would have an adverse, but nonsignificant impact (Class III) on water quality.

Accident Conditions

An oil spill has a minimal effect on the physical properties of seawater, but can have significant impacts to water chemistry. The reduction in light transmissivity and resulting sea surface warming by an oil spill from the Proposed Project are considered to be adverse, but nonsignificant (Class III) impacts to marine water quality.

A significant (Class I or II) impact to water quality will result from changes in water chemistry from an accidental spill of crude or product in either the Bay or the outer coast. Severity of the impact will depend on spill size, oil composition, spill characteristics (instantaneous vs. prolonged discharge, surface vs. subsurface spill, and so forth), environmental conditions and their effect on weathering of spill properties, and cleanup effectiveness. A product spill would be more toxic, but of shorter duration than a crude oil spill. A spill of less than 50 bbl may be contained and significant adverse water quality impacts thus mitigated (Class II). A larger spill would not be effectively contained and would violate water quality objectives. Beneficial uses of the Bay and ocean waters will be impaired. A spill over 50 bbl would have a significant unmitigable impact on water quality (Class I).

Analysis of Future Conditions

The projected future increase in the level of operation at the Marine Terminal would be expected to have a proportional increase in the level of small leaks, spills, and segregated ballast water discharges. These are considered to be a very small, adverse, but nonsignificant impact (Class III).

In the future, as the Refinery uses less San Joaquin Valley crude and more imported crude, a reduction in the mass loadings of selenium into the Bay may be expected (Central Valley crude contains higher selenium concentrations than those of Alaskan crude). Because no increase in the amount of wastewater discharged from the Refinery is anticipated as a result of increased tanker traffic at the Terminal, there should be no increase in the pollutant loading of other contaminants.

An increase in tanker traffic would result in an increased risk of an oil spill at the Terminal, in the Bay, or along the outer coast. Impacts from a spill remain as described for the continuation of current operations.

Cumulative Analysis

Within the San Francisco Bay estuary, levels of a number of pollutants exceed thresholds, which can have adverse impacts to aquatic life. The contributions of the Unocal Terminal to those pollutant loadings are very small compared to other sources. However, any increase in contaminants that are already at harmful levels would be a significant cumulative impact (Class I).

S.5.1.3 Marine Biology

Continuation of Current Operations

Routine Operations

Routine operations at the Marine Terminal have the potential to impact marine life from disturbance due to the passage of ships, including disturbance to bottom sediments, annual maintenance dredging, collisions, the discharge of segregated ballast water and chronic inputs of toxicants from wastewater discharge, and leaks, drainage, and small spills from vessels using the Terminal as well as the Terminal pipelines.

Because of the large sand-sized particles that comprise the sediment at the Marine Terminal, turbidity generated by annual maintenance dredging is minimal, and particles would be expected to remain in suspension less than 1 hour after dredging is finished. Turbidity impacts are thus expected to be minimal. The contaminant levels in these sediments have been shown to be well below the value shown to cause mortality in bioassays. Benthic organisms in the dredged material may be killed, but recolonization of dredged areas is expected to be rapid (probably within months). Fishes would be expected to avoid the dredge. There is some possibility that juvenile salmon in the dredge area could be damaged. Because winter and spring run salmon are sensitive species, impacts would be significant (Class II). These impacts could be avoided by dredging from July to August when smolts of the sensitive populations are absent. Data suggest that elevated selenium levels in the area may be related to the Unocal operations, but that high selenium levels are more likely to result from the Refinery's use of Central Valley crude and not from any activity associated with the Marine Terminal. The impacts of toxic contaminants on marine organisms are expected to be adverse, but nonsignificant (Class III). Discharge of segregated ballast water has a slight potential to introduce invasive organisms to the San Francisco estuary ecosystem (Class II). This impact could be avoided by prohibiting water discharge in the Bay.

Ship noise represents a temporary disturbance to fishes, but Unocal Marine Terminal-related ship traffic represents an incremental amount compared to the background noise of ship traffic in San Francisco Bay and along the north coast. Thus, disturbance to fishes from tanker traffic at the Terminal is considered to be adverse, but nonsignificant (Class III).

Birds are common, but not abundant, near the Terminal possibly because they preferentially select waters and shoreline areas where food sources are more abundant and accessible. California brown pelicans (endangered) are known to roost in small numbers at a few sites in San Pablo Bay and are accustomed to noise and marine activity. Continued operation of the Terminal will not result in significant impacts to birds (Class III). Any discharges and small chronic leaks and spills associated with continued operations would be below levels that would have direct impacts on birds. Effects, such as soiling of feathers, would be adverse but nonsignificant (Class III). Also, Unocal does not significantly contribute (Class III) to the input of contaminants into the Bay that affect the health of bird populations. Continued tanker transport is expected to produce nonsignificant (Class III) impacts on birds. Birds are not affected by moving vessels and more typically forage or rest in waters shallower than those of the tanker routes.

Within San Pablo and San Francisco Bays, the marine mammal fauna typically includes harbor seals, California sea lions, and harbor porpoises. Off the outer coast (other than species listed as threatened or endangered), there are fur seals, elephant seals, Dall's porpoise, and three species of dolphins. Injury or death of these small, fast-swimming marine mammals species has not been reported. Because of the remote chance for occurrence, the potential impacts of collision with nonlisted marine mammals from Unocal vessel traffic are nonsignificant (Class III). Routine operations at the Terminal are not expected to impact these marine mammals (Class III).

Tanker traffic produces a risk of collision with whales. Whales are very rare in the bays; thus, risk of death or injury from Unocal tankering is negligible. However, the potential for collisions increases along the outer coast, especially in the Gulf of the Farallones in late summer and fall during migration. Despite the potential for collisions, the probability of such an event is low. Thus, the potential for collisions and injury or death to whales is considered to be adverse, but nonsignificant (Class III).

Accident Conditions

Trajectory modeling showed that oil spill risk is greatest at the Marine Terminal, but that small spills would be most likely to occur. The impacts to biological resources from these small spills are nonsignificant (Class III). Spills in tankering lanes would be less likely, but would be more significant because greater quantities of spilled oil would result. Spills of 1 to 50 bbl could potentially have significant impacts to biological resources, but could be contained and cleaned before significant impacts occurred (Class II). Larger spills would have significant biological impacts (Class I). In the Bay, Unocal tanker spills would have the greatest probability of contacting waters through central and northern San Francisco and San Pablo Bays. Carquinez Strait could also be affected by moderate oiling with less risk of oiling to the shallow waters of San Pablo Bay and Suisun Bay. Offshore, the tanker routes with the highest risk are near the Golden Gate and from Cape Mendocino north. The area around Point Reyes and just south of San Francisco Bay are also at high risk of moderate oiling. While impacts will vary depending on the origin of the spill, current conditions, and sensitive resources present, spills greater than 50 bbl will have the potential to significantly (Class I) impact biological resources.

Biological resources that have the potential to suffer significant (Class I) impacts include the following:

- phytoplankton in San Pablo Bay, Carquinez Strait, and Suisun Bay, and for a short-time in localized areas of the north coast;
- zooplankton in San Pablo Bay, Carquinez Strait, and Suisun Bay, and locally off the north coast;
- rocky intertidal and shallow subtidal in San Francisco Bay estuary and off the north coast;
- intertidal mudflats in San Francisco estuary;
- dungeness crab, bay shrimp, eelgrass, longfin smelt, Pacific herring, Chinook salmon, striped bass, American shad, white sturgeon, and starry flounder in San Francisco Bay estuary;
- salt marsh habitat;
- coastal estuaries/river mouths;
- shorebirds and waterfowl (migrant populations in San Francisco Bay estuary); and
- double-crested cormorant (regional breeding population in northern California).

Threatened/endangered/candidate species at risk of significant (Class I) impacts include the following:

- Suisun marsh aster,
- soft-haired bird beak,
- Delta tule pea,
- Mason's lilaeopsis,
- Delta smelt,
- winter run Chinook salmon,
- California clapper rail and California black rail (breeding population in San Francisco Bay estuary),
- California least tern (breeding population in San Francisco Bay estuary),
- long-billed curlew (migrant population in San Francisco Bay estuary),
- California brown pelican (migrant population in San Francisco Bay),
- southern sea otter,
- Steller sea lion (regional breeding population in California), and
- blue, fin, and humpback whales (regional breeding population in California).

Analysis of Future Conditions

Future conditions are not expected to result in substantial changes in effects on the marine environment. The projected increases in operations at the Terminal would have a proportionally small increase in the level of small leaks and spills that would be considered to have an adverse, but nonsignificant impact (Class III) on marine resources.

As discussed above for water quality, because the Refinery uses less San Joaquin Valley crude and more imported crude, a reduction in the mass loadings of selenium into the Bay may be expected and there would be no increase in the pollutant loading of other contaminants to impact marine resources (Class III impact).

An increase in tanker traffic would result in an increased risk of an oil spill at the Terminal, in the Bay, or along the outer coast. Impacts from a spill on marine resources would remain as described for the continuation of current operations.

Cumulative Analysis

Cumulative impacts to biological resources include those from cumulative degradation of water quality and cumulative risk of a major oil spill. Unocal's contribution to this impact is a small, localized significant impact. The most significant actions to decrease cumulative loadings of pollutants to the Bay estuary are the new regulations and recommended practices by the U.S. Environmental Protection Agency to control nonpoint source pollution. The largest source of contaminants to the Bay estuary is urban and nonurban runoff. Implementation of management measures and practices to control nonpoint source pollution could significantly improve water quality in the Bay and, thus, estuarine biological resources.

S.5.1.4 Fisheries

Continuation of Current Operations

Routine Operations

The area around the Unocal Marine Terminal accommodates several fisheries, including shrimp, salmon, sturgeon, bass, and perch. Very little of the fisheries area is precluded from fishing due to Terminal routine operations. In addition, fishing activities (commercial and recreational) are light within the area around the Terminal. Thus, impacts to fisheries from routine operations are considered to be adverse, but nonsignificant (Class III).

Within the Terminal area, maintenance dredging occurs almost annually to ensure adequate water depth for tankers and barges. Little disturbance to fishing activities is anticipated, and disturbance to bottom and water column fish and shellfish is considered to be minimal. Disposal of dredged materials occurs in Carquinez Strait, an area subject to scouring due to Bay conditions. Some smothering of Bay organisms is expected, but impacts on bay shrimp and other species are considered to be adverse, but nonsignificant (Class III).

Because tankers and barges traverse the shipping lanes, fisherman cannot access the area and thus temporarily lose a small portion (1.0 square mile) of fishing area, which is about 0.5 percent of water area available for fishing. This is not considered to be significant (Class III). In particular, herring fishing is at risk of conflict with vessels in the shipping channels. Shipping corridors used by Unocal tankers and barges pass through currently fished herring grounds around Angel Island, off Alcatraz, and along portions of Tiburon shore. At any one time, a tanker would take up nearly 1 square mile or 25 percent of the fishing area. This is a significant (Class II) impact that can be mitigated through Unocal's vessel conformance to agreements developed between the California Department of Fish and Game, herring harvesters, and other interested parties with regard to ways of minimizing conflicts between vessels and herring activities.

Accident Conditions

Significant impacts (Class I and II) to fisheries can result from an accidental spill of crude oil or crude oil product near the Marine Terminal, within the shipping lane, or along the outer coast. The severity and impact of a spill to fisheries depend on the following: (1) the physical presence of the oil on the water, (2) fishing restrictions imposed by public agencies to ensure that no tainted seafood reaches markets, (3) harbor closures to keep oil in or out, (4) spatial conflicts with cleanup operations, (5) long- and short-term biological effects on fish and habitat, (6) changes in seafood markets due to public fears of eating contaminated seafood, (7) fishermen avoiding areas for fear of contaminating gear and catching tainted fish, (8) fishing area closures forcing fishermen to other areas, thus crowding those areas and decreasing the catches of crowded fishermen, and (9) for recreational fishing, public reluctance to return to an area after a spill.

San Francisco Bay commercial and recreational fishing areas with the highest risk of oil spill contact are

- western Suisun Bay,
- Honker Bay,
- Sacramento River mouth,
- Mare Island Strait (Napa River),
- Carquinez Strait,
- eastern San Pablo Bay,
- central San Francisco Bay from Richmond to Alameda,
- Tiburon,
- Yerba Buena Island, and
- Angel Island.

The most vulnerable fisheries are

- commercial shrimp (Carquinez Strait and eastern San Pablo Bay) and herring (central San Francisco Bay);
- recreational salmon, sturgeon, and bass (San Pablo Bay, San Francisco Bay, Carquinez Strait, and Napa River); western Suisun Bay fisheries; halibut and rockfish (central Bay); smelt (Tiburon, Angel Island, and Berkeley Pier); perch (San Pablo Bay, central Bay, Angel Island, Berkeley Pier, and Tiburon); and clambeds (Richmond); and
- herring spawning (southern San Pablo Bay, central Bay, and Oakland/Alameda).

Along the outer coast, most offshore fisheries have a moderate to high risk of contact with spills from Unocal and all tankers traveling the outer coast. Nearshore fisheries, mainly dungeness crab and sea urchin, are vulnerable around the Eel River, near Albion and the Navarro River, around Point Arena, at Point Reyes, and along the coast from San Francisco to Davenport (the southern boundary of the study area).

Analysis of the outer coast scenarios shows that aquaculture impacts are likely in Monterey Bay and off Santa Cruz. Kelp harvesting impacts are expected from Point Montara south to Monterey Bay and from Bruhel Point to Navarro Head.

Oil spill impacts range from significant (Class I and II) to nonsignificant (Class III). Mitigation for the described impacts focuses on timely oil spill response and cleanup, compensation for financial losses and environmental damages, and evaluation of the effectiveness of the response measures and procedures.

Analysis of Future Conditions

For the future conditions, fisheries in the immediate vicinity are expected to remain as they are now, barring any unforeseen major changes in regulations, habitat, and harvesting methods. Impacts on fisheries during this period will continue, except that the increased number of tanker and barge trips has the potential to increase the risk of accidents and result in more frequent disruptions to fisheries.

Cumulative Analysis

Cumulative impacts (Class I) to fisheries can result from oil tankering, Marine Terminal and Refinery operation, and other industrial and agricultural sources in the Bay Area that have the potential to pollute the Bay. Compliance with agency criteria, management strategies, and contribution to mitigation and restoration programs designed to restore and enhance Bay fisheries by all potential polluters would help mitigate some of the impacts. However, residual effects from oil (and other industrial) spills would remain significant.

The level of Unocal's contribution to mitigation and restoration programs should include periodic review of Bay conditions and the Unocal Marine Terminal lease conditions and mitigation measures. If necessary, revisions to these conditions and measures should be made to adjust Unocal's level of responsibility for mitigating its share of contributions to cumulative impacts. In this manner, Unocal's contribution to cumulative impacts can be reduced to a level of nonsignificance.

S.5.1.5 Air Quality

Continuation of Current Operations

In terms of local air quality, granting a new lease for the Unocal Marine Terminal will not change the quantity or affect the quality of air emissions as long as operations remain unchanged. Direct sources of emissions are associated with operation of the thermal oxidizer, loading operations, ballasting, and fugitive sources (pumps, valves, and flanges). Indirect sources derive from mobile operations, including trucks, rail, barges, tankers, tugboats, and so forth as they travel through the area to and from the Terminal. Based on the assumption that no changes in operational volumes occur, emissions will be less than those that occurred under the original lease. Some emission reductions have recently been mandated by the Bay Area Air Quality Management District (BAAQMD), and vapor control equipment, including the thermal oxidizer, has been installed. Additionally, indirect project emissions will continue to be reduced in accordance with the control measures in BAAQMD's "Bay Area '91 Clean Air Plan (CAP)" and the Federal Clean Air Act State Implementation Plan (FCAA SIP). These changes would contribute to a beneficial (Class IV) impact.

The health risks of the Marine Terminal are not considered to be significant and will not change with the Proposed Project. The contribution to the excess cancer risk by the Marine Terminal was shown to be far below the significance level of one excess cancer case in one million. The evaluation includes installation of the vapor recovery control systems, which results in a cancer risk of 2.8×10^{-8}.

Analysis of Future Operations

Impacts from vessel emissions and future truck and rail emissions will depend on future regulations and best available control technology in place at the time. For this analysis, a worst case was assumed based on current emission factors. All future operational emissions, with the exception of carbon monoxide, were shown to exceed daily significance thresholds, producing a potentially significant (Class II) impact. Mitigation for these increases focuses on use of the best available control technology available at the time. Furthermore, future increased operations will require additional permitting through the BAAQMD, which will set limitations on allowable emission levels. Through the use of improved technology, retrofit of existing components with improved equipment, and BAAQMD requirements, the impacts will be reduced to a level of adverse, but nonsignificance (Class III).

Cumulative Analysis

The Proposed Project, as well as other stationary and mobile sources, will continue to contribute air emissions to the region. Until Terminal operations are augmented, these emissions are within the existing conditions and will not contribute additional emissions to the cumulative environment (Class III).

S.5.1.6 Truck and Rail Traffic

Continuation of Current Operations

No additional Marine Terminal-related traffic will be associated with continuation of operations at current levels, and no impacts to truck or rail traffic will result.

Analysis of Future Operations

Increases in traffic over a 20-year projected period were shown to result in an area-wide growth of approximately 10 percent. Future Marine Terminal assumptions included a 30-percent increase in tanker product export that results in a corresponding 30-percent increase in truck/rail product export. No significant impacts were found to result from increases in truck or rail transportation, with the exception of significant (Class II) impacts to truck use of I-80 and SR-4, which both presently operate at a significant level of impact (Level of Service [LOS] F). Mitigation includes a range of measures including restriction of trucking hours to off-peak hours and use of rail over trucking. Also, the additional truck trips could be compensated for by reductions in other site-generated vehicle trips through trip reduction planning, carpooling, and other various incentives.

Cumulative Analysis

Cumulatively, traffic impacts are due to the placement of vehicles on I-80, San Pablo Avenue, SR-4, and other streets. Class I and/or II impacts occur at congestion points, especially during rush hours. Because most of Unocal's truck traffic is restricted to nonpeak hours of travel, its contribution to cumulative impacts is minor (Class III).

S.5.1.7 Noise

Continuation of Current Operations

Noise levels from Terminal operations are not audible at offsite sensitive receptors. No additional noise over that presently generated will be generated from continuation of current operations. No additional traffic from Terminal operations will be generated to add to noise conditions. No impacts will result.

Analysis of Future Operations

Growth assumptions included a 10-percent growth rate over 20 years. The assumed increase in truck/rail product export resulting from an assumed increase in tankering and product export would not significantly (Class III) increase noise levels in the project area.

Cumulative Analysis

The cumulative noise environment includes the localized area where noises can be transmitted and heard. Noise increases can be expected primarily from nonrefinery-related uses, including residential, commercial, and other industrial uses. Unocal will not contribute significantly (Class III) to noise increases.

S.5.1.8 Earth Resources and Structure Stability

Continuation of Current Operations

No known active faults underlie the site; thus, fault rupture does not pose a significant impact to the continued operation of the Terminal. The Terminal has been designed to withstand seismic shaking of a Level VIII or IX (Modified Mercalli scale), and no significant impact would be expected during a maximum credible seismic event. If a major seismic event occurred during loading/offloading operation, it may be possible that pipelines, valvings, support bracings, and so forth could fail, resulting in spillage of materials and a significant (Class II) impact. Mitigation includes routine inspections with consideration of seismic integrity and incorporation of seismic retrofit designed for large seismic events.

No significant impacts would be expected to occur to the Marine Terminal wharf structure due to liquefaction. However, significant (Class II) impacts due to differential settlement, lateral spreading, and/or lurching were found to potentially occur along the riprap shoreline acreage where the pier connects to land. These effects could result in damage to the shoreline. Mitigation includes routine inspection and repair as required. No impacts are expected from a tsunami because the Terminal is located far enough into the Bay that a wave would attenuate prior to reaching the Terminal.

The Proposed Project also involves granting a new lease for filled state lands that Unocal presently uses for butane storage. This area is susceptible to the effects of liquefaction. Unocal's engineering and design records regarding the adequacy of the pile foundation beneath the butane sphere were unavailable. As such, a potentially significant (Class II) impact from liquefaction to the butane tank has been presumed.

The present structural design of the approach structure, wharf, and mooring dolphin was found to be adequate for the ongoing use of the facility at present loading conditions. No structural impacts (Class III) are expected from the continued routine use of the pier. There is some corrosion of the structural steel in batter piles and reinforcing steel in cast-in-place beams that may have reduced the load-carrying and transferring capacity of some of these members. As further deterioration occurs, this will result in a significant (Class II) impact from failure or excessive deflections that can be mitigated by repairs to these corroded areas. Mitigation also includes development and implementation of a risk management audit program, periodic wharf inspection, upgrade of fenders, and an avoidance system that monitors vessel approach rates to the wharf.

Secondary significant (Class I or II) impacts could also occur if pipes fail, resulting in a materials spill into the Bay, the smaller of which can be mitigated by planning and adherence to Spill Prevention and Response Plans.

<u>Analysis of Future Operations</u>

No additional impacts are expected for future operations unless larger vessels of greater loading capacity would be used. If the mooring of larger displacement vessels would occur, there could be a potential for significant (Class II) impacts to the structural integrity of the wharf or dolphin from wind load transferred from the vessel into the wharf, mooring tension loads on deck restraints, and berthing loads. Evaluations of any changes in requirements for wharf loading and engineering modifications would be necessary to mitigate for any potential impacts.

If the butane tank is used in the future for storing material of a heavier specific gravity, it is possible that a significant (Class II) static, pseudodynamic, and/or overturning impact could result. Engineering and design review and tank modification would be necessary to mitigate for any potential impacts.

<u>Cumulative Analysis</u>

A significant (Class I) impact may result in the cumulative environment from damage to structures at shoreline marine and industrial facilities, regardless of precautionary steps taken. Seismic retrofitting, where feasible, is recommended, and all new structures should be designed for maximum credible earthquakes within the region. This would be implemented on a project-by-project basis throughout the Bay Area.

S.5.1.9 Aesthetics

<u>Continuation of Current Operations</u>

Routine Operations

Under routine operations, continued operation of the Marine Terminal will not result in any significant impacts to the visual environment. The Terminal has been at its present location for nearly 40 years and blends into the surrounding industrial environment. Unocal tankering also will continue as present with no new visual impacts in the Bay or along the outer coast.

Accident Conditions

Spills at the Marine Terminal have the potential to impact the north portion of San Pablo Bay and into Carquinez Strait; spills within the Bay shipping lane have the potential to impact almost any portion of San Francisco/San Pablo Bay depending on spill size, spill location, and wind and current conditions. Similarly, most portions of the outer coast are susceptible to oiling given the right current and spill situation. Visually, oiling conditions could range from light oiling, which appears as a surface sheen, to heavy oiling, including lumps of floating tar. In events where light oiling will disperse rapidly, providing natural mitigation, significant (Class II) impacts can generally be expected. In events where medium to heavy oiling is encountered over a wide-spread area or in areas of high visibility and/or where cleanup efforts and residual effects of oiling may be observed for periods in excess of 3 months, significant (Class I) impacts can be expected. The physical effort involved in the cleanup, including the equipment that would be used, in itself will contribute to a short-term significant (Class II) impact.

<u>Analysis of Future Conditions</u>

Over the long term, it is expected that an increase of up to 60 percent in Unocal tankering activity could occur due to tankering of foreign crude. There will be an increase in tanker traffic seen in the Bay, along the outer coast, and at the Terminal; however, no significant visual impacts will result from normal operating conditions. Impacts from accidents remain as described for accident conditions above, except that there will be a greater risk from increased activity.

<u>Cumulative Analysis</u>

The Proposed Project and other ongoing and foreseeable projects in the Bay Area would continue to approximate existing conditions, and no significant changes (Class III) would result to the visual environment. If more than one spill event would occur in a very short timeframe, a significant (Class I or II) impact would result. Oil spill prevention and response contingency planning for the entire Bay Area will help prevent and respond to spill events and minimize visual impact.

S.5.1.10 Land Use/Recreation

<u>Continuation of Current Operations</u>

Routine Operations

The continued operation of the Marine Terminal will not require any changes with land use designations or policies. No modifications of the Terminal are proposed that would affect land or recreational resources. No significant impacts will result.

Planned recreational trail development by Contra Costa and the East Bay Regional Park District is proposed along San Pablo Avenue through the Unocal Refinery. The Refinery and Terminal preempt the use of the shoreline for recreational access. Continuation of the lease will continue to preempt this use as well. Also, because San Pablo Avenue is too narrow for recreational access, dedication of right-of-way or an easement and bike trail improvement provided by Unocal would be required to avoid an indirect significant (Class II) impact with planned policy.

Accident Conditions

Spills at the Marine Terminal have the potential to impact the northern portion of San Pablo Bay and into Carquinez Strait; spills within the Bay shipping lane have the potential to impact almost any portion of San Francisco/San Pablo Bay depending on spill size, spill location, and wind and current conditions. Similarly, most portions of the outer coast are susceptible to oiling given the right current and spill situation.

Oil spill modeling shows that oil spills originating at or near the Marine Terminal will potentially impact the project site, Carquinez Strait, and northern sections of San Pablo Bay, including the San Pablo National Wildlife Refuge, Martinez and Point Benicia Fishing Piers, Point Pinole Regional Shoreline, Bennett's Marina in Rodeo, and many others. Spills originating at other points within the Bay (with the greatest risk being within central San Francisco Bay) have the potential to extend to the northern portion of south San Francisco Bay, all of San Pablo Bay, and into Carquinez Strait. The significance of impact will depend on the size of spill, extent of oiling, and the residual effects. As described above for aesthetics, Class I impacts would be those that have residual effects lasting more than 3 months. Except for small spills, tankering activity, recreational boating, and fishery activities would be slowed or stopped. Marinas, harbors, piers, Bay parks, ecological reserves, and mud and marsh areas located throughout the San Francisco Bay/San Pablo Bay Area could also be significantly impacted. Oil on the shoreline would disrupt nearshore water activities and shoreline recreational activities such as beachgoing.

Land uses along the outer coast, with many undeveloped and inaccessible shoreline areas, are more diverse. In remote portions of the shoreline, even the worst of spills would not necessarily impact land use/recreational activities. However, there are many portions of the outer coast that are populated or heavily used, including beaches, sand dunes, tidepools, shoreline reserves, harbors, marinas, and other recreational boating and fishing areas that can be significantly (Class I or II) impacted by spills. Mitigation includes measures for spill prevention and response and mitigation measures for biological resources.

<u>Analysis of Future Conditions</u>

According to the Contra Costa County General Plan, over the next 20 years, a 10-percent increase in growth is projected in the Bay Area. This will bring with it an increase in recreational facilities. Under normal Terminal operations, no significant impacts would result to these facilities. As growth occurs, there will be more shoreline and recreational facilities that could be impacted by an oil spill. Results of spills and impacts remain as presented above for the continuation of current operations. Spills would result in significant (Class I or II) impacts.

Along with this growth will be a potential increase in the risk of accidents between tanker/barge traffic and recreational boaters. Because small boats are highly maneuverable and large tankers and barges travel at slow speed, impacts are considered to be adverse, but nonsignificant (Class III).

Cumulative Analysis

A large oil spill and/or the effects of multiple spills in a short timeframe could significantly impact (Class I and II) the cumulative environment. Oil spill prevention and response contingency planning for the entire Bay Area will help to prevent and respond to spill events and minimize impacts.

S.5.1.11 Cultural Resources

Neither the continued operation at current tankering levels nor future increases in Unocal tankering will have significant impacts to any cultural resources. No facility modifications are proposed that would affect any land resources and consequently have a potential to impact cultural resources.

Cumulative Analysis

Cumulative projects and future development in the greater project area will result in the potential for adverse impacts to cultural resources. Because no new construction is proposed, Unocal should not contribute to any major disturbances of prehistoric or historic resources within the cumulative environment.

S.5.1.12 Energy

Continuation of Current Operations

Issuing a new lease will not result in changes to existing crude oil deliveries, refining capacity, or product shipment. No impacts will occur to the energy perspective.

Analysis of Future Operations

Over the long term, Bay Area refining capacity is expected to remain relatively constant and may even decline as smaller refineries in the Bay Area cease operation. Because the production of Central Valley and Alaskan crude is expected to decline, it is expected that there will be an increase in tankering activity bringing in crude from foreign sources. No adverse impacts to energy use are expected.

Cumulative Analysis

The overall cumulative crude deliveries and refining capacities are expected to remain constant. Based on the assumption that the California economy recovers, there should be a low, but steady increase in demand for crude delivery to the Bay Area via tanker.

S.5.2 No Project Alternative

S.5.2.1 Operational Safety/Risk of Accidents

If the lease is not renewed and Unocal could no longer use the Marine Terminal, then the risk of a spill or accident at the Terminal would be removed (Class IV impact). However, the overall risk of spills from tankering may not decrease because it is likely that crude oil and product shipment would be transferred to another marine terminal, and impacts would remain as described in the Proposed Project.

Pier Structure Scenarios

If the wharf is abandoned in-place, there would be a small potential for spill (Class II impact) from residual crude or product in the pipelines during the pipeline removal process. Mitigation would include careful planning and development of a comprehensive abandonment plan including response measures for small spills. If the pier remains in-place, there would be an adverse, but nonsignificant risk (Class III) to vessel traffic passing through the area. If the pier is removed, there would be no risk to vessel traffic through the area.

If the pier structure is retained for nonterminal uses, risks would be the same as those of abandonment in-place, except for uses for the general public such as a fishing pier. The only public access to the pier is through the Refinery. While the probability of a Refinery accident is low, an accident could range from a fire or explosion to a member of the public being hit by a Refinery vehicle. If an accident occurred there would be a significant (Class I or II) impact to public safety. Mitigation for some impacts includes development of traffic control measures and other safety measures to allow for public access. No mitigation would be available for risk of injury or death to the public from an explosion or fire at the facility.

Refinery Scenarios

If the Refinery continued operating at current capacity, without the Marine Terminal, construction of a pipeline for crude and possibly product transport would be required. Pipeline capacity from the San Joaquin Valley is currently committed; therefore, pipeline options include a new pipeline to the Central Valley, connection to a common carrier, or a pipeline connection to another marine terminal or the Wickland Oil Selby Terminal storage facility. Pipeline transport of crude generally presents less of an impact on the environment than tanker transport due to less volume spilled.

Worst-case spill volumes are based on the assumption of complete drainage by gravity of the section of pipe between high ground and the point of rupture. Additional spillage depends on the flow rate and response time to shut down the pipeline. Other factors include valves and terrain gradient. The average spill size from a 16-inch-diameter crude oil pipeline is 2,680 bbl (2 miles of pipeline). Mean time between leaks and ruptures of a 350-mile pipeline would be 24 and 48 years, respectively. Existing pipelines may also be used; however, older pipelines are at higher risk to failure due to age and corrosion (Class II impact) that can be mitigated by routine inspections and replacement/repair of damaged lines. Thus, in the event of an accident, the amount of crude spilled from a pipeline would generally be less than a tanker. However, depending on the resources present, significant (Class I) impacts would still occur on sensitive resources on land. Class II impacts would result from any spill.

If Unocal replaced crude import and product export via use of another marine terminal facility, vessel/barge transit risk could either slightly increase or decrease, depending on terminal location and terminal characteristics. If terminals in the Carquinez Strait were used (Shell Martinez, Tosco, Exxon Benicia), tankers/barges would travel farther; if terminals in the Richmond area were used, tankers/barges would travel a shorter distance. Added traffic at other marine terminals may create congestion and increase the risk for collisions, and other terminals may have either a better or worse level of spill response.

If increased truck and/or rail transport is used, there would be a potential for a significant increase in the level of risk for spills and accidents. The numbers of spills per billion-ton miles for trucks, tankers, rail, and pipeline are 44.6, 9.4, 7.8, and 0.5, respectively. Corresponding deaths for trucks, tankers, rail, and pipeline per billion-ton miles are 10.9, 0.31, 2.5, and 0.01, respectively. The reason for higher death rates for truck and rail is related to a commingling with public transportation and a high-energy impact from collision, overturning, or derailment. Marine and pipeline transport is much safer from a risk perspective. Replacement of crude and product transport by truck and rail have the potential to result in significant increases in the potential for significant (Class I and II) impacts to public safety. Some forms of mitigation, such as trucking during nonpeak traffic hours and greater use of rail, can be applied to reduce risk.

Reduced Refinery operation or Refinery shutdown would decrease risks at the Unocal Refinery slightly; the demand for crude and product would be compensated by increases at other area refineries. Lesser or greater risks could result at other refineries, depending on their locations relative to populated areas, age or design of facilities, and transport risk depending on location.

S.5.2.2 Water Quality

Pier Structure Scenarios

Abandonment in-place, removal, or retention for other uses of the Marine Terminal would eliminate the adverse, but nonsignificant (Class III) impacts to water quality from leaks, spills, and discharges associated with the Terminal and would have a minor beneficial (Class IV) impact on water quality in the vicinity of the Terminal. Abandonment would also eliminate the risk of a major spill from the Unocal Marine Terminal or from ships at the Terminal; however, the risk would most likely be transferred to another area terminal(s).

If the pier was abandoned in-place, there would be a small potential for a spill from the pipelines during their removal from the wharf structure. This is considered to be a significant (Class II) impact that can be mitigated by implementation of spill prevention and response measures.

Removal of the pier structure itself would result in adverse, but nonsignificant (Class III) impacts on water quality during removal, resulting in only short-term increases in turbidity.

Refinery Scenarios

If tankered crude oil is replaced by other nontankered sources, the risk of crude oil spills from the Terminal would be eliminated resulting in a beneficial (Class IV) impact. Replacement of Alaskan crude by Central Valley crude could cause a slight difference in discharge from the Refinery outfall because Central Valley crude is higher in selenium. However, discharges would continue to meet NPDES limitations, and no significant impacts would result (Class III).

If tankered crude or product is replaced by pipeline via other marine terminals in the area, the risk of water quality impacts from Unocal tankering and Terminal activity would be transferred to other area terminals. Depending on which terminal received the oil, the overall risk of a spill could be slightly increased or decreased. If any construction of new submerged pipelines between the Unocal Refinery and other marine terminals occurred, there would be an adverse but nonsignificant (Class III) impact due to the temporary resuspension of sediments.

Use of increased trucks and rail for product transport would eliminate the risk of oil spills and impacts to water quality resulting in a beneficial (Class IV) impact. Truck and rail transport has a higher risk for accidents than either pipeline or tanker transit. An oil spill into an inland waterway would have a significant (Class I) impact on that waterway.

If the Refinery operated at reduced levels or shut down, oil spill risks would be eliminated resulting in a beneficial (Class IV) impact. Also, there would be either a reduction or complete elimination of wastewater discharge, which would also result in a beneficial (Class IV) impact.

S.5.2.3 Marine Biology

<u>Pier Structure Scenarios</u>

Abandonment in-place of the Marine Terminal would eliminate the adverse, but nonsignificant impacts (Class III) to marine life from decreased water quality due to leaks, spills, and discharges associated with the Terminal. The risk of a major oil spill at the Terminal and from Unocal-related tanker traffic would also be eliminated. Elimination of these inputs would have a minor beneficial (Class IV) impact on marine life. During pipeline removal, there would be a small risk of a spill (Class II impact) that can be mitigated by adherence to a plan addressing spill prevention and response. In addition to the above impacts, if the entire Terminal is removed, there would be an adverse, but nonsignificant (Class III) impact on marine life from the removal process that would result in short-term increases in turbidity. If the pier is retained for other nonterminal uses, impacts would be as described for abandonment in-place.

<u>Refinery Scenarios</u>

Under all Refinery scenarios (Alaskan crude replacement by Central Valley crude via pipeline, crude supply and product export replacement via other pipeline from/to other marine terminals, increased use of rail and truck), a beneficial (Class IV) impact to birds and marine mammals would result because the risk of crude spills from tankering and Marine Terminal use by Unocal would be eliminated. However, there may be an increase in the amount of selenium discharged from the Refinery wastewater. On a Unocal-specific basis, this in not considered significant (Class III). It should be noted that import/export through another marine terminal would shift the risk of spills to the other facility, which may increase the potential for spills at that facility. Oil spill impacts from other facilities would remain as described for the Proposed Project as significant (Class I) impacts.

If any new submerged pipeline construction is associated with intake/export via other marine terminals, there would be adverse, but nonsignificant (Class III) impacts from temporary turbidity, and from temporary disturbance to birds from noise. During construction and operation of inland pipelines, any spills into inland waterways have the potential to result in significant (Class I) impacts on aquatic resources. There may also be indirect adverse, but nonsignificant (Class III) impacts to terrestrial organisms due to decreases in air quality and increases in noise disturbance from truck and rail traffic.

If the Refinery reduced its level of operation or shut down, there would be a reduction or complete elimination of all risk associated with spills and wastewater discharge, which would result in beneficial (Class IV) impacts to marine resources.

S.5.2.4 Fisheries

<u>Pier Structure Scenarios</u>

If the Marine Terminal is abandoned in-place, the previously precluded buffer area around the Terminal would become available for fishing, resulting in a slight (Class IV) beneficial impact. Dredging would cease, resulting in beneficial (Class IV) impacts to habitat. Unocal vessel/barge actions would most likely transfer to other Bay Area facilities, increasing the number of vessel calls at other docks and piers. Adverse, but nonsignificant (Class III) impacts would be expected because these other terminals already have vessels/barges calling at their facilities.

Removal of the Marine Terminal would temporarily preclude fishing within the area of removal operations. Biological impacts from this action would be nonsignificant as would habitat disturbances. After completion of Terminal removal, the entire area would be available for both commercial and recreational boat fishing. Thus, this alternative would provide for additional fishing and a very small beneficial (Class IV) impact from the reduction in Bay dredging.

If the pier is retained for nonterminal uses, there would be a small beneficial (Class IV) impact from the additional boat fishing area that would open around the pier.

<u>Refinery Scenarios</u>

If tankering crude is replaced by other sources, with no Marine Terminal in operation, impacts would remain as described above for pier structure scenarios. If the Refinery reduced operations or shut down, wastewater discharges from the Refinery would be reduced or eliminated, resulting in benefits to fisheries and their habitat (Class IV impact).

S.5.2.5 Air Quality

<u>Pier Structure Scenarios</u>

If the Terminal is abandoned and left in place or if the entire pier structure is removed, then deconstruction of pipelines and pumping facilities or removal of the entire pier, pipelines, and pumping facilities would be required, respectively. Such efforts would require the use of heavy equipment brought onsite to conduct the required level of deconstruction. Short-term emissions during deconstruction were shown to result in an adverse, but nonsignificant (Class III) impact. Long-term emissions would result from elimination of the direct and indirect source emissions presently emitted from the Marine Terminal. This would result in a beneficial (Class IV) impact within the Bay Area.

<u>Refinery Scenarios</u>

In order for the Refinery to continue operating at current levels, additional crude would be purchased and transported through a common carrier line or through pipeline connections to a nearby refinery or storage facility such as the Wickland Oil Selby Terminal. Some pipeline construction would be necessary. Pipeline construction emissions are calculated on a daily basis; thus, length of pipeline would correspondingly lengthen the number of days of construction. During pipeline construction, nitrogen oxide (NOx) emissions would be expected to exceed the 150-pound-per-day significance threshold resulting in a significant (Class II) impact. This impact is mitigated through restrictions on equipment operations, proper maintenance, and the use of "clean burning" fuels. In addition, fugitive dust would be raised by trench excavation and equipment usage on unpaved surfaces. With use of standard watering procedures, an adverse, but nonsignificant (Class III) impact would be expected from fugitive dust.

During operations, pipeline emissions would occur only at pump stations. Based on the assumption of a pump station with a 10-million-Btu-per-hour heater, emissions were shown to be considerably less than those produced by the present operation of the Marine Terminal. Thus, operation of a pipeline as an alternative to the Terminal would result in a beneficial (Class IV) air quality impact.

If the Marine Terminal is no longer available, some product export could be partially accommodated by an increase in truck and rail product transport. Even with an increase in emissions due to loading losses for truck and rail transport that are greater than those predicted for ships, a decrease in air emissions would result with increased truck and rail transport. A beneficial (Class IV) impact would result.

If the Refinery operated at reduced levels, air emissions from the closure of Refinery process units would result in a beneficial (Class IV) impact. Similarly, if the entire Refinery closed, a beneficial (Class IV) air quality impact would result to the air basin.

S.5.2.6 Truck and Rail Traffic

<u>Pier Structure Scenarios</u>

Heavy equipment would need to be used for dismantling the pipelines and pumping equipment if the pier is abandoned in-place or if the pier structure is removed. If the entire pier is abandoned, up to 25 workers and up to five haul trucks may be used to remove debris on a daily basis. This mix of short-term traffic added to existing roadways is not expected to result in any significant (Class III) impact. However, once on I-80 the vehicles would be subject to travel on a freeway that already operates at LOS F, and a short-term significant (Class II) impact would result. Mitigation would include avoidance of peak-hour traffic, removal of debris by rail or barge, and use of trip reduction planning.

<u>Refinery Scenarios</u>

Crude oil replacement through use of a new pipeline or pipeline segment would have the potential to create significant (Class I and II) impacts during construction and operation of the pipeline. The Class I and II levels would depend on the level of existing congestion and whether any mitigation would serve to alleviate the impact. Heavy equipment and construction worker travel would use portions of various roadways that are at or over capacity, exacerbating existing conditions and creating a significant (Class II) impact. Short-term Class I impacts would also result at any points where the pipeline would need to cross roadways and result in a short (1 to 2 day) closure of a roadway portion for pipeline installation. Alternative routing of traffic in these cases may alleviate some of the congestion.

Without tankering ability, there would be increases in product transport by truck and rail. The only impacts that would be expected would be to I-80 because this roadway already exceeds rated capacity. A significant (Class I) impact would result from Unocal trucks adding to an already impacted condition.

If the Refinery was entirely shut down, it is not anticipated that removal of the facility would require the volume of trucks that is presently deployed on a daily basis. The demolition crew would be smaller than that of the current staff load of the Refinery. Thus, beneficial, short- and long-term (Class IV) impacts would be anticipated along all area roadways.

S.5.2.7 Noise

<u>Pier Structure Scenarios</u>

Deconstruction would be required for removal of pipelines and pumping facilities, and possibly for complete abandonment of the pier. Heavy construction equipment noise would be expected to dissipate to an acceptable level of 75 decibels on an A-weighted scale (dBA) day/night noise level (Ldn) (for industrial areas) at a distance of 141 feet from the source, which is within the confines of the facility, and thus would not disturb sensitive receptors. The 60-dBA Ldn level (for residential areas) would be met at a distance of 792 feet. No sensitive residential receptors are located within this distance, and no impacts would result.

If debris from dismantling of the pier is trucked out, noise along the local streets could potentially increase. The additional volume of truck and construction employee traffic on the local arterials would not significantly (Class III) add to noise in the area.

<u>Refinery Scenarios</u>

Based on 89 dBA at 50 feet from the construction source, construction of a new pipeline for crude import would create significant (Class II) temporary noise impacts within 998 feet of low-density residential areas; 561 feet of multifamily and lodging areas; 315 feet of schools, libraries, and office areas; and 177 feet of golf courses, stables, and water recreation areas. Construction haul trips could also result in temporary significant (Class II) impacts on area roadways. Mitigation would include avoiding sensitive routes, restricting construction and haul trip hours, keeping equipment in tune and using mufflers, placing stationary equipment away from receptors, and using portable noise barriers.

During operations, if all crude and product are transferred by truck, a significant (Class II) impact would result on San Pablo Avenue. Mitigation would include restrictions on hours of travel. However, it is more likely that both truck and rail would be used, in which case no significant noise increases (Class III) would result.

If the Refinery operated at reduced levels, there would be a decrease in truck, rail, and employee vehicle trips, which would result in a slight beneficial (Class IV) impact due to the reduction of vehicle-generated noise.

If the Refinery shut down, there would be less traffic involved in Refinery demolition than from current operations. A long-term beneficial (Class IV) impact would result from the decrease in roadway traffic-generated noise.

S.5.2.8 Earth Resources and Structure Stability

<u>Pier Structure Scenarios</u>

If the Marine Terminal is dismantled in part or in entirety, there would be no pipelines and associated pumping facilities that could be damaged and release materials into the Bay. A beneficial (Class IV) impact would result.

<u>Refinery Scenarios</u>

The Refinery could use a pipeline for crude import from one or several sources to replace tankering to maintain current refining capacity. Pipelines are generally constructed with some tolerance for flexure and can be designed to withstand damage from a maximum credible earthquake. As such, no impacts would be expected unless a larger seismic event occurred. More common to pipelines are spills resulting from corrosion of aged pipelines or damage caused by vandalism, resulting in a significant (Class II) impact. Mitigation includes routine inspection of aging lines and repair, as well as coverage, of lines to prevent vandalism.

Rail operations could be temporarily disrupted by relatively minor displacements of rail alignments due to fault rupture, liquefaction, lateral spreading, settlement, or lurching. If a truck or rail car is damaged during a seismic event, spilling contents, then a significant (Class I or II) impact would result, depending on the environmental resources in the spill path.

S.5.2.9 Aesthetics

<u>Pier Structure Scenarios</u>

If the Marine Terminal is abandoned in-place, the visual environment would remain as it exists at present. Based on the assumption that maintenance is performed, no significant impacts would result. However, if the pier is allowed to deteriorate, it could suffer visually from signs of neglect. If this occurred, it is not expected that significant (Class III) impacts would result due to the low number of viewers of the structure.

If the Marine Terminal is dismantled, the character of the nearshore environment would change; a slight beneficial Class IV impact would result. No significant (Class III) impacts would be expected from deconstruction of the pier, even though heavy equipment and possibly barges would be working offshore for a period of up to 4 months.

<u>Refinery Scenarios</u>

Construction of a pipeline for crude import would incur temporary significant (Class II) impacts along areas of pipeline routing. These impacts would mainly occur in nonindustrial areas, such as residential, recreational, commercial, and other highly sensitive visual areas (open space, undeveloped areas). Impacts within paved areas can be quickly mitigated through repaving. In other areas, vegetation and landscape scarring would be mitigated by incorporation of new vegetation and landscaping. Due to growing times, the residual effects of pipeline construction impacts are generally more severe in areas that require revegetation than in areas that only require repaving.

Increases in truck and rail traffic have the potential to result in a visual impact due to the addition of vehicles. However, this is generally considered to be more of a nuisance than an impact and is not considered to be significant (Class III).

If the Refinery reduced its capacity, no visual impacts would occur. If the Refinery is closed and dismantled, then the overall character of the immediate area at Davis Point could change. If the land is to be used for other industrial uses, which is the most likely scenario, the eventual visual effect would be similar to its present use. However, if the land is rezoned for other uses, the general expectation of the community could change, and a beneficial (Class IV) impact could result if the land is used for open space or recreational uses. There would be several obstacles in reaching such use, including cleanup of probable onsite hazardous wastes.

S.5.2.10 Land Use/Recreation

<u>Pier Structure Scenarios</u>

No changes would occur from the abandonment in-place of the Marine Terminal. The Terminal would not be used for tankering, but also could not be used for recreational purposes because access is only through the Refinery. No significant impacts would result. If the Terminal is dismantled, this portion of submerged tidelands would become open for nearshore boating. No adverse or beneficial impacts would be expected from this scenario. As presented in Section S.5.1.10, the Refinery would continue to preempt use of the shoreline for recreational access resulting in a significant (Class II) impact with proposed trail development policy. This would be mitigated through the dedication of access right-of-way for recreational trail improvements along San Pablo Avenue.

<u>Refinery Scenarios</u>

If the Refinery continued operating at current capacity through crude import via pipeline(s), no land use changes would be expected other than to obtain pipeline easements. A temporary nonsignificant (Class III) impact would result due to precluding land uses along construction routes. No conflicts are foreseen with the County General Plan. Similarly, no land use changes would occur from a reduction in Refinery operation. If the Refinery is shut down and dismantled, several steps would be required before the site could be considered for other uses, the most prominent involving cleanup of hazardous wastes. If the site is slated for other uses, zoning changes may be required. Based on the assumption that no incompatible land uses would be permitted by SLC or the County on the site, no land use or land use policy impacts are expected.

This alternative also preempts recreational shoreline trail development and results in a significant (Class II) impact. This impact would be mitigated through the dedication of an access right-of-way for recreational trail improvements along San Pablo Avenue.

S.5.2.11 Cultural Resources

<u>Pier Structure Scenarios</u>

If the Marine Terminal is abandoned and dismantled in part or in entirety, there could be a potential for a significant (Class II) impact to cultural resources located at the end of Davis Point where the Terminal connects to land. There is a potential that sites may exist that have not been previously recorded. An archaeological monitor would be required to be present during any ground-disturbing activity. Any sites would be evaluated to determine resource potential, and mitigation measures would be implemented as prescribed by an archaeological professional.

<u>Refinery Scenarios</u>

Pipeline construction to either a common carrier, another marine terminal, or, as a worst case, the Central Valley would have the potential to significantly (Class II) impact cultural resources. Depending on the route, there could be both previously identified sites and sites not yet recorded.

If the Refinery operated at reduced levels, no impacts to cultural resources would be expected as long as all facilities remained in place. Shutdown of portions or all of the Refinery would result in the potential to uncover cultural resources during dismantling and cleanup of the Refinery. These sites would be previously unrecorded sites that could be uncovered during cleanup and would result in a significant (Class II) impact. Mitigation would be as described for the pier structure scenarios.

S.5.2.12 Energy

If the Unocal Refinery obtained crude via other sources by sharing with other marine terminals or via new pipeline(s), it is expected that any increased use through other sources would not result in a major disruption of energy supplies. This is an adverse, but nonsignificant (Class III) impact because careful queuing of shipments would be necessary to avoid delays in tanker deliveries.

If the Unocal Refinery shut down, there would be a loss of about 9 percent of refining capacity in the Bay Area. This loss, coupled with the potential closure of other facilities, could result in a shortfall in refining capacity over the long term. This would be a significant (Class II) impact that may require importation of refined products.

S.5.3 <u>Consolidation Alternative</u>

S.5.3.1 Operational Safety/Risk of Accidents

Consolidation of the Unocal and Pacific Refining Marine Terminals to the Unocal facility would have advantages and disadvantages. Unocal's trestle-mounted pipelines are much easier to maintain and are at less risk of leakage or breakage than Pacific Refining's subsea pipelines. Access to the Unocal facility via land (rather than water access only for Pacific) is advantageous for emergency situations resulting in a beneficial (Class IV) impact. However, the addition of the Pacific Refining vessels calling at the Unocal Terminal would increase congestion, resulting in an increase in the potential for accidents, which is considered adverse, but nonsignificant (Class III). Consolidation would approximately double the current amount of tankers handled on an annual basis by Unocal (from 87 to approximately 175).

S.5.3.2 Water Quality

The combined risk of spills to water quality from consolidation would be approximately the same as having both the Unocal and Pacific Refining Marine Terminals in operation at the same time due to the closeness of their locations. Thus, no changes to the risk of water quality impacts would be expected from consolidation.

During either construction or abandonment and removal of new submerged pipelines, there would be a temporary nonsignificant (Class III) impact due to resuspension of sediments. The same impact would occur from dismantling of the Pacific Refining pier. Also, during pipeline removal of the Pacific Refining pier, there could be a small potential for leakage or spillage from the pipeline, resulting in a significant (Class II) impact that can be addressed through spill prevention and response planning.

S.5.3.3 Marine Biology

As stated above for water quality, there would be the same approximate risk for spills from consolidation as that of two operating terminals. Thus, the impacts to marine biology from consolidation remain approximately the same as those described for the Proposed Project. Temporary, nonsignificant (Class III) impacts would result to marine resources from turbidity caused by construction or removal operations as well as (Class III) impacts on birds from noise associated with these activities. Any small spills (Class II) can be addressed through spill prevention and response planning.

S.5.3.4 Fisheries

For this analysis, it was assumed that submerged pipelines could be installed from the Pacific Refining Refinery to the Unocal Terminal. Pipeline installation would be short term and considered to be nonsignificant (Class III) because fishing in the immediate vicinity is light. This impact would preclude access to fishing in the area during the construction period.

S.5.3.5 Air Quality

Short-term air emissions would result from dismantling the Pacific Refining Terminal and construction of a connecting pipeline between the Unocal and Pacific Refining Refineries. Emissions would either be significant (Class II) or nonsignificant (Class III) depending on the level of demolition/construction. Class II impacts would be mitigated through restriction on equipment operations, paper maintenance, and the use of "clean burning" fuels.

Long-term emissions from consolidation would result in an increase in throughput of petroleum liquids at the Unocal Terminal, thus raising its emissions. However, the long-term direct source emission increases may have to be offset at a greater than 1.0 to 1.0 ratio depending on permit conditions and emission decreases from elimination of the Pacific Refining Terminal, creating a net emissions reduction and resulting in a beneficial (Class IV) impact.

Indirect source emissions would remain unchanged at present production levels.

S.5.3.6 Truck and Rail Traffic

Some construction traffic would be associated with dismantling the Pacific Refining Terminal and constructing a pipeline between refineries. A short-term significant (Class II) impact would occur from heavy equipment and workers using I-80. No additional traffic would be expected during operations. Mitigation would be as described for the No Project Alternative.

S.5.3.7 Noise

Due to its distance from sensitive receptors, no noise impacts would be expected during demolition of the Pacific Refining Pier and construction of a connecting pipeline between the Unocal and Pacific Refining Refineries. Demolition and removal would be via barge operating offshore because the Pacific Pier does not connect to land. No traffic-generated noise impacts would be produced from either pipeline construction or operations.

S.5.3.8 Earth Resources and Structure Stability

If Pacific Refining would abandon and remove its marine terminal and use the Unocal Marine Terminal, there would be no differential in impacts over that presented for the Proposed Project. No impacts are associated with removal of the Pacific Refining Marine Terminal.

S.5.3.9 Aesthetics

Consolidation of the Unocal and Pacific Refining Marine Terminals would result in little effect in San Pablo Bay. Visually, this highly industrialized shoreline would not change due to the elimination of the offshore Pacific Refining Pier. Public sensitivity to the area would not change, and the general character of the area would not change. A slight beneficial (Class IV) impact could result for some of the local residents who have view of the Terminals.

S.5.3.10 Land Use/Recreation

Land use redesignations would not be involved in the Consolidation Alternative. No land use/recreation impacts would result. This impact and mitigation associated with recreational trail policy planning for a trail along the San Pablo Avenue remain the same as those for the Pier Structure/Refining Scenarios and could be mitigated by Unocal's granting of access and improvements for a trail.

S.5.3.11 Cultural Resources

Construction of a new pipeline between the Unocal and Pacific Refining Refineries could result in the potential to uncover previously unrecorded sites. This could result in a significant (Class II) impact. Mitigation would be as described for the No Project Alternative.

S.5.3.12 Energy

Consolidation of the Pacific Refining Terminal at the Unocal facility would not create any significant impact to the overall energy supply picture.

S.6 IDENTIFICATION OF THE ENVIRONMENTALLY SUPERIOR ALTERNATIVE

CEQA requires the identification of the Environmentally Superior Alternative (ESA). Under CEQA, if the ESA is the "No Project" alternative, then another alternative must be deemed the ESA. However, "No Project," under most CEQA EIRs, usually means that no project action will occur and thus, no impacts to the environment will result. For this project, therefore, the No Project alternative has several consequential alternatives that have been studied throughout this EIR process and have been considered for selection of the ESA.

Table S-2 presents the comparison of impacts for the Proposed Project, and the No Project and Consolidation alternatives, summarized from Table S-1. Consolidation was considered to approximate the impacts of the Proposed Project. The ESA is determined to be the combination of two No Project consequential alternatives: (1) abandonment and removal of the pier, combined with (2) reduced Refinery operations.

Pier removal is slightly more beneficial than abandonment in place as it would open up slightly more fishing area. With no Marine Terminal potential significant impacts of spills to water and marine biological and fisheries resources would be eliminated.

Combined with pier removal, the Refinery scenario of reduced operation would result in minimization of environmental impact associated with crude oil delivery. The Refinery scenarios of continued operations at current capacity via new pipeline and/or increased truck and rail transport were found to result in temporary pipeline construction related noise, air, and traffic, impacts; potentially significant safety impacts associated with increased truck and rail transport; increased potential for a pipeline, truck, or rail spill; the potential of a spill to impact inland water and biological resources; and, the impact of increased truck transportation on roadways. Further, crude replacement via pipeline involving the import of Alaskan crude through another Bay Area marine terminal, would actually transfer tanker shipping oil spill impacts to that terminal and not eliminate them; thus, this consequential alternative could be more impacting than the proposed project. While transport of Central Valley crude via pipeline would be less environmentally impacting than truck and/or rail transport, the alternative of reduced Refinery capacity further reduces potential environmental impact by eliminating those impacts associated with crude transport for continued operations at current capacity.

Table S-1

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
OPERATIONAL SAFETY/RISK OF ACCIDENTS				
PROPOSED PROJECT				
Continuation of Existing Operations				
Recent inspection of the Terminal discovered potential deficiencies in the structural integrity of the wharf.	If allowed to remain, may result in potentially significant (Class II) impact to wharf's structural integrity and lead to spills.	Conduct a structural and system safety audit of the Terminal as per SLC's Marine Terminal Audit program document, and implement required improvements. Install Allision Avoidance System to prevent damage to pier.	Unocal with review and inspection by SLC, and third party consultant.	Reduced to nonsignificant.
There has been a history of small spills from the pipelines on the wharf due to corrosion and erosion.	If allowed to remain, may result in releases of hydrocarbons into the water (Class II).	Develop and implement program to minimize the potential for pipeline leaks. Program should assess current condition of the pipelines, plan for correcting deficiencies, inspection and maintenance, installation of a leak detection system, and an option for SLC to reopen lease if spills greater than 50 bbl occur. ?	Unocal with review and inspection by SLC.	Reduced to nonsignificant.
The potential exists for spills to occur during transfer operations at the Terminal. The probability of small release is higher than those of large releases.	Accidental spills greater than 50 bbl during hydrocarbon transfers are a significant (Class I) impact.	Institute operational procedures to reduce the probability of a spill occurring. These shall include loading limits for vessel tanks, limits on vessels per year, – ? manning requirements for vessels and terminal, inspection of vessels, English language requirements, quick release couplings, planned audit and maintenance program, booming, and SLC option to reopen lease if spills greater than 50 bbl occur.	Unocal with review and inspection by SLC.	Impacts to sensitive resources remain significant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
The detonation arrester at Berth M-1 has been removed from its original location. This and other factors result in a small probability of a fire or explosion at the Terminal.	A fire or explosion could cause significant damage to the wharf and/or vessel at the wharf (Class I).	Institute measures to reduce the potential for a fire or explosion including reinstallation of the detonation arrester, inspecting vessels, requiring English fluency, assuring vessels can depart the wharf in 30 minutes in the event of an accident, requiring minimum vessel and terminal manning levels, use of quick-release couplings, and developing emergency response procedures for vessel accidents.	Unocal with review and inspection by SLC.	Reduced to nonsignificant.
The potential exists for spills from tankers and barges in route to or from the Unocal Terminal due to accidents or other unexpected incidents.	The release of hydrocarbons from a tanker or barge is considered a significant (Class I) impact.	Require all vessels to use the VTS, use pilots that are not members of the vessel's crew, adhere to recommendations of the Harbor Safety Plan, undergo a thorough inspection before calling first time at the Terminal, assure adequate underkeel clearance near Terminal, limit vessel and barge calls per year, ensure that all vessels have approved oil spill response plan, use state-of-the-art tug escorts, stay 50 miles off the coast when carrying persistent oil, and have double bottoms/hulls to the maximum extent possible.	Unocal with review by SLC.	Impacts to sensitive resources remain significant.
A butane tank will continue to be leased on filled state lands.	Tank constructed to rigorous standards resulting in remote possibility of explosion. Explosion could cause damage to nearby neighborhoods (Class I).	Because tank is designed and operated in accordance with strict standards and because potential for accident is remote, no additional mitigation measures are recommended.	Remote possibility of damage to surrounding neighborhood remains.	Remains significant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
Future Conditions				
The probability of spills at the Terminal and along the shipping lanes will increase.	Even though the risk increases, the significant (Class I) impacts to sensitive resources from a spill remain as for continuation of existing conditions.	See above.	Unocal with SLC inspection.	Remains significant.
Cumulative Impacts				
Twenty-four marine terminals operate within the Bay and contribute to the risk for accidents.	Even though the risk increases, the significant (Class I) impacts to sensitive resources from a spill remain as for the continuation of existing conditions.	See above. All terminals should be required to comply with all regulations and specific mitigations to be determined on an individual basis.	All terminal operators.	Remains significant.
NO PROJECT ALTERNATIVE				
Abandonment/Pier Scenarios				
Abandonment would involve removal of pipelines and/or removal of complete structure, or conversion of pier to other uses.	If the pier is abandoned in-place or removed completely, there would be a small potential for spillage from pipeline removal resulting in a significant (Class II) impact. There would be no risk to vessel traffic from pier remaining in-place.	Removal of pipeline mitigation involves development and adherence to a spill contingency response plan.	Unocal.	Reduced to nonsignificant.
Refinery Scenarios				
Unocal has no pipeline available to bring in the quantity of crude to Unocal to replace tankering. A new pipeline or connection to another pipeline or terminal would be necessary. Risks of pipeline spills are nearly the same as those for tankers; however, amount of oil released is substantially less.	A pipeline spill or rupture would generally not cause as much environmental damage as a tanker spill because less oil would generally be released. However, if a spill was to occur with sensitive resources present, a significant (Class I or II) impact would result.	No effective mitigation is available for spillage onto sensitive resources. Other spills can be contained through adherence to spill control contingency measures.	Unocal.	Impacts on sensitive resources remain significant. Other impacts reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
As an option, increased truck and rail transport may be used. Risks for spills and deaths are substantially higher for truck and rail transport.	Because of commingling with public transportation, there is a potential to result in significant (Class I and II) safety impacts.	Safety measures may be incorporated into the Refinery, but no measures would guarantee that no injury would occur to the general public.	Unocal.	Remains significant.
The Refinery may also either decrease its level of operation or shut down entirely.	Risks at the Unocal facility would be decreased or eliminated (Class IV) impact. Risk could be transferred to other facilities.	No mitigation is required.		
CONSOLIDATION ALTERNATIVE				
Unocal and Pacific Refining would share Unocal's Terminal.	Emergency access would be beneficial (Class IV). An increase in congestion could increase accident potential; however, this is not considered significant (Class III).	No mitigation is required.		
	Impacts from oil spills would be similar to the Proposed Project resulting in significant (Class I and II) impacts.	Mitigation for oil spills would remain as described for the Proposed Project.		
New pipeline construction between terminals and removal of Pacific Pier would be required.	No safety impacts associated with construction. Potential for small spills from pipeline removal at Pacific Pier.	Pipeline removal in adherence with spill contingency response plan.	Pacific Refining.	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
WATER QUALITY				
PROPOSED PROJECT				
<u>Continuation of Existing Conditions</u>				
Unocal tankers unload product and take on ballast water to stabilize the vessels.	Unocal tankers unload product at ports that may have higher levels of certain contaminants than San Pablo Bay. Because of the small volume of water that would be discharged to San Pablo Bay, adverse but nonsignificant (Class III) impacts would be expected to result from discharge of segregated ballast water.	No mitigation required.		
Water quality inputs include trace metals, small leaks and spills from the Terminal, tankers and barges, and effluent discharge from Refinery (including oil transport from the Terminal) and maintenance dredging.	Contamination from small leaks and spills is considered to be adverse but nonsignificant (Class III) because rapid tidal flushing causes rapid dispersion. All discharges will continue to meet NPDES and are not significant (Class III). Sediments from dredging are clean except for small amount of elevated nickel, which is considered adverse but nonsignificant (Class III).	No mitigation required.		
	Unocal does not currently use TBT on tankers, but this substance has the potential to have significant (Class II) adverse impacts on water quality.	Use of TBT should be prohibited.	SLC, as a lease condition and inspection.	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
An oil spill has minimal effect on physical properties of seawater, but can have significant impacts to water chemistry.	Light transmissivity reduction and sea surface warming by a spill are considered to be adverse but nonsignificant (Class III). Any size spill will violate water quality objectives and impact water chemistry, resulting in a significant (Class I) impact. The spill size, composition, and characteristics will determine severity of impact.	All operations to be conducted in a safe manner and all equipment to be maintained in proper working order to minimize chances of accidents. If a spill occurs, Unocal must be able to provide rapid response through booms and skimmers.	Unocal with inspections by SLC.	Impacts from an oil spill remain significant.
Future Conditions				
The Refinery will use less San Joaquin and more imported crude.	No significant changes in effluent discharge would be expected (Class III). Oil spill impacts remain as above.	No mitigation required for routine operations. Mitigation for spills as above.		
Cumulative Impacts				
The water quality of San Francisco Bay has been degraded by inputs of pollutants from various sources.	Any contribution to the Bay waters of a contaminant already at significantly high levels would have a cumulatively significant (Class I) impact.	Bay-wide mitigation would include measures to reduce inputs and nonpoint source discharges as well as increased control of point source discharges.	Regional Water Quality Control Board.	Impacts may remain significant.
NO PROJECT ALTERNATIVE				
Abandonment/Pier Scenarios	Abandonment, removal, or retention for other uses of the Terminal would eliminate the adverse but nonsignificant (Class III) impacts to water quality from leaks, spills, and discharges.	No mitigation required.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
	During pipeline removal, there would be a small potential for spills resulting in a significant (Class II) impact. Turbidity impacts would not be significant (Class III).	Preparation and adherence to a spill prevention and response plan.	Unocal.	Reduced to nonsignificant.
<u>Refinery Scenarios</u>				
	With no Marine Terminal, the risk of crude spills into the water would be eliminated (Class IV impact). Changes in crude selenium levels are not expected to significantly impact NPDES discharge (Class III).	No mitigation required.		
New Pipeline Construction	Any submerged pipeline construction to connect to other area terminals would result in temporary sediment suspension (Class III impact).	No mitigation required.		
Truck and Rail Use Only	Would result in elimination of oil spill risks to water (Class IV impact). However, an oil spill to an inland waterway could have a significant (Class I) impact.	Mitigation for any oil spillage would include adherence to spill response plans.	Unocal or truck or rail operator.	Impacts to sensitive resources remain significant.
Reduced operation or shutdown	Reduced operation or shutdown would eliminate spill risks and reduce or eliminate discharge into Bay, resulting in a beneficial (Class IV) impact.	No mitigation required.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
CONSOLIDATION ALTERNATIVE				
	No changes in levels of risk to water quality are expected over those of the Proposed Project.	No mitigation required for operations. Mitigation for accidents remains as per Proposed Project.		
	During either construction or abandonment of submerged pipelines there would be a temporary but nonsignificant (Class III) impact from sediment resuspension. There would be a significant (Class II) impact if any spillage would occur from a pipeline.	Mitigation for any spillage would be adherence to spill prevention and response plans.	Unocal.	Reduced to nonsignificant.

Table S-I
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
MARINE BIOLOGY				
PROPOSED PROJECT				
<u>Continuation of Existing Conditions</u>				
Marine biological conditions are dependent on water quality conditions as presented above. The Marine Terminal sediment is large grained, has low levels of contaminant, and creates minimal turbidity. Dredged sediments recolonize rapidly.	Continued annual maintenance dredging is expected to be adverse but nonsignificant (Class III).	No mitigation required.		
Small inputs of contaminants.	Any small discharges and small chronic leaks from the Marine Terminal are not expected to result in significant impacts (Class III). Increase in contaminants would contribute to significant cumulative impacts.	No mitigation required.		
Maintenance dredging could have some adverse effects on the sensitive winter and spring runs of Chinook salmon.	Dredging at the Terminal could have significant (Class II) impacts on migratory juveniles of the sensitive winter and spring runs of Chinook salmon.	Conduct dredging between July and August when lowest number of juveniles of these runs are present.	Unocal	Impacts from dredging on juvenile Chinook salmon would be mitigated to nonsignificant.
Unocal tankering contributes an incremental amount of underwater noise as compared to the overall amount of tankering. Birds and fishes are accustomed to Bay activities.	Ship noise disturbance and dredging are not considered to be significant (Class III) impacts to fishes and to birds.	No mitigation required.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
Marine mammals in Bays typically are small and fast-swimming and avoid moving vessels. Injury or death from collision with whales has occurred, but is considered remote.	Impacts are considered to be adverse, but not significant (Class III) from collisions with marine mammals from continued operation.	No mitigation required.		
Oil spills have greatest risk for impacts to biological resources from spills greater than 1,000 bbl. Risks to resources are greater in shipping lanes, but chances of spills are less than those for the Marine Terminal.	Oil spills greater than 50 bbl are considered to be significant (Class I) impacts to marine resources and their habitat. Numerous species, including those that are threatened, endangered, and candidate, are at risk.	No effective mitigation is available to mitigate the effects of a large spill. Impacts can be minimized and partially mitigated through adherence to spill prevention and response plans, plans for response to sensitive resources in vulnerable locations, rehabilitation plans for oiled birds, and strategies for restoration of lost resources.	Unocal with direction from California Department of Fish and Game (CDFG) and coordination with Clean Bay and other cleanup organizations.	Impacts from oil spills remain significant.
<u>**Future Conditions**</u>				
The Refinery will use less San Joaquin and more imported crude.	No significant changes in water quality will result in no changes to future routine operations. Oil spill impacts remain as described above.	No mitigation required for routine operations. Mitigation for oil spills remains as above for continued operations.		
<u>**Cumulative Impacts**</u>				
Cumulative conditions produce a greater threat of an oil spill to resources from the combined actions of all tankering and all terminals.	Significant (Class I) impacts to the cumulative environment would result from oil spills.	No effective mitigation is available to mitigate spill effects. In addition to above mitigation for spill prevention and other plans, include cooperative efforts of all terminal operators through Clean Bay and others.	All marine terminal operators and cooperative agencies.	Oil spill impacts remain significant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
Small impacts of contaminants will contribute to mass loadings in San Francisco estuary.	Any contribution to the Bay waters of a contaminant already at significantly high levels would have a cumulatively significant (Class I) impact.	Bay-wide mitigation would include measures to reduce inputs and nonpoint source discharges as well as increased control of point source discharges.	Regional Water Quality Control Board.	Impacts may remain significant.
NO PROJECT ALTERNATIVE				
<u>Abandonment/Pier Scenarios</u>	Abandonment, removal, or retention for other uses would eliminate adverse but nonsignificant water quality impacts and thus eliminate impacts to marine resources resulting in a beneficial (Class IV) impact.	No mitigation required.		
	During pipeline removal, there could be a potential for significant (Class II) impacts from a spill. Turbidity impacts would be nonsignificant to marine resources (Class III).	Adherence to spill prevention and response plan for small spills. No mitigation required for turbidity.	Unocal.	Reduced to nonsignificant.
<u>Refinery Scenarios</u>				
New Pipeline Construction	Replacement of crude by Central Valley via pipeline, or other terminals would result in elimination of marine biology impacts (Class IV). Increased selenium discharged from the Refinery would be adverse, but not significant (Class III). Construction from submerged pipelines resulting in sediment suspension would be nonsignificant (Class III).	No mitigation required.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
New Pipeline Construction (Cont'd)	An oil spill to an inland waterway could result in significant (Class I) impacts to biological resources.	Mitigation for oil spills would include adherence to spill response plans.	Unocal and truck and rail operators.	Impacts to sensitive resources remain significant.
Truck and Rail Use Only	Would result in elimination of oil spill impacts to water and biological impacts (Class IV). An oil spill to an inland waterway could result in significant (Class I) impacts to biological resources.	Mitigation for oil spills would include adherence to spill response plans.	Unocal and truck and rail operators.	Impacts to sensitive resources remain significant.
Reduced Operation or Shutdown	Would result in elimination or reduction in discharge into Bay and eliminate or reduce impacts from Unocal Refinery to marine resources (Class IV impact).	No mitigation required.		
CONSOLIDATION ALTERNATIVE				
	No changes to levels of impacts to marine resources over that of the Proposed Project.	No mitigation is required for operation. Mitigation for accidents remains as for Proposed Project.		
	During either construction or abandonment of submerged pipelines, there would be a temporary but nonsignificant (Class III) impact to marine resources from turbidity. There would be a potential for significant (Class II) impact to resources from a pipeline spillage.	Mitigation for any spillage would include adherence to spill prevention and response plans.	Unocal.	Reduced to nonsignificant.

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Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Cumulative Impact
FISHERIES				
PROPOSED PROJECT				
<u>**Current and Future Operations**</u> The area around the Marine Terminal supports shrimp, salmon, sturgeon, bass, and perch.	Fishing activity is light, and continued impacts to fisheries around the Terminal are considered adverse but nonsignificant (Class III). Disturbance from continued maintenance dredging is considered minimal with adverse But nonsignificant impacts on bay shrimp from smothering of dredged materials disposal (Class III).	No mitigation required.		
	Loss of fishing area from tankers and barges in the shipping lanes is not significant (Class III), except for herring, which loses about 25% of its fishing area resulting in a significant (Class II) impact.	Vessel conformance with agreements between CDFG, herring harvesters, and other parties to minimize conflicts.	Unocal.	Reduced to nonsignificant.
	Fishing areas at highest risk from tanker and Terminal oil spills are those located in Suisun Bay, rivers and sloughs near the Unocal Terminal, eastern San Pablo Bay, and the central portion of San Francisco Bay. The most vulnerable species are shrimp, herring, salmon, sturgeon, bass, smelt, perch, and clambeds. Depending on the size and type of spill, significant (Class I or II) impacts are predicted.	No mitigation is available after a spill for impacts to tainted fisheries. Targeting cleanup measures to the most vulnerable locations, financial compensation, contributions to habitat enhancement programs, and education and research are recommended to minimize the effects.	Unocal with cooperating agencies and organizations.	Remains significant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Cumulative Impact
Outer coast fisheries at risk include dungeness crab because of their vulnerability in the bay, and Pacific hake, salmon and other anadromous species, and estuarine species including halibut, starry founder, and English sole.	Along the outer coast, most offshore fisheries have a moderate to high level of risk from oil spills from tankers. The most vulnerable nearshore fisheries are dungeness crab, sea urchin, and fisheries harvested from shore. Impacts are predicted to be significant (Class I and II). Impacts to aquaculture and kelp harvesting are considered to be significant, Class I and II, respectively.	No mitigation is available after a spill for impacts to tainted fisheries. Mitigation for kelp includes financial compensation.	Unocal.	Fisheries impacts remain significant. Kelp impacts are reduced to nonsignificant.
Cumulative Impact				
Oil tankering, terminals, refineries, other industrial and agricultural polluters all contribute to fisheries impacts.	Water pollution results in significant (Class I) impacts to fisheries.	Abide by policies and criteria, contribute to mitigation and restoration programs.	All industrial/agricultural sources.	Remains significant.
		Unocal's share to be determined through periodic review of lease.	Unocal.	Reduced to nonsignificant.
NO PROJECT ALTERNATIVE				
Abandonment/Pier Scenarios				
	If the Marine Terminal is abandoned, the previously precluded buffer area around the Terminal would open for fishing and dredging would cease (Class IV impacts). Removal of the pier would temporarily preclude fishing, but no significant (Class III) impact would occur. Removal of the pier would open additional fishing area (Class IV).	No mitigation required.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Cumulative Impact
Refinery Scenarios	If tankering was replaced by pipelines, rail, or trucks, impacts to fisheries would remain as slightly beneficial (Class IV) as described above for abandonment.	No mitigation required.		
CONSOLIDATION ALTERNATIVE				
	Removal of the Pacific Refining pier and removal or construction of submerged pipelines would result in a short-term but nonsignificant (Class III) impact to fishing area disruption. A previously precluded buffer area would open to fishing (Class IV impact).	No mitigation required.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
VEHICULAR AND RAIL TRANSPORTATION				
PROPOSED PROJECT				
Continuation of Existing Conditions				
The site currently generates approximately 65 truck trips on a daily basis.	The project would continue operations as they presently exist and no additional truck trips would be produced.	No mitigation is required.		
Future Conditions				
Based on an import increase of 60% and export increase of 30% through the Terminal, as many as 152 equivalent average daily trips could be produced if all additional product is shipped out by truck.	Traffic forced onto I-80 or SR-4 will encounter Level of Service (LOS) F traffic, producing a significant (Class II) impact. The use of other local access routes will not produce significant impacts.	Restrict truck hauls to offpeak hours or ship by rail. Develop a trip reduction plan to achieve 1.5 persons per vehicle. Provide peripheral park-n-ride lots. Provide preferential parking to high-occupancy vehicles and shuttle services. Charge parking lot fees to low-occupancy vehicles.	Unocal.	Reduced to nonsignificant.
Cumulative Impacts				
	Significant (Class I and/or II) impacts occur at congestion points on I-80, San Pablo Avenue, SR-4, and other streets.	As above for future conditions, plus use of local shuttles, promote TDMs, work with City/developers on new projects, provide bicycle storage.		For roadways already exceeding capacity, impacts will remain significant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
NO PROJECT ALTERNATIVE				
Abandonment/Pier Scenarios	Construction efforts to remove pipelines and pumping equipment only or in conjunction with pier removal will force construction vehicles onto I-80, which operates at LOS F resulting in a short-term significant (Class II) impact.	Haul trips: Haul trips should be scheduled to avoid peak-hour traffic. Unocal should stockpile the debris onsite for subsequent removal by rail or barge. Worker trips: If workers other than those currently employed by the site are to be used, the work schedule should be staggered so that peak-hour traffic can be avoided. Unocal should develop a trip reduction plan to achieve 1.5 persons per vehicle for both construction and permanent employees. Unocal could provide peripheral park-n-ride lots. Unocal could provide preferential parking to high-occupancy vehicles and shuttle services. Unocal could charge parking lot fees to low occupancy vehicles. Delivery of the pipe to the various staging areas and removal of soil should be conducted during offpeak hours.	Unocal.	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
<u>Refinery Scenarios</u>				
New Pipeline Construction	Construction vehicles will be forced onto LOS F routes (I-80) resulting in a short-term significant (Class II) impact.	The work schedule should be staggered so that peak-hour traffic can be avoided.	Unocal.	Reduced to nonsignificant.
		Unocal should develop a trip reduction plan to achieve 1.5 persons per vehicle for construction workers and permanent employees.		
		Delivery of pipe to various staging areas and removal of soil should be conducted during offpeak hours.		
	Pipelines crossing or paralleling roads may necessitate temporary lane closures and traffic congestion, resulting in short-term significant (Class I and II) impacts.	Where pipelines are to cross or parallel roadways, the following measures should be applied:	Unocal.	Remains significant where lane closures cannot be avoided. Other impacts reduced to nonsignificant.
		Avoid closing any lanes entirely during construction unless absolutely necessary.		
		If possible, keep all lanes open during peak traffic hours and schedule necessary lane closures during offpeak hours.		
		Use signing and flagmen where construction equipment is to interface with traffic and give sufficient warning such that cars may choose an alternate route if possible.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
New Pipeline Construction (Continued)		Institute public information programs to enable motorists to avoid congested areas. Include placement of public notices in local newspapers and the distribution of fliers in the project area.		
New Pipeline Operations	The replacement of the Terminal with pipelines to import crude will necessitate some use of trucks and rail to export product and force vehicles on to LOS F routes, resulting in a significant (Class I) impact.	Same as Proposed Project cumulative and future listed above.	Unocal.	If trucks are used, the impact remains significant. If rail transport is heavily used, impact is reduced to nonsignificant.
Truck and Rail Use Only	The replacement of the Terminal with increased truck and rail use and force vehicles on to LOS F routes, resulting in a significant (Class I) impact.	Same as Proposed Project cumulative and future listed above.	Unocal.	If trucks are used, the impact remains significant. If rail transport is heavily used, impact is reduced to nonsignificant.
Reduced Level of Operation	Reduced operations would reduce truck, passenger vehicle, and rail transport, resulting in a beneficial (Class IV) impact.	No mitigation required.		Beneficial impact.
Refinery Shutdown	Both short- and long-term beneficial (Class IV) impacts because the level of traffic generated by the site would be reduced during demolition and curtailed afterward.	No mitigation required.		Beneficial impact.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
CONSOLIDATION ALTERNATIVE				
	Construction traffic would be forced on to LOS F routes, resulting in a short-term significant (Class II) impact.	Same as New Pipeline Construction listed above.	Unocal.	Impact of vehicles on LOS F routes is reduced to nonsignificant. If pipelines are to cross major roads, the impact is expected to remain significant through construction period.
	Operations traffic would be similar to current site-generated traffic levels.	No impact.	No mitigation required.	

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Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCES FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
AIR QUALITY				
PROPOSED PROJECT				
Continuation of Existing Operations				
The site currently generates air emissions from both direct and indirect sources. However, these are considered in the existing conditions for the local air basin.	The project would continue operations as they presently exist, and no additional emissions would be produced. Indirect emission reductions will result in a beneficial (Class IV) impact.	No mitigation required.		
Future Conditions				
Based on an import increase of 60% and export increase of 30% through the Terminal and 30% over land, additional air emissions would be produced from both direct and indirect sources.	PM_{10}, SO_x, NO_x, and POC will be increased by significant levels.	Mitigation focuses on the use of the best available control technology available at the time. BAAQMD will set limitations on allowable emissions levels. Offsets may be required.	Unocal working with BAAQMD.	Reduced to less than significant.
Cumulative Impacts				
All projects generate direct and indirect air emissions in the cumulative environment.	Only if Unocal augments its facility operation will it increase its contribution to the local air shed.	No mitigation required.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCES FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
NO PROJECT ALTERNATIVE				
Abandonment/Pier Scenarios				
	Construction efforts to remove pipelines and pumping equipment will result in a short-term Class III impact. A Class IV impact would result from elimination of direct and indirect emissions from the Terminal.	No mitigation required.		
Refinery Scenarios				
New Pipeline Construction	Construction equipment and vehicles will create a short-term significant (Class II) impact for NO_x. Fugitive dust will be raised, but will be controlled by standard watering techniques.	Keep all equipment in a proper state of tune per the manufacturer's recommendations. Equipment should incorporate an additional 4 degrees of ignition retard. Equipment should use "clean burning" low-sulfur diesel. Equipment should not be left idling for prolonged periods.	Unocal.	Reduced to nonsignificant.
New Pipeline Operation	Emissions would be less than those produced by the Marine Terminal, resulting in a beneficial (Class IV) impact.	No mitigation required.		Beneficial impact.
Truck and Rail Use Only	Beneficial (Class IV) impact is associated with the reduction in air emissions.	No mitigation required.		Beneficial impact.
Reduced Level of Operation	Reduced operations would reduce both direct and indirect source emissions, resulting in a beneficial (Class IV) impact.	No mitigation required.		Beneficial impact.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCES FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
Refinery Shutdown	Curtailed operations would reduce both direct and indirect source emissions, resulting in a beneficial (Class IV) impact.	No mitigation required.		Beneficial impact.
CONSOLIDATION ALTERNATIVE				
Operation of the consolidated terminals would lead to the elimination of a terminal, reducing air emissions.	Construction could produce a short-term significant (Class II) impact or a nonsignificant (Class III) impact.	Same as New Pipeline Construction listed above.	Unocal.	Reduced to nonsignificant.
	Reduced or curtailed operations would reduce direct source emissions, resulting in a beneficial (Class IV) impact.	No mitigation required.		Beneficial impact.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
NOISE				
PROPOSED PROJECT				
Continuation of Existing Conditions				
Ambient noise levels range from 59.4 dBA on streets to 74.3 dBA at the Terminal.	The project would continue operations as they presently exist. No impacts would result.	No mitigation required.		
Cumulative and Future Uses				
Noise increases can be expected primarily from non-refinery related uses.	Unocal will not contribute significantly to cumulative or future noise increases.	No mitigation required.		
NO PROJECT ALTERNATIVE				
Abandonment/Pier Scenarios				
Truck and rail noise ranges as high as 83 dBA along I-80 and 69 dBA at grade rail crossings at 50 and 100 feet, respectively.	Construction efforts to remove pipelines and pumping equipment only, or in conjunction with pier removal, are expected to reach 89 dBA at 50 feet. Because sensitive receptors are out of range, no impacts will result.	No mitigation required.		
Refinery Scenarios				
New Pipeline Construction	Construction of a new pipeline could be significant near sensitive receptors. This would be a temporary, significant (Class II) impact. Truck and rail noise increases would be considered nonsignificant.	Pipeline construction should avoid sensitive areas; equipment should be kept in tune with operating mufflers. Hours of construction should be restricted. Stationary equipment should be located as far from receptors as feasible. Portable noise barriers may be necessary.	Unocal.	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
Truck and Rail Use Only	Use of truck and rail only with no pipeline would result in significant (Class II) noise impacts.	Mitigation includes trip reduction measures, maximize use of rail, limitation on trucking hours, keeping trucks in tune, and use of mufflers.	Unocal.	Reduced to nonsignificant.
Reduced Levels of Operation	Reduced operation would reduce truck and rail trips, resulting in a slight Class IV impact.	No mitigation required.		Beneficial impact.
Refinery Shutdown	Potential short-term, significant (Class II) construction impacts would result from Refinery dismantling.	No effective mitigation except limitation on construction hours and daily number of haul trips.	Unocal.	Reduced to nonsignificant.
	Long-term impacts would be less traffic and less noise, resulting in a slight Class IV impact.	No mitigation required.		Beneficial impact.
CONSOLIDATION ALTERNATIVE				
	New pipeline construction would be required between refineries, resulting in increased noise levels during the construction period; however, all temporary impacts would be nonsignificant due to distances to receptors.	No mitigation required.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
EARTH RESOURCES				
PROPOSED PROJECT				
<u>Existing and Future Conditions</u>				
Faulting and Seismic Ground Shaking				
There are no known active faults under the site.	No significant impacts will result from fault rupture.	No mitigation required.		
Several active faults are located with the Bay Area.	The Terminal and butane tank are designed to withstand major events; however, pipeline valving or bracings could fail, resulting in materials spill creating a significant (Class II) impact.	Routine inspection program and seismic retrofit where needed.	Unocal and SLC inspection.	Reduced to nonsignificant.
<u>Secondary Effects</u>				
Liquefaction:				
The Marine Terminal and wharf are supported by vertical and battered piles founded on dense sands and bedrock.	The potential impact to the wharf is considered to be adverse but nonsignificant (Class III).	No mitigation required.		
The area beneath the butane sphere is fill material with a high water table.	Pile foundation may result in susceptibility to potentially significant (Class II) impact.	Conduct soils/geotechnical engineering to determine adequacy of pile foundation and retrofit as needed.	Unocal.	Reduced to nonsignificant.
Differential Settlement Spreading and Lurching:				
Shoreline acreage consists of artificial fill and Bay mud adjacent to Terminal.	Potential for significant (Class II) impacts along the shoreline acreage.	Conduct surveys and inspection of shoreline areas after seismic events and refilling and use of riprap as required.	Unocal	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
Tsunami:				
Tsunami potential considered low - a 200-foot wave at the Golden Gate would occur 1/200 years.	Wave height would attenuate from the Golden Gate to the Terminal to levels of nonsignificance.	No mitigation is required.		
<u>Structural Conditions of Terminal</u>				
Data interpolation shows that the Terminal's load bearing capacity is adequate for continued use at present loading conditions with a factor of safety of 1.5.	No impacts will result. If future vessels are larger, potentially significant (Class II) impacts would occur to pier's structural integrity.	Inspection and preventative maintenance; engineering and modification if larger displacement vessels are used.	Unocal, third party consultant, and SLC inspection.	Reduced to nonsignificant.
Corrosion of structural steel on piles and beams.	If left to deteriorate, could result in significant structural (Class II) impacts.	Conduct structural and system safety audit as per SLC Marine Terminal Audit Program, repair deficiencies, and use of avoidance monitors for approaching vessels.	Unocal, third party consultant, and SLC inspection.	Reduced to nonsignificant.
<u>Structural Condition of Butane Sphere</u>				
Data interpolation shows concrete piles capable of supporting the 30-ton design load with the factor safety of 2.	No impacts are foreseen with present continued use of the sphere. If used for heavier materials, further evaluations should be conducted to avoid significant (Class II) impacts.	Inspection and engineering to be conducted to determine viability for storage of other materials.	Unocal with SLC concurrence of structural analysis review.	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
Cumulative Conditions				
The San Francisco Bay Area is an area of high seismic activity.	Extensive damage in the Bay Area could result from large earthquakes resulting in a significant (Class I) impact. The Unocal Marine Terminal would contribute nonsignificantly to overall damage.	Inspection of structures, seismic retrofitting, and proper design of new structures to safeguard against damage to the maximum extent feasible.	All facilities.	Potential for damage remains significant.
NO PROJECT ALTERNATIVE				
Abandonment/Pier Scenarios				
	If pier is dismantled in part or completely, there would be no structures to be damaged, and no spills that would occur (Class IV impact).	No mitigation required.		
Refinery Scenarios				
New Pipeline Construction	Additional pipeline for oil import could result in an increased risk for rupture and spills on land resources. However, as long as these are properly designed to withstand a maximum credible earthquake, no significant impacts should result (Class III). Significant (Class I) impacts could occur from corrosion of aged pipelines and/or vandalism.	Pipelines are to be constructed in accordance with all seismic engineering considerations and checked throughout the life of the pipeline.	Unocal.	Reduced to nonsignificant.
Reduced Operation/Shutdown	With no new lease, there could be a reduction in Refinery operation or closure. With no facility to damage, impact risk would reduce to a beneficial (Class IV) impact.	No mitigation required.		

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Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
CONSOLIDATION ALTERNATIVE				
	Pacific Refining would abandon and dismantle Terminal. No additional significant impacts would result. Impacts are as described for the Proposed Project.	See Proposed Project above.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
AESTHETICS				
PROPOSED PROJECT				
Existing and Future Conditions				
Continuation of the Terminal operations will not result in any changes to the existing visual environment.	No impacts will occur from normal operations. Visual impacts from oil spills could range from a slight surface sheen to heavy lumps of floating tar, resulting in significant (Class I and II) impacts.	No additional measures available other than adherence to contingency planning and response procedures to minimize spread of spills.	Unocal/Clean Bay.	Remains significant until natural dissipation occurs.
Cumulative Conditions				
	If several spill events occurred in the Bay simultaneously, significant (Class I and II) visual impacts would result.	No additional measures available other than adherence to contingency planning and response procedures to minimize spread of spills.	Responsible facilities/Clean Bay.	Remains significant until natural dissipation occurs.
NO PROJECT ALTERNATIVE				
Abandonment/Pier Scenarios				
	As long as the pier is maintained, no impacts would result from abandonment. If the pier is removed, slight beneficial (Class IV) visual impacts would result.	No mitigation required.		
Refinery Scenarios				
New Pipeline Construction	Temporary significant (Class II) visual impacts could result from new pipeline construction from grading, trenching, landform alteration, and vegetation scarring.	Repaving, revegetation, returning contouring to existing conditions.	Unocal.	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
	An adverse, but nonsignificant (Class III) impact would result from truck traffic increases.	No mitigation required.		
Refinery would operate at reduced levels or shut down	No significant changes would occur to the visual environment from reduced operations. If the Refinery was removed entirely, a beneficial visual (Class IV) impact would result.	No mitigation required.		Beneficial impact.
CONSOLIDATION ALTERNATIVE				
Consolidation between the Unocal and Pacific Refining Terminals to the Unocal Terminal would result in the dismantling of the Pacific Pier.	Elimination of the Pacific Pier would result in a slight beneficial (Class IV) visual impact.	No mitigation required.		Beneficial impact.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
LAND USE/RECREATION				
PROPOSED PROJECT				
Existing and Future Conditions				
The continuation of Terminal operations will not require any physical land use modification or changes to the recreational environment.	No changes in existing land uses or recreational resources will occur from the Proposed Project. No impacts will result.	No mitigation required.		
	The Unocal facility precludes proposed shoreline recreational trail access development resulting in a significant (Class II) policy impact.	Unocal should dedicate a right-of-way and improvements along San Pablo Avenue.	Unocal with SLC oversight.	Reduced to nonsignificant.
	During accident conditions, there is a potential for significant (Class I and II) impacts to the shoreline affecting onshore land uses and recreation. There would also be a significant (Class I and II) impact for Bay and offshore recreation.	No effective mitigation is available other than adherence to contingency planning and spill response procedures.	Unocal/Clean Bay.	Impacts may remain potentially significant until natural dispersion occurs and/or cleanup is complete.
Cumulative Conditions				
	Cumulatively, multiple spills or accidents would significantly affect land use and recreational resources, creating significant (Class I and II) impacts.	All terminals should have contingency planning and spill response procedures. Interaction between involved agencies and terminals to provide for Bay-wide spill response.	All marine terminals, Clean Bay, and other responsible cleanup parties.	Impacts may remain potentially significant until natural dispersion occurs and/or until cleanup is complete.

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Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
NO PROJECT ALTERNATIVE				
<u>Abandonment/Pier Scenarios</u>				
	Abandonment in place or pier removal would not result in any land use or recreation impacts. Pier removal would open a small area to offshore fishing and other uses.	No mitigation is required.		
	The Unocal facility precludes shoreline recreational trail access development, resulting in a significant (Class II) impact.	Unocal should dedicate a right-of-way and improvements along San Pablo Avenue.	Unocal.	Reduced to nonsignificant.
<u>Refinery Scenarios</u>				
New Pipeline Construction	Construction of a new pipeline would result in temporary (Class III) impacts to land use along its route due to disturbance. No conflicts with zoning or land use policies are anticipated.	No mitigation is required.		
	The Unocal facility precludes shoreline recreational trail access development, resulting in a significant (Class II) impact.	Unocal should dedicate a right-of-way and improvements along San Pablo Avenue.	Unocal.	Reduced to nonsignificant.
Reduced Levels of Operation	No changes would occur to land use, and no impacts would result.	No mitigation is required.		
	The Unocal facility precludes shoreline recreational trail access development, resulting in a significant (Class II) impact.	Unocal should dedicate a right-of-way and improvements along San Pablo Avenue.	Unocal.	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
Refinery Shutdown	Complete remediation of the site would be required to allow for other uses if the facility is dismantled. No land use impacts are expected if this site was to be used for other uses compatible with site zoning.	No mitigation required.		
	The Unocal facility precludes shoreline recreational trail access development, resulting in a significant (Class II) impact.	Unocal should dedicate a right-of-way and improvements along San Pablo Avenue.	Unocal.	Reduced to nonsignificant.
CONSOLIDATION ALTERNATIVE				
	No impacts would result from consolidation. No land use or recreation resources would be involved.	No mitigation required.		
	The Unocal facility precludes recreational trail access development resulting in a significant (Class II) impact.	Unocal should dedicate a right-of-way and improvements along San Pablo Avenue.	Unocal.	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
CULTURAL RESOURCES				
PROPOSED PROJECT				
Continuation of Existing Operations and Future Conditions	No impacts would result to cultural resources from continued operation of the Marine Terminal.	No mitigation required.		
Cumulative Conditions Cumulative uses in the area have the potential for increases in disturbances to prehistoric and historic resources.	There is the potential for significant (Class I and II) impacts to the area's cultural resources.	Mitigation should be developed on a project-specific basis. Cultural resource specialists would possibly be required to be onsite during excavations. If resources are uncovered, appropriate mitigation would be applied.	Project developers.	Reduced to nonsignificant.
NO PROJECT ALTERNATIVE				
Abandonment/Pier Scenarios	If the Marine Terminal is dismantled, there is a potential that previously unrecorded cultural resources could be disturbed, resulting in a significant (Class II) impact. No impacts are expected to historic resources.	An archaeological monitor would be required to be present during removal when earth resources are involved. If resources are uncovered, appropriate mitigation would be applied.	Unocal.	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
<u>Refinery Scenarios</u>				
New Pipeline Construction	New pipeline construction has the potential to impact prehistoric and historic resources resulting in significant (Class II) impacts.	Mitigation would include avoidance during route planning. Also an archaeological monitor would be required to be present during removal when earth resources are involved. If resources are uncovered, appropriate mitigation would be applied.	Unocal.	Reduced to nonsignificant.
Reduction in Operation or Refinery Shutdown	There is a potential that previously unrecorded cultural resources could be disturbed, resulting in a significant (Class II) impact.	An archaeological monitor would be required to be present during removal when earth resources are involved. If resources are uncovered, appropriate mitigation would be applied.	Unocal.	Reduced to nonsignificant.
CONSOLIDATION ALTERNATIVE				
	No impacts are expected from removal of subsea pipelines between the Pacific Terminal and Refinery.	No mitigation required.		
	Construction of new pipelines between Refineries has the potential to disturb previously unrecorded sites, resulting in a significant (Class II) impact.	An archaeological monitor would be required to be present during removal when earth resources are involved. If resources are uncovered, appropriate mitigation would be applied.	Unocal/Pacific Refining.	Reduced to nonsignificant.

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
ENERGY				
PROPOSED PROJECT				
Continuation of Existing Conditions				
New lease will result in maintenance of existing crude oil deliveries, refining capacity, and product shipment.	No impacts will result.	No mitigation required.		
Future Conditions				
Overall refining capacity to remain constant and may decline. Crude oil tankering to increase.	No impacts will result.	No mitigation required.		
Cumulative Conditions				
Overall oil deliveries and refining to remain relatively constant with a low, but steady growth demand.	No impacts will result.	No mitigation required.		
NO PROJECT ALTERNATIVE				
Refinery Scenarios				
Reduced Refinery Operation:				
Reduction in refining capacity at Terminal.	An adverse, but nonsignificant (Class III) impact is associated with product shipment.	No mitigation required.		
Obtain Crude/Shipment of Product from Other Sources:				
Sharing of marine terminals/ pipelines with other facilities.	An adverse, but nonsignificant (Class III) impact will result.	No mitigation required.		

Table S-1
(Continued)

IMPACT AND MITIGATION SUMMARY BY RESOURCE FOR PROPOSED PROJECT AND ALTERNATIVES

Existing Conditions	Issues and Impacts	Mitigation	Responsible for Mitigation	Residual Impact
Shutdown of Refinery: Loss of about 9 percent of refining capacity in Bay area.	A significant (Class II) impact will result due to shortfall in refining capacity.	May require importation of refined products.	Unocal.	Reduced to nonsignificant.
CONSOLIDATION ALTERNATIVE				
	No impact to overall energy supply.	No mitigation required.		

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Table S-2

COMPARISON OF IMPACTS FOR PROPOSED PROJECT AND ALTERNATIVES

Alternative	Proposed Project		No Project Alternatives		Consolidation Alternative
	Continuation of Existing Operations	Future Conditions	Abandonment/Pier Scenarios	Refinery Scenarios	
Operational Safety/Risk	Structural deficiencies to wharf reduced to nonsignificant. Small spills from pipeline leakage reduced to nonsignificant. Significant impacts remain for spills or releases of oil at Terminal that cannot be contained. Significant impacts remain for spills or releases of oil from tankers in Bay or north coast if sensitive resources are present. Risk of explosion from butane tank remains significant.	Slight increase in risk of spills. Significant impacts remain for spills or releases of oil that cannot be contained at Terminal, in Bay, and north coast.	Potential for spill from abandonment reduced to nonsignificant.	A pipeline, truck, or rail spill affecting sensitive resources remains significant. Increased truck and rail transport could result in safety impacts that remain significant. Refinery reduction or shutdown reduces risk, resulting in beneficial impact.	Potential for spill from pipeline removal reduced to nonsignificant. Beneficial impact for emergency access. Impacts from oil spills during operation as per Proposed Project.
Water Quality	Spill composition, size, and characteristics will determine severity of impact. Significant impacts remain for spills that cannot be contained. Possible use of TBT reduced to nonsignificant.	Spill composition, size, and characteristics will determine severity of impact. Significant impacts remain for spills that cannot be contained. Possible use of TBT reduced to nonsignificant.	Potential for spill from pipeline removal reduced to nonsignificant. Elimination of potential for leaks, spills, and discharges from Terminal results in beneficial impact.	Removal of Terminal would eliminate risk of spills to marine environment, resulting in beneficial impact. Potential of spill to inland waterways from increased truck, rail, or pipeline transport remains significant. Elimination or reduction of Refinery discharge into Bay from shutdown or reduced operations results in beneficial impact.	Potential for spill from pipeline removal reduced to nonsignificant.

Table S-2
(Continued)

COMPARISON OF IMPACTS FOR PROPOSED PROJECT AND ALTERNATIVES

Alternative	Proposed Project		No Project Alternatives		Consolidation Alternative
	Continuation of Existing Operations	Future Conditions	Abandonment/Pier Scenarios	Refinery Scenarios	
Marine Biology	Significant impacts remain for spills of oil that cannot be contained.	Significant impacts remain for spills of oil that cannot be contained.	Potential for spill from pipeline removal reduced to nonsignificant. Elimination of potential for leaks, spills, and discharges from Terminal results in beneficial impact.	Potential of spill to inland waterway from increased truck and rail transport or pipeline use remains significant. Elimination of potential for leaks, spills, and discharges for Terminal results in beneficial impact. Elimination or reduction of discharge to Bay from Refinery shutdown or reduced operations results in beneficial impact.	Potential for spill from pipeline removal reduced to nonsignificant. All other impacts and residuals same as for Proposed Project.
Fisheries	Potential for oil contact with marine life from spill remains significant for fisheries and is reduced to nonsignificant for kelp. Loss of herring fishing area reduced to nonsignificant.	Potential for oil contact with marine life from spill remains significant for fisheries and is reduced to nonsignificant for kelp. Loss of herring fishing area reduced to nonsignificant.	Pier removal results in beneficial impact through additional fishing area.	Beneficial impact through additional fishing area.	Beneficial impact through additional fishing area. Impacts from oil spills during operations as for Proposed Project.
Air Quality	Beneficial impact through indirect emissions reductions.	Increased air emissions due to increased operations reduced to nonsignificant.	Elimination of direct and indirect source emissions results in beneficial impact.	Pipeline construction will produce short-term significant quantities of air pollutants that would be reduced to nonsignificant. Beneficial impact due to reduced or curtailed operational emissions.	Impacts are as for Refinery Scenarios.

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Table S-2
(Continued)

COMPARISON OF IMPACTS FOR PROPOSED PROJECT AND ALTERNATIVES

Alternative	Proposed Project		No Project Alternatives		Consolidation Alternative
	Continuation of Existing Operations	Future Conditions	Abandonment/Pier Scenarios	Refinery Scenarios	
Vehicular & Rail Transportation	No significant impacts.	Impacts from project-generated vehicles being forced onto LOS F roadways are reduced to nonsignificant.	Impacts from construction vehicles being forced onto LOS F roadways are reduced to nonsignificant.	Short-term impacts for construction vehicles forced onto LOS F roadways remain as above. Short-term impacts for pipeline construction necessitating lane closures remain significant during construction. Impact remains significant if operations require the use of trucks. Refinery reduction or shutdown reduces traffic resulting in beneficial impact.	Short-term impacts are as for Refinery Scenarios.
Noise	No significant impacts.	No significant impacts.	No significant impacts.	Short-term impacts for pipeline construction at sensitive receptor locations reduced to nonsignificant. Impact due to truck use only reduced to nonsignificant. Reduced operations traffic reductions result in beneficial impact. If dismantled, short-term impact from construction result from Refinery shutdown. Long-term beneficial impact from Refinery shutdown.	No significant impacts.

Table S-2
(Continued)

COMPARISON OF IMPACTS FOR PROPOSED PROJECT AND ALTERNATIVES

Alternative	Proposed Project		No Project Alternatives		Consolidation Alternative
	Continuation of Existing Operations	Future Conditions	Abandonment/Pier Scenarios	Refinery Scenarios	
Earth Resources	Potential impacts due to failure of pipeline valving and bracings on butane tank and wharf, pile foundation, and shoreline acreage during earthquake reduced to nonsignificant. Potential impacts due to use of larger vessels reduced to nonsignificant. Impacts from corrosion on piles and beams reduced to nonsignificant. Potential failure of butane sphere if heavier materials are stored reduced to nonsignificant.	Potential impacts due to failure of pipeline valving and bracings on butane tank and wharf, pile foundation, and shoreline acreage during earthquake reduced to nonsignificant. Potential impacts due to use of larger vessels reduced to nonsignificant. Impacts from corrosion on piles and beams reduced to nonsignificant. Potential failure of butane sphere if heavier materials are stored reduced to nonsignificant.	Elimination of pier results in elimination of potential for spills resulting in beneficial impact.	Potential for pipeline failure reduced to nonsignificant.	Impacts are as for Proposed Project.
Aesthetics	Significant impacts remain for spills that cannot be contained.	Significant impacts remain for spills that cannot be contained.	Temporary impact from pipeline construction reduced to nonsignificant.	No significant impacts from reduced operations. Refinery removal would result in a beneficial impact.	Elimination of Pacific Pier would result in beneficial impact.
Land Use/ Recreation	Significant impacts due to Refinery precluding recreational trail access development reduced to nonsignificant. Significant impacts remain for oil spills that cannot be contained, affecting shoreline and offshore land uses and recreation.	Significant impacts due to Refinery precluding recreational trail access development reduced to nonsignificant. Significant impacts remain for oil spills that cannot be contained, affecting shoreline and offshore land uses and recreation.	Impacts from Refinery precluding recreational access as for Proposed Project.	Impacts from Refinery precluding recreational access as for Proposed Project.	Impacts from Refinery precluding recreational access as for Proposed Project.

Table S-2
(Continued)

COMPARISON OF IMPACTS FOR PROPOSED PROJECT AND ALTERNATIVES

Alternative	Proposed Project		No Project Alternatives		Consolidation Alternative
	Continuation of Existing Operations	Future Conditions	Abandonment/Pier Scenarios	Refinery Scenarios	
Cultural Resources	No significant impacts.	No significant impacts.	Potential impact from demolition reduced to nonsignificant.	Potential impact from pipeline construction or Refinery shutdown reduced to nonsignificant.	Potential impacts from pipeline construction reduced to nonsignificant.
Energy	No significant impacts.	No significant impacts.	No significant impacts.	Shutdown of Refinery, resulting in shortfall of refining capacity reduced to nonsignificant.	No significant impacts.

SECTION 1 - INTRODUCTION

1.1 PURPOSE AND SCOPE

The Proposed Project is the potential granting of a new lease of State of California tidelands to Unocal Corporation by the California State Lands Commission (SLC). The lease applied for would allow Unocal to continue operating its San Francisco Marine Terminal (Marine Terminal or Terminal) that has been in operation at its present location at Oleum since 1955. This project involves the continuation of current operations and any additional, foreseeable uses/throughputs for a period of up to 40 years.

The SLC has determined that the proposed new lease is a discretionary action subject to the California Environmental Quality Act (CEQA). Furthermore, the SLC has determined that the Proposed Project may significantly impact the environment and that an Environmental Impact Report (EIR) is required. The EIR is intended to provide the SLC with the information that it will require to exercise its jurisdictional responsibilities on the proposed lease.

The scope of the EIR covers the environmental impacts associated with the continued present and future operation of the Marine Terminal with particular emphasis on the potential impact of oil transportation activity at the Terminal, as well as along shipping routes within San Francisco and San Pablo Bays and along the Pacific Coast from San Francisco Bay north to the Oregon/California border and south to Santa Cruz.

1.2 PROJECT LOCATION

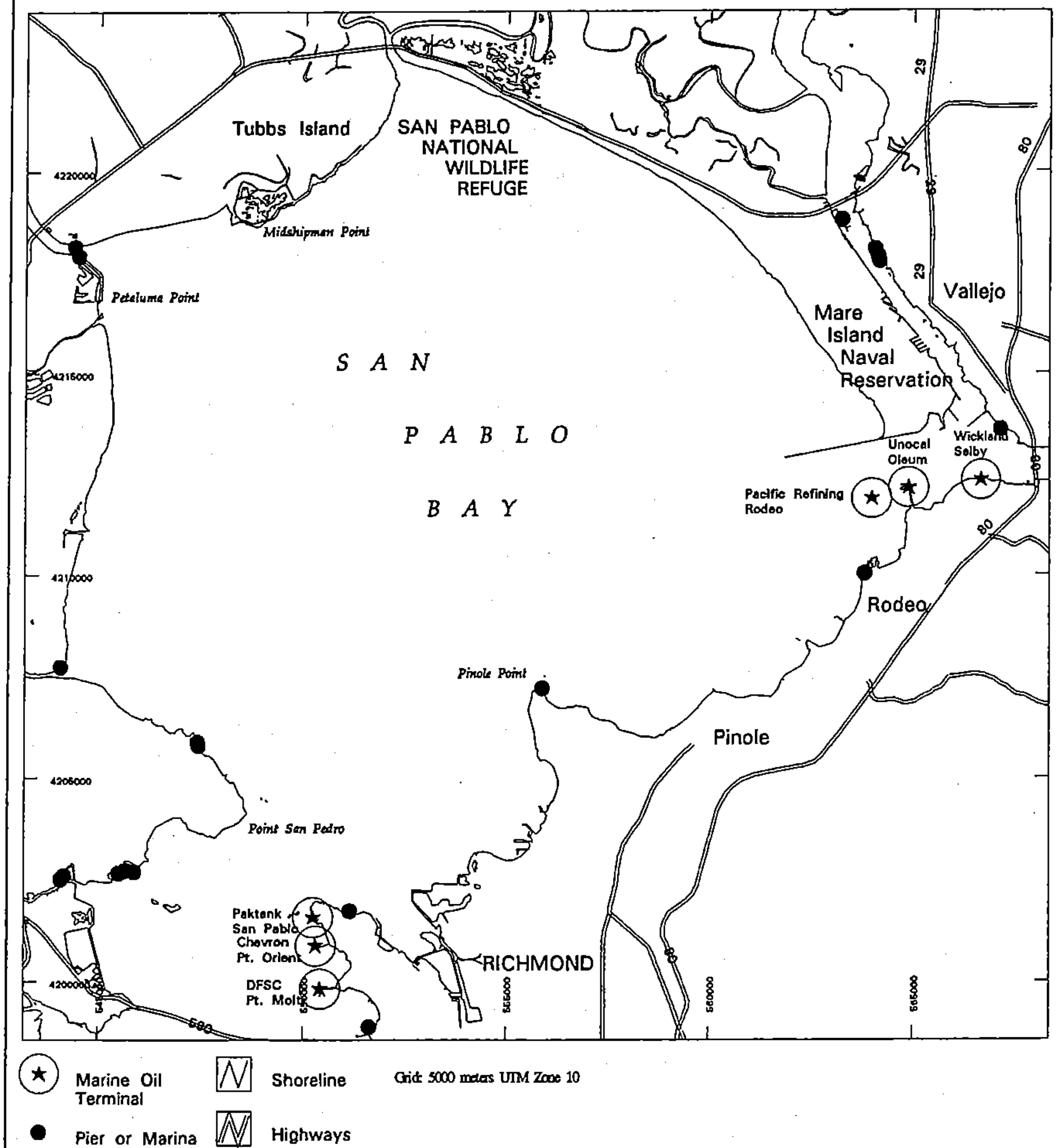
Unocal's Marine Terminal is located on the east side of San Pablo Bay, Contra Costa County, between the Cities of Rodeo and Crockett on San Pablo Avenue (also known as U.S. Highway 40), 1.8 miles west of the Carquinez Strait Bridge as shown on Figure 1.2-1 (vicinity map) and Figure 1.2-2 (location map). The location is at Davis Point near the district of Oleum and is approximately 20 miles northeast of the City of San Francisco.

1.3 PROJECT HISTORY

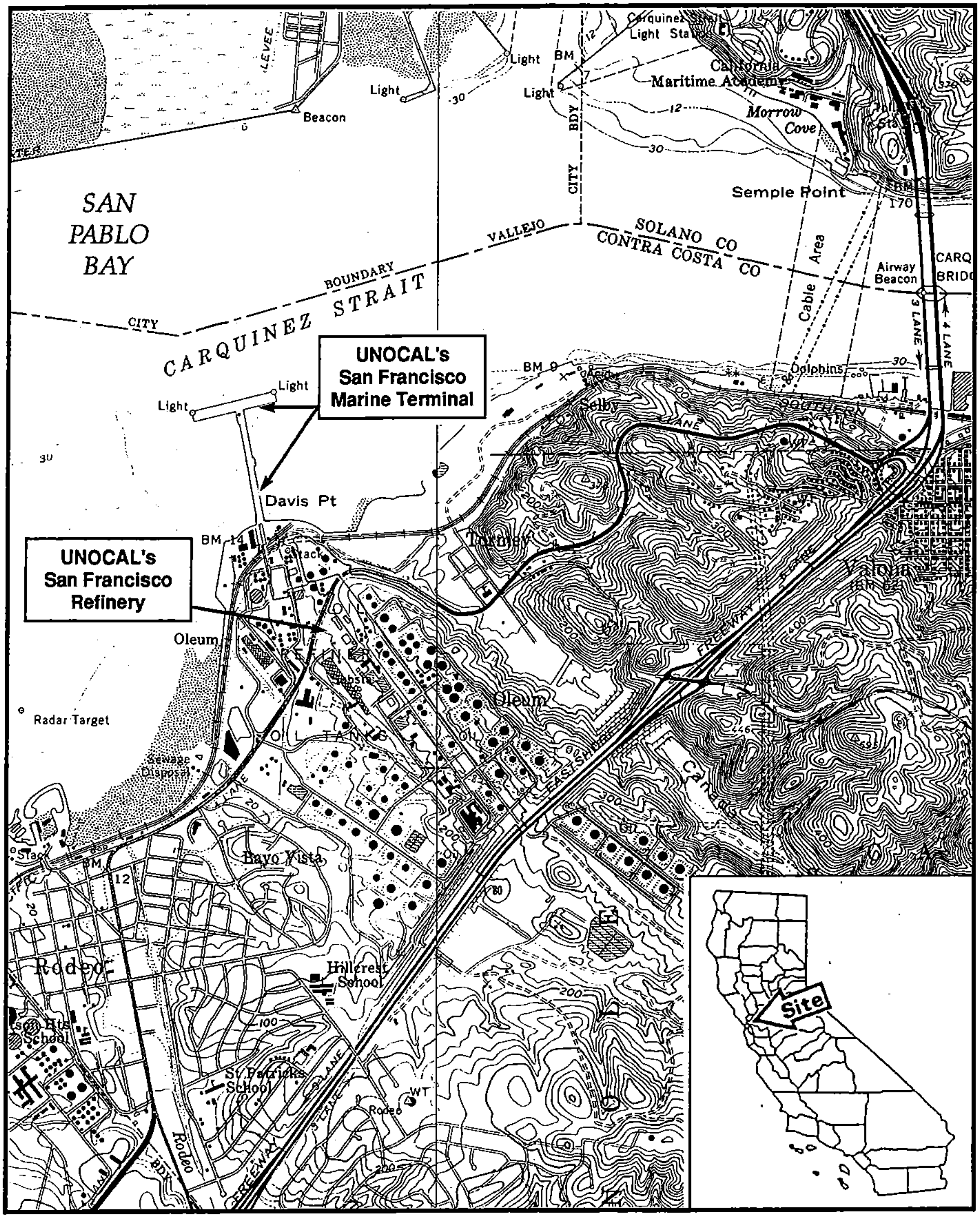
The Unocal San Francisco Refinery (Refinery) has been at its Rodeo location since 1896. A Marine Terminal has been located at the site since approximately 1928. The present Terminal has been operating since 1955. Between April 1951 and March 1986, state tidelands and submerged lands have been leased to Unocal by the SLC. Since April 1986, the Terminal has continued to operate through short-term, 6- to 18-month lease agreements. Since 1986, discussions have taken place within the SLC on the approach to granting a new or continued long-term lease for the Terminal. In 1990, the SLC determined that an EIR would be required prior to the SLC's consideration of a new lease for the Marine Terminal. Unocal is presently operating through an interim lease that has been authorized by the SLC for Unocal pending the completion of the EIR and its consideration of Unocal's application for a new lease.

1.4 ORGANIZATION OF EIR

Section 2 of this EIR provides a description of the Proposed Project, including a description of the Marine Terminal, its layout and facilities, and an overview of its operation. Because the focus of the Proposed Project is on shipping and potential environmental consequences, a description of the regional study area and its characteristics is also presented. Section 2 also contains a description of project alternatives and a description of the cumulative projects for the assessment of cumulative impacts. Existing environmental conditions are described in Section 3. Project-specific impacts and mitigation measures, as well as alternatives and cumulative impacts and mitigation measures, are presented in Section 4. Section 5 describes those alternatives to the Proposed Project that were considered but eliminated from detailed evaluation. Sections 6, 7, 8, and 9 provide various required discussions under CEQA, including short- versus long-term productivity, growth-inducing impacts, significant irreversible environmental consequences, and report preparation sources. Appendix A of this document provides the Notice of Preparation (NOP), Initial Study (IS), and agency responses to the NOP. Other technical appendices are also included in this document.



UNOCAL SAN FRANCISCO REFINERY
VICINITY MAP
Figure 1.2-1



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Source: USGS 1:24,000 series, Benicia and Mare Island, CA

LOCATION MAP
Figure 1.2-2

1.5 APPROACH USED FOR PREPARATION OF EIR

1.5.1 Introduction and Study Area Boundary

The study area for this project includes the San Francisco-San Pablo Bay region (the Bay or Bay Area) and the lower Sacramento-San Joaquin Delta and the north coast of California from the Oregon border south to Santa Cruz. Figures 1.5-1 through 1.5-4 show the Bay and its subregions. San Pablo Bay was shown on Figure 1.2-1. The outer coast study area is shown on Figure 1.5-5.

The study area is rich in natural and other public resources that could be severely impacted by oil spills. One of the major concerns of the analysis of the Proposed Project is the minimizing of environmental consequences of oil spills should they occur at the Terminal, in the shipping lanes inside or outside the Bay, or elsewhere along transportation routes. The primary goal of mitigation measures within this document is the prevention of oil spills during operations of the Marine Terminal.

Because of the numerous sizes, types, and possible spill locations, combined with the seasonal variations in hydrodynamic flow conditions in San Francisco Bay, the possible consequences of a spill could vary greatly. The methodology used in this EIR combined hydrodynamic and oil spill models with a Geographic Information System (GIS) to analyze and assess the potential for resource damage for a range of oil spill scenarios. Several indices were used to classify aquatic and shoreline resources and rate their vulnerability to oil spills. In general, the analysis was more detailed in the Bay than along the outer coast.

Impacts to marine resources resulting from the tankering of oil along the outer coast from San Francisco south to Santa Barbara have previously been addressed in the GTC Gaviota Marine Terminal Project Final Supplemental EIR/EIS (Aspen 1992). The County of Santa Barbara, the SLC, and the U.S. Army Corps of Engineers (Corps) joined to direct the preparation of that document.

The GTC document addresses the proposed Gaviota Marine Terminal's impacts for all resources of the Santa Barbara Channel and focuses on the impacts to marine biological resources for spills occurring within the shipping lanes from Santa Barbara north to San Francisco Bay.

This EIR for the potential granting of a new lease to Unocal to continue operating its San Francisco Marine Terminal, incorporates by reference results of oil spills modeled in the GTC document and impacts to marine biological resources.

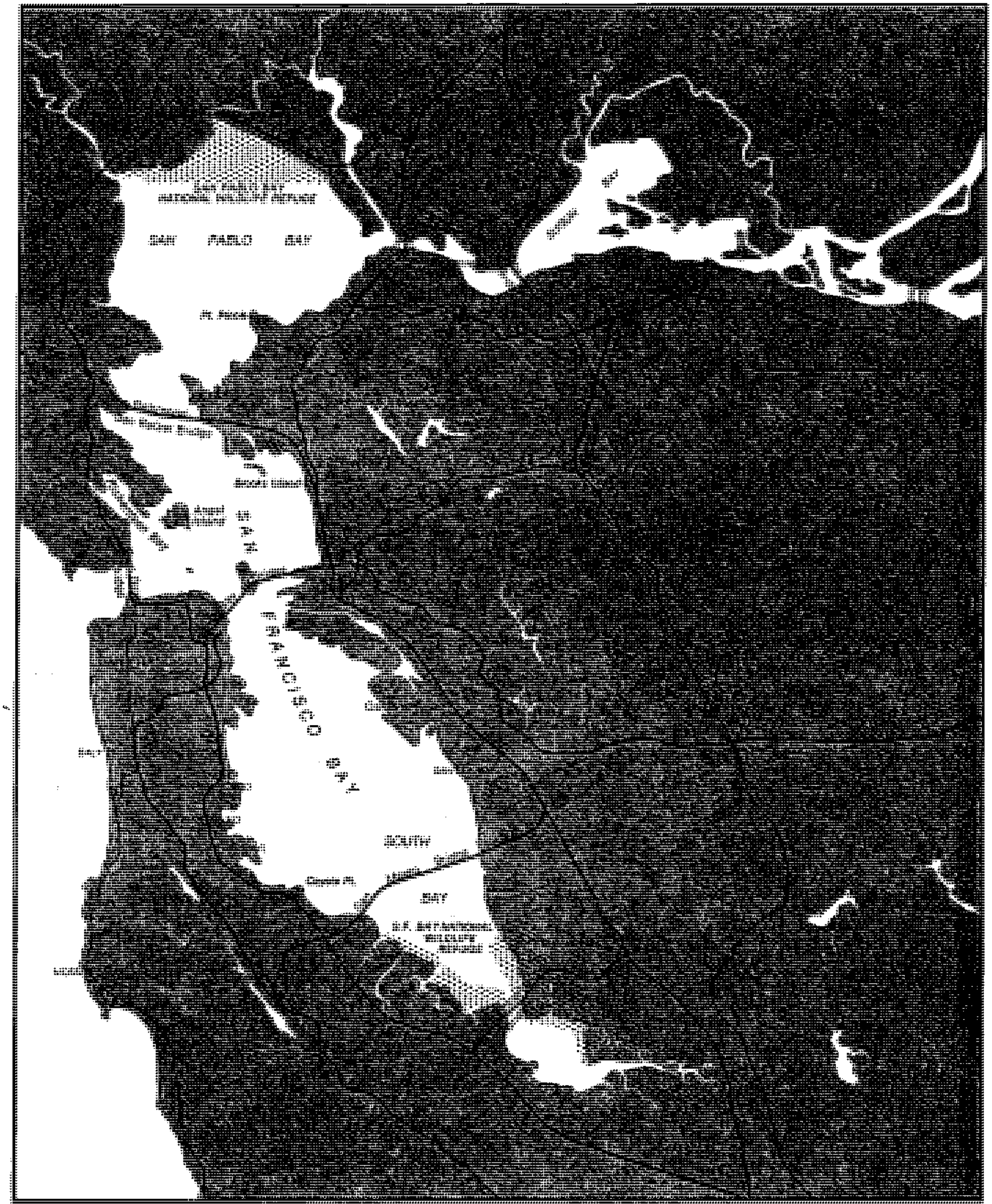
1.5.2 Oil Spill Modeling

In order to estimate the probability of spills and fate of the spilled material (e.g., where the oil would go if a spill occurred) both within the greater Bay Area and the outer coast, spill trajectory modeling was used to evaluate (1) the effectiveness of existing response capabilities of Unocal and supporting Bay Area organizations responsible for assisting in cleanup operations, (2) impacts on future response capability, and (3) assessment of impacts to biology, water quality, and other resource disciplines.

Three levels of modeling were conducted. The first involved probabilistic/conditional modeling that shows the general flow of high, medium, and light volumes of oil during three seasonal variations reaching the shoreline in the Bay. Outside of the Bay, the high, medium, and light volumes of oil were shown for four seasons based on Minerals Management Service (MMS) spill centroids. These were used to portray the level of risk that an area has based on its hydrodynamic characteristics.

The second level of modeling involves receptor mode runs that were conducted to determine potential spill sites that represent the greatest risk to sensitive Bay shoreline resources. Runs were performed to determine the probability that a spill released from (1) particular tanker route segments, and (2) particular terminals would contact any of 20 selected receptor locations.

The third level of modeling involves the display of 12 individual, various-sized Bay scenarios for both crude and product, which are meant to be representative of the types of spill events that could possibly occur at various locations. Spill sizes ranged from 500 barrels (bbl) of product at the Terminal to 100,00 bbl of crude in the Precautionary Zone near Alcatraz. Other locations include adjacent to the Terminal in the Bay shipping lane, outside of the Golden Gate in the west side of the Precautionary Zone, the mouth of Carquinez Strait, and Anchorage 9 in south San Francisco Bay. Two seasonal variations were run for each scenario, representative of the variable wind conditions in the Bay. Two scenarios were also run as



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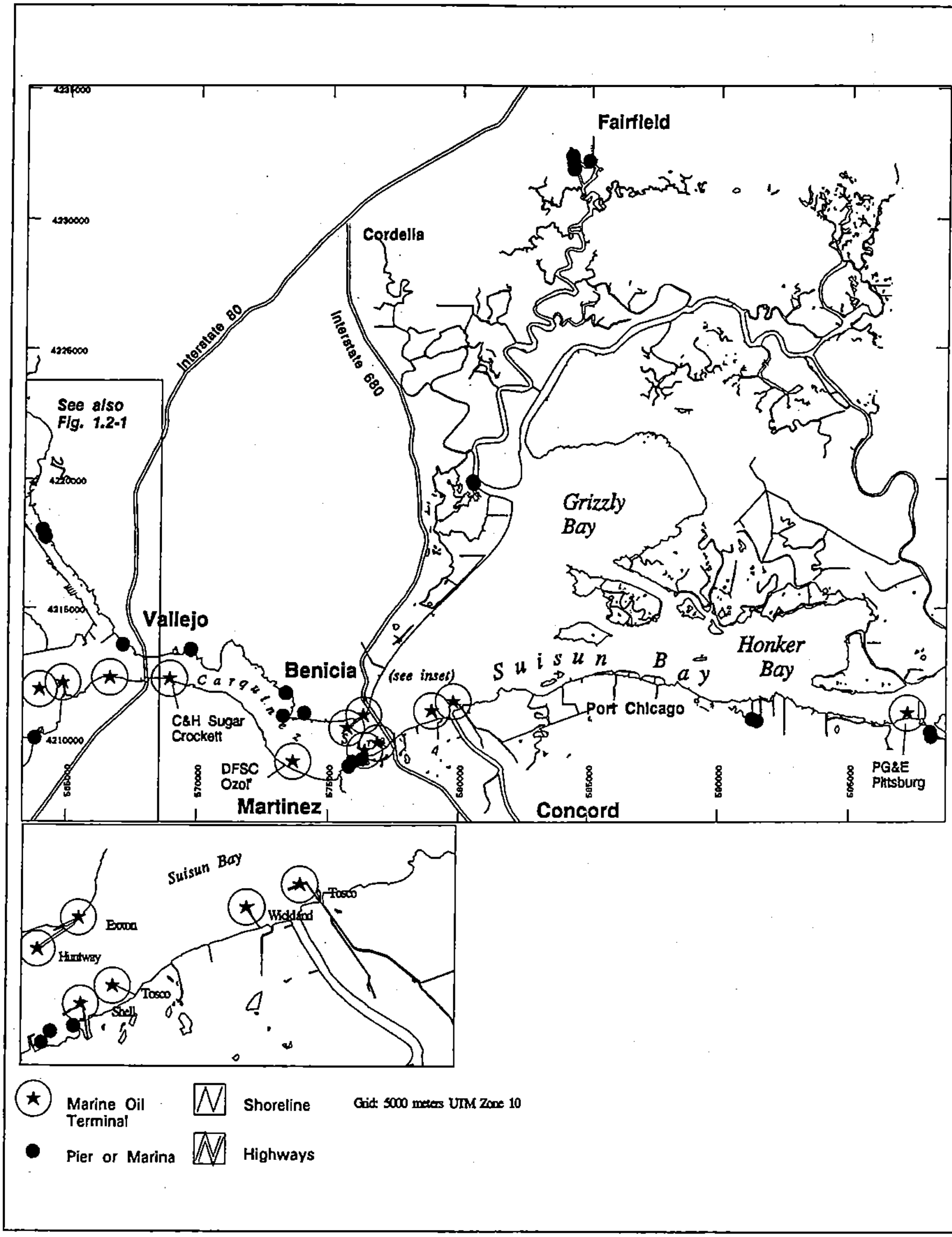
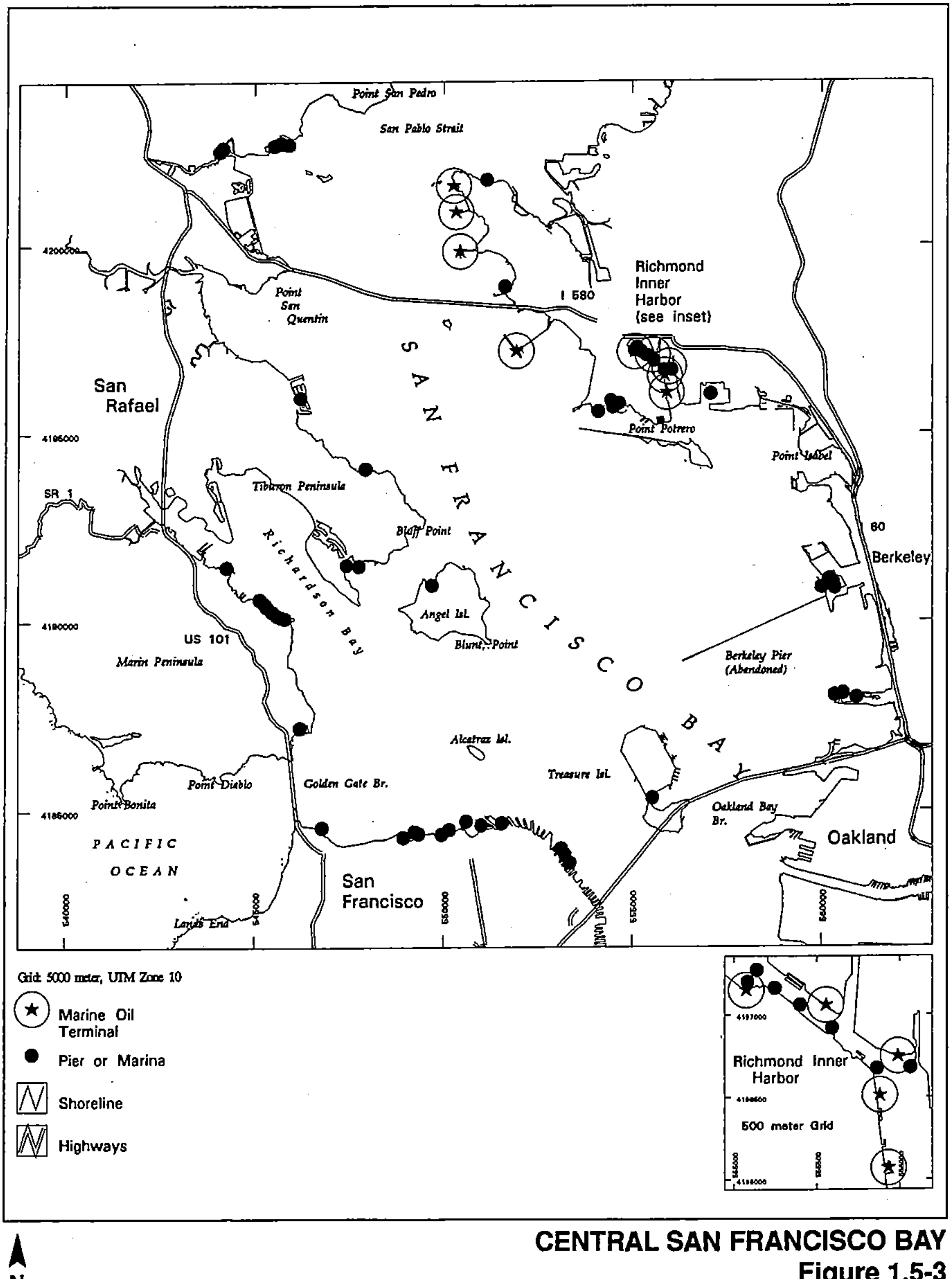
Source: California Coastal Resource Guide
California Coastal Commission, 1987

BAY STUDY AREA
Figure 1.5-1



CARQUINEZ STRAIT AND SUISUN, GRIZZLY, AND HONKER BAYS

Figure 1.5-2



CENTRAL SAN FRANCISCO BAY
Figure 1.5-3

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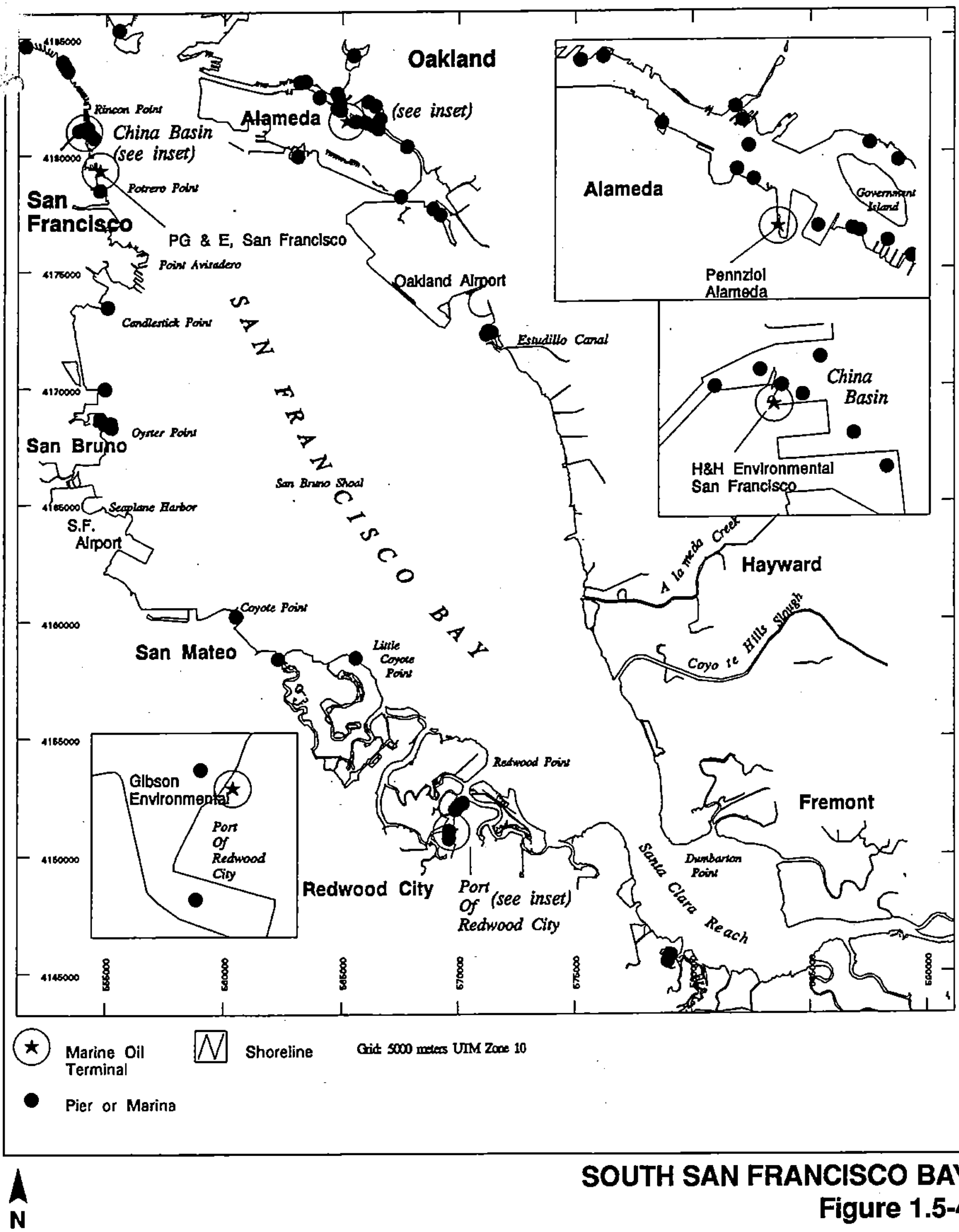

SOUTH SAN FRANCISCO BAY
Figure 1.5-4

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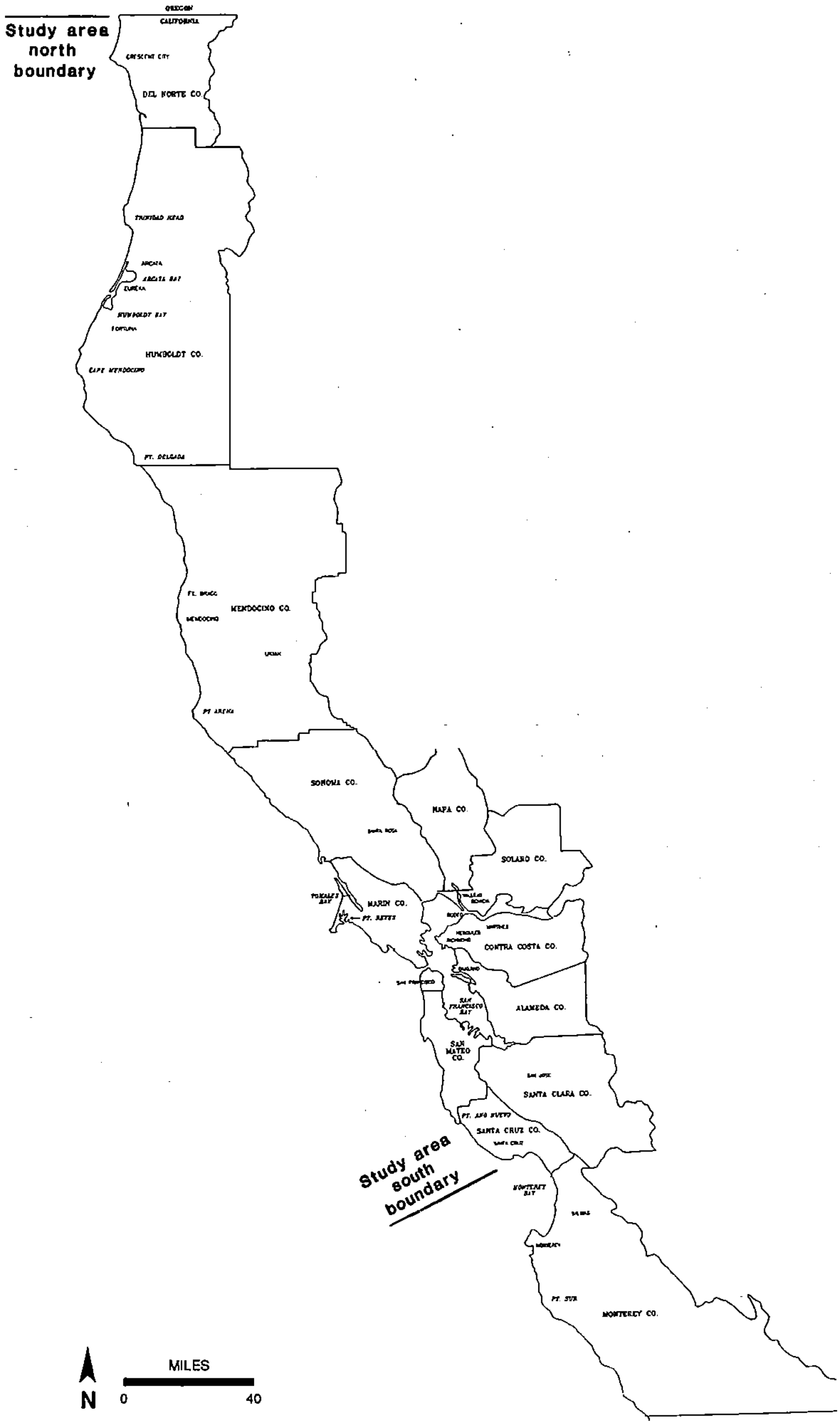


OUTER COAST STUDY AREA
Figure 1.5-5

representative of 100,000-bbl spills along the outer coast. All models were run to display the maximum areal extent of oiling.

The hydrodynamic simulation modeling was conducted by the Center for Environmental and Water Resources Engineering of the University of California at Davis, California, and the oil spill modeling was conducted by Ecological Consulting, Inc., Portland, Oregon. Modeling details are presented in Appendix B.

1.5.3 Resource Mapping

Resource mapping was undertaken by the SLC, the Center for Environmental Design Research at the University of California at Berkeley (UCB), and at Chambers Group, Inc. (Chambers Group), with assistance from Ecological Consulting, Inc. In all cases, resource mapping involved a map-based delineation of relevant features of ecological interest or related importance, and the conversion of those features to a digital form.

At SLC and Chambers Group, various maps were developed by drafting features of interest onto standard base maps (USGS 1:24,000 quadrangles) and digitizing them using Arc/Info. Other materials were obtained from Teale Data Center; these have been created and maintained using essentially the same procedure. As a separate effort, SLC digitized the entire California and San Francisco Bay shoreline at 1:24,000 scale. Resource maps were merged with this standard shoreline to ensure geographic consistency across data sets.

At UCB, a number of maps had already been assembled in the database for the San Francisco Bay/Delta region. Similarly, Ecological Consulting, Inc., had previous, recent maps assembled for the outer coast. These had been compiled from numerous sources, including original mapping and digitizing, conversion from preexisting digital data sources, and interpretation from other digital geo-data.

1.5.4 GIS Analysis

GIS was used as an analysis tool for this document. The GIS analysis for this project was completed in three parts. First, resource mapping described above was entered into a GIS-computer database. This phase included gathering and transfer of some existing resource databases that were already in GIS format. Second, as described above, three types of oil spill models were run. Third, the results from these oil spill models were combined with the resource databases to produce a synthesized map coverage that displayed the interaction between oil spill scenarios and vulnerable resources. These new coverages were used to analyze potential impacts.

The GIS analysis was able to produce output in both mapped and tabular formats. The maps show a resource, or a grouping of resources, with either probabilistic or scenario oil spill information overlayed. Tables were produced, showing the amount of a resource that was affected by probabilistic, scenario, and receptor mode modeling. The amount of resource affected was presented in either miles or acres, depending on whether the GIS was measuring a linear resource such as a shoreline, or an areal resource such as a wetland habitat. These outputs enabled the EIR document preparers to visually assess and quantify potential impacts.

The use of the GIS in context with that which is already known about the impacts of oil spills and the natural resources of the study area were used by the EIR document preparers to reach their conclusions.

Because of the level of detail of database mapping coverage available and the concerns of oil spills within the Bay Area, the GIS coverage is generally more detailed for resources within the Bay Area than for the California coast.

GIS activities were coordinated by the SLC with support from UCB.

1.6 COMPLIANCE WITH CEQA

1.6.1 Initial Study and NOP

The SLC is the Lead Agency for the Proposed Project and has authorized the preparation of this EIR to assess the potential environmental impacts of the project pursuant to and in accordance with CEQA (Public Resources Code, Section 21000 et. seq.), the Guidelines for Implementation of the CEQA published by the Resources Agency of the State of California (California Administrative Code, Sections 15000 et. seq.), and the SLC.

In accordance with CEQA guidelines, the SLC prepared an IS (refer to Appendix A, IS/NOP). The IS and NOP were circulated by the SLC from

October 4 to November 4, 1991. The SLC determined that the project may result in significant adverse impacts and therefore required that the EIR be prepared for the Proposed Project. This EIR addresses the potential significant environmental impacts identified in the IS and other relevant issues that were raised during the 30-day circulation of the NOP.

1.6.2 CEQA Compliance and EIR Review

The purpose of this EIR is to identify environmental impacts of the Proposed Project on the existing environment, indicate how these impacts could be mitigated or avoided, and identify and evaluate alternatives to the Proposed Project. The document is intended to provide the SLC and other permitting agencies with the information they will require to exercise their jurisdictional responsibilities on the proposed lease.

CEQA requires that a Lead Agency shall neither approve nor perform a project as proposed unless the significant environmental impacts have been reduced to an acceptable level (Section 15091). An acceptable level is defined as eliminating, avoiding, or substantially lessening significant impacts to below a level of significance. If the Lead Agency approves the project even though significant impacts identified in the EIR cannot be fully mitigated, the agency must state in writing the reasons for its action. Findings and a Statement of Overriding Considerations must be included in the record of project approval and mentioned in the Notice of Determination.

This Draft EIR is being circulated to local and state agencies and to interested individuals who may wish to review and comment on the report. Written comments may be submitted to the SLC during the 45-day review period. Verbal comments on the Draft EIR will be heard at a public meeting (notice under separate cover). All comments received will be addressed in a Response to Comments addendum document, which, together with the Draft EIR, will constitute the Final EIR.

SECTION 2 - DESCRIPTION OF PROPOSED PROJECT AND ALTERNATIVES

2.1 PROJECT BACKGROUND

2.1.1 Refinery and Related Operations

The Unocal Refinery at Rodeo, California, the first major oil refinery in the Bay Area, has been a water-dependent facility at its present location since 1896. The Refinery manufactures fuels and lubricants through the receipt of crude oil from both tankers and pipeline. The Refinery processes about 77,000 bbl per day (bpd) of crude oil but has capacity to process 100,000 bpd. The products are transported offsite via a combination of tankers and pipelines, with some minor product transported by rail and truck. The Refinery spans over 1,000 acres, employs more than 500 people, and operates 24 hours per day.

A Marine Terminal has been located at the present location since approximately 1928. The present Terminal has been operating since 1955 with redesign and reconstruction and a mooring dolphin addition in the early 1970s. All shoreline properties were fully developed by 1938. From April 1951 to March 1986, state tidelands and submerged lands have been leased to Unocal by the SLC. Since April 1986, the Terminal has continued to operate through short-term, 6- to 18-month lease agreements up to the present time. The Terminal provides docking and crude oil unloading facilities for both Unocal-owned and other tanker vessels and also provides for product export via ships and barges.

In January 1986, Unocal filed a lease application with the SLC for the construction and operation of a treated process wastewater outfall and diffuser system. The location of the diffuser is shown on Figure 2.1-1. The refining processes result in the production of several wastewater streams. The discharge of these streams is regulated by the California Regional Water Quality Control Board, San Francisco Bay Region (SFRWQCB) under the waste discharge requirements of the Refinery's National Pollutant Discharge Elimination System (NPDES) Permit. An EIR was prepared in 1987 and finalized in 1988 (Entrix 1987, 1988) and a 30-year lease was granted to Unocal by the SLC beginning on September 1, 1988. The wastewater outfall line and diffuser are now in operation and attached to the Marine Terminal.

The wastewater outfall line and diffuser are not part of the Proposed Project described below. However, in accordance with terms of the outfall and diffuser lease, if a new Marine Terminal lease is negotiated and approved, then the pipeline outfall and diffuser will be included in this new lease, and the existing outfall and diffuser lease will terminate.

2.1.2 Definition of Existing Conditions and Future Existing Conditions

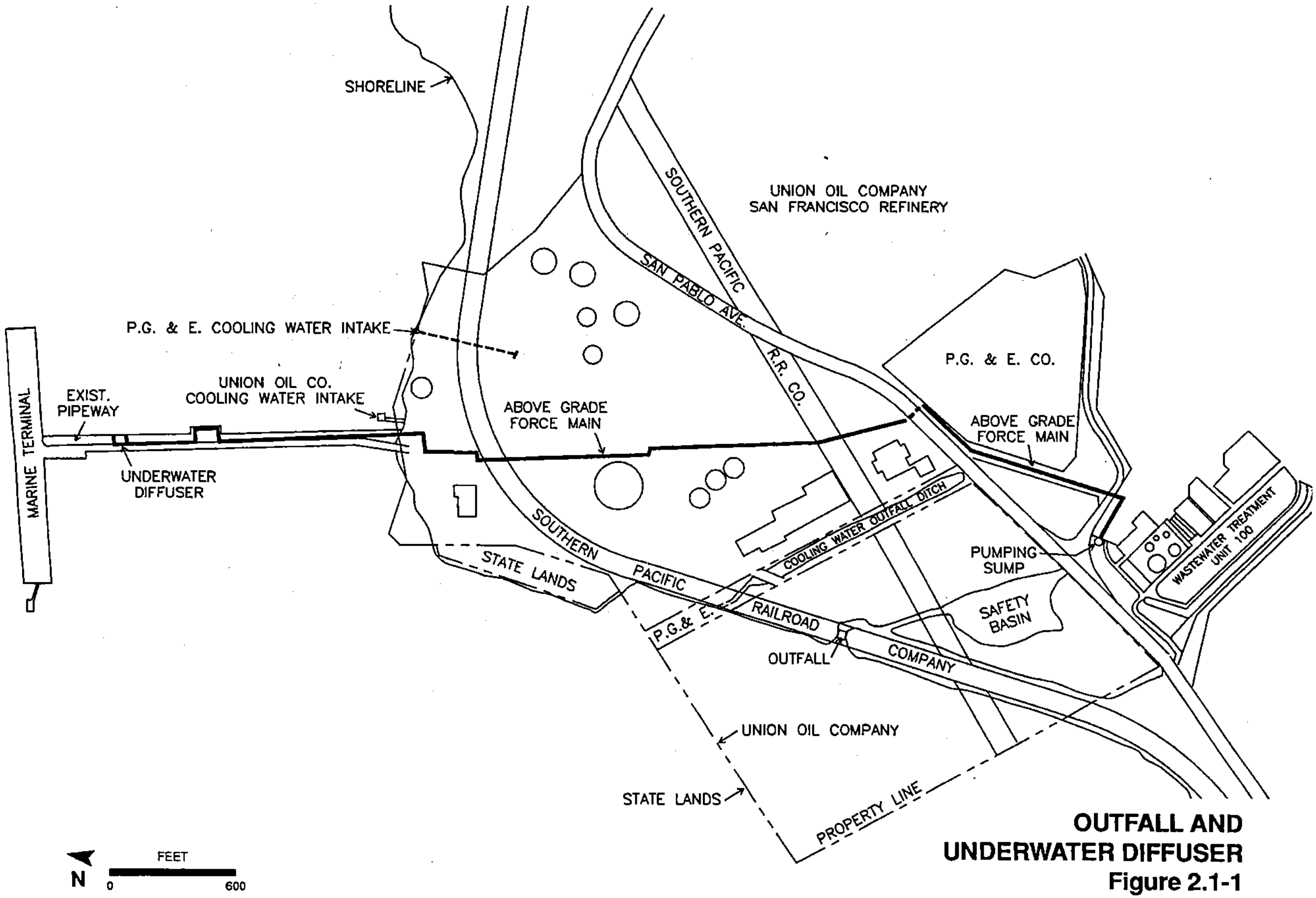
2.1.2.1 Existing Conditions

For the description of the Proposed Project, existing conditions are defined as current facilities and operations. Because the Unocal Marine Terminal is a presently operating facility, it has been modeled and considered as part of the baseline conditions. Existing permit limitations are described as well because they are pertinent to limitations of current facility actions. The contribution of the Unocal vessel traffic relative to other vessel traffic (and similarly for other resource disciplines such as air quality) is described in existing conditions.

2.1.2.2 Future Existing Conditions

During the next 40 years, substantial unforeseen changes can be expected to occur in Terminal operations, the San Francisco Bay environment, and in the regulations and technology involved in oil spill prevention and cleanup, air quality control, water quality control, fisheries regulations, and other environmental disciplines. Examples of changes that have occurred just in the past year include Unocal's discontinuation of use of the Sansinena II for bringing oil in from Alaska and its replacement by the smaller tanker, the Blue Ridge (see Section 2.2.4.1), and official listing of the Delta smelt and delisting of the California gray whale.

Because of such unforseen future changes, little reliable data are available upon which to base assumptions of future conditions. One of the major driving components of the future is the long-term energy perspective. The long-term Refinery



OUTFALL AND UNDERWATER DIFFUSER
Figure 2.1-1

requirements and the shipment of crude oil and products are dependent on a wide variety of worldwide, national, and regional factors, including the following:

- general economy, which is directly related to consumption of fossil fuels;

- availability, characteristics, and price of various crude sources;

- environmental concerns relative to the type of crude to be refined and reformulation of fuels using oxidizers such as MTBE (methyl tertiary butyl ether) may give small refiners a competitive disadvantage; and

- individual marketers may change marketing areas or locations for refineries because of market pressure.

Because of the many variables, it is not possible to predict with certainty the energy picture within the Bay Area. However, the following assumptions are based on available California Energy Commission projections and appear to be in line with a reasonable worst-case analysis for CEQA purposes:

- The demand for petroleum products will increase by 1.1 percent per year as predicted by the California Energy Commission (1991) for the next 20 years. Reasonable projections for a 40-year basis are not available.

- The sources of San Joaquin Valley heavy crude (SJVH) and other domestic crude, including Alaskan crude, will be reduced substantially as fields continue to be depleted. The Bay Area thus will rely more on tankering of crude from foreign sources. For the purposes of this analysis, it is estimated that crude oil tanker deliveries will increase by 50 percent regionally. The Unocal Refinery will increase its crude oil tanker deliveries by 60 percent (from 9.2 to 14.7 million bbl per year [bpy]).

- Shipment of product by tanker will occur as it currently does with an approximately 30-percent increase in quantities shipped in the next 20 years (from 14 to 18.2 million bpy).

- At least one small refinery in the Bay Area will close.

- Other refineries in the area will also increase proportionately in capacity in relation to demand for crude import.

In its application for a new lease, Unocal proposes no modifications to its refining operations. Thus, in order to evaluate future existing conditions regarding Terminal throughput, it is assumed that no throughput modifications will occur. It is expected that some modifications may be required to comply with future pollution permitting regulation; however, the Terminal is currently capable of handling an increase in deliveries and product export.

Where feasible, the analysis of future conditions within the impact sections (Section 4) of the EIR were based on a 40-year period. Where predictability of the condition of future resources was very uncertain, a 20-year projection was used based on the energy assumptions presented above.

2.2 PROPOSED PROJECT

2.2.1 Project Action

The Proposed Project is the consideration of a new lease for the Unocal Marine Terminal at Rodeo. This involves the continuation of current operations, as well as any additional, foreseeable uses/throughputs for a period of up to 40 years. The granting of the new lease may involve the issuance of shorter (such as 3 to 5 years) interim leases that would allow for periodic review of lease conditions by the SLC with respect to Unocal's operations and with respect to revisions in local, state, and federal regulations. Such interim leases and conditions of review will be set by the SLC.

As described in Section 1.2, the Unocal Marine Terminal is located between Rodeo and Crockett, 1.8 miles west of the Carquinez Strait Bridge, on San Pablo Bay. The Terminal property under lease to Unocal from the SLC consists of approximately 16.6 acres of tide and submerged lands in and adjacent to San Pablo Bay. Of these, approximately 3.6 acres are filled. These filled lands have been leased to Unocal as part of the same lease as that of the Terminal. This filled land area would continue to be leased to Unocal, regardless of any decisions pertaining to the Terminal.

No physical modification of the existing Terminal is proposed at this time under this action.

2.2.2 Physical Description of Marine Terminal

2.2.2.1 Pier

The Refinery Marine Terminal pier consists of a tee-head ship and barge-berthing structure, a mooring breasting dolphin, and a shore-connecting trestle-pipelineway as shown in the photograph on Figure 2.2-1 and in the drawing on Figure 2.2-2. The ship-berthing structure is 1,250 feet long and 136 feet wide. The mooring breasting dolphin measures 51 by 32 feet and is located about 74 feet from the west of the end of the tee. The trestle-pipelineway connecting the Terminal to shore is 1,730 feet long and 77 feet wide.

The present pier structure was constructed of precast concrete piles that were driven below the mudline to depths ranging from 83 to 89 feet. The deck is supported between rows of piles on reinforced cast-in-place concrete cross members that, in turn, support precast concrete deck panels. The finished elevation of the deck is 17.0 feet above mean lower low water (MLLW). In 1971, a mooring dolphin, constructed of prestressed concrete vertical and batter piles, was built off of the west end of the wharf with a walkway to connect the two structures. The dolphin was constructed to accommodate larger vessels.

The north (waterward) side of the Terminal wharf has two ship-berthing areas, M-1A/M-1 and M-2, and three manifold areas consisting of M-1A, M-1, and M-2. Manifold area M-1A has two 16-inch mechanical loading arms. These arms are presently out-of-service; while they are not planned to be used in the future, they are maintained in standby condition. Areas M-1 and M-2 have hose risers with loading hoses provided and three manifold areas.

The south (shoreside) of the wharf has three barge berths consisting of B-2 and B-3, which are west of the trestle-pipelineway, and B-4, which is east of the trestle-pipelineway. Berths B-2, B-3, and B-4 have hose risers but have no hoses. Barges furnish their own hoses.

A timber fender system with steel coil springs is located along the front face of the pier, and a timber fender system with rubber blockers is located along the rear face. The pier is lighted. Table 2.2-1 summarizes the principal characteristics of the pier.

Table 2.2-1

PRINCIPAL CHARACTERISTICS OF UNOCAL MARINE TERMINAL PIER

Pier Feature	Face (Tanker Berth)	Rear of Face (Barge Berth)
Depth along side at MLLW[1]	35	20
Breasting distance[1]	1,375 with dolphins	622 & 520
Total berthing space[1]	1,375 with dolphins	622 & 520
Width of apron[1]	65	25
Height of deck at MLLW[1]	17	17
Load capacity[2]	300	300

[1] feet
[2] lbs per square foot

Other key elements of the Terminal are presented below. Additional specific information is provided as portions of the existing conditions sections of this document, including information pertinent to the Terminal's operational safety (Section 3.1) and to structural integrity of the wharf with respect to wave and seismic conditions (Section 3.8).

2.2.2.2 Pier Pipelines

The trestle-pipeline supports one ballast water pipeline, two 16-inch crude oil pipelines, and 17 petroleum product pipelines. These product pipelines include four 12-inch, three 10-inch, five 8-inch, and five 6-inch pipelines. All pipelines extend from the pier along the trestle-pipelineway to shore and then onto storage tanks located at the Refinery. No submerged pipelines service the Terminal. In addition, five other pipelines handle potable water, fire water, wastewater, steam, and compressed air.

All pipelines are constructed in accordance with Code ANSI B31.3 for pressure piping/petroleum refinery piping. All pipelines are painted and/or covered with insulation materials, including Denso Tape in areas near high water levels. All commodity pipelines are located above the water line; therefore, cathodic protection is not applicable.

All pipelines are equipped with high-pressure shutdown switches and thermal relief valves and are pressure tested to one and one-half times the expected maximum operating pressures of individual pipelines. All pipelines were tested throughout their construction and initial operation by visual, hydrostatic, and radiographic methods. Visual, pressure test, and safety device testing on pipelines are performed as per

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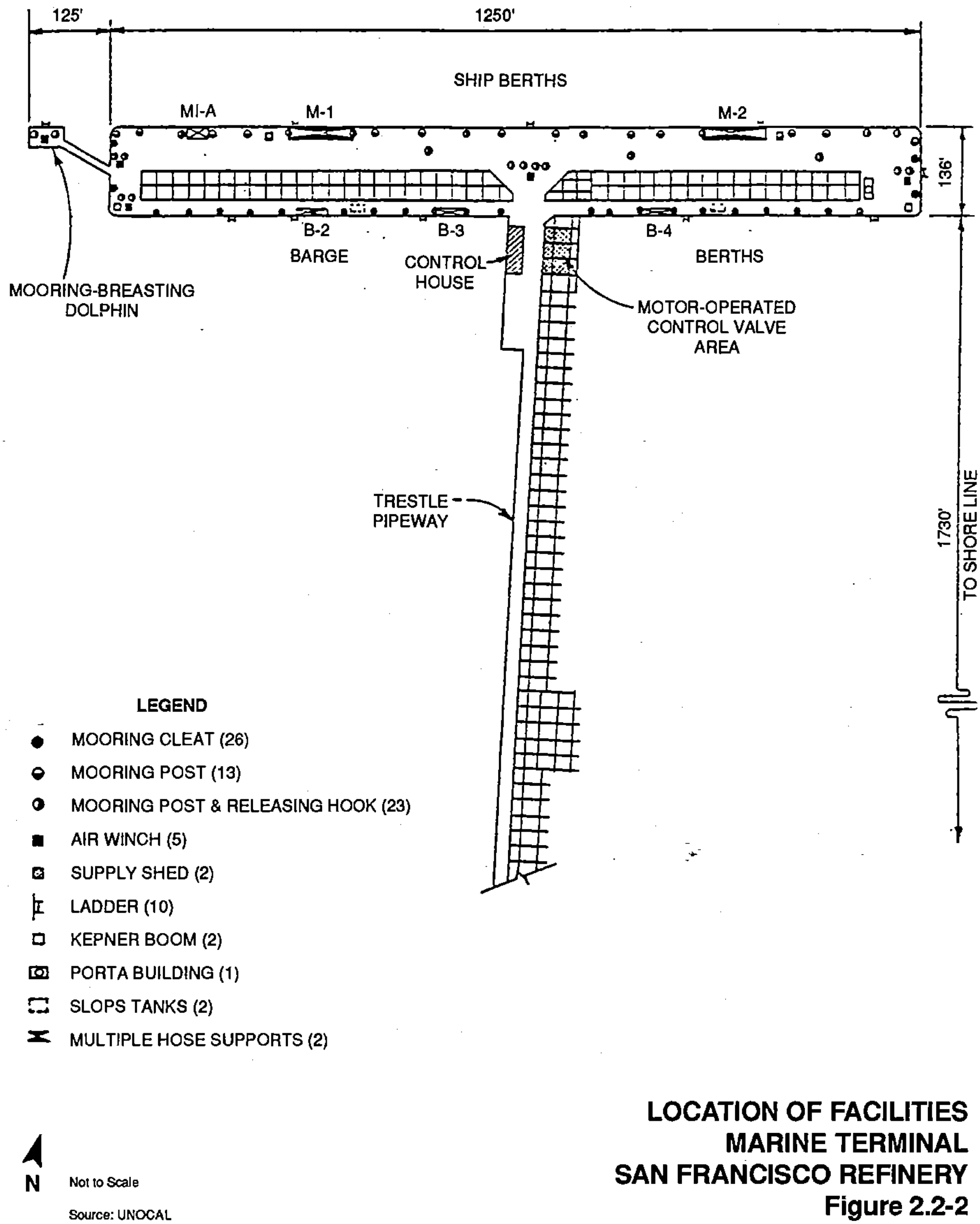
UNOCAL MARINE TERMINAL AND REFINERY
Figure 2.2-1



LOCATION OF FACILITIES
MARINE TERMINAL
SAN FRANCISCO REFINERY
Figure 2.2-2

33 CFR 156.170(f)(1) each year. All lines are inspected over a 5-year period. Radiographic inspections are performed every 5 years.

Table 2.2-2 summarizes information on the pipelines, including line number, line size, commodity shipped, loading rate, and maximum test and thermal relief pressure. MTBE is also discharged via line 101 at a rate of 2,500 barrels per hour (bph).

2.2.2.3 Drip and Ballast Discharge Facilities

A discharge containment system is provided for each manifold area. Each system consists of a curb around its manifold area with a low-point drain connected to drain lines located below the deck surface. These lines connect to air-driven pumps located at each containment area that pump product to a shore ballast tank. The containment area can be emptied by vacuum truck in case of pump failure.

The cargo hoses and risers at the ship and barge berths are drained by pumping them out with air-driven pumps located at each berth. These pumps also discharge to the shore ballast tank. The hoses and risers can be emptied by vacuum truck in case of pump failure.

The sample station located near the Marine Terminal Complex control room has two drums used expressly for draining the sample trough into after collecting

Table 2.2-2

MARINE TERMINAL PIPELINE LOADING AND DISCHARGE RATES AND DESIGN PRESSURE

Line No.	Size (in.)	Commodity	Loading Rate (bph)	Test Pressure (psi)*	Thermal Relief (psi)
101	12	Gasoline Stocks	2,500	140	250
102	8	Unleaded Regular C[1]	3,000	290	250
103	12	Super Unleaded C and I[2]	4,400	225	250
104	8	Unleaded Regular W[3]	2,200	270	250
107A	6	Super Unleaded W	2,500	270	250
107B	6	Super Unleaded W	2,500	290	250
108	8	Leaded Regular C[4]	2,000	330	250
121	12	Diesel #2	4,500	255	250
122	8	Diesel #2	2,000	135	250
142	10	Low sulfur Fuel Oil/#6 Fuel Oil	2,500	390	250
143	12	Gas Oils	6,800	460	250
146	16	Alaska Crude	16,000	225	250
147	16	Alaska Crude	16,000	225	250
148	8	#6 Fuel Oil	1,700	390	250
152	10	Ballast	1,500	225	200
161	10	Jet A (Aviation)	4,500	225	250
181	6	450 Neutral	900	395	275
182	6	190 Bright Stock	500	395	275
183	6	90 Neutral	1,100	320	275
184	6	150 Neutral	1,500	210	230

* pounds per square inch
[1] C - cold weather formulation
[2] I - intermediate weather formulation
[3] W - warm weather formulation
[4] Leaded gasoline is no longer refined
Source: Unocal, May 1992

samples. One drum is used for each half of the sample trough. Each drum has a high-level alarm indicator inside the control room and a sight glass on the drum itself. When drums are full, they are pumped off with the air-driven pump located on the deck below the sample station. This pumps the liquid to the ballast tank.

The inboard section of both unloading arms is pumped into either of the two crude receiving lines by a small air-driven pump. The outboard leg of both unloading arms is drained to the vessel.

The vessel slop and ballast reception facilities on the Marine Terminal consist of a hose riser at each manifold area, except M-1A, and a 10-inch common line to the shore ballast tank.

2.2.2.4 Control House

The Control House, from which all transfers to and from vessels are controlled, is located on the west side of the trestle next to the tee. It also serves as the base of the Terminal's communication system, which includes both radio and backup intercom systems operating on separate dedicated frequencies and a loud speaker system. Its facilities consist of sanitary facilities, lunchroom, personnel lockers, Terminal Control Room, and offices.

2.2.2.5 Vapor Control System

A thermal oxidizer (TO) vapor control system (VCS) is located near the Terminal Control House. Hydrocarbon vapors discharged from individual ship compartments during liquid product loading operations are collected and conveyed through a vapor collection system to a discharge flange on the ship. The Unocal Marine Terminal VCS connects to the ship's flange and conveys the vapors to the TO where they are combusted to carbon dioxide and water vapor. The VCS consists of a vapor recovery arm, vapor piping, and the TO equipment.

The VCS is designed to collect, convey, and combust vapors from the ship-loading operations in a safe manner by thermal oxidation. The hydrocarbon vapors controlled by the VCS result primarily from volumetric displacement of cargo compartment vapors by liquid product during loading. Due to the volatile nature of the liquid product, some vaporization occurs as liquid is loaded, resulting in a 25-percent increase in total vapor flow.

Prior to loading, ships establish an inert atmosphere in the empty cargo vapor space by purging with inert gas (exhaust gases) from the ship's engines; this is the inert gas system (IGS). Thus, empty compartments contain primarily inert gas when loading of liquid product begins, and the vapor displaced is almost entirely inert gas. As loading proceeds and the liquid level rises in the compartment, the concentration of inert gas decreases while the concentration of hydrocarbon from the product increases. The concentration of hydrocarbon reaches a maximum as the compartment approaches full.

Vapor collected from the various ship compartments is channeled through the ship's vapor manifold and piped to the TO through the vapor recovery hose and piping. The vapor flows in a single pipeline from either berth through a detonation arrester located on Berth M-2 to the water seal and then on the TO for combustion. The purpose of the TO is to efficiently and safely destruct the hydrocarbon vapor to meet the Bay Area Air Quality Management District (BAAQMD) emission limits while not unduly compromising safety of the loading operation. Because there is only one TO, only one ship can be loaded at a time.

2.2.2.6 Communication Systems

The primary communication system is a dedicated radio system for the Marine Terminal operations. The base station is located in the Control House and has portable radios for use by the Marine Terminal operators and the outside vessel's "Person-in-Charge" while the vessel is at the Terminal. A second radio system on a different frequency is normally used as the primary communication system between the facility and West Coast Shipping Company (WCSC) vessel's Person-in-Charge.

A dedicated intercom is used as a backup system. The main control station is located in the Control House and operated by the Dispatcher. Stationary speakers are located at all vessel berths. Portable speakers are also located at all vessel berths and are put aboard the vessel for communication with the Dispatcher.

2.2.2.7 Emergency Shutdown System

The emergency shutdown system consists of portable radios and/or the dedicated intercom communication system and the remote-controlled, motor-operated valve on each line. The valves are controlled remotely by the Dispatcher from the Control House.

2.2.3 Physical Description of Filled Lands

The approximately 3.6 acres of filled lands comprise a wedge-shaped parcel located southwest of the landside of the Terminal. The location is shown on Figure 2.2-3. Located on this property is a 20,000-bbl (840,000-gallon) butane storage sphere surrounded by a 7-foot-high earthen containment dike as shown on Figure 2.2-4. The sphere is a 60-foot-diameter, aboveground steel structure, supported on ten 4.5-foot-high square pedestals attached to the equator of the sphere. A ring-shaped footing is supported by 240 cast-in-place reinforced concrete piles. As-built drawings of the sphere indicate that it was constructed in 1970. The inland portion of the site abuts Southern Pacific Railroad sidings. Butane is a product of the refining process and is stored in the sphere prior to shipment offsite via rail transport.

The special design of this closed pressure storage tank is required because the boiling point of butane is much lower than normal atmospheric temperatures. This tank ensures that the butane will remain in a liquid state and can be handled as a liquid.

2.2.4 Volumes and Types of Materials Handled

2.2.4.1 Ships and Barges

The Marine Terminal, which is available for continuous operation, accommodates both ships and barges. The Terminal can handle two vessels of 105,000 DWT or one vessel of 200,000 DWT, or, two barges of 50,000 bbls or one barge of 140,000 bbls.

Four ships owned by Unocal Oil Company of California and operated by WCSC call at Unocal's San Francisco Terminal at an average of 2.3 calls per ship per month in routine voyage patterns. These ships and their average calls per month between June 1, 1985, and June 1, 1989, shown in parentheses include the Sierra Madre (3.2), Coast Range (3.5), Sansinena II (1.8), and Cornucopia (0.7). Marine Exchange records show 3.1 and 2.0 calls per month for the Coast Range and Sierra Madre, respectively, between May 1, 1991, and April 30, 1992.

From June 1, 1985, through August 15, 1992, the Sansinena II delivered almost all of the crude oil offloaded at the Terminal. Use of the Sansinena II was discontinued in mid-August 1992. The Sansinena II is a 71,589-DWT, single-hull tanker with a segregated and clean ballast configuration. This ship typically operated between Drift River, Alaska, and Unocal's San Francisco Refinery delivering Alaskan Cook Inlet crude oil. Although the Sansinena II has a capacity of 535,000 bbl, it had been carrying only an average of 325,000 bbl of oil per trip so it could dock at the Terminal to avoid the need for lightering.

The Sansinena II was replaced by the Blue Ridge, which is presently making approximately two trips per month between Drift River, Alaska, and the Unocal San Francisco Refinery. The Blue Ridge is a 42,268-DWT, double-bottom, single-hull tanker capable of carrying 300,000 bbl of crude oil, but is being restricted to carrying approximately 285,000 bbl so that it can call on the Terminal without lightering.

The Coast Range and the Sierra Madre currently make one trip per month combined, for a total of three trips per month with the Blue Ridge trips. The Coast Range and the Sierra Madre are each 40,631-DWT, double-bottom, single-hull vessels capable of carrying 300,000 bbl of oil. They are normally used to transport product from the Terminal; however, as indicated above, they are sometimes used to deliver crude to the Terminal.

The Cornucopia is an ammonia tanker that operates between Cook Inlet, Alaska, and Stockton, California. The tanker stops to refuel on its way back to Alaska after it has offloaded its ammonia in Stockton. San Francisco Bay Marine Exchange records show that the Cornucopia called at the Unocal Terminal five times between May 1, 1991, and April 30, 1992, and Unocal reported an average of about 8.5 calls per year between June 1, 1985, to June 1, 1989.

Numerous tankers owned by other companies, referred to as "outside tankers," also occasionally visit the Terminal. These tankers represent an international registry, and calls numbered 51 between 1985 and 1989. The Marine Exchange records show 14 calls by outside tankers for the period between May 1, 1991, and April 30, 1992.

Tank barges also call at the Terminal. They primarily load products at the Terminal but also deliver gas oil. Unocal reports that 237 barge callings occurred between January 1, 1988, and May 31, 1992, or an average of about 4.5 per month. All barge shipping is by charter service through three Bay Area barge companies.

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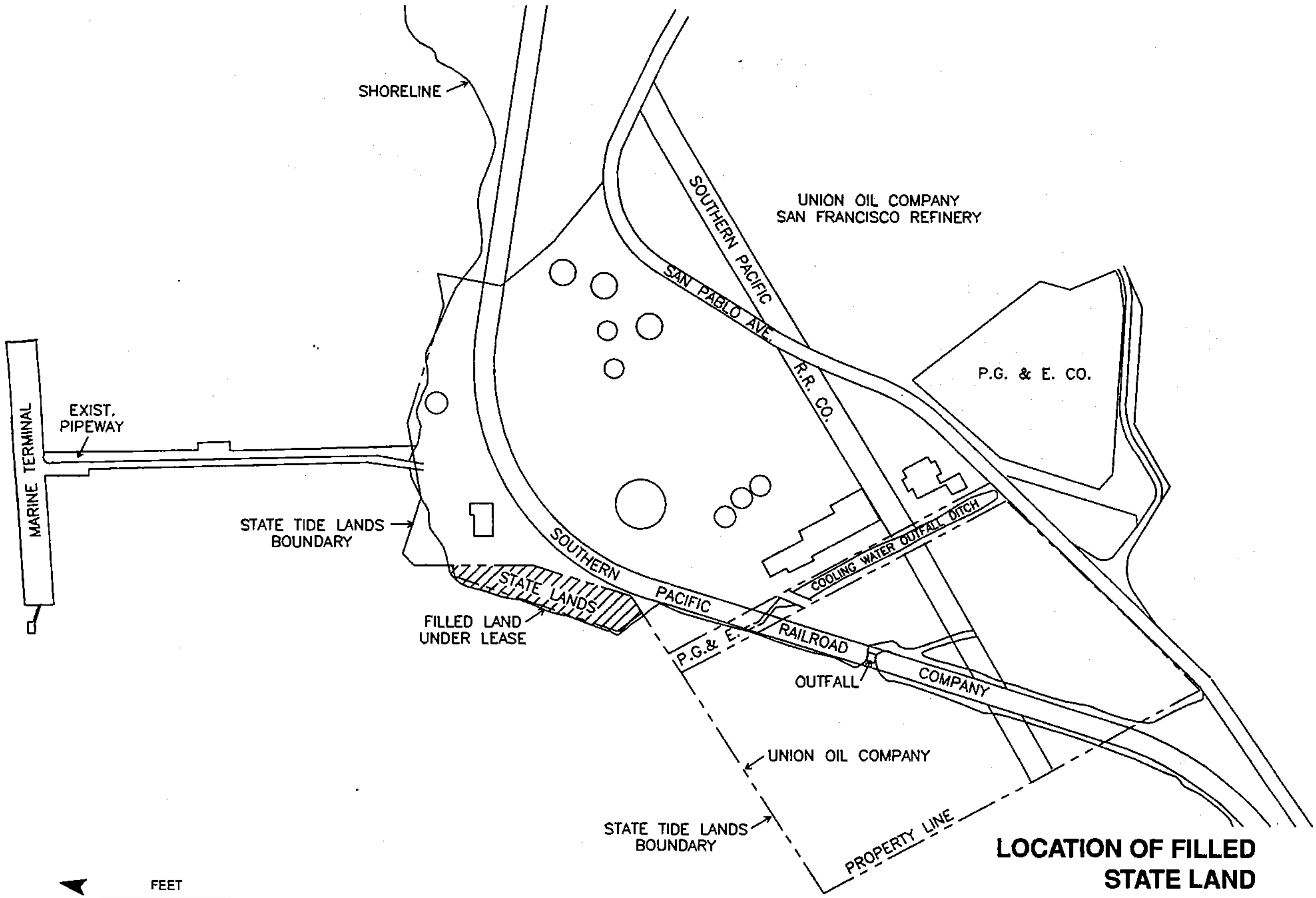
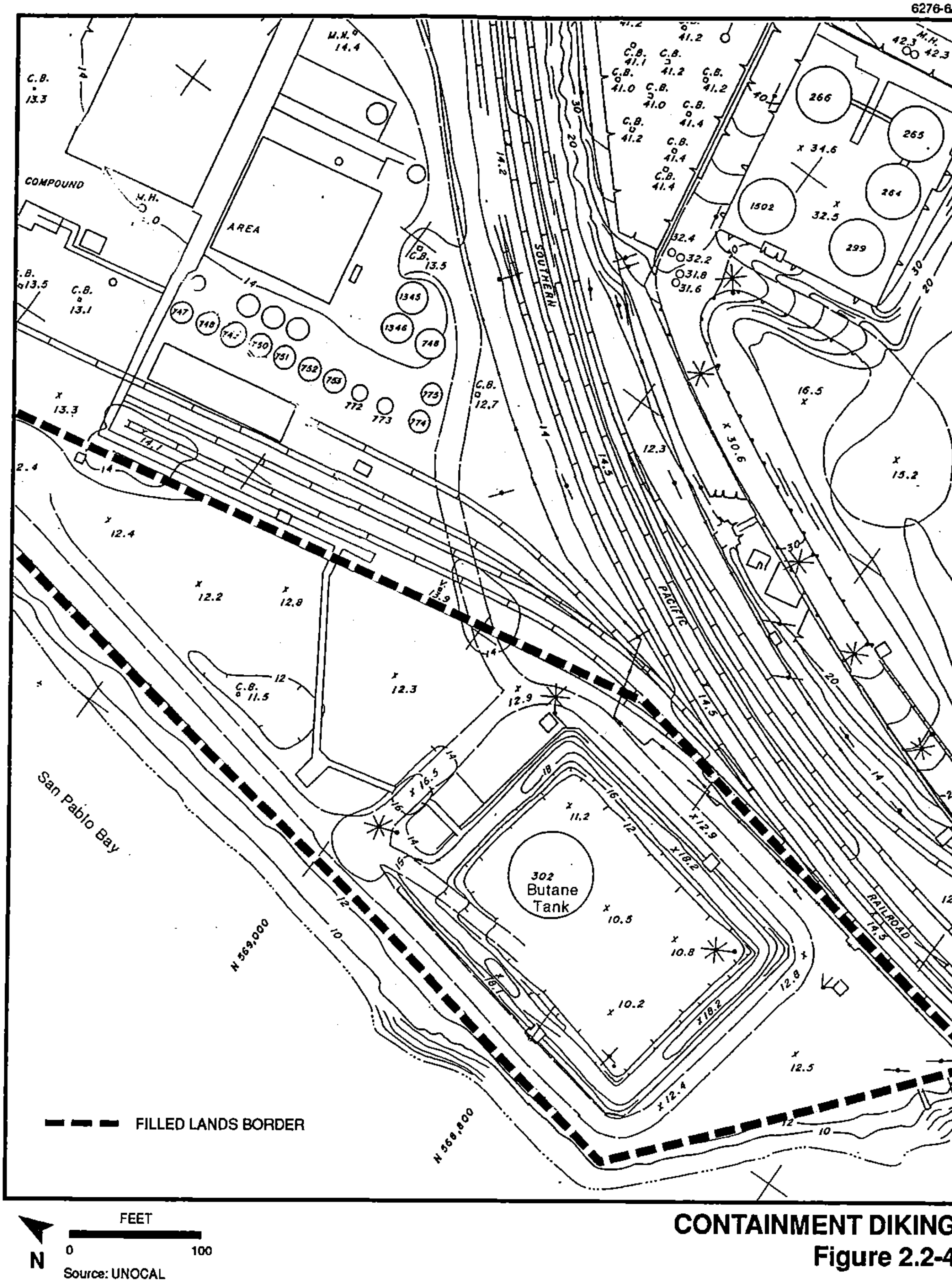


LOCATION OF FILLED STATE LAND
Figure 2.2-3



CONTAINMENT DIKING
Figure 2.2-4

2.2.4.2 Crude/Product Transfer

Marine Terminal Pipeline Transfer

Alaskan crude has been the primary crude oil transported by ships to the Refinery between 1985 and 1992, transferring from 7.5 to 9.2 million bpy. Lightering of Alaskan crude by Unocal at Anchorage 9 has occurred in the past, with the greatest amount of approximately 1.3 million bbl lightered in 1988. Lightering is not currently performed by Unocal. Other crudes that have been delivered primarily for "test runs" include Tapis Resid, Bekapai Crude, Thai Condensate, and Arun Condensate.

The quantity of product loaded onto the ships at the Terminal is approximately 14 million bpy. Typical types of product loaded include low-sulfur fuel oil, diesel, fuel oil for ships, various octane unleaded gasolines, aviation fuel oil, lube oil blending stocks, catalytic gas oil, medium and light unicrackate, heavy coker gasoline oil, sidecut from prefractionator, and reformate. There is no transport of crude oil by ships from the Refinery.

Other product offloads include products such as Santa Maria gas oil (semirefined), light gas oil from outside the Refinery, MTBE as a gasoline blending stock, isomerate feed for higher octane blending stock, Los Angeles refinery high octane reformate for gasoline blending, diesel No. 2, Los Angeles refinery gasoline stock for blending, aviation fuel oil and toluene, alkalate, and ballast water.

Refinery Pipeline Transport

In addition to the Marine Terminal, the Refinery is served by Unocal's "Oleum Pipeline." The Oleum Pipeline is a 16-inch unheated line from Coalinga in the San Joaquin Valley to the Refinery. The pipeline route parallels Interstate Highway 5. This crude oil receiver pipeline has a capacity of 68,400 bpd. It is normally used to 94 percent of its capacity for the receipt for SJVH and Coalinga Nose crude to the Refinery. SJVH has averaged between 61 to 66 percent of crude transport, with Coalinga Nose averaging between 3 and 7 percent for the period 1985 through present. Santa Maria gas oil and pressure distillate from the Unocal Santa Maria Refinery are semirefined products that are also transported via the Oleum Pipeline. Total Refinery crude received by pipeline averages about 24 million bpy.

Products are shipped from the Refinery via three pipelines. Two of the pipelines are owned by the Santa Fe-Pacific Pipeline Company and are referred to as the Concord Pipeline and Brisbane Pipeline. Unocal shares the time on the Santa Fe-Pacific Pipeline with the other Bay Area refineries. At present, Unocal uses approximately 45 percent of the current capacity of the Santa Fe-Pacific Pipelines. The other pipeline is owned by Unocal and is referred to as the Richmond Pipeline.

The Concord Pipeline is an 8-inch line from the Refinery to Concord. From Concord, products can be pumped on other Santa Fe-Pacific Pipelines to Sacramento and Reno, Stockton and Fresno, and San Jose. The Concord Pipeline is operated at a pressure of approximately 500 pounds per square inch gauge (psig). Pumping capacities for gasoline are 2,400 bph; for both diesel and jet fuel, the pumping capacity is 2,200 bph. The Brisbane Pipeline is a 12-inch line from the Refinery to Richmond and Brisbane. This line is operated at a pressure of approximately 200 psig with a pumping capacity of 2,800 bph for gasoline and 2,500 bph for both diesel and jet fuel. The Unocal Richmond Pipeline is a 6-inch line from the Refinery to the Unocal Richmond Terminal. This pipeline is approximately 13 miles long and operates at approximately 600 psig with a throughput of 1,000 bph for gasoline and 900 bph for diesel and jet fuel.

The Refinery has a direct connection at its Refined Oil Products Shipping Unit 80, which enables Unocal to transfer product to the Wickland Oil Selby Terminal, a product receiving storage and shipping terminal located 1 mile east of Unocal's Refinery. This connection has only been used occasionally to transfer product into Wickland Oil storage tanks. The Wickland Oil Selby Terminal can load vessels from this terminal, but not directly from this pipeline from Unocal's Unit 80. This line cannot handle the volume of products currently transferred by the Unocal Marine Terminal.

Truck and Rail Transport

All crude oil is delivered to the Refinery either by ship through the Marine Terminal or the Oleum Pipeline. Truck and rail transport is used for product export. Unocal does not transport any gasoline by truck or rail, and no loading facilities exist for this type of transport.

Products transported by truck include coke, lube oil, sulfur, bulk wax, and packaged wax. Coke is transported from the Refinery to the Unocal Calciner located in Rodeo on Highway 4. Travel is through Rodeo via San Pablo Avenue to Highway 4. All other products are transported to various locations; however, all travel through Rodeo to Interstate 80.

Products transported by rail include butane, lube oil, and bulk wax. Butane is railed to the Unocal Refinery in Wilmington, California, or to underground storage in Arizona. Lube oil and bulk wax are transported to various destinations.

2.2.5 Shipping Routes

The four ships owned by Unocal and operated by WCSC follow an established pattern from as far south as San Pedro, California, to as far north as the Cook Inlet in the Gulf of Alaska. All products supplied to the northwestern U.S. and British Columbia by Unocal are shipped because no product pipelines exist. The vessels Coast Range and Sierra Madre load finished clean petroleum products at the Unocal Refinery at Oleum and deliver cargo to distribution terminals in California, the Pacific Northwest, and Alaska. Typical ports of call for cargo discharge are Eureka, California; Coos Bay, Oregon; Point Wells, Washington (Chevron Terminal); Tacoma, Washington; and Ketchikan, Alaska. The Cornucopia picks up ammonia in Alaska that is offloaded in Stockton, and stops at the Unocal Refinery only to refuel. The Blue Ridge routinely carries Alaskan crude oil, loading at the Cook Inlet Pipeline's Drift River Terminal in Cook Inlet, discharging at the Unocal Refinery at Oleum, and returning in ballast, completing a roundtrip approximately once every 2 weeks.

In agreement with CDFG, a minimum distance of 50 miles offshore the mainland has been adopted for loaded crude oil tankers, except when fairing in an approach from offshore into the Main (west) directed traffic area south of the Farallon Islands. The other product tankers typically follow routes closer to shore at an average distance of approximately 15 to 20 miles offshore.

2.2.6 Mooring Procedures

When docking, the tankers generally approach the berth into the tide (flood or ebb) and leave in the direction of the tide. Based on weather and tide conditions, generally one or two tugs are used for docking and undocking. All maneuvering and navigation in the vicinity of the Terminal are coordinated by the onboard pilot with the U.S. Coast Guard (USCG) Vessel Traffic Service (VTS). Ship and barge mooring procedures are detailed in the Unocal Marine Terminal Operating and Training Manual (Unocal, February 1992).

Prior to vessel arrival, the Unocal Dispatcher sets up a vessel tie-up crew. The crew is generally assembled at least 20 minutes prior to the vessel's arrival at the Terminal. The normal size crew for all current WCSC vessels is six persons for tie-up and four persons for release. When releases are conducted from Berth M-2, an extra line handler is required on the west end. Most outside vessels require nine persons for tie-up and six persons for release because these vessels are typically larger than the WCSC vessels.

The crew consists of the First Person-in-Charge, the Operator-in-Charge, winch operators, and line handlers. The number of winch operators and line handlers depends on the size of the vessel as described above. The Unocal Terminal Complex Operating and Training Manual details the duties for each of these positions and presents diagrams of typical mooring tie-ups for various vessels.

2.2.7 Oil Transfer Procedures

Information on operating procedures is detailed in the Marine Terminal's Operating Manual, updated February 1992. Two persons, at a minimum, are present on the Terminal during loading, discharging, and tank washing operations. A Terminal Person-in-Charge (TPIC) or Dispatcher is normally located in the Control House. Any time this person is away from the Control House, constant radio communication is maintained with the vessel and the standby Operator in the Control House. The TPIC is responsible for the following:

- coordinating all plans for transferring oil with the vessel's Person-in-Charge prior to commencement of the oil transfer;
- checking, filling out, and signing the Declaration of Inspection before start of oil transfer;
- maintaining communication with the vessel during all phases of oil transfer;

- starting, stopping, and controlling oil transfer and coordinating with the vessel's Person- in-Charge;
- conducting all operations in a safe manner;
- shutting down oil transfer operations in the event of a spill or during emergencies in the area of the Refinery that contains the Terminal; and
- initiating the Oil Spill Emergency Plan.

The second person in charge is the Marine Terminal Operator who reports to the TPIC. This operator makes the proper lineup at the manifolds, puts on or removes the hoses or loading arms to or from the vessels, notifies the TPIC when the lineups are correct, opens and closes the valves at the manifold areas, and performs other duties as directed by the TPIC.

The Marine Terminal Operator makes periodic checks of the hoses or loading arms used during the oil transfer and informs the TPIC if a problem is found In addition, the Operators make periodic checks of all areas on and around the Terminal and vessels for uncontrolled oil and, if found, report it to the TPIC immediately.

2.2.8 Oil Spill Response Capability

The TPIC is able to activate the Refinery Emergency Organization and/or Refinery Oil Spill Organization during an emergency by announcing the emergency over the Refinery radio and public address system. Help responds immediately from these onsite organizations. Unocal indicates that emergency shutdown can be achieved from the Control House within 60 seconds as required by 2 CCR §2380(h)(3)(A).

In compliance with SLC and USCG regulations, Unocal has contracted with Crowley Maritime Corporation for a crewboat that provides standby capability to deploy 600 feet of boom within a 30-minute period for each vessel loading and unloading operation.

In addition, the Terminal's oil spill containment equipment consists of 4,500 feet of an oil-retention boom. The boom is stored on 2,000- and 2,500-foot reels located at the western and eastern ends of the tee head of the Marine Terminal, respectively. In the event of a spill, the boom may be deployed by the Refinery's spill response emergency crew consisting of Refinery operators and supervisors who are on duty around the clock, operating from the Marine Terminal, using pulley winches and capstans. Unocal indicates that this boom can be deployed within 30 minutes which is consistent with current state regulation's for deployment. The other nearest vessel available to assist in boom placement and other deployment is a Clean Bay response vessel that can be dispatched from Martinez and arrive at the Terminal within 1 hour and 20 minutes. As a member of Clean Bay, industry's response cooperative in San Francisco Bay, Unocal has access to that organization's boom supply that is stored locally and can be brought to the Terminal for deployment within 4 hours.

Other emergency response equipment at the Terminal, as required by law, includes fire extinguishers, hoses, hydrants, and monitors. Additional discussion on oil spill response capability is presented in Section 3.1. The effectiveness of current response capabilities is presented in Section 4.1.

2.3 ALTERNATIVES TO PROPOSED PROJECT

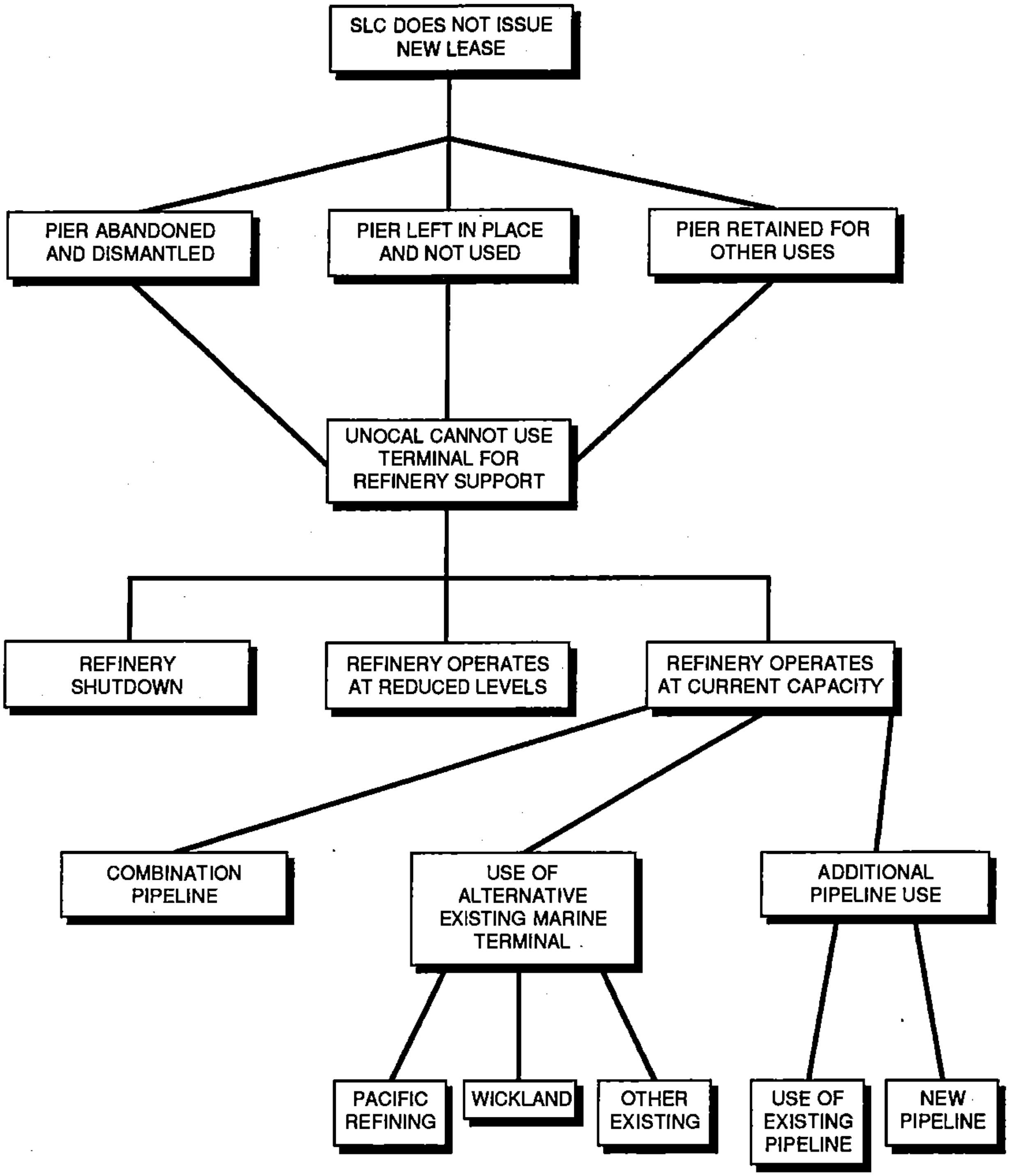
Alternatives to the Proposed Project include the No Project Alternative and consolidation of the Unocal and Pacific Refining Company Marine Terminals at the Unocal Marine Terminal. The consequences of the No Project Alternative are presented below. The impacts of these alternatives are addressed in Section 4 as appropriate for each resource discipline. Alternatives that were eliminated from further analysis are discussed in Section 5.

2.3.1 No Project Alternative

The No Project Alternative is that of not granting a new lease for Unocal to operate the Marine Terminal. A separate lease may be granted to Unocal for the filled lands that contain the butane tank.

If no new lease is granted, Unocal would not be able to use the Terminal for Refinery support. Several consequential alternatives could result to both the pier itself and the Refinery from this action. Figure 2.3-1 diagrams the possible ramifications.

Without use of the pier, Unocal would be faced with one of two scenarios for the pier: (1) abandon and dismantle, or (2) abandon and leave in place.



UNOCAL MARINE TERMINAL
NO PROJECT ALTERNATIVE
Figure 2.3-1

The alternatives of not having the Terminal to support the Refinery could result in one of three scenarios for the Refinery: (1) continue to operate at current levels, (2) operate at reduced levels, or (3) be shut down.

Discussion is presented below on the ramifications of these various scenarios. Aspects of the No Project Alternative are examined, as appropriate, within each resource discipline in Section 4.

2.3.1.1 Pier Structure Scenarios

Without a new lease, the Marine Terminal would cease to be used for its present purposes. The Marine Terminal pier could either be abandoned in-place, or removed.

Abandonment In-Place of Pier Terminal - Under this option, the Terminal would be abandoned and the pier structure would be left in place. The SLC would likely require that Unocal remove the pipelines and pumping facilities from the pier.

Abandonment and Removal of Pier - Under this option, the Terminal would be completely removed, including the pier.

Consideration was given to retaining the pier structure for other uses, such as a fishing pier. However, access to the pier is via the Unocal Refinery; thus, the feasibility of public access becomes a major issue. Access through the Unocal facility would present problems and would be highly impractical and onerous for the operator. This alternative is considered infeasible and was not carried forward in the impacts analysis. A summary of this alternative is presented in Section 5.

2.3.1.2 Refinery Scenarios

Refinery Continues to Operate at Current Capacity

Under this scenario without Marine Terminal usage, in order for the Refinery to continue operating at current capacity levels, crude intake would be obtained from sources other than the Marine Terminal and alternatives would be developed for product export. In the future, because the SJVH crude supply will continue to decline (see Section 2.1.2.2), the feasibility of replacing the full quantity of 9 million bpy of Alaskan crude with Central Valley crude may be questionable. However, for environmental assessment purposes, full replacement is assumed for this alternative. The following presents the options for increased Central Valley crude and alternatives for product export.

Replacement of Crude from Central Valley via Pipeline - The Refinery is presently served by the Oleum Pipeline, which is a 16-inch line from Coalinga to the Unocal Refinery for the receipt of SJVH crude and Coalinga Nose crude. The Oleum Pipeline is normally used to 94 percent of capacity and brings in about 24 million bpy. Under this scenario, enhancement of the Oleum Pipeline or construction of an additional pipeline to the Central Valley would be required to make up for the approximately 9 million bpy that would be lost from having no Marine Terminal.

The length of new pipeline that would be required could vary. At the present time, capacity is available through common carrier services. For example, effective January 1, 1993, Chevron Pipeline Company (CPL) acquired ownership of unheated crude oil pipelines and is offering crude oil transportation service from multiple origins in the San Joaquin Valley. Its line to the Bay Area passes near the Tosco and Shell Oil Martinez Refineries, both of which have connections to this pipeline, and extends west and then south to the Richmond Chevron Refinery. The nearest point of this line to the Unocal Facility is approximately 2 miles. If CPL offered sufficient capacity, such that Unocal would be able to transport crude via this line, then construction of a new 2-mile segment would be required. Texaco also has a common carrier line and it is likely that other carriers may also develop lines for future capacity. Only under a worst-case scenario would construction of a new line from Unocal into the San Joaquin Valley be required.

Modifications would be necessary to the Refinery to process additional Central Valley crude. The lube oil manufacturing portion of the Refinery requires a specialty crude with suitable properties to match unit design and meet product specifications. These requirements are currently met by processing a combination of Alaskan Cook Inlet (approximately 25,000 bpd by tanker) and Coalinga Nose crude (approximately 3,000 bpd by pipeline). Without Alaskan Cook Inlet crude, the lube portion of the Refinery would shutdown because alternative crude oils suitable for processing in Unocal's present lube units are unavailable. Also, the lube crude distillation unit and the downstream processing units are constrained by crude sulfur content by (permit limit) and metallurgical limitations of the equipment (corrosion control). Without a lube crude supply, 7 out of 30 refinery process units that produce lubricating oil and waxes would be shut down. The fuels producing process units would also be affected and operate at reduced capacity. Unocal estimates that approximately 100 direct jobs could be affected.

In order to accommodate an increased refining demand using Central Valley crude, modification and expansion of existing facilities would be required. Modification or expansion of these facilities would, in part, compensate for the loss of jobs from the shutdown of the lube units.

Crude import via other existing lines is presented in Section 5 (Alternatives Eliminated from Detailed Evaluation).

<u>Replacement of Crude via Pipeline from Other Marine Terminals</u> - Unocal could purchase crude from other refineries in the area, such as the Shell Martinez Refinery, the Tosco Refinery, the Exxon Benicia Refinery, or the Wickland Oil Selby Terminal, and transport this crude to its Refinery via pipeline. No pipelines currently exist that could service the import of crude from other refineries. The existing pipeline connection from Unocal to Wickland is a product line. It would not be able to handle the volume of incoming crude necessary to support current Refinery production. Construction of a new crude oil pipeline would be required.

<u>Product Export via Pipeline to Other Marine Terminals</u> - The Refinery has both direct and indirect connections to other marine terminals in the Bay Area for product transfer. A direct connection exists via the 6-inch pipeline that runs from the Refinery in Rodeo to Unocal's Richmond Terminal. Products are presently transferred to the Richmond Terminal. An increase in product transfer may be possible; however, this pipeline would not have the capacity to handle export of all product from the Rodeo Refinery.

A direct connection is available at Unocal's Refined Oil Product Shipping Unit 80, which enables Unocal to transfer product to the adjacent Wickland Oil Selby Terminal. An indirect connection is available that requires the use of the Santa Fe-Pacific Pipelines (Brisbane and Concord lines). Via these pipelines, Unocal could potentially transfer products to several other Bay Area marine terminals. However, these connections are limited in capacity and, in the case of the Brisbane and Concord lines, are time-shared (available usage may be limited). Thus, it is assumed that construction of new pipelines for the transport of product would be required. Crude and product transport via any other marine terminals in the Bay Area would require new pipeline construction.

<u>Truck and Rail Product Transport</u> - Truck and rail product transport is presently used at the Unocal Refinery. While increases in truck and rail transport are possible, the number of trucks and rail cars that would be necessary to accommodate the increase in product transport due to the loss of export via tanker would be so great that this alternative is not feasible. It would be possible, however, to use some increase in truck and rail transport in combination with other alternatives.

<u>Refinery Operates at Reduced Levels</u>

Without the Marine Terminal and with no crude replacement, a reduction of approximately 25,000 bpd or 9,000,000 bpy would result. Without Alaskan Cook Inlet crude, the lube portion of the Refinery would shutdown. According to Unocal, 7 out of 30 refinery process units that produce lubricating oils and waxes would shut down. The fuels producing process units would also be impacted and would operate at reduced capacity. Unocal estimates that 100 direct jobs would be lost at the Refinery, including operating, maintenance, and administrative personnel.

<u>Refinery Shutdown</u>

This alternative assumes that, without the crude being supplied to the Refinery through the Marine Terminal, it would be uneconomical for the Refinery to continue operations and would shut down.

If the Refinery was shut down, extensive direct and indirect consequences could result in several areas. Not only would both direct and indirect jobs be lost locally, but effects of the Refinery shutdown would be felt on a regional scale. Unocal's three West Coast refineries (Los Angeles, Santa Maria, and San Francisco) have an integrated operation. The refineries are interdependent on each other for intermediate feed stocks (mainly gas oil, butane, and gasoline blending stocks). Gas oil and gasoline stocks are transferred between Los Angeles and San Francisco by tanker. The closure of the Refinery would significantly affect these other refineries.

Twenty products representing 45 percent of the Refinery's output are presently shipped out of the

Marine Terminal. All products supplied by Unocal to the northwest U.S. are shipped by tanker because no product pipelines exist. Without alternative product supplies, direct consequences to the northwest U.S. would also result.

Shutdown of the Refinery would entail extensive economic study prior to any decisions by Unocal. Such study is beyond the scope of this document. Without a Marine Terminal, it seems more likely that alternative sources of crude would be purchased or that the Refinery would continue to operate under reduced conditions.

2.3.2 Consolidation of Unocal and Pacific Refining Company Terminals at Unocal Terminal

This alternative would involve abandonment of the Pacific Refining Company's Marine Terminal, with both Unocal and Pacific Refining's Refineries using the Unocal Marine Terminal. The Pacific Refining Company Hercules wharf is located about 1,000 feet west of Unocal's wharf. The wharf is a concrete pile and concrete-decked nearshore wharf with two breasting and four mooring dolphins in line with the face connected by catwalks, and two breasting dolphins in line with the rear of the face. The face tanker berth is 1,228 feet while the rear of the face barge berth is 258 feet. One 24-inch, one 10-inch, two 8-inch, and one 6-inch submerged pipelines extend from the wharf to storage facilities onshore. The terminal is used for the receipt of crude oil and the shipment of petroleum products.

The existing system of pipelines in the Unocal pier could probably accommodate the transfer of crude and product for both facilities from ship or barge to the landside of the Terminal. From the landside of the Terminal, construction of additional pipelines extending to the Pacific Refining Refinery would be required. Alternatively, submerged pipelines could be brought from the Unocal pier to the Pacific Refining Refinery.

2.4 DESCRIPTION OF CUMULATIVE PROJECTS

2.4.1 Boundary of Cumulative Projects Study Area

The cumulative environment study area is viewed as having two separate components as follows:

- Consideration of the other marine terminals operating in the Bay Area, as well as that area related to the shoreline land uses in the general vicinity of the Marine Terminal. A description of this study area is described in Sections 2.4.2.1 and 2.4.2.2.

- That area related to shipping of crude and product within the San Francisco and San Pablo Bays area, including Carquinez Strait, and the shipping lanes off the coast from San Francisco Bay north to the Oregon/California border and south to Santa Cruz. The shipping lanes from San Francisco Bay south to southern California and their cumulative impacts relevant to tanker traffic have been previously addressed in the GTC Gaviota Marine Terminal Project Final Supplemental EIR/EIS (Aspen 1992b). A description of the regional characteristics of transport in the Bay Area and outer coast is presented in Section 2.4.2.3.

2.4.2 General Description of Cumulative Environment

2.4.2.1 Marine Facilities

The cumulative environment for this project includes facilities located on the shoreline within the Bay. Five of California's twelve largest refineries are located in the Bay Area. These include Chevron at Richmond, Shell and Tosco at Martinez, Exxon at Benicia, and the Unocal tandem at Santa Maria/Rodeo. These refineries generally run a combination of Alaskan North Slope (ANS) and San Joaquin Valley (SJV) crudes along with a small amount of foreign crude, mostly condensate. The Unocal Santa Maria complex processes local heavy crude production, including some outer continental shelf (OCS) along with SJVH and transports the product stream to Rodeo for further refining.

SJV crude is supplied to these refineries directly by three pipeline systems and tankers. The Texaco pipeline from the San Joaquin Valley is a heated, proprietary system that supplies SJVH crude to Tosco, Exxon, and Shell. The Chevron Refinery at Richmond receives its pipeline crude via its own unheated, proprietary system. Due to the integrated nature of the Unocal Santa Maria and Rodeo complexes, the supply at Rodeo is solely through Unocal's Oleum Pipeline. Chevron Pipeline Company (CPC) also operates a common carrier line importing SJV crude to the Bay Area. Tosco, Shell, and Chevron-Richmond have connections to this pipeline. With the exception of Santa Maria, the other refiners also receive ANS crude. All ANS crude is supplied by tankers.

In total, there are 8 ports, 26 marine terminals, and several Naval terminals in the Bay. The Naval terminals are located at Alameda, Treasure Island, Hunters Point, Point Molate, Mare Island, Concord Naval Weapons Depot, and Moffet Field. Figure 2.4-1 is a map of the Bay Area showing the location of the various marine terminals. For discussion purposes, the marine terminals have been categorized as follows:

- Port of San Francisco,
- Port of Redwood City,
- Port of Oakland/Alameda,
- Richmond Area,
- San Pablo Bay, and
- Carquinez Strait and further inland.

<u>Port of San Francisco</u> - The Port of San Francisco is one of the largest ports on the Bay. It is primarily a general cargo port. No major oil terminals are in the Port. The general cargo and specialized terminals are located on the Bay and Islais Creek and the canal extending from China Basin. The port has 30 active deepwater piers.

<u>Port of Redwood City</u> - The Port of Redwood City operates three deepwater municipal wharves with four berths. The wharves are generally used for receipt and shipment of general cargo, although one wharf is used occasionally for receipt of petroleum products. A salt-loading wharf and barge wharf for a cement plant are also located nearby.

<u>Port of Oakland</u> - The Port of Oakland is the largest general cargo port of the Bay and a leading container-ship terminal of the Pacific Coast. This port encompasses three areas: Outer, Middle, and Inner Harbors. The Port of Oakland owns and leases 12 major terminals, which have a total of 29 deep draft berths. Encinal and Fortmann Basins, on the Alameda side of the Oakland Inner Harbor, have several general cargo marine terminals. Several privately owned general cargo piers are also in the Inner Harbor as is the Pennzoil Terminal.

<u>Richmond Area</u> - Facilities in the Richmond area are subdivided into three areas: at Richmond, on Harbor Channel, and on Santa Fe Channel.

Three major facilities are at Richmond. The City of Richmond Terminal No. 4 wharf is used for receipt and shipment of bulk liquids, including petroleum products, petrochemicals, and chemicals. The City of Richmond Terminal No. 1 wharf is used for receipt and shipment of vegetable oils and petrochemicals.
Five major facilities are on Harbor Channel. The City of Richmond Terminal No. 7 wharf is used for receipt of automobiles, the City of Richmond Terminal No. 3 wharf is used for the receipt and shipment of containerized cargo, and the City of Richmond Terminal No. 2, upper wharf and lower wharf are used for receipt and shipment of liquid chemicals. The ARCO tanker and barge docks are used for receipt and shipment of petroleum products and petrochemicals, and for bunkering vessels. The Union tanker dock is used for receipt and occasional shipment of petroleum products and bunkering vessels.

Five major facilities are on Santa Fe Channel. The Time Oil Co. wharf is used for receipt and shipment of petroleum products. The Levin-Richmond Terminal Berths A, B, and C are used for receipt and shipment of dry bulk cargo, chemicals, and steel. The Texaco wharf is used for receipt and shipment of petroleum products as is the Burmah-Castrol wharf. The National Gypsum Co. dock is used for receipt of gypsum rock.

<u>San Pablo Bay</u> - Three major marine terminals are in San Pablo Bay. The Pacific Refining Company Hercules wharf is located approximately 1,000 feet west of the Unocal Refinery wharf. The terminal is used for the receipt of crude oil and the shipment of petroleum products.

The Wickland Oil Selby Terminal is located approximately 1 mile east of the Unocal wharf. The wharf is used for receipt of petroleum products. In addition, the Mare Island U.S. Naval Shipyard is located on the north side of San Pablo Bay.

<u>Carquinez Strait and Further Inland</u> - Numerous marine terminals, including oil terminals, are inland of Carquinez Bridge. Marine terminals in Carquinez Strait include California and Hawaiian Sugar Co. Refinery (for sugar processing only); Defense Fuel Supply Center Support Point, Ozol Oil Wharf; Shell Oil Co., Martinez Refinery wharf; Tosco Corp., Amorco and Avon wharves; Exxon Benicia Refinery, crude oil and product wharf; and Benicia Pier No. 95. Other terminals are located in Suisun Bay, Sacramento, and Stockton.

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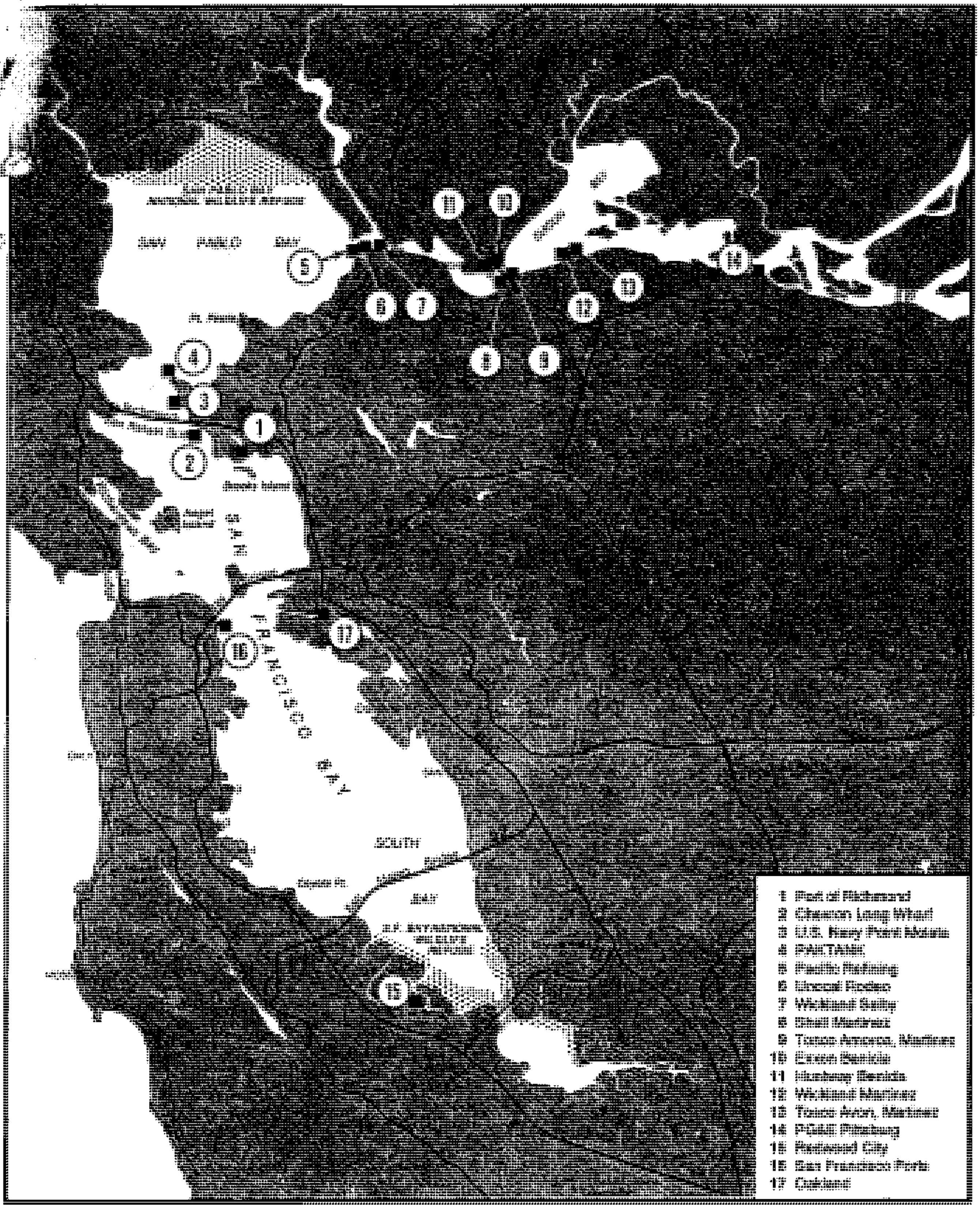

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Source: California Coastal Resource Guide
California Coastal Commission, 1987

LOCATION OF TERMINALS
Figure 2.4-1

2.4.2.2 Facilities and Communities in Vicinity of Terminal

Immediately east of the Unocal Refinery is the Wickland Oil Selby Terminal, which has limited pipeline capacity and is primarily used as a product terminal. A slag pile at Wickland has recently been remediated and paved. South of the Unocal Terminal is Pacific Refining Company's Refinery. Other facilities include the PG&E Oleum Power Plant, the C&H Sugar Refinery, and other smaller industrial facilities.

The communities in the general vicinity include Oleum/Rodeo, Vallejo, Crockett-Valona, Benicia, Martinez, central Contra Costa, and Vine Hill.

2.4.2.3 Regional Characteristics of Crude/ Product Transportation in Bay and Along Coastal Shipping Lanes off Northern California

San Francisco Bay Area Marine Exchange Tanker Reports were used to describe tanker transits in the Bay Area. One year tanker transit data from May 1991 through April 1992 are presented. The various marine terminals were lumped together geographically into the following categories for the purpose of analysis:

- San Francisco ports,
- Oakland/Alameda ports,
- Richmond ports,
- Oleum ports (Unocal, Pacific Refining Company, and Wickland),
- Redwood City, and
- Ports upstream of Carquinez Bridge.

In addition, movements to and from Anchorages 8 and 9 were included in the analysis. Table 2.4-1 summarizes the number of vessel movements between the various locations in the matrix. As can be seen from the table, a moderate amount of movement occurs between ports. For example, the table shows that 57 movements were between ports in the Richmond area and 39 were from Richmond to ports past the Carquinez Bridge. As can be seen from the table, 2,760 total tanker movements occurred during the 1-year time period. Marine Exchange reported that 3,671 vessel arrivals occurred during 1991, of which 1,006 were oil tankers. It also reports that 2,238 shifts or total in-Bay vessel movements occurred, of which well over one-half were oil tankers or barges. The above vessel traffic estimates do not include Naval vessels.

As a comparison, the 1988 Corps Waterborne Commerce data were added to the table where appropriate. As can be seen, the data are in close agreement with the current Marine Exchange data for total vessel movements. Also, the Port Needs Study (U.S. Department of Commerce 1991) 1987 baseline and 1995 forecast tanker movement data have been added to the table. Again, these numbers are consistent with Marine Exchange and Corps data for total vessel movements in the Bay.

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Table 2.4-1

PETROLEUM TANKER MOVEMENTS WITHIN SAN FRANCISCO BAY MAY 1991 TO APRIL 1992 (FROM MARINE EXCHANGE)

From/To	Outside Bay	San Francisco Ports	Oakland Alameda Ports	Anchorage 8	Anchorage 9	Richmond Ports	Oleum Ports	Ports Past Carquinez Bridge	Redwood City	Total	Corps 1988 Waterborne Commerce
Outside Bay		18	4	47	239	299	126	268	2	1,003	1,001
San Francisco Ports	29			1	3	5		6		44	45
Oakland/Alameda Ports	2	1						1		4	5
Anchorage 8	7	2				9	11	29		58	N/A
Anchorage 9	155	6				86	25	136		408	N/A
Richmond Ports	285	17		5	69	57	26	39		498	486
Oleum Ports	154				18	17	7	34		230	N/A
Ports Past Carquinez Bridge	369			5	79	25	35			513	512
Redwood City	2									2	1
Total	1,003	44	4	58	408	498	230	513	2	2,760	
Corps - 1988 Waterborne Commerce	997	49	4	N/A	N/A	486	N/A	513	1		

Marine Exchange Total Movements (1992) - 5,520
USCG Port Needs Study (1987) - 5,436
USCG Port Needs Study (1995 Forecast) - 5,798
N/A - not available

SECTION 3 - EXISTING ENVIRONMENT

3.1 OPERATIONAL SAFETY/RISK OF ACCIDENTS

3.1.1 Introduction

This section describes those aspects of the existing environment that may have an impact on operational safety or that may be impacted by an accident associated with the facility and its operations, including transportation of petroleum and petroleum products. A physical description of the Unocal Marine Terminal was presented in Section 2. This section begins with an operational description of facility components as related to safety issues and emergency response. This is followed by a summary of laws and regulations that may affect the safety and potential risk from the facility. A cumulative description of the Bay Area is also presented that addresses other marine terminals, vessel traffic, and transportation patterns, and oil spill and emergency response capability. The last subsection summarizes historical casualties involving the Unocal facility and vessel traffic.

3.1.2 Operational Description

This subsection describes the procedures used to operate the Marine Terminal. It addresses the products transferred, vessels used, mooring and transfer procedures, and safety/response procedures. The Marine Terminal is capable of operating 24 hours per day; however, current deliveries and product export do not even average 8 hours per day of use of the Terminal.

3.1.2.1 Products Transferred

Table 3.1-1 presents a listing and description of all crude and products handled at the Marine Terminal. Over 90 percent of cargo offloaded at the Terminal is Alaskan crude. Smaller amounts of gas oil, MTBE, and C_5/C_6 (natural gasoline) are also offloaded. The remaining products listed in Table 3.1-1 are loaded on tankers or tank barges for distribution.

3.1.2.2 Vessels Calling at Terminal

Barges and tankers presently call at the Terminal. The majority of crude oil is delivered by Blue Ridge, a 42,268-DWT, double-bottom tanker capable of carrying 300,000 bbl of crude oil. Blue Ridge is restricted to carrying approximately 285,000 bbl when calling at the Unocal Terminal because the water depth is only 35 feet there. Blue Ridge makes approximately two roundtrips per month between Alaska and the Unocal Terminal. Coast Range and Sierra Madre make an additional trip between them each month for a total of approximately three roundtrips between San Francisco and Alaska each month.

The Coast Range and Sierra Madre are 40,631-DWT, double-bottom tankers capable of carrying 300,000 bbl of oil. Their loaded draught is 33 feet and thus, their cargo load is not restricted by the water depth at the Terminal. They are normally used to transport product from the Terminal; however, they also sometimes deliver feed stocks. All three vessels, built in 1981, are operated by WCSC.

The Sierra Madre and Coast Range normally call upon terminals in California, Oregon, Washington, Alaska, and Hawaii. Based on Marine Exchange records, Coast Range and Sierra Madre called at the Unocal Terminal 37 and 24, times, respectively, between May 1, 1991, and April 30, 1992. Unocal reported that Coast Range and Sierra Madre averaged 42 and 38 calls per year, respectively, between June 1, 1985, and June 1, 1989.

Other non-WCSC-operated tankers also call occasionally at the Terminal. These tankers primarily load products at the Terminal. Marine Exchange records show that 14 such tankers called at the Terminal between May 1, 1991, and April 30, 1992. Unocal reported that approximately 20 outside tankers per year called at the Terminal between June 1, 1985, and June 1, 1989.

In addition to the above tankers, the WCSC ammonia tanker Cornucopia calls at the Terminal to refuel. The tanker operates between Cook Inlet, Alaska, and Stockton, California, and stops to refuel at the Unocal Terminal on its way back to Alaska after it has

Table 3.1-1

PRODUCTS HANDLED AT UNOCAL SAN FRANCISCO REFINERY MARINE TERMINAL

Product	Description
150 NEUT OIL	Lube oil blending stock; light yellow, light motor oil odor, fire combustible
190 B.S.	Lube oil blending stock, opaque green motor oil odor, fire combustible
450 NEUT OIL	Lube oil blending stock; light yellow-green light motor oil odor
76AV FUEL JETA	Aviation fuel oil; clean liquid, kerosene odor, combustible
90 NEUT OIL	Lube oil blending stock (high sulfur content); clear light yellow tint, light motor oil odor, fire combustible
ALASKAN CRUDE	Crude oil; black, sweet gaseous odor, extremely flammable
BUNK F/O NO 6	Fuel oil for ship; black, light sulfurous odor, fire combustible
C GRAD DSL	Diesel for cool climate, light-dark amber, diesel odor, combustible
C5C6	Isomerate feed for higher octane blending stock; clear, gasoline odor, extremely flammable
CAT GAS OIL	Catalytic gas oil; opaque green, gaseous or sulfurous odor, fire combustible
DSL2 SHIP USE	Diesel for ship use; light-dark amber, diesel odor, combustible
HEAT OIL NO 2	Heating oil
HVY COKR G.O>	Heavy coker gasoline oil; opaque green gaseous or sulfurous odor, fire combustible
ISOMERATE	Blending stock; clear, gasoline odor, extremely flammable
LAR CASO STK	L.A. refinery gasoline stock for blending; clear, gasoline odor, extremely flammable
LAR REF	L.A. refinery high-octane reformate for blending; clear, light green tint, gasoline odor, extremely flammable
LSFO PGE EXCH	Low sulfur fuel oil; black, light sulfurous odor, liquid under heat, fire combustible
LT COKR G.O.	Light coker gas oil; opaque green, gaseous or sulfurous odor, fire combustible
LT CYCL OIL	Light cycle oil
LT WAXY	Light waxy oil as an isomerate feed
LUK	Light unicrackate
L.S. FUEL OIL	Low sulfur fuel oil; black, light sulfurous odor, liquid under heat, fire combustible
MTBE	Methyl tertiary butyl ether used as a blending stock; clear, terpene-like odor, extremely flammable
MUK	Medium unicrackate
OUTSIDE LTGO	Light gas oil from outside S.F. Refinery; opaque green, gaseous odor, combustible
OUTSIDE REF	Reformate from outside S.F. Refinery; clear, light green tint, gasoline odor, extremely flammable
PREF SIDECUT 1	Sidecut from prefractionator; opaque green, gaseous or sulfurous odor, fire combustible
PRE SIDECUT 2	Sidecut from prefractionator; opaque green, gaseous or sulfurous odor, fire combustible
REG LDC	Leaded gasoline for cool climate; bronze liquid, gasoline odor, extremely flammable

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Table 3.1-1 (Continued)

PRODUCTS HANDLED AT UNOCAL SAN FRANCISCO REFINERY MARINE TERMINAL

Product	Description
SHIP USE LSFO	Ship use low sulfur gas oil; black, light sulfurous odor, fire combustible
SHIP USE #6FO	Ship use fuel oil; black, light sulfurous odor, fire combustible
SMGO	Santa Maria gas oil (semi-refined); opaque green, gaseous or sulfurous odor, fire combustible
SUPR UNLC GASO	Super unleaded gasoline for cool climate; red liquid, gasoline odor, extremely flammable
SUPR UNLI GASO	Super unleaded gasoline for intermediate climate; red liquid, gasoline odor, extremely flammable
SUPR UNLW GASO	Super unleaded gasoline for warm climate; red liquid, gasoline odor, extremely flammable
TOLUENE	Gasoline additive; colorless liquid with aromatic benzene-like odor; extremely flammable
U231 REF	Reformate; clear, light green tint, gasoline odor, extremely flammable
U244 REF	Reformate; clear, light green tint, gasoline odor, extremely flammable
UNLD REGC	Octane 87 unleaded gasoline for cool climate; light green tint liquid, gasoline odor, extremely flammable
UNLD REGW	Octane 87 unleaded gasoline for warm climate; light green tint liquid, gasoline odor, extremely flammable
UNLW GASO	Octane 89 unleaded gasoline for warm climate; light green tint liquid, gasoline odor, extremely flammable
UNON DSL #2	Diesel #2; light-dark amber, diesel odor, combustible

offloaded its ammonia in Stockton. Marine Exchange records show that Cornucopia called at the Unocal Terminal five times between May 1, 1991, and April 30, 1992, and Unocal reported that it averaged about 8.5 calls per year between June 1, 1985, and June 1, 1989.

Barges also call at the Marine Terminal. Unocal charters barges to load products at the Terminal and distribute them to other terminals throughout the Bay Area. Barges are also occasionally used to deliver gas oil. Unocal presently charters barges from Marin Tug and Barge, Inc., Bay Bunkering Services, Inc., and Crowley Maritime Corp. Unocal reports (Unocal, July 9, 1992) that 237 barge callings occurred between January 1, 1988, and May 31, 1992, for an average of about 4.5 per month. Only seven of the barges delivered product. Barge sizes range in length from 275 feet (25,000 bbl capacity) to 400 feet (140,000 bbl capacity). Less than 10% of barge activity is associated with bunkering.

3.1.2.3 Mooring Procedures

Pilotage in and out of San Francisco Bay and adjacent waterways is compulsory for all vessels of foreign registry and United States vessels under enrollment not having a federally licensed pilot on board. The masters on board the WCSC-operated oil tankers calling at the Terminal are federally licensed pilots, and thus San Francisco Bar Pilots are not used. The WCSC-operated Cornucopia does use a Bar Pilot to take the vessel to Stockton and back. The other tankers that call at the Terminal use either a Bar Pilot or onboard federally licensed pilot as appropriate. Section 3.1.6.2 describes Bay Area pilotage procedures. Barges are not required to use pilots.

When docking, tankers generally approach the berth into the tide (flood or ebb) and leave in the direction of the tide. Blue Ridge, Sierra Madre, and Coast Range generally use one tug to dock and undock, while Cornucopia and many other tankers use two tugs. Additional tugs may be used depending on the environmental conditions. All maneuvering and navigation in the vicinity of the Terminal are coordinated by the onboard pilot (master or Bar Pilot) with the USCG Vessel Traffic System (VTS). The VTS is described in Section 3.1.5.1. The Terminal can accommodate two ships and two barges simultaneously; however, only one vessel will be maneuvered at a time. If multiple vessels are handled simultaneously, the Terminal can accommodate two vessels of 105,000 DWT and two barges of the 25,000-bbl size.

The ship and barge mooring procedures used at the Marine Terminal are detailed in the Unocal Marine Terminal Complex Operating and Training Manual (Unocal, May 1989) and summarized below.

Prior to vessel arrival, the Unocal Dispatcher sets up a vessel tie-up crew. The crew is generally assembled at least 20 minutes prior to the vessel's arrival at the Terminal.

Normal crew size is six people for the Blue Ridge, Sierra Madre, Coast Range, and Cornucopia. Releasing the tankers requires four people. When releasing ships at Berth M-2, an extra line handler is required on the west end. Non-WCSC ships require nine people. Releasing a non-WCSC ship requires six people. The crew consists of the following:

- First Person-In-Charge,
- Operator-In-Charge,
- Winch Operators, and
- Line Handlers.

The duties for each of the above positions are described in the Unocal Marine Terminal Complex Operating and Training Manual. The Manual also presents diagrams of typical mooring tie-ups for various vessels that regularly call at the Terminal.

3.1.2.4 Transfer Procedures

The Unocal Dispatcher is normally designated as the Terminal Person-In-Charge (TPIC) of the Terminal and is responsible for the transfer operations. The following summarizes the normal steps taken during transfer operations as described in Unocal's Marine Terminal Operating Manual. This Manual was last approved by the USCG with a Letter of Adequacy issued on January 7, 1992.

1. The Dispatcher and Vessel agent, if available, have a preplanning conference on the transfer of product before the vessel arrives. The SLC is notified at least four, but not more than 24 hours prior to the initiation of any transfer operation.

2. The Dispatcher and Vessel Person-In-Charge (VPIC) hold a pretransfer conference on details of the transfer after the vessel arrives and before product is transferred.

   The Dispatcher and VPIC thoroughly discuss the Declaration of Inspection, which consists of a detailed list of items that must be verified prior to commencement of transfer operations. Both the Dispatcher and VPIC must attest to this list. In addition, the VPIC of loading or unloading of low flash-point (less than 150°F) cargoes (tankers and barges) must attest that they are equipped with a properly operating inert gas system (IGS). At the present, no barges equipped with IGSs call at the Terminal. This verification is an attachment to the Declaration of Inspection. The Dispatcher must also complete the Marine Terminal Operations and Vessel Log.

3. When requested by the Dispatcher, the Marine Terminal Operator connects the loading arms or hoses to the vessel in accordance with procedures presented in the Marine Terminal Operating Manual (Unocal, February 1992). The Terminal Operator also checks those items on the Marine Terminal Operator's Check List that require checking prior to loading.

4. The Dispatcher checks with shore personnel to ascertain that the proper lineup (pipeline connections and valve alignment) has been made for transfer. The Dispatcher also checks with the VPIC to ascertain if the vessel is ready for transfer. Flow of cargo is begun slowly to ensure that operations are proceeding correctly.

5. The Marine Terminal Operator checks those items on the checklist that are required immediately after start of loading. The Marine Terminal Operator also makes periodic checks for leaks.

6. The VPIC notifies the Dispatcher approximately 15 minutes prior to completion of transfer operations.

7. Upon completion of transfer operations, the Dispatcher closes the motor-operator control valve.

8. When agreed by the Dispatcher and VPIC, the Dispatcher notifies the Marine Terminal Operator to remove the unloading arms or hoses in accordance with the procedures in the Marine Terminal Operating Manual.

3.1.2.5 Safety Procedures

The Safety Procedures followed at the Unocal Marine Terminal are described in the various operating manuals, training manuals, and response plans.

The Marine Terminal Operating Manual describes the emergency procedures to be implemented in the event of a fire or other emergency at the Marine Terminal. Emergency notification telephone numbers and notification procedures based on the use of radio and loudspeaker systems are clearly documented. The plan also identifies the location of all safety equipment at the Terminal.

Unocal's Emergency Organization is the first line of defense for protection of the Marine Terminal during fires and/or other emergencies. Unocal has developed a detailed San Francisco Refinery Emergency Response Plan and Procedures Manual (Unocal, February 1992). The plan addresses the entire Refinery complex, including the Marine Terminal. It addresses Unocal's emergency response policy, organization, training program, personnel evacuation, medical evaluation and surveillance program, procedures, and integration with other plans/agencies.

In response to the Oil Pollution Act of 1990 (OPA 90), Unocal recently developed and implemented an Oil Spill Contingency/Response Plan and a Response Plan for their San Francisco Refinery. The Oil Spill Contingency/Response Plan was developed to address spills from the Marine Terminal portion of the Refinery, while the Response Plan was developed to address onshore spills from any place within the Refinery complex. The objectives of the plans are to describe Unocal's response to an oil spill incident and to present resources and other supportive information that are potentially necessary and/or useful in formulating response strategies and tactics. The combination of these two plans is designed to meet the current requirements of the USCG, EPA, and the California Department of Fish and Game (CDFG), office of Oil Spill Prevention and Response (OSPR) for spill plans. An update of one or both of the plans will most likely be required by April 1994 to meet OSPR's proposed spill plan regulations.

3.1.2.6 Emergency Response Equipment

<u>Oil Spill Response Equipment</u>

The oil spill response equipment available at the Marine Terminal and elsewhere at the Refinery is listed in Table 3.1-2. Also included in the table are the quantities, locations, and estimated deployment times of the various equipment.

In addition to the oil spill response equipment stored at or near the Terminal, Unocal has a contract with Crowley Maritime Corporation to provide a standby vessel capable of deploying the boom on the pier when a transfer is being conducted. Unocal is also a member of Clean Bay and MSRC and thus, has access to their equipment if needed. This equipment is described in Section 3.1.5.4.

<u>Fire Response Equipment</u>

Unocal maintains the following fire response equipment at the Terminal. The number of pieces of equipment is listed in parentheses.

- Ansul dry chemical extinguishers (12),
- Carbon dioxide (CO_2) extinguisher (1),
- Fire hose stations/hose reels (6),
- Hydrants (15), and
- Fire monitors (9).

In addition, Unocal maintains its own fire/emergency response department at the Refinery. The following major pieces of equipment are maintained by the Unocal Fire Department:

- Personnel Protective Equipment (PPE) van,
- Two fire engines,
- Mini pumper (four wheel drive/foam truck),
- Ladder truck (75-foot aerial),
- Monitor truck, and
- Four fire pump stations.

3.1.3 Regulatory Setting

Many laws and regulations are presently in place or in the process of being implemented that regulate the Terminal, vessels calling at the Terminal, and emergency response/contingency planning. Responsibilities under these laws and regulations fall to various international, federal, state, and local agencies. The various agencies and their responsibilities are summarized below.

Table 3.1-2

UNOCAL OIL SPILL RESPONSE EQUIPMENT

Type	Quantity	Location	Deployment Time (minutes)
Kepner Seal Curtain - Boom 11" x 16"	(2) 1,000 ft reels	One at each end of Marine Terminal	45
Sea Curtain Reel Pak Open - Harbor Boom	8-250' sections	Marine Terminal	
Orion Radio Signal Buoy	2	Marine Terminal Oil Spill Office	5
3M Type #126 Sweeps - 100' Lengths	10 bales	Marine Terminal	15
3M Type #126 Sweeps - 10' Lengths	20 bales	Marine Terminal	15
Burlap Bags	200	Marine Terminal	15
Vis Queen Polyethylene (Black Plastic)	100 ft roll	Marine Terminal	15
Nylon Tie Lines - 100' Lengths	3	Marine Terminal	15
Manila Handlines - 50' Lengths	4	Marine Terminal	15
Coveralls	8	Marine Terminal	15
Life Jackets	15	Marine Terminal	15
Drinking Water Cans and Cups	2	Marine Terminal	15
Open Top Barrels	6	Marine Terminal	30
Barrel Slings	1	Marine Terminal	15
Rakes	4	Marine Terminal	15
Pitch Forks w/Mesh	6	Marine Terminal	15
Long Handle Paddles for Skimming	4	Marine Terminal	15
Conwed Sorbent Blanket - 3' x 200'	1 roll	Marine Terminal	30
Plastic Garbage Can Liners	200	Marine Terminal	15
Heaving Lines	2	Marine Terminal	51
3M Type #126 Sweeps - 10' Lengths	30 bales	Under trestle or at was/grease complex	30
3M Type #126 Sweeps - 100' Lengths	30 bales	Under trestle or at wax/grease complex	30
Burlap Sacks	1,000	Under trestle or at wax/grease complex	30
Nylon Tie Lines - 100' each	2	Under trestle or at wax/grease complex	30
Pitch Forks with Mesh	10	Under trestle or at wax/grease complex	30
Rakes	14	Under trestle or at wax/grease complex	30
Shovels	10	Under trestle or at wax/grease complex	30
Long Handle Paddles for Skimming	20	Under trestle or at wax/grease complex	30
Extension Cords, Portable Lights, etc.	1 box	Under trestle or at wax/grease complex	30
Wire Mesh 1/2"	1 roll	Under trestle or at wax/grease complex	30
Plastic Garbage Can Liners	400	Under trestle or at wax/grease complex	30
Johns-Manville 5' Sea Serpents	20	Under trestle or at wax/grease complex	60
Portable Skimmer w/Air Pump and Discharge Hose	1	Under trestle or at wax/grease complex	60

3.1.3.1 International Maritime Organization

The major body governing the movement of goods at sea is the International Maritime Organization (IMO), which does so through a series of international protocols. Individual countries must approve and adopt these protocols before they become effective. The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78 and amendments) governs the movement of oil and specifies tanker construction standards and equipment requirements. Regulation 26 of Annex I of MARPOL 73/78 requires that every tanker of 150 tons gross tonnage and above shall carry on board a shipboard oil pollution emergency plan approved by IMO. The U.S. implemented MARPOL 73/78 with passage of the Act of 1980 to Prevent Pollution from Ships. The IMO (IMO 1992) has recently issued "Guidelines for the Development of Shipboard Oil Pollution Emergency Plans" to assist tanker owners in preparing such plans that comply with the cited regulations and to assist Governments in developing and enacting domestic laws which give force to and implement the cited regulations. Plans that meet the Oil Pollution Act of 1990 (OPA 90) and the Lempert-Kenne-Seastrand Oil Spill Prevention and Response Act (California SB2040) requirements also meet IMO requirements.

All Vessel Traffic Separation Schemes (VTSS), such as the ones off the entrance to San Francisco Bay and in the Santa Barbara Channel, must be approved by the IMO. These two VTSSs have been approved.

3.1.3.2 Federal Agencies

There are a number of federal laws that have been enacted to regulate marine terminals and vessels. These laws address, among other things, design and construction standards, operational standards, and spill prevention and cleanup. Regulations to implement these laws are contained primarily in Titles 33 (Navigation and Navigable Waters), 40 (Protection of Environment), and 46 (Shipping) of the Code of Federal Regulations. The most recent act to address spill prevention and response is called the Oil Pollution Act of 1990 (OPA 90).

OPA 90 was enacted to expand prevention and preparedness activities, improve response capabilities, ensure that shippers and oil companies pay the costs of spills that do occur, and establish an expanded research and development program. The Act also establishes a new $1 billion Oil Spill Liability Trust Fund funded by a tax on crude oil received at refineries. The USCG, EPA, and Research and Special Programs Administration (RSPA) are in the process of developing regulations to implement OPA 90 for transportation related facilities (e.g., marine terminals, vessels), nontransportation related facilities (e.g., storage tanks, refineries), and onshore pipelines, respectively.

All facilities and vessels that have the potential to release oil into navigable waters are required by OPA 90 to have up-to-date oil spill response plans and to have submitted them to the appropriate federal agency for review and approval. Of particular importance in OPA 90 is the requirement for facilities and vessels to demonstrate that they have sufficient response equipment under contract to respond to and clean up a worst-case spill.

Other key acts addressing oil pollution include:

- Federal Water Pollution Control Act of 1972,
- Clean Water Act of 1977,
- Water Quality Act of 1987,
- Act of 1980 to Prevent Pollution from Ships,
- Resource Conservation and Recovery Act (RCRA) of 1978,
- Hazardous and Solid Waste Act of 1984, and
- Refuse Act of 1899.

Responsibilities for implementing and enforcing the federal regulations addressing terminals, vessels, and pollution control fall to a number of agencies as described below.

<u>United States Coast Guard</u>

The USCG is the federal agency responsible for vessel inspection, marine terminal operations safety, coordination of federal responses to marine emergencies, enforcement of marine pollution statutes, marine safety (e.g., navigation aids), and operation of the National Response Center for spill response and is the lead agency for offshore spill response. The USCG can be expected to inspect all new arriving foreign vessels. The regulations for the above functions are contained in Titles 33 and 40 of the Code of Federal Regulations. As part of these responsibilities, the USCG has reviewed and issued a Letter of Adequacy for Unocal's Marine Terminal Operations Manual.

The USCG is in the process of issuing regulations to implement OPA 90. Interim final rules have been issued for transportation related facilities and tank vessels addressing the requirement for spill response plans. Unocal and WCSC submitted their OPA 90 spill response plans to the USCG prior to the February 18, 1993, deadline and implemented the plans prior to the August 18, 1993, deadline. At this time, the USCG has not completed their review of the plans.

The USCG has also issued an interim final rule addressing double hull standards for vessel (tankers and tank barges) carrying oil in bulk operating in the navigable waters or the Exclusive Economic Zone of the United States (Federal Register 1992). The rule, based on OPA 90, requires all new tank vessels to have double hulls, and establishes a timetable for phasing out single-hull, double-hull, and double-side tankers according to their size and age beginning January 1, 1995. The phaseout schedule is summarized in Table 3.1-3. As can be seen from the table, larger nondouble hull vessels must be phased out at a younger age than smaller vessels. Single-hull vessels greater than 30,000 gross tons must be phased out at the age of 28 years, while single-hull vessels between 5,000 and 30,000 gross tons must be phased out at the age of 40 years. Double-bottom or double-sided vessels can essentially operative 5 years longer than single-hull vessels. The three WCSC vessels being used at the Unocal Terminal for crude and product tankering (Blue Ridge, Coast Range, and Sierra Madre) are double bottom, greater than 30,000 gross tons, and were built in 1981. In the year 2000, they will be 19 years old. Hence, under these rules they can continue service until 2015.

Environmental Protection Agency (EPA)

EPA is responsible for the National Contingency Plan and acts as the lead agency in response to an onshore spill. EPA also serves as co-chairman of the Regional Response Team which is a team of agencies established to provide assistance and guidance to the on-scene coordinator (OSC) during the response to a spill. The EPA also regulates disposal of recovered oil and is responsible for developing regulations for Spill Prevention, Control, and Countermeasures (SPCC) Plans. SPCC Plans are required for nontransportation-related onshore and offshore facilities that have the potential to spill oil into waters of the United States or adjoining shorelines. The EPA is in the process of updating SPCC regulations in response to OPA 90. The Unocal Refinery and storage tanks are required to have an SPCC Plan in accordance with the EPA regulations.

Department of Commerce through the National Oceanic and Atmospheric Administration (NOAA)

NOAA provides scientific support for response and contingency planning including assessments of the hazards that may be involved, predictions of movement and dispersion of oil and hazardous substances through trajectory modeling, and information on the sensitivity of coastal environments to oil and hazardous substances. They also provide expertise on living marine sources and their habitats, including endangered species, marine mammals and National Marine Sanctuary ecosystems, and information on actual and predicted meteorological, hydrological, and oceanographic conditions for marine, coastal, and inland waters, and tide and circulation data for coastal waters.

Department of the Interior (DOI)

DOI through its various offices, provides expertise during spills in a number of areas as described below.

- Fish and Wildlife Services - Anadromous and certain other fishes and wildlife, including endangered and threatened species, migratory birds, and certain marine mammals; waters and wetlands; and contaminants affecting habitat resources.

- Geological Survey - Geology, hydrology (ground water and surface water), and natural hazards.

Department of Defense (DOD)

DOD, through the U.S. Army Corps of Engineers (Corps), is responsible for reviewing any aspects of a project and/or spill response activities that could affect navigation. The Corps has specialized equipment and personnel for maintaining navigation channels, for removing navigation obstructions, and for accomplishing structural repairs.

Table 3.1-3

NON-DOUBLE HULL VESSEL PHASEOUT SCHEDULE

Year[1]	Vessel Size (Gross Tons)						
	<5,000	5,000 - 15,000		15,000 - 30,000		>30,000	
	Non-Double Hull	Single Hull Vessel Age	Double Bottom/Side Vessel Age	Single Hull Vessel Age	Double Bottom/Side Vessel Age	Single Hull Vessel Age	Double Bottom/Side Vessel Age
1995		40	45	40	45	28	33
1996		39	44	38	43	27	32
1997		38	43	36	41	26	31
1998		37	42	34	39	25	30
1999		36	41	32	37	24	29
2000		35	40	30	35	23	28
2001				29	34		
2002				28	33		
2003				27	32		
2004				26	31		
2005		25	30	25	30		
2010		All Vessels		All Vessels		All Vessels	
2015	All Vessels		All Vessels		All Vessels		All Vessels

[1] January 1 of the year specified

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3.1.3.3 State Agencies

Chapter 1248 of the Statutes of 1990 (SB 2040), the Lempert-Keene-Seastrand Oil Spill Prevention and Response Act, established a comprehensive approach to prevention of and response to oil spills. The SLC Marine Facility Inspection and Management Division was given the responsibility for governing marine terminals. Through Article 5 of the California Code of Regulations which became effective in December 1992, the Marine Facilities Inspection and Management Division established a comprehensive program to minimize and prevent spills from occurring at marine terminals and to minimize spill impact should one occur. Article 5 establishes a comprehensive inspection monitoring plan whereby SLC inspectors monitor transfer operations on a continuing basis, cause a comprehensive inspection to be conducted at least once a year, and cause structural analysis to be performed at least once every 3 years.

Article 5 is similar to but more comprehensive than federal regulations in the area of establishing exchange of information between the Terminal and vessels, information that must be contained in the Declaration of Inspection, requirements for transfer operations, and information that must be contained in the Operations Manual. All marine terminals are required to submit updated Operations Manuals to SLC for review and approval by December 1993. Article 5 also requires that prior to the commencement of transfer of persistent oil, boom shall be deployed to contain any oil that might be released. Marine terminals, such as Unocal's, which are subject to high velocity currents where it may be difficult or ineffective to pre-deploy boom, are required to provide sufficient boom, trained personnel, and equipment so that at least 600 feet of boom can be deployed for containment within 30 minutes.

The Office of Oil Spill Prevention and Response (OSPR) was created within the CDFG to adopt and implement regulations and guidelines for spill prevention, response planning, and response capability. Final regulations regarding oil spill contingency plans for vessels and marine facilities were issued in November 1993. These regulations are similar to but more comprehensive than the federal regulations. These regulations require that tank vessels, barges, and marine facilities develop and submit their comprehensive oil spill response plans to OSPR by April 1, 1994. In the meantime, OSPR has required vessels and marine facilities to submit their OPA 90 plans.

OSPR's regulations require that marine facilities and vessels be able to demonstrate that they have the necessary response capability on hand or under contract to respond to specified spill sizes including a worst case spill. The regulations also require that a risk and hazard analysis be conducted on each facility. This analysis must be conducted in accordance with procedures identified by the American Institute of Chemical Engineers (AIChE).

SB 2040 established financial responsibility requirements and required that Applications for Certificate of Financial Responsibility be submitted by the middle of August 1991. California's requirement for financial responsibility is in excess of the federal requirements.

SB 2040 also requires the OSPR to develop a State Oil Spill Contingency Plan. In addition, each major harbor is directed to develop a Harbor Safety Plan addressing navigational safety, including tug escort for tankers. The Harbor Safety Committee of the San Francisco Bay Region issued its Draft Harbor Safety Plan in June 1992. The draft plan contains several recommendations to improve safety. One recommendation first implemented in May 1993 through the OSPR's issuance of interim regulations was the requirement that all tank vessels carrying more than 5,000 tons of oil be escorted by a tug when in one of the following zones:

- from a line drawn between Point Bonita Light, through Mile Rocks Light to the shore (the COLREGS Demarcation Line), and eastward to the Golden Gate Bridge;
- from the Golden Gate Bridge, south to a line between the southern tip of Bay Farm Island and the southeastern tip of Point San Bruno Peninsula, and north to a line from Point San Pablo Bay Light 4, to San Pablo Bay Channel Light 5, to Point San Pedro;
- from 1 mile north of and to 1 mile south of the San Mateo Bridge; and
- from Light 15 through the Carquinez Strait, north on the Sacramento Ship Channel to 1 mile beyond the Ryer Island Ferry Terminal and east

on the San Joaquin River to 1 mile beyond the Antioch Bridge.

The interim regulations expire at the end of 1994. A study is bieng conducted to develop and implement permanent regulations to continue the requirement for tug escorts.

3.1.4 Environmental Description

This section summarizes environmental conditions that could have an impact on vessel safety in the Bay Area. More detailed information on many of the areas can be found in the existing conditions description of other sections (e.g., detailed meteorological data can be found in the air quality section).

3.1.4.1 Winds

Bay Area weather is seasonably variable with three discernable seasons for marine purposes, as discussed below.

Winter Winds

Winter winds from November to February shift frequently and have a wide range of speeds dependent on the procession of offshore high- and low-pressure systems. Overall, calms occur between 15 and 40 percent of the time inside the Bay and 10 to 12 percent outside the Bay. Extreme wind conditions of 50 knots gusting to 75 knots have occurred during the winter. The strongest winds tend to come from the southeast to southwest ahead of a cold front.

Spring Winds

Spring tends to be the windiest season with average speeds in the Bay of 6 to 12 knots. Extremes are less likely than during the winter, but windspeeds from 17 to 28 knots occur up to 10 percent of the time. The approaches to the Golden Gate receive heavier weather and may experience 17- to 28-knot winds up to 40 percent of the time. Wind direction stabilizes as the Pacific High Pressure System becomes the dominant weather influence. Northwesterly winds are generated and reinforced by the sea breeze. Inside the Bay, winds are channeled and vary from northwest to southeast.

Summer Winds

Summer winds are the most constant and predictable. The winds outside the Golden Gate are normally from northwest to north and are generated by the strong Pacific High. This condition lasts through October until the system weakens and the winter cycle starts again. Winds inside the Bay are local depending on the land contours acting on the onshore flow. One of the few occurrences that will alter this pattern is when a high-pressure system settles over Washington and Oregon. When that happens, a northeast flow develops, bringing warm dry air with it. This will clear away the summer fog, but also will dry the landscape and increase fire dangers.

3.1.4.2 Fog

Fog is a well known problem in the Bay Area, particularly around the Golden Gate. It is most common during the summer, occasional during fall and winter, and infrequent during spring. The long-term fluctuations are not predictable, but daily and season cycles are.

Summer Fog

Summer fog is dependent on several routine conditions. The Pacific High becomes well established off the coast and maintains a constant northwest wind. It also drives the cold California Current south and causes an upwelling of cold water along the coast. Air closest to the surface becomes chilled so that the temperature increases with altitude. This forms an inversion layer at about 500 to 1,500 feet. Moist, warm ocean air moving toward the coast is cooled first by the California Current, then more by cold coastal water. Condensation occurs and fog will form to the height of the inversion layer. This happens often enough to form a semipermanent fog bank off the Golden Gate during the summer. Under normal summer conditions, a daily cycle is evident. A sheet of fog forms off the Golden Gate headlands during the morning and becomes more extensive as the day passes. As the temperatures in the inland valleys rise, a local low pressure area is created, and a steady indraft takes place. By late afternoon, the fog begins to move through the Golden Gate at a speed of about 14 knots on the afternoon sea breeze. Once inside the Bay, it is carried by local winds. In general, the north part of the Bay is the last to be enveloped and the first to clear in the morning. The flow is so strong at times that the sea fog penetrates as far east as Sacramento and Stockton. If it continues for a few days, cooler ocean air replaces the warm valley air and causes the sea breeze mechanism to break down. Winds diminish and the Bay Area clears for a few days. Slowly the valley reheats and starts the cycle again.

<u>Winter Fog</u>

Winter fogs are usually radiation fog or "tule" fog. With the clear skies and light winds, land temperature drops rapidly at night. In low, damp places such as the Delta and Central Valley (where tules and marsh plants grow), it results in a shallow radiation fog (moist sea air reacting to cold land mass) that may be quite dense. In contrast to the summer fog that moves from sea to land at about 14 knots, the winter tule fogs move slowly seaward at about 1 knot.

3.1.4.3 Currents

The currents at the entrance to San Francisco Bay are variable, uncertain, and at times attain considerable velocity. Immediately outside the bar is a slight current to the north and west known as the Coast Eddy Current. The currents that have the greatest effect on navigation in the Bay and out through the Golden Gate are tidal in nature.

<u>Golden Gate Flood Current</u>

In the Golden Gate, the flood or incoming current sets (direction of flow) straight in (east) with a slight tendency to the north shores and with heavy turbulence at both Lime Point and Fort Point when the flood is strong. This causes an eddy or circular current between Point Lobos and Fort Point.

<u>Golden Gate Ebb Current</u>

The ebb or outgoing current has been known to reach more than 6.5 knots between Lime and Fort Points. Its general set is westward. As with the flood, it causes eddies between Point Lobos and Fort Point. A heavy rip and turbulence extend to a quarter of a mile south of Point Bonita.

<u>Golden Gate Current Maximums</u>

In the Golden Gate, the maximum flood current occurs about 1-1/2 hours before high water, with the maximum ebb occurring about 1-1/2 hours before low water. The average current velocities are 3 knots for the flood and 3.5 knots for the ebb.

<u>Inner Bay Currents</u>

Inside the Golden Gate, the flood sets to the northeast and causes swirls and eddies. This is most pronounced between the Golden Gate, Angel Island, and Alcatraz Island. The current sets through Raccoon Strait (north or Angel Island), taking the most direct path to the upper bay and the delta area. The ebb current inside the Golden Gate is felt on the south shore first. The duration of the ebb is somewhat longer than the flood due to the addition of runoff from the Sacramento and San Joaquin River systems.

3.1.4.4 Tides

Tides in the San Francisco Bay Area are mixed in that there are usually two cycles of high and low tides daily but with inequality of the heights of the two. Occasionally, the tidal cycle will become diurnal (only one cycle of tide in a day). As a result, depths in the Bay are based on MLLW, which is the average height of the lower of the two daily low tides. The mean range of the tide at the Golden Gate is 4.1 feet, with a diurnal range of 5.8 feet. During the periodic maximum tidal variations, the range may reach as much as 9 feet and have lowest low waters 2.5 feet below MLLW datum.

<u>Accuracy of Tidal Information</u>

The previous paragraph presents a general description of the tidal current situation in the Bay Area. There are presently no valid tidal current charts in effect. In late 1991, NOAA withdrew the local tidal current charts from use due to significant errors in predictions. This also affected the tide tables. NOAA is addressing the problem of inaccurate tide and current information but faces severe problems in funding and will be working behind a 2-year data-gathering time lag.

3.1.4.5 Depths

Water depth in the Bay Area is generally shallow and subject to silting from river runoff and dredge spoil recirculation. Economic pressures are causing mariners to navigate in waters of marginally adequate depth, basing their keel clearances on charted depths and predicted tidal levels. As noted above, the information provided for tidal prediction is not accurate and unfortunately the same conditions may prevail for charted depths.

Surveys

Specific areas with high interest levels are surveyed on a frequent basis. The last general surveys of the Bay Area were completed as follows:

San Francisco Bay, North Part	Late 1970s
San Francisco Bay, Middle Part	Early 1980s
San Francisco Bay, South Part	Mid 1980s
San Pablo Bay	1983-1984
Suisun Bay	Late 1980s
Source: Index of Hydrographic Surveys 1978-1991, San Francisco Bay and Vicinity.	

Variables

Even charts based on modern surveys may not show all seabed obstructions or shallow areas due to mobile bottoms caused by localized shoaling. Recent observations have indicated that manmade channels may be influencing tidal currents to a greater degree than anticipated, with consequent effect on silting. Additional indications are that not as much dredge spoil deposited in the Alcatraz dump site may be making its way to sea as estimated, causing alterations in the bottom topography and silt recirculation in the north and middle San Francisco Bay regions.

3.1.5 Cumulative Environment

3.1.5.1 Navigational Description

A Traffic Separation Scheme (TSS) has been established off the entrance of San Francisco Bay. It is composed basically of three directed traffic areas, each with one-way inbound and outbound traffic lanes separated by defined separation zones, a precautionary area, and a pilot boat cruising area. The TSS is recommended for use by vessels approaching or departing the Bay, but is not necessarily intended for tugs, tows, or other small vessels that traditionally operate outside the usual steamer lanes or close inshore. This TSS has been adopted by the IMO. Figure 3.1-1 depicts the TSS area and navigation aids.

An additional TSS has been established through the Main Ship Channel and Golden Gate into San Francisco Bay. The TSS consists of one-way traffic lanes separated by a separation line and, after entry into San Francisco Bay, includes a precautionary area, a limited traffic area, and recreation areas. This TSS has not yet been adopted by the IMO.

A VTS has been established by the USCG for San Francisco Bay, its seaward approaches, and its tributaries as far inland as Stockton and Sacramento. The VTS has three components: a position reporting system, traffic routing within the Bay and anchorage monitoring, and communication and surveillance equipment. Participation in the VTS is currently voluntary, however, all tank vessels subject to tug escort requirements and the vast majority of all other commercial traffic do participate.

VTS Position Reporting Requirements

Currently, three different position reporting requirements exist for vessels operating within the VTS service area: vessels operating offshore, vessels operating within the radar-surveillance areas of the Bay, and vessels operating beyond the radar-surveillance areas of the Bay. In all three areas, vessels are requested to report to the VTS at certain locations and when certain other actions happen.

Traffic Routing Within the Bay

The Traffic Routing System within the Bay designates traffic lanes, precautionary areas, and limited traffic areas. The primary shipping lanes within the Bay call for eastbound and westbound vessels to pass south of Alcatraz into a precautionary area. However, traffic patterns have changed since the establishment of the TSS, and some vessel movements are contrary to the TSS for the following reasons:

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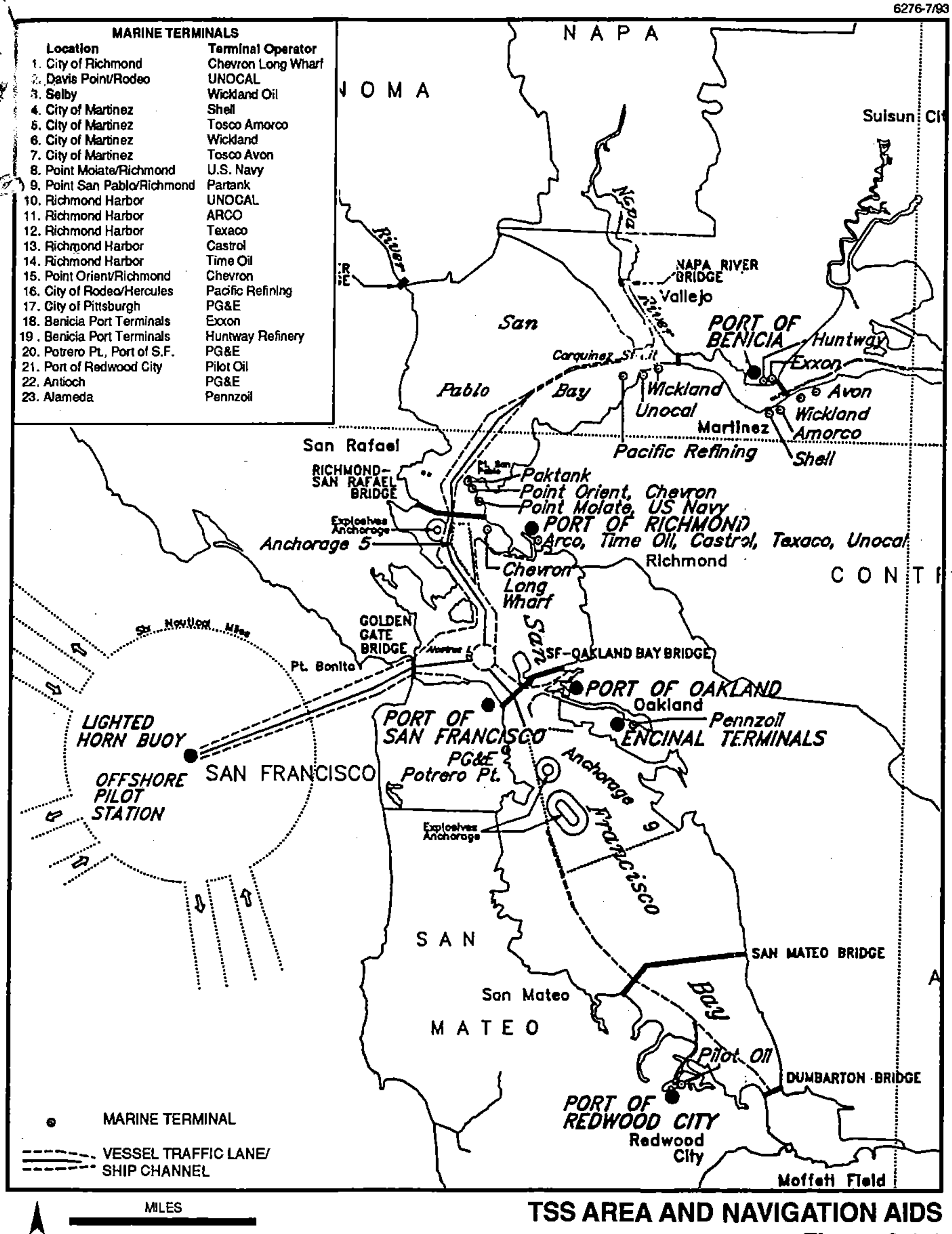


Source: Joint California Coastal Commission/ BCDC Oil Spill Program

TSS AREA AND NAVIGATION AIDS
Figure 3.1-1

- Geography confines deep draft vessels to pass east of Blosson Rock and proceed south in the northbound traffic lane passing under the C-D or D-E span of the San Francisco-Oakland Bay Bridge.

- Maneuvering characteristics make it much safer for vessels bound for Oakland to cross the traffic lanes and pass under the C-D or D-E spans of the bridge to facilitate "shaping-up" for the Oakland Bar Channel.

- Ferries and vessels arriving and departing berths on the waterfront cross the traffic lanes as a matter of necessity. The number of ferry transits has significantly increased over the years from 21,000 in 1974 to 58,000 in 1990.

Communication and Surveillance

The USCG Vessel Traffic Center (VTC) at Yerba Buena Island is the communications center for the VTS. Radar installations are located at Pt. Bonita and Yerba Buena Island. Two closed-circuit television cameras on Yerba Buena Island provide visual coverage of the central Bay. The Harbor Safety Committee has recommended expansion of the area of sensor coverage to monitor the navigable waters of San Pablo Bay north of the San Rafael-Richmond Bridge and east of the Carquinez Bridge to New York Point and Antioch. Figure 3.1-2 shows that the existing and proposed sensor would provide continuous vessel coverage between the Bay entrance and the Unocal Terminal.

Pilotage

Pilotage in and out of San Francisco Bay and adjacent waterways is compulsory for all vessels of foreign registry and U.S. vessels under enrollment not having a federal licensed pilot on board. The San Francisco Bar Pilots provide pilotage to ports in San Francisco Bay and to ports on all tributaries to the Bay. Pilots board the vessels in the Pilot Boarding Area outside the Golden Gate entrance and then pilot the vessels to their destinations. Pilots normally leave the vessels after docking and reboard the vessels when they are ready to leave and pilot them to sea or other destinations within the Bay Area.

Navy pilots pilot military vessels and Military Sealift Command (MSC) vessels. The MSC vessels are normally boarded in the Pilot Boarding Area outside the Golden Gate entrance. The military vessels are boarded either outside the Golden Gate entrance or inside the Bay (Wakefield, 1991).

3.1.5.2 Vessel Traffic in Bay

Several sources were used to estimate the amount, type, and routing of vessel traffic in the Bay Area. The USCG Port Needs Study (U.S. Department of Commerce, 1991) developed vessel traffic information for 1987 based primarily on Corps Waterborne Commerce data and then made vessel traffic forecasts for 1995, 2000, 2005, and 2010. The vessel traffic forecasts were constructed by applying commodity tonnage growth rates developed by the Bureau of Labor Statistics (BLS) to each vessel type, adjusting for projected changes in average capacity of vessels. The number of vessel transits is broken down by subzone within the Bay Area, vessel type, and vessel size. Table 3.1-4 summarizes the vessel traffic for 1987, and Table 3.1-5 summarizes the forecast for 1995. Figure 3.1-3 depicts the subzones as defined in the Port Needs Study.

Marine Exchange tanker reports were used to analyze tanker transits in the Bay Area in more detail. One year of tanker transit data from May 1991 through April 1992 was analyzed. The various marine terminals were combined geographically into the following categories for the purpose of the analysis:

- San Francisco ports,

- Oakland/Alameda ports,

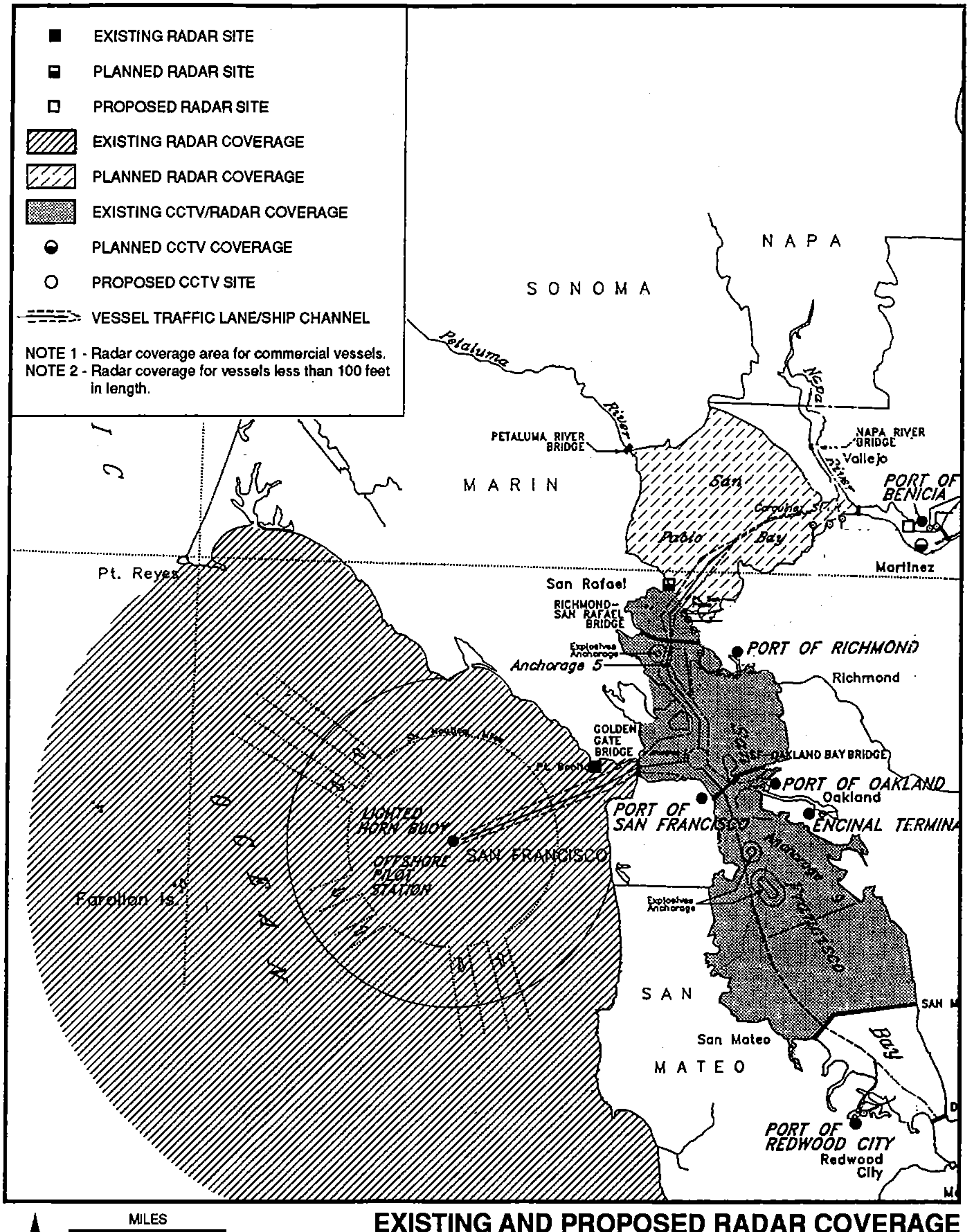
- Richmond ports,

- Oleum ports (Unocal, Pacific Refining Company, and Wickland),

- Redwood City, and

- ports upstream of Carquinez Bridge.

In addition, movements to and from Anchorages 8 and 9 were included in the analysis. Table 3.1-6 summarizes the number of vessel movements between the various locations in the matrix. As can be seen from the table, a moderate amount of movement occurs between ports. For example, the table shows that 57 movements were among ports in the Richmond area and 39 were from Richmond to ports past the



Source: Joint California Coastal Commission/ BCDC Oil Spill Program

EXISTING AND PROPOSED RADAR COVERAGE
Figure 3.1-2

Table 3.1-4

BASE YEAR 1987: VESSEL TRANSITS BY SUBZONE, VESSEL TYPE, AND SIZE

Vessel Type	Large	Medium	Small	Total
Subzone: 1401A				
Passenger	0	60	0	60
Dry Cargo	3,439	7,266	1,149	11,854
Tanker	2,040	2,388	1,008	5,436
Dry Cargo Barge Tow	85	0	358	443
Tanker Barge Tow	156	0	184	340
Tug/Tow Boat	0	0	151	151
Subzone Total:	**5,720**	**9,714**	**2,850**	**18,284**
Subzone: 1402B				
Passenger	0	60	3,850	3,910
Dry Cargo	1,841	3,629	882	6,352
Tanker	1,141	1,402	804	3,347
Dry Cargo Barge Tow	57	0	0	57
Tanker Barge Tow	120	0	0	120
Subzone Total:	**3,159**	**5,091**	**5,536**	**13,786**
Subzone 1403C				
Passenger	0	60	42,107	42,167
Dry Cargo	1,841	3,629	4,412	9,882
Tanker	1,141	1,402	804	3,347
Dry Cargo Barge Tow	57	0	6,746	6,803
Tanker Barge Tow	120	0	3,773	3,893
Tug/Tow Boat	0	0	12,750	12,750
Subzone Total:	**3,159**	**5,091**	**70,592**	**78,842**
Subzone: 1404D				
Passenger	0	0	100	100
Dry Cargo	1,267	1,504	310	3,081
Tanker	1	0	1	2
Dry Cargo Barge Tow	0	0	697	697
Tanker Barge Tow	0	0	625	625
Tug/Tow Boat	1	0	6,170	6,171
Subzone Total:	**1,269**	**1,504**	**7,903**	**10,676**
Subzone: 1405F				
Dry Cargo	264	1,012	201	1,477
Tanker	571	732	380	1,683
Dry Cargo Barge Tow	56	0	2,889	2,945
Tanker Barge Tow	90	0	1,662	1,752
Tug/Tow Boat	0	0	1,287	1,287
Subzone Total:	**981**	**1,744**	**6,419**	**9,144**
Note: Sum of all vessel transits within each study subzone.				
Zone Totals (1987)				
Passenger	0	60	42,107	42,167
Dry Cargo	3,439	7,266	4,679	15,384
Tanker	2,040	2,388	1,008	5,436
Dry Cargo Barge Tow	85	0	7,104	7,189
Tanker Barge Tow	156	0	3,957	4,113
Tug/Tow Boat	0	0	12,901	12,901
1987 Zone Total:	**5,720**	**9,714**	**71,756**	**87,190**

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Table 3.1-5

FORECAST 1995: VESSEL TRANSITS BY SUBZONE, VESSEL TYPE, AND SIZE

Vessel Type	Large	Medium	Small	Total
Subzone: 1401A				
Passenger	0	63	0	63
Dry Cargo	4,439	9,428	5,868	19,735
Tanker	2,170	2,564	1,064	5,798
Dry Cargo Tow	0	0	8,240	8,240
Tanker Tow	0	0	4,266	4,266
Tug/Tow Boat	0	0	16,242	16,242
Subzone Total:	**6,609**	**12,055**	**35,680**	**54,344**
Subzone: 1402B				
Passenger	0	63	4,054	4,118
Dry Cargo	2,405	4,712	5,522	12,639
Tanker	1,208	1,503	848	3,559
Dry Cargo Tow	0	0	7,832	7,832
Tanker Tow	0	0	4,057	4,057
Tug/Tow Boat	0	0	16,404	16,404
Subzone Total:	**3,613**	**6,278**	**38,717**	**48,609**
Subzone 1403C				
Passenger	0	63	49,680	49,743
Dry Cargo	2,405	4,712	5,522	12,639
Tanker	1,208	1,503	848	3,559
Dry Cargo Tow	0	0	7,832	7,832
Tanker Tow	0	0	4,057	4,057
Tug/Tow Boat	0	0	16,404	16,404
Subzone Total:	**3,613**	**6,278**	**84,343**	**94,234**
Subzone: 1404D				
Passenger	0	0	4,547	4,547
Dry Cargo	1,681	2,015	412	4,108
Tanker	1	0	0	1
Dry Cargo Tow	0	0	798	798
Tanker Tow	0	0	700	700
Tug/Tow Boat	0	0	8,244	8,244
Subzone Total:	**1,682**	**2,015**	**14,701**	**18,398**
Subzone: 1405F				
Dry Cargo	322	1,238	238	1,798
Tanker	603	786	398	1,787
Dry Cargo Tow	0	0	3,350	3,350
Tanker Tow	0	0	1,785	1,785
Tug/Tow Boat	0	0	1,444	1,444
Subzone Total:	**925**	**2,024**	**7,215**	**10,164**
Note: Sum of all vessel transits within each study subzone.				
Zone Totals (1995)				
Passenger	0	63	44,343	44,406
Dry Cargo	4,049	8,622	5,485	18,156
Tanker	2,170	2,564	1,064	5,798
Dry Cargo Tow	0	0	8,240	8,240
Tanker Tow	0	0	4,260	4,266
Tug/Tow Boat	0	0	16,242	16,242
1995 Zone Total:	**6,219**	**11,249**	**79,640**	**97,108**
Note: Sum of all arrivals/departures to/from all terminals within the study zone.				

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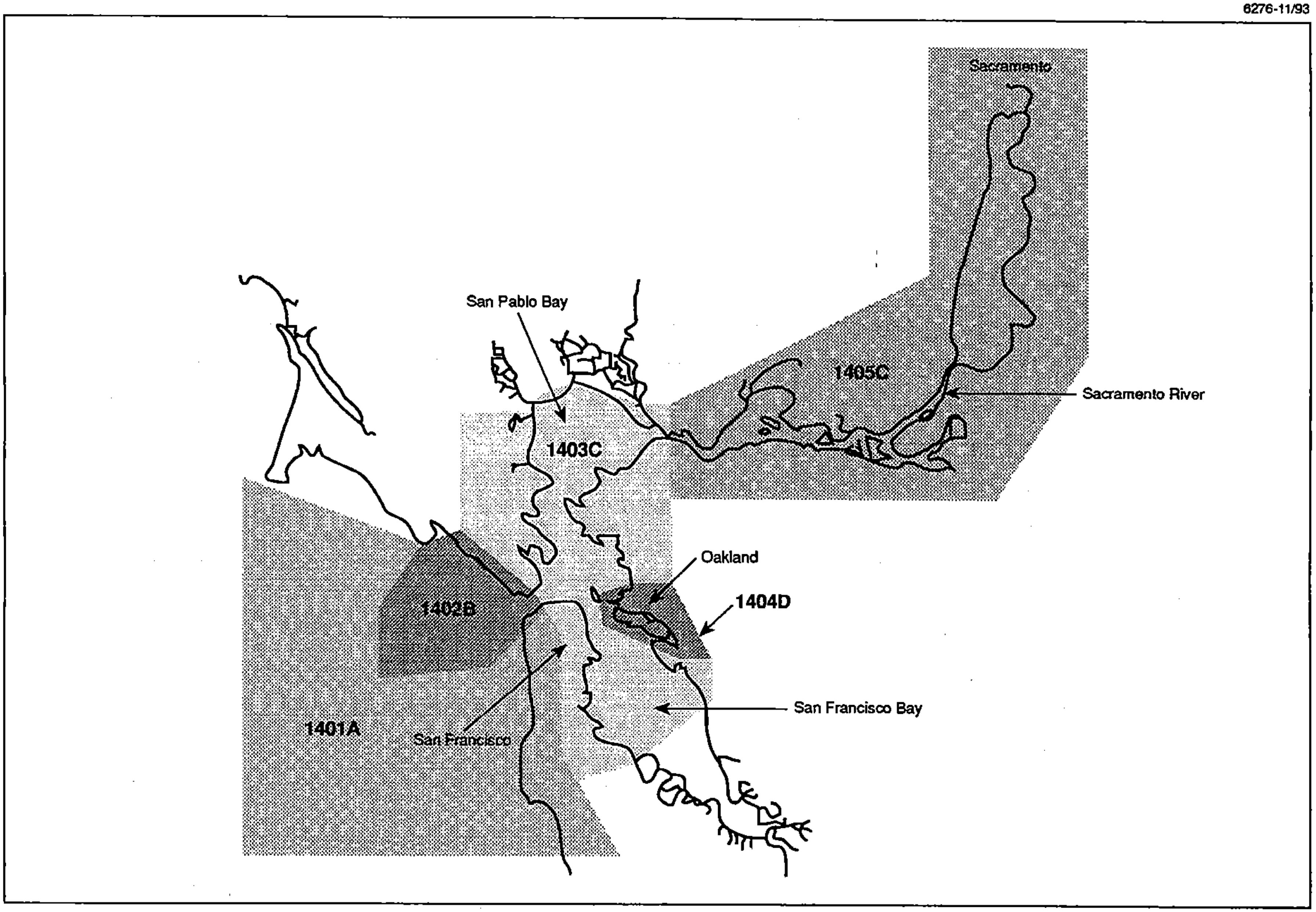

ZONE 14-SAN FRANCISCO, CA
ZONE AND SUBZONE BOUNDARIES
Figure 3.1-3

Table 3.1-6

PETROLEUM TANKER MOVEMENTS WITHIN SAN FRANCISCO BAY MAY 1991 TO APRIL 1992 (FROM MARINE EXCHANGE)

From/To	Outside Bay	San Francisco Ports	Oakland Alameda Ports	Anchorage 8	Anchorage 9	Richmond Ports	Oleum Ports	Ports Past Carquinez Bridge	Redwood City	Total	Corps 1988 Waterborne Commerce
Outside Bay		18	4	47	239	299	126	268	2	1003	1001
San Francisco Ports	29			1	3	5		6		44	45
Oakland/Alameda Ports	2	1						1		4	5
Anchorage 8	7	2				9	11	29		58	N/A
Anchorage 9	155	6				86	25	136		408	N/A
Richmond Ports	285	17		5	69	57	26	39		498	486
Oleum Ports	154				18	17	7	34		230	N/A
Ports Past Carquinez Bridge	369			5	79	25	35			513	512
Redwood City	2									2	1
Total	1,003	44	4	58	408	498	230	513	2	2,760	
Corps - 1988 Waterborne Commerce	997	49	4	N/A	N/A	486	N/A	513	1		

Total movement as reported by:
Marine Exchange (1991/1992) - 5520
USCG Port Needs Study (1987) - 5436
USCG Port Needs Study (1995 Forecast) - 5798

Carquinez Bridge. As can be seen from the table, 2,760 total tanker movements occurred during the 1-year time period. Marine Exchange reported that 3,671 vessel arrivals occurred during 1991, of which 1,006 were oil tankers. They also report that 2,238 shifts or total in-Bay vessel movements occurred, of which well over one-half were oil tankers or barges. The above vessel traffic estimates do not include naval vessels.

As a comparison, the 1988 Corps Waterborne Commerce data were added to the table where appropriate. As can be seen, the data are in close agreement with the current Marine Exchange data. Also, the Port Needs Study 1987 baseline and 1995 forecast tanker movement data have been added to the table. Again, these numbers are consistent with Marine Exchange and Corps data.

Lightering, transfer of oil from one vessel to another, takes place in Anchorage 9. Lightering is normally conducted from a large tanker, whose draft is too deep to allow it to call at a certain terminal with a full load, to a smaller tanker. Lightering has decreased in the Bay Area since the inception of air quality regulations requiring receiving vessels to be equipped with vapor recovery. Approximately seven to ten lighterings take place monthly. The vast majority of these operations are by Exxon to the Baytown and Galveston. While there is presently no regulation or requirement for having an oil spill response vessel present during lightering operations, virtually all lightering operations are conducted with one present. OSPR has issued proposed regulations requiring that such vessels be present during lightering operations.

3.1.5.3 Vulnerable Resources

Vulnerable resources are those resources that could potentially be harmed by an accident or spill involving the facility or vessels calling at the facility. Biological resources are addressed in Section 3.3. Besides commercial vessel traffic in the Bay, a great deal of fishing and recreational boating traffic occurs, as well as ferry service. The Harbor Safety Committee estimates that the ferry system annually makes approximately 60,000 trips and that an estimated 20,000 boat berths exist around the Bay, exclusive of the Sacramento and San Joaquin Rivers. Fishing and recreation boating are presented in Sections 3.4 and 3.10, respectively.

The Marine Terminal is located in an area away from housing, recreation, or other populated areas. The land use near the Marine Terminal is addressed in Section 3.10.

3.1.5.4 Oil Spill Response Capability

All of the marine terminals and vessels calling at the marine terminals are required to have oil spill response plans and a certain level of initial response capability. The requirements for this level of capability are in the process of being increased in response to recent federal and state legislation. See Section 3.1.3 for a discussion of this legislation. However, it is not economically feasible or practical for terminal operators to each have their own equipment to respond to more than minor spills. Therefore, operators must rely on pooled or contract capabilities. The capabilities available to Unocal are described below.

Oil Spill Cooperatives

An oil spill cooperative, Clean Bay, has been established for the Bay and outer coast areas. Specifically, Clean Bay's area of response includes San Francisco Bay, including Suisun Bay and Honker Bay to the Antioch Bridge in the Delta, and the outer coast from Fort Bragg in the north to Cap San Martin in the south. An oil spill cooperative is an organization established by a group of companies to provide oil spill response capability. Each company contributes its share of the cost of the cooperative and then has access to the cooperative's equipment and manpower when needed. Oil spill cooperatives also provide training to member company personnel and take part in member company drills on a regular basis.

Clean Bay has an extensive inventory of response equipment located throughout the Bay Area. This equipment is listed in the Clean Bay Oil Spill Contingency Plan and consists of over 45,000 feet of boom, 28 skimmers, 2 large response vessels, 9 workboats, an oil storage barge, and other ancillary equipment. Table 3.1-7 lists the types, sizes, and locations of booms in the Clean Bay inventory. Table 3.1-8 lists the types, location, and nameplate recovery capacity of the skimmers in the Clean Bay inventory. Both the proposed state and federal oil spill response regulations recognize that skimmers do not necessarily operate at their nameplate capacity and that it is usually not possible to skim at night. Thus, they require a facility operator to multiply the daily

Table 3.1-7

CLEAN BAY CONTAINMENT BOOM

Type	Brand/ Description	Size (inches)	Length (feet)	Storage Location
Inflatable	Expandi 4300	20 x 23	9,950	3,000 feet on Clean Bay II, 2,000 feet on Clean Bay I, 1,650 feet at IT Corp., 1,250 feet at Clean Bay Warehouse, 2,050 ft at DMS
	Expandi 3000	13 x 17	1,700	DMS
	Vikoma Seapack	27 x 17	1,600	DMS
	Net Boom	11 x 36	80	DMS
	Texaboom	11 x 36	40	DMS
Harbor Boom		16 x 12	4,400	IT Corp.
		9 x 11	14,500	2,400 ft at Oscar Niemeth Towing, 3,700 ft at DMS, 300 ft on Munson I, 300 ft on Munson II, 600 ft on Raider I, 800 ft on Raider II, 600 ft on Raider III, 800 ft on Raider IV, 5,000 ft at Clean Bay Warehouse
		6 x 11	5,400	1,400 ft at DMS, 4000 ft at Clean Bay Warehouse
		5 x 11	2,000	1,000 ft at Clean Bay Warehouse, 500 ft at Cordelia Fire Dept., 500 ft at Vallejo Marina
Swamp Boom		3 x 3	3,000	2,000 ft at Clean Bay Warehouse, 500 ft at Cordelia Fire Dept., 500 ft at Vallejo Marina
		4 x 4	2,000	Clean Bay Warehouse
Fence Boom	Troil 1100	16 x 42	450	200 ft on Clean Bay I, 20 ft on Clean Bay II, 50 ft at DMS
	Aquafence	12 x 12	500	Clean Bay Warehouse
	Hurricane Fence		200	Clean Bay Warehouse
Total Length of Containment Boom			**45,820**	

Clean Bay II moored at Berth 40, Port of Oakland
Clean Bay I moored at ARCO Terminal in Port of Richmond
IT Corp. located at Vine Hill Yard
Clean Bay Warehouse located in Concord
DMS located in Martinez
Oscar Niemeth Towing located at Berth 40, Port of Oakland
Munson I and II located at Martinez Marina
Raider I, II, II, and IV located at DMS in Martinez

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Table 3.1-8

CLEAN BAY SKIMMERS

Type	Brand/Description	Number	Unit Capacity (bbl/hr)	Total Capacity (bbl/hr)	20 Percent Nameplate Capacity (bbl/day)	Location
Self-Propelled	Marco Class III (58 ft)	2	300	600	2,880	Oakland Outer Harbor, Martinez Marina
	Marco Class I (34 ft)	2	15	30	144	Long Wharf (Richmond), Martinez Marina
Weir Type	Walosep W-4	2	742	1,484	7,123	DMS (Martinez), Clean Bay Warehouse
	Walosep W-1	2	300	600	2,880	Clean Bay I, DMS (Martinez)
	Walosep W-2	1	400	400	1,920	Clean Bay II
	Walosep WM	2	62	124	595	DMS (Martinez), Clean Bay Warehouse
	GT-185	2	285	570	2,736	Clean Bay I, Clean Bay II
	GT-260	1	625	625	3,000	DMS (Martinez)
	Demsi 250	1	485	485	2,328	DMS (Martinez)
Oil Mop	6 inches	1	10	10	48	Clean Bay Warehouse
	4 inches	8	7	56	269	DMS (Martinez) and Clean Bay Warehouse
Other	Oil Hawg	2				Clean Bay Warehouse
	Skim Pac	2	25	50	240	Clean Bay Warehouse
Total Skimmer Capacity				**5,034**	**24,163**	

skimmer nameplate capacity by 20 percent when calculating the skimmer capacity available. The capacity using the 20-percent factor has also been included in the table.

Table 3.1-9 presents information on the Clean Bay response vessels including location, size, and major response equipment on board (boom and skimmers). In addition to the response vessels, Clean Bay maintains a 10,000-bbl oil storage barge at Harbor Tug & Barge in Alameda. Clean Bay states in its Oil Spill Contingency Plan that two to six of the small response boats would respond to the Unocal Terminal within 1.4 hours of being informed of a spill. In addition, Clean Bay also states that a Level 2 response effort will be at the Terminal within 3 hours. A Level 2 response would consist of the following:

- <u>Clean Bay I</u>,
- one spill spoiler (self-propelled skimmer),
- one mini-spoiler (self-propelled skimmer),
- six workboats, and
- 5,000 feet of boom.

Clean Bay maintains various pumps that can be used to lighter vessels and/or transfer oil from response vessels to barges or terminals. Information on these pumps is contained in Table 3.1-10. Clean Bay also maintains an inventory of trailers and trucks to transport equipment to spill locations. Information on these vehicles is also contained in Table 3.1-10. Clean Bay also maintains an inventory of dispersant and has a contract with Air Response, Inc. in Mesa, Arizona, for a dispersant aircraft. Table 3.1-10 also contains information on dispersants, communications, and storage. Table 3.1-11 summarizes response equipment available from Clean Bay member companies.

Clean Bay's Oil Spill Contingency Plan is a comprehensive document that describes Clean Bay's response equipment, organization, and strategies; sensitive resources; and other information necessary to respond to an oil spill. Volume II of the plan contains detailed maps of the outer coast and the Bay.

Clean Bay has a number of experienced companies under contract to provide equipment, services, and/or manpower as required. A summary of the companies and their capabilities is contained in the Oil Spill Contingency Plan. Clean Bay also has mutual aid agreements with 17 other spill cooperatives, including the three other California cooperatives, Clean Coastal Waters, Clean Seas, and Humboldt Bay, to provide assistance if needed. Clean Coastal Waters' area of responsibility extends from the Mexican border to Point Dume, Clean Seas' area of responsibility extends from Point Dume to Cape San Martin, and Humboldt Bay's area of responsibility extends from Fort Bragg to the Oregon border.

<u>U.S. Navy Supervisor Salvage</u>

Located in Stockton, the U.S. Navy Supervisor Salvage relies primarily on JB 3001 self-propelled skimmers. The Navy also has smaller, unspecified skimming systems and boom in units of 500 feet. The equipment is most suited to harbors or quiet waters.

<u>U.S. Coast Guard, Pacific Strike Team</u>

Located at Hamilton Air Force Base, this team maintains skimmers and booms applicable for offshore use. They also maintain systems capable of lightering vessels if required.

<u>Marine Spill Response Corporation</u>

In response to the Valdez oil spill in Alaska, the oil companies created two new organizations: the Marine Spill Response Corporation (MSRC) and the Marine Preservation Association (MPA). MSRC is an independent oil spill response organization. It is headquartered in Washington, D.C. and operates out of five regional response centers, each supported by several strategically placed equipment sites. MPA is an organization of oil companies and shippers and receivers of oil. MPA members pay annual dues based on the amount of oil they transport. MPA then funds MSRC but has no control over their operations. If an MPA member has a spill, MSRC is available to aid the spiller. The spiller must reimburse MSRC for the costs of their response effort.

The coast of California is included in the MSRC region headquartered in Port Hueneme, California. The region maintains equipment and response personnel in Port Hueneme, Richmond, and Eureka/Humboldt Bay in California and in Honolulu and Hilo in Hawaii. Table 3.1-12 summarizes the major equipment maintained in California by location. MSRC also maintains an inventory of support equipment including mobile communications equipment, pumps, hoses, etc. MSRC maintains three

Table 3.1-9

CLEAN BAY RESPONSE VESSELS

Vessel Name	Location	Length (feet)	Major Equipment on Board
Clean Bay II	Berth 40, Port of Oakland	166	3,000 ft Expandi 4,300 Boom GT-185 Skimmer Walosep W-2 Skimmer
Clean Bay I	ARCO Terminal, Port of Richmond	140	2,000 ft Expandi 4,300 Boom GT-185 Skimmer Walosep W-1 Skimmer
Raider I	Martinez Marina	32	600 ft 9" x 11" Boom
Raider II	Martinez Marina	32	800 ft 9" x 11" Boom
Raider III	Martinez Marina	38	600 ft 9" x 11" Boom
Raider IV	Martinez Marina	38	800 ft 9" x 11" Boom
Munson I	DMS, Martinez	21	300 ft 9" x 11" Boom
Munson II	DMS, Martinez	21	300 ft 9" x 11" Boom
Boston Whaler	DMS, Martinez	16	
Rigid Hull Inflatable	On Board Clean Bay I	15	
Rigid Hull Inflatable	On Board Clean Bay II	15	

Table 3.1-10

CLEAN BAY RESPONSE EQUIPMENT

Category	Type	Description	Location
Pumps	Tanker Lightering Equipment (Anti-Pollution Transfer System)	One 400-hp, air-cooled diesel engine prime mover mounted in a fiberglass container complete with hydraulic pump. ▸ Two 6" submersible pumps, each with a 1,000 - gpm capacity. ▸ 1,400 ft of 8" floating discharge hose. ▸ 400 ft of 6" floating discharge hose. Accessory equipment for handling prime mover, pumps and hoses, including one drum of hydraulic oil.	Clean Bay Warehouse
	TK-150	Two hydraulically powered, submersible cargo transfer pumps.	▸ 1 on board Clean Bay I ▸ 1 on board Clean Bay II
	Desmi 250	Hydraulically driven cargo transfer pump.	DMS, Martinez
	Miscellaneous Portable Pumps	▸ Two Wilden M15B spark-free, diaphragm pumps; compressed air driven, 150 gpm, with 100 psi air pressure. ▸ One 2" gasoline-driven portable pump with hoses. ▸ One 3" gasoline-driven portable pump with hoses.	Clean Bay Warehouse
Vehicles	Mobile Headquarters Trailer	8' x 25' office trailer with tandem axle. ▸ One Craftsman multi-band AM receiver. ▸ Two Motorola multi-unit chargers. ▸ Two headphone sets. ▸ Six headphone sets, helicopter. ▸ One Intech marine base station (Channels 10, 16, 18A & 22A). ▸ One marine radio telephone manual. ▸ One Motorola UHF marine radio. ▸ 13 Motorola 6-W paksets; cases with belts. ▸ One Intech scan receiver (Channels 10, 16, 18A, 22A & WXI). ▸ Two telephone cable coils.	Clean Bay Warehouse
	Boom Storage/Hauling Trailers (11)		DMS, Martinez
	Boat Trailers (8)		DMS, Martinez
	Sorbent Storage Trailer	35 ft semi-trailer van with sorbent pads, boom, and blankets.	IT Corporation, Martinez
	Dispersant Tank Trailer		IT Corporation, Martinez
	2-Ton Truck		DMS, Martinez
	Pickup Trucks		DMS, Martinez

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Table 3.1-10 (Continued)

CLEAN BAY RESPONSE EQUIPMENT

Category	Type	Description	Location
Vehicles (Continued)	Auto w/Cellular & UHF		Concord
	Forklift (4,000 lb)		Clean Bay Warehouse
	Tool Trailer	Gross vehicle weight is 3,560 lbs. It is recommended that this vehicle be towed with a 1/2-ton or larger pickup truck.	Clean Bay Warehouse
Aircraft	DC-4 Dispersant Aircraft	(Lease)	Air Response, Inc. Mesa, Arizona (602) 844-0800
Communications	Radio Base Station, Fixed		Clean Bay Office, Concord
	Radio Base Station, Mobile		Clean Bay Warehouse
	Radio Repeater, Fixed		Clean Bay Office, Concord
	Tracking Buoys		Clean Bay Warehouse
	Buoy Receiver/Antenna		Clean Bay Warehouse
	Cellular Phones (7)	Seven handheld portable cellular phones with rechargeable batteries.	Clean Bay Office, Concord
Miscellaneous	Dispersant	14,740 gallons of Exxon Corexit 9527 Oil Spill Dispersant Concentrate. *Hauling:* Dispersant not to be moved except by instruction from the Clean Bay Manager.	▸ 4,400 gal - Tank trailer stored at IT Corporation Yard, Martinez ▸ 10,340 gal - Chevron Richmond Refinery, Warehouse No. 8
	Dispersant - Additional Supply	2,000 gallons of Corexit 9527 co-owned by California coops.	Air Response, Inc. Mesa, Arizona (602) 844-0800
	Storage Bags		DMS, Martinez
	Portable Storage Tanks	Three 2,400-gallon Fastanks; portable field erectable temporary storage tanks.	▸ 2 at Clean Bay Warehouse ▸ 1 at DMS, Martinez

Table 3.1-11

RESPONSE EQUIPMENT AVAILABLE TO CLEAN BAY FROM MEMBERS' FACILITIES

Item	Location						
	ARCO Richmond	Chevron Richmond	Exxon Benicia	Shell Martinez	Texaco Richmond	Tosco	Unocal Rodeo
Booms (in feet)							
Kepner Seacurtain (16x12)	900		2,500				
24" Crowley Petro Barrier		4,000					
Optimax				2,000		2,000	
6" Slickbar Spill Boom					1,835		
Skimmers							
Mark II		3					
Manta Ray Skimmer					1		
Workboats							
32' Aluminum			1				
Slickbar Containment Boat					1		
22' Boston Whaler				1		2	
21' Aluminum (Munson)		2				1	
20' Workboats			1	2			
16-17' Aluminum Boat/Workboat	1	3			1	3	
12-14' Workboat		2	1			4	2
Pumps							
Misc. Portable Pumps			1				
Vehicles							
Dispersant Storage/Hauling Trailer			1				
Four Wheel Drive Pickup		1					
Tool Trailers		2					
Sand Trailer		1					
Communications							
Radio repeater, mobile			1				
Handsets			20				
Miscellaneous							
Sorbent (bales)		45	250	Yes	4	62	
Sorbent Booms (feet)		175	2,000	Yes	160	5,800	
Sorbent Sweeps (feet)			1,000	Yes			2,100
Dispersant in drums (gallons)			10,340				
Bird Capture Supplies		Yes					
Oil Blowers					1		

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Table 3.1-12

MSRC RESOURCES - AMOUNT OF EQUIPMENT/PERSONNEL AT EACH LOCATION

Equipment	Port Hueneme		Richmond		Eureka/Humboldt Bay		San Diego	
Oil Recovery Devices	**Units**	**Recovery Cap. Each**	**Units**	**Recovery Cap. Each**	**Units**	**Recovery Cap. Each**	**Units**	**Recovery Cap. Each**
GT-185	8	1,368 BPD						
Walosep W-4	1	3,024 BPD						
WP-1	2	2,064 BPD			1	2064 BPD		
Vikoma 3 Weir	2	5,664 BPD						
Transrec 350	1	10,560 BPD	1	10,560 BPD				
Desmi Ocean			1	3,024 BPD				
AAPD VAC					1	3,840 BPD	1	3,840 BPD
Storage Capacity	**Units**	**Storage Cap. Each**	**Units**	**Storage Cap. Each**	**Units**	**Storage Cap. Each**	**Units**	**Storage Cap. Each**
Barge	1	40,000 BBL	1	40,000 BBL				
Towed Storage Bladder (small)	4	500 BBL	19	500 BBL				
Towed Storage Bladder (large)			3	3,000 BBL				
Shuttle Barge Systems	1	1,200 BBL	1	1,200 BBL				
Oil Spill Response Vessel	1	4,000 BBL	1	4,000 BBL				
Containment/Shoreline Protection Boom	**Size**	**Length**	**Size**	**Length**	**Size**	**Length**	**Size**	**Length**
Sea Sentry II	67 in	16,500 ft	67 in	5,280 ft	67 in	2,640 ft		
Texaboom	22 in	4,000 ft	22 in	6,000 ft	22 in	1,000 ft	22 in	1,000 ft
Slickboom	24 in	6,000 ft	24 in	6,000 ft	24 in	2,000 ft		
Personnel	**Number**		**Number**		**Number**		**Number**	
Supervisors	17		1		0		0	
Responders	30		7		0		0	

large oil spill response vessels equipped with booms, skimming capability, and storage capacity. The boats, with crews, are maintained at Port Hueneme, Richmond, and Hawaii.

3.1.6 Historical Casualties

This section summarizes spills and accidents that have occurred in the Bay Area since 1986. In particular, it addresses releases that have occurred at the Unocal Terminal and other marine terminals within the Bay Area and casualties that have occurred involving tankers and tank barges.

3.1.6.1 Unocal Marine Terminal

Table 3.1-13 summarizes all the spills at the Marine Terminal since 1986 that have been reported by Unocal. As can be seen by the table, it includes all reported releases, no matter how small, that reached the water. The largest spill occurred in 1990 when 168 bbl of diesel fuel leaked from a pipeline. The pipeline had shifted such that the bearing pad attached to the underside of the pipe was not resting on the pipe support. Rubbing of the line on the support rail during the normal expansion and contraction at the expansion loop over time apparently caused a hole to be worn in the pipe.

One potential incident involving the Sansinena II occurred in October 1990. The tanker experienced a turbine failure when it was about 10 miles offshore Pt. Arena and was dead in the water. Two tugs (9,000 and 2,400 horsepower [hp]) were dispatched and stood by the tanker while repairs were made. The tanker continued on to the Unocal Terminal under its own power after repairs were completed.

3.1.6.2 San Francisco Bay Area

The San Francisco Bay has had very few incidents of tanker spills greater than 1,000 bbl. No tanker spills of any type greater than 1,000 bbl have been recorded in the Minerals Management Service (MMS) database from 1974 through 1989 (Aspen 1992). Similarly, a search of the USCG Marine Safety Information System (MSIS) database for the 1980s resulted in no spills greater than 1,000 bbl. However, casualties involving tankers and barges have occurred. For example, the 1971 collision, in dense fog, under the Golden Gate Bridge between the Arizona Standard and the Oregon Standard is often recognized as the catalyst for modern VTS in the United States. Approximately 800,000 gallons of bunker fuel escaped from the Oregon Standard causing significant pollution in the Bay. Table 3.1-14 lists tanker and barge casualties that occurred between 1988 and 1991. None of the casualties resulted in the release of oil into the water.

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Table 3.1-13

SPILLS AT UNOCAL TERMINAL FROM 1986 THROUGH 1993

Date	Product Released	Amount	Cause	Response
2/10/93	Neutral oil	< 1 qt	Leak in valve packing	None required
2/2/93	Mixed oil	< 2 gal	Unknown	Unocal boom and sorbent material deployed
10/24/92	Diesel fuel	~ 12 bbls	Corrosion leak in pipeline	Clean Bay called in
5/22/92	Gasoline	< 1 gal	Motor operated valve failure to seat	None required
11/12/91	Jet fuel	< 1 pint	Corrosion leak in pipeline	None required
10/16/91	Diesel fuel	< 1 gal	Corrosion leak in pipeline	None required
3/25/91	Crude oil	3 - 5 gal	Utility pump packing leak	Unocal boom and Clean Bay skimmer deployed - most of spill recovered
12/30/90	Diesel fuel	168 bbls	Erosion leak in pipeline	Unocal boom and Clean Bay skimmer deployed - no product recovered because extreme tidal conditions rapidly dispersed the fuel
11/15/90	Diesel fuel	~ 5 gal	Bleed valve left open	Unocal boom deployed - spill cleaned up with sorbent pads
3/16/90	Diesel fuel	< 1 pint	Corrosion leak in pipeline	None required
3/16/90	Diesel fuel	< 1 pint	Packing seal leak	None required
2/27/90	Diesel fuel	~ 2 gal	Gasket rupture on barge transfer pump	None required
11/21/89	Light fuel oil	~ 1 pint	Leak during removal of abandoned pipeline	None required
10/18/89	Gasoline	< 1 pint	Corrosion leak in pipeline (may have been exacerbated by earthquake)	Sorbent pads
10/27/88	Oily water	< 0.5 gal	Hose separated from nozzle on cleanout hose	None required
7/8/87	Mixture of oils	~ 5 gal	1.5-inch hose inadvertently uncoupled	None required
5/13/86	Crude oil	10 - 15 gal	Seawater pump failed; crude oil backflowed	Unocal boom deployed - Clean Bay assisted in cleanup
2/26/86	Crude oil	~ 1 bbl	Valve inadvertently left open	Unocal boom deployed - Clean Bay called in

Table 3.1-14

TANKER/BARGE CASUALTIES, SAN FRANCISCO BAY REGION, 1988 - 1991

Location	Vessel	Size (gross tons)	Primary Nature	Primary Cause
1988				
Carquinez Bridge	Tanker	57,692	Collision with bridge	Failure to ascertain position
Oakland Harbor	Tanker	2,572	Disabled	Mechanical failure
San Joaquin River	Tanker	32,328	Accidental grounding	Personal judgment
Chevron Long Wharf	Tanker	37,784	Boiler failure	Mechanical failure
Oakland Harbor	Navy Tanker	25,742	Electrical & steering systems failure	Electrical failure, inadequate firefighting equipment
Chevron Long Wharf	Tanker	37,784	Hull failure	Structural failure
Sacramento River	Tanker	21,668	Accidental grounding	Shoaling
1989				
Chevron Long Wharf	Barge	1,285	Collision with dock	Operator error
Carquinez Strait/Tanker			Collision with dock	Operator error
Ocean-Pilot Area	Tanker	57,692	Disabled	Mechanical failure
Anchorage 9	Tanker	42,619	Explosion - NEC	Carelessness
Chevron Long Wharf	Tanker	12,671	Accidental grounding	Shoaling
Anchorage 9	Tanker	44,698	Accidental grounding	Error in judgment
Carquinez Strait	Barge	7,912	Accidental grounding	Error in judgment
Stockton Channel	Tanker	20,239	Accidental grounding	Error in judgment
Suisun Channel	Tanker	25,692	Accidental grounding	Operator error
Pt. San Pablo	Tanker	16,876	Failure - hydraulic cont..	Mechanical failure
Stockton Channel	Tanker	13,334	Steering system failed	Failed materials
Richmond Harbor	Barge	4,233	Failure - rudder/shaft	Failed materials
Sacramento River/Tanker			Collision with dock	Operator error

Table 3.1-14 (Continued)

TANKER/BARGE CASUALTIES, SAN FRANCISCO BAY REGION, 1988 - 1991

Location	Vessel	Size (gross tons)	Primary Nature	Primary Cause
		1990		
Carquinez Strait	Barge	3,179	Collision - meeting	Error in judgment
Sacramento River	Tanker	21,668	Accidental grounding	Shoaling
Suisun Bay	Tanker	9,111	Accidental grounding	Operator error
Suisun Bay	Tanker	21,668	Accidental grounding	Operator error
Oakland Harbor	Tanker	34,266	Hull failure	Structural failure
Anchorage 9	Tanker	34,266	Hull failure	Structural failure
Anchorage 9	Tanker	61,213	Hull failure	Stress fracture
Carquinez Strait	Tanker	59,289	Engine failure	Failed materials
Suisun Bay	Tanker	27,899	Failure main generator	Electrical failure
Anchorage 5	Tanker	16,584	Steering system failure	Mechanical failure
Sacramento River	Tanker	16,584	Shaft system failure	Mechanical failure
		1991		
Richmond Harbor	Tanker	21,446	Accidental grounding	Operator error
Alcatraz	Tanker	32,05	Hull failure	Corrosion
Anchorage 9	Tanker	37,784	Hull failure	Fatigue fracture
Anchorage 9	Tanker	30,684	Hull failure	Fatigue fracture
Anchorage 9	Tanker	75,272	Hull failure	Structural failure
Port San Francisco	Tanker	27,899	Hull failure	Normal wear
Oakland Harbor	Tanker	23,785	Material failure - NEC	Mechanical failure
Treasure Island	Barge	1,406	Failure - rudder/shaft	Structural failure

Source: Draft San Francisco, San Pablo and Suisun Bays Harbor Safety Plan (Summary by J. Lunstrom from U.S. Coast Guard Records)

Note: As of February 1994, casualties through 1991 is the most information available. The system of tracking casualties is currently being revised.

3.2 WATER QUALITY

3.2.1 Water Quality Plans and Policies

3.2.1.1 Federal Policies

The Coastal Zone Management Act of 1972 (16 U.S.C. 1455 et seq) regulates development and use of the Nation's coastal zone by encouraging states to develop and implement coastal zone management programs. Long-range planning and management of California's coastal zone were conferred to the state with implementation of the California Coastal Act in 1977. The quality of California's coastal water is protected under the California Coastal Act Section 30231 (see discussion in Section 3.2.1.2).

The Federal Clean Water Act (Public Law 92-500, as amended) provides for the delegation of certain responsibilities in water quality control and water quality planning to the states. In California, the EPA and the State Water Resources Control Board have agreed to such delegation and regional boards implement portions of the Clean Water Act, such as the National Pollutant Discharge Elimination System (NPDES) program (see discussion in Section 3.2.1.2). The aim of the Clean Water Act of 1977 (33 U.S.C. 1251 et seq) is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. Specific sections control the discharge of wastes into marine and aquatic environments. Section 404 of the Act establishes a permit program to regulate the discharge of dredged material into coastal waters of the United States. The Corps of Engineers (Corps) has jurisdictional authority pursuant to Section 404 of the Act. The EPA assists the Corps in evaluating environmental impacts of dredging and filling, including water quality and historic and biologic values. Maintenance dredging at the Unocal Marine Terminal and disposal of its dredge material have been evaluated by the Corps.

3.2.1.2 State Plans and Policies

The SLC issues dredging permits for projects that propose to dredge in state-owned submerged lands, tidelands, and marshes. An SLC dredging permit has been issued for maintenance dredging at the Unocal Marine Terminal and for disposal at the Carquinez Strait site. In addition, any project sponsor seeking to use state-owned lands for right-of-way uses, as in the case of the Unocal Marine Terminal, must obtain a land use lease from the SLC. For each of these discretionary decisions, the SLC bases its decision on information presented in environmental documentation prepared pursuant to the requirements of the CEQA on the NEPA.

The Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) is the primary policy document that guides the California Regional Water Quality Control Board (RWQCB), San Francisco Bay Region. Established under the requirements of the 1969 Porter-Cologne Water Quality Control Act, the Basin Plan was originally adopted in April 1975, and the most recent revisions relevant to the petroleum refinery industry were adopted on December 17, 1986. The Basin Plan assigns beneficial uses (e.g., "municipal water supply," "water contact recreation," and so forth) to all waters in the basin. The Basin Plan also sets water quality objectives, subject to approval by the EPA, intended to protect designated beneficial uses. The water quality objectives in the Basin Plan are written to apply to specific parameters (numeric objectives) and general characteristics of the water body (narrative objectives). An example of a narrative objective present in the San Francisco Bay Basin Plan is the requirement that all waters must remain free of toxic substances in concentrations producing detrimental effects upon aquatic organisms. Numeric objectives specify concentrations of pollutants that are not to be exceeded in ambient waters of the basin. The water quality objectives are achieved primarily through effluent limitations embodied in the NPDES program.

The RWQCB, San Francisco Bay Region, has NPDES permit authority on any facility or activity that discharges waste into the Bay. Refinery process wastewater discharges and effluent limits have been set by the RWQCB, San Francisco Bay Region, pursuant to the Federal Clean Water Act and the California Water Code. Effluent limits are contained within the NPDES permit; the discharge of process wastewater containing constituents in excess of the limits stated within the NPDES permit is prohibited. The Unocal Refinery presently operates under an NPDES permit (Permit No. CA0005053). Effluent limits as required under the NPDES permit, in addition to the levels of process wastewater constituents measured in 1991-1992, are listed in Table 4.3-4. Allocations for pollutants attributable to ballast water and stormwater runoff discharged as part of the Refinery's wastewater stream have also been set by the RWQCB as part of the effluent limitations given in the Unocal NPDES permit. A complete discussion of the water quality characteristics of the Unocal Refinery's effluent is presented in Section 4.3.

The Water Quality Control Plan for Ocean Waters of California (California Ocean Plan) 1990, as revised, and the Water Quality Control Plan for Enclosed Bays and Estuaries of California (Enclosed Bays and Estuaries Plan) 1991, as revised, are two policy documents that guide the State Water Resources Control Board. The California Ocean Plan is applicable to point and nonpoint sources of waste discharge to the ocean, but it is not applicable to vessel wastes or the control of dredge material disposal or discharge. The Ocean Plan specifies limits or levels of water quality characteristics for ocean waters to protect beneficial uses of ocean waters of the State. These beneficial uses include industrial water supply, water and noncontact recreation, navigation, commercial and sportfishing, mariculture, preservation and enhancement of Areas of Biological Significance, rare and endangered species habitat, marine habitat, fish migration, fish spawning, and shellfish harvesting.

Like the California Ocean Plan, the Enclosed Bays and Estuaries Plan does not apply to vessel wastes or to the control of dredging spoil. The narrative and numerical water quality objectives set forth in the Enclosed Bay and Estuaries Plan were developed on a statewide basis to ensure the reasonable protection of beneficial uses, contained in the basin plans, and protect saltwater aquatic life and human health.

The Enclosed Bay and Estuaries Plan water quality objectives to protect saltwater aquatic life in bays and estuaries from the effects of waste discharge relate to concentrations of various metal and organic pollutants to observed toxic effects in aquatic organisms. Where there might be a conflict between the San Francisco Bay Basin Plan and the state's Enclosed Bays and Estuaries Plan, the more stringent provisions apply.

3.2.1.3 Local Plans and Water Quality Policies

The Bay Conservation and Development Commission's San Francisco Bay Plan, adopted in 1968, provides policies to guide future uses of the Bay and shoreline. The commission is empowered to grant permits for all bay dredging and filling to protect marshes, wetlands, and other resources of the Bay. Its jurisdiction includes all areas of the Bay below the line of highest tidal action as well as 100 feet inland from the line of highest tidal action. The San Francisco Bay Plan designates most of the southern shoreline of San Pablo Bay for Water-Related Industry. Policies within the Plan indicate that "pipeline terminal and distribution facilities near the bay should generally be located in industrial areas" and that "marine terminals should also be shared as much as possible among industries and port uses."

3.2.2 <u>San Francisco Bay Estuary Water Quality</u>

3.2.2.1 Physical Setting and Freshwater Inflow

The San Francisco Bay estuary is the largest estuary on the Pacific Coast of the United States. The estuary has two basic elements: San Francisco Bay and the Delta, a 2,800-square-kilometer (km^2) wetland formed at the confluence of the San Joaquin and Sacramento Rivers. San Francisco Bay can be divided, in turn, into distinct water bodies that have different physical and chemical properties. The northern reach includes two major embayments: Suisun Bay and San Pablo Bay. The northern reach conveys outflow from the Delta at its head and thus can be considered to be a typical estuary (Conomos 1979). Central Bay is deeper and more oceanic in character than the northern and southern reaches because of its proximity to ocean inflow through the Golden Gate, a deep narrow channel through the coastal range. The southern reach is separated from the northern reach by the Central Bay and extends from the Oakland Bay Bridge to San Jose.

Fresh water strongly influences environmental conditions in the San Francisco Bay estuary. Over 90 percent of the estuary's fresh water originates from the Sacramento-San Joaquin drainage basin and enters the northern reach (Conomos et al. 1985). The Sacramento River provides about 80 percent of this flow, and the San Joaquin River and other streams contribute the remainder. The remaining 10 percent of fresh water comes from the San Francisco Bay watershed and flows into the southern reach. The southern reach has the physiographic characteristics of an estuary but lacks the freshwater inflow to drive a strong estuarine circulation. As a result, circulation in the southern reach is influenced predominantly by tides, evaporation, and wastewater discharges and thus functions much like a tidally oscillating lagoon for most of the year (Conomos 1979).

The total annual volume of fresh water reaching the estuary is highly variable and depends on the amount of rainfall in the Central Valley watershed and the amount of fresh water diverted or stored for agricultural, municipal, industrial, and other uses in the Central Valley. Beginning in the 1850s, flood control projects and agricultural diversions began to influence the timing and volume of the annual freshwater inflow into the estuary. Although it is difficult to estimate the exact flow of fresh water into San Francisco Bay because of the complicated topography of the Delta and tidal flow, by the late 1970s, the annual volume of water entering the estuary was reduced by more than one half in some years (Monroe and Kelly 1992). This fluctuation is important because high flows flush the estuary and check the inland migration of saline ocean water into the Delta.

Water storage and diversions affect not only the total volume but also the seasonal flow of fresh water into the estuary. At current levels of development, a reduction in freshwater flow to the estuary has occurred in every month except August, September, and October (Monroe and Kelley 1992). The effects on seasonal flow are the greatest in the spring. Spring seasonal flows during the months of April, May, and June play an important role in the reproductive success and survival of several estuarine species, including striped bass and salmon, by transporting eggs and young through the Delta and into the estuary. Seasonal flows strongly affect physical processes including salinity, water transparency, and pollutant concentrations. The effect of freshwater diversions and altered flow on these physical processes is discussed briefly in the following paragraphs.

In years when the spring outflow of fresh water into the estuary is low, salinity rises in many segments of the estuary. This effect is seen best in the segment of the estuary upstream of Carquinez Strait in Suisun Bay. One study shows that in dry years, relatively high salinities occur yearlong in Suisun Bay (Williams and Fishbain 1987, cited in Monroe and Kelley 1992). Although the salinity in the estuary is affected by Delta outflow, it is also influenced by changes in ocean salinity. One study suggests that the increase in ocean salinity since the 1940s is responsible for much of the rise in salinity in the estuary at locations near the mouth of the estuary (Fox et al. 1991, cited in Monroe and Kelley 1992).

It is believed that the present diversion of fresh water from the Delta is partially responsible for the increase in transparency of waters since the 1980s (Monroe and Kelly 1992). This might be the result of reduced riverine sediment input, declining phytoplankton production, and the export of estuarine sediments in bottom currents to the Delta under conditions of high pumping of fresh water in the Central Valley.

Freshwater flows affect the influx of pollutants to the estuary from the Delta, and water movements disperse and eventually transport toxic materials out of the estuary. When outflow from the estuary is low, water may reside in San Pablo Bay for nearly 3 weeks before entering Central Bay. When outflow is high, water moves through the northern reach of the estuary and out to the ocean in as little as 5 days (Smith 1987).

3.2.2.2 Circulation and Dispersion Capacity

Circulation and mixing are relatively complicated in San Francisco Bay because of the complex geometry and variable amount of freshwater flow during the year. Maintaining a sufficient Delta flow of fresh water is important for dispersing and flushing the estuary of wastes discharged into the Bay. The circulation of water in the Bay is driven primarily by tides and also by wind mixing and estuarine circulation (Davis 1982).

Tides are responsible for most of the water motion within the Bay, are the dominant force for mixing, and contribute greatly to the dispersion of material within the estuary. However, tidal motion is oscillatory and consequently contributes proportionately little to the transport of material out of the Bay (Davis 1982). Net transport into and out of the Bay is driven primarily by estuarine circulation. Estuarine circulation is driven by the density difference between fresh and saline ocean water, and its magnitude is controlled by the amount of fresh water flowing into the estuary from the Delta. Estuarine circulation varies greatly with season and location. During the winter, the water residence time for the northern reach is on the order of 2 weeks but can be less than 5 days when outflow from the Delta is up. In the southern reach residence time is on the order of 2 months. During the summer, the water residence time in the northern reach is on the order of 2 months, and in the southern reach it is on the order of 5 months (Conomos 1979). Thus, the water residence time in the southern reach is about four times longer than in the northern reach because the southern reach has no large freshwater inflow. Wind mixing, like tidal mixing, contributes greatly to local mixing and dispersion, but contributes very little to net flow of fluids, sediments, and pollutants out of the Bay.

The exchange of water between the ocean and the Bay is complicated and not entirely understood. The factors that control ocean-bay exchanges through the Golden Gate include the following:

- the tidal prism, which is the tide-induced fraction of the water that passes through the Golden Gate between low and high tide;
- the river-induced seaward flow, which is the net amount of water leaving the Bay;
- density differences between the Bay and local coastal ocean and wind, which influence the vertical structure of currents in the Golden Gate;
- circulation and mixing in the Bay, which exchange Bay water for ocean water near the Golden Gate; and
- circulation and mixing in the local coastal ocean (Smith 1987).

Tides

In the San Francisco estuary, the tidal cycle is 24 hours and 50 minutes long, with two high tides and two low tides in each cycle. Over each month, periods occur when the range from high to low tide is larger (spring tides) and periods when it is smaller (neap tides). The morphometry and bathymetry of the estuary affect the timing of maximum tidal currents in each reach of the estuary; the southern reach is flooding while the northern reach is ebbing (Davis et al. 1991). The Bay's tidal range is relatively large compared to the average water depth and creates a tidal prism of 24 percent of the Bay volume (Conomos 1979). In other words, during each tidal cycle, 24 percent of San Francisco Bay's volume moves in and out of the estuary. On flood tide, ocean water moves into the southern reach producing a tidal range from low to high of more than 8 feet with a range of about 3 feet in the northern reach at the upstream edge of the estuary (Monroe and Kelly 1992). However, due to complex circulation eddies outside the entrance of the Bay, only a portion of the water entering the Bay is water that has not entered the Bay during previous tidal cycles (Denton and Hunt 1986). This fact has important implications on the introduction of pollutants into the Bay from the Pacific Ocean (see Section 3.2.3.4).

Surface Waves and Winds

The annual wind pattern is important to the mixing and circulation of San Francisco Bay. Local winds create wind waves that can generate basin-wide circulation, resuspend sediments, oxygenate the water, and disperse organisms throughout the Bay (Conomos et al. 1985). In the San Francisco Bay Area, strong wind conditions are typical during the summer afternoons and winter storms. During summer, the prevailing winds in the Bay Area are from the west and southwest. During the winter, when storm centers pass to the south, the prevailing winds remain westerly (Conomos et al. 1985). Prevailing summer winds generate waves with maximum periods of 2 to 3 seconds (5-second waves during the winter) and wave heights exceeding 1 meter (m). Seaward of the Golden Gate, swells (surface waves produced by remote storms at sea traveling over long distances) with periods of 8 to 12 seconds are common during the summer and with periods of 18 seconds during the winter (Conomos et al. 1985). More detailed information on Bay Area winds is provided in Section 3.1.4.1.

Estuarine Circulation

As previously mentioned, a strong estuarine circulation exists in the northern reach, particularly in the winter when Delta outflows are high. In the northern reach, seaward-flowing surface currents of low salinity are found in conjunction with a net transport up-estuary of bottom currents of high-salinity water. At the farthest landward penetration of saline water is a region of mixing known as the "null zone," which is characterized by an accumulation of suspended matter and a concentration of phytoplankton. The accumulation of nutrients and plankton in the null zone has great biological importance, which is discussed in Section 3.3. Landward of the null zone, the net currents are seaward at all water depths. The null zone is located in the vicinity of Suisun Bay during most months of the year. During periods of high freshwater inflow, the null zone moves seaward toward San Pablo Bay, altering the mixing and circulation regime of the northern reach. The null zone appears to advance rapidly in response to peak flow, while its retreat back upstream may take several months (Smith

1987). Because in recent years increased freshwater diversions have reduced Delta outflows, the null zone is often located upstream of Suisun Bay in the deeper waters of the Sacramento River.

In the southern reach of the estuary, there is insufficient freshwater inflow to establish the salinity gradients found in the northern reach. During the summer, the lack of a salinity difference between Central Bay and the southern reach leads to oscillatory net currents of high saline waters. During periods of high freshwater inflow in the winter, there is sufficient influx of fresh water into Central Bay to generate an exchange of low-salinity surface waters with high-salinity bottom waters.

<u>Residence Times</u>

The mean hydraulic residence time or the average time a parcel of water remains in the estuary or smaller embayment is an important indicator of pollutant transport in the estuary. Larger estimates of residence time reflect more sluggish currents and mixing processes. Residence times for the entire estuary depend on exchange between the Bay and the Pacific Ocean; however, little is known about exchange. The estimates for residence time of different reaches of San Francisco Bay estuary vary significantly under high- and low-flow conditions. For example, during high-flow conditions, the residence time for the northern reach has been estimated to be as brief as 1.2 days; under low-flow conditions, it is estimated to be as long as 60 days. For San Pablo Bay, under high-flow conditions the residence time is estimated to be a minimum of 0.8 day, and under low-flow conditions, about 25 days. Estimated residence times for the southern reach are on the order of several months under low-flow and several weeks under high-flow conditions (Davis et al. 1991).

These estimates for the entire San Pablo Bay embayment provide important insight on the fate of dissolved pollutants introduced into the embayment. If the chemical constituent discharged into the estuary undergoes a chemical or biological transformation on the timescale of 1 week, then such a contaminant could have an important impact on water quality under low-flow conditions. Conversely, chemical or biological transformations that occur on the timescale of 1 week would have little to no impact on conditions in San Pablo Bay under high-flow conditions because, in that time interval, the contaminant would have been flushed into Central Bay. It is believed by some investigators that the estimates of residence time for either the whole estuary or San Pablo Bay given above probably underestimate the actual residence time for waters in the broad, shallow reaches of the estuary because the majority of the data have been collected in the deeper channels (Davis et al. 1991). Therefore, the average residence times may not apply to shallow marshy areas even under conditions of high Delta outflow.

3.2.2.3 Water and Sediment Properties

<u>Ambient Water Quality</u>

The water quality of San Francisco estuary affects not only the estuary's beneficial uses, but also the distribution and abundance of aquatic organisms. The ranges of aquatic organisms are determined by the tolerance of each to salinity, temperature, water currents, and other factors. These factors vary greatly from one reach of the estuary to the next and markedly between seasons.

Salinity

The salinity of waters in the northern reach increases along a gradient from the Delta to Central Bay. Waters of the Delta flowing into the northern reach average less than 0.1 part per thousand (ppt). Therefore, salinity in Suisun Bay and San Pablo Bay is lower in the winter due to increased flow of freshwaters from the Delta. In San Pablo Bay, for example, salinity ranges from 6 to 22 ppt on the surface and from 20 to 30 ppt near the bottom. In the summer, however, salinity ranges from 20 to 30 ppt near the surface and from 20 to 30 ppt near the bottom (Conomos 1979; Conomos et al. 1979). In the southern reach and in Central Bay, the mean annual salinity is at near-ocean concentrations during much of the year or 30 ppt (Davis et al. 1991).

Dissolved Oxygen

The waters of the estuary are well oxygenated (greater than 5 milligrams per liter [mg/L]) during much of the year, except in the extreme end of the southern reach during the summer when high water temperatures and poor mixing reduce dissolved oxygen levels. Oxygen concentrations in estuarine waters are also reduced by plant and animal respiration, chemical oxidation, and bacterial decomposition of organic matter. Today, few places in the estuary exist where low oxygen levels adversely affect beneficial uses (Davis et al. 1991). However, low dissolved oxygen levels have sometimes been a concern in the salt marshes around the Bay (G. Arlob, personal communication 1992).

Nutrients

Nutrient concentrations vary seasonally within the estuary. The estuary's main nutrients are nitrogen (in the form of nitrates and ammonium), phosphate, and silicate. In the northern reach, river flow from the Delta provides most of the nutrient load; therefore, nutrient concentrations are highest during the winter and lowest during the summer. In the southern reach, there is less annual variation in the nutrient concentrations because sewage treatment plants provide most of the fresh water and thus nutrients to this segment of the estuary. Today, few places in the estuary exist where high nutrient levels adversely affect beneficial uses (Davis et al. 1991).

Suspended Particulates

In the northern reach, Delta outflow is the major source of suspended particulates. Besides Delta outflow, other major sources of suspended particulates are local surface runoff, sewage inputs, resuspension of suspended particulates from the bottom of the Bay by wind waves, and in-situ production of organic material by phytoplankton. The total input of suspended particulates to San Francisco Bay is dropping in about the same proportion as the amount of Delta outflow to the Bay (Russell et al. 1982). The contribution of suspended particulates from the Delta has been lowered as impoundments trap sediments and lowered flow rates reduce the amount of bottom scour of river and stream channels.

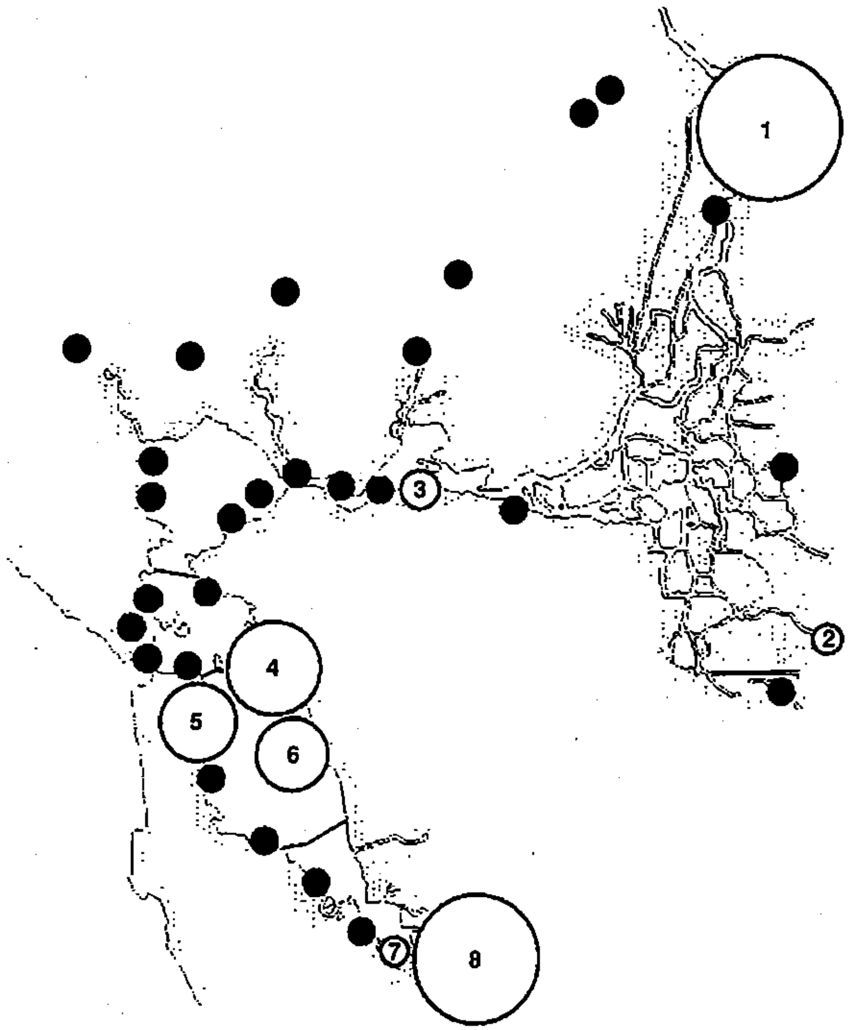
3.2.2.4 Pollutants in San Francisco Bay

Like most urbanized estuaries, the waters, sediments, and biota of San Francisco Bay estuary receive contaminants from various sources. Two classes of compounds are of concern in the Bay system: inorganics (trace metals including transition metals and selenium) and organics (petroleum hydrocarbons, phenols, and metal organic compounds). Phillips (1987, 1988) listed 13 trace metals "of particular concern" or "of concern": arsenic, antimony, cadmium, copper, chromium, cobalt, lead, mercury, nickel, selenium, silver, tin, and zinc. Of the organic compounds, polycyclic aromatic hydrocarbons (PAHs) are of special concern in the Bay because some of them are known toxicants (Phillip 1987), they have long half-lives in some biological systems, and high concentrations of PAH are found in sediments from some portions of the Bay. Organic pesticides are also a concern. A number of reviews have been published that summarize the occurrence, distribution, and fate of these contaminants in the Bay (Davis et al. 1991; Monroe and Kelly 1992). The following is a brief summary of these reviews with special attention to the northern reach of the estuary.

<u>Categories of Wastewater Discharged into San Francisco Bay</u>

The quantity and composition of contaminants to San Francisco Bay waters vary in several ways. Point-source discharges, such as municipal wastewater or industrial facility wastes, may vary in composition or in quantity over time, but they represent a continuous source of pollutants to the estuary. Superimposed on this background of continuous waste input are the following intermittent sources of pollutants to the estuary: (1) urban and nonurban runoff, (2) riverine inputs from the Central Valley, (3) dredging and dredge material disposal, (4) marine vessel discharges, (5) atmospheric deposition, and (6) accidental spills (Monroe and Kelly 1992). Several reports recently published (Monroe and Kelly 1992; Davis et al. 1991; Gunther et al. 1987) summarize these main sources of pollutants to the estuary and their characteristics. The following paragraphs briefly discuss the contents of these reports.

More than 50 municipal wastewater treatment facilities continuously discharge effluent into the Bay/Delta system. The combined flow from these facilities averaged 855 million gallons per day (mgd) during the period from 1984 through 1986 (Monroe and Kelly 1992). Nearly one-half of the total volume discharged is contributed by only four facilities located in the North Delta and in the southern reach of the estuary (Figure 3.2-1). Although the volume of municipal discharge flows has steadily increased over the past 40 years with an increase in population of the watershed, technical advances and upgrading of wastewater treatment facilities around the estuary have reduced the quantity of conventional pollutant loadings from municipal treatment plants into the estuary. As a result, the most apparent symptoms of poor water



Eight Largest Dischargers
(Discharge, Million Gallons/Day)

1. Sacramento RWTP (134)
2. Stockton STP (29)
3. Central Contra Costa SD (39)
4. East Bay MUD (87)
5. San Francisco Southeast (74)
6. East Bay Dischargers Authority (68)
7. Palo Alto WTP (28)
8. San Jose/Santa Clara WTP (118)

● Discharges up to 25 mgd

① Discharges greater than 25 mgd - circle size is proportional to volume of discharge.

Note: Only discharges greater than 3 mgd are shown.

From data in Gunther et al. 1987

N

Source: Monroe and Kelly 1992

MUNICIPAL DISCHARGERS AND MEAN DISCHARGE VOLUMES TO THE BAY/DELTA ESTUARY, 1984-1986

Figure 3.2-1

quality, including odors, algal blooms, low oxygen levels, and high coliform bacteria levels, have disappeared from the estuary (Luoma and Cloern 1982).

The treatment of waste from industrial facilities has also improved over the past 40 years. There are more than 65 industrial dischargers into the Bay; industrial facilities include petroleum refining and the manufacturing of agricultural pesticides, fertilizers, solvents, steel, paper, sugar, and other products. Loads of some pollutants from petroleum refineries have reduced dramatically since the early 1960s through pollution prevention and source reduction. Petroleum refineries are the largest single class of industrial dischargers. More than 30 mgd of process water were discharged into the estuary by the six largest refineries during the period from 1984 through 1986 (Monroe and Kelly 1992). Among these six refineries, the Unocal Refinery had the fourth largest mean discharge volume to the estuary during this period. Of the more than 65 industrial dischargers contributing waste to the estuary, approximately 50 of these industrial facilities discharge less than 100,000 gallons per day (gpd). Even though less effluent is discharged by industrial facilities compared to municipal wastewater treatment plants, they contribute greater quantities of certain pollutants such as selenium and polyaromatic hydrocarbons. Figure 3.2-2 shows the location of the major industrial facilities and their mean discharge volumes to the Bay/Delta estuary. The largest industrial facilities are located in the estuary's northern reach where pollutant concentrations may be influenced by flushing that is driven by Delta outflow.

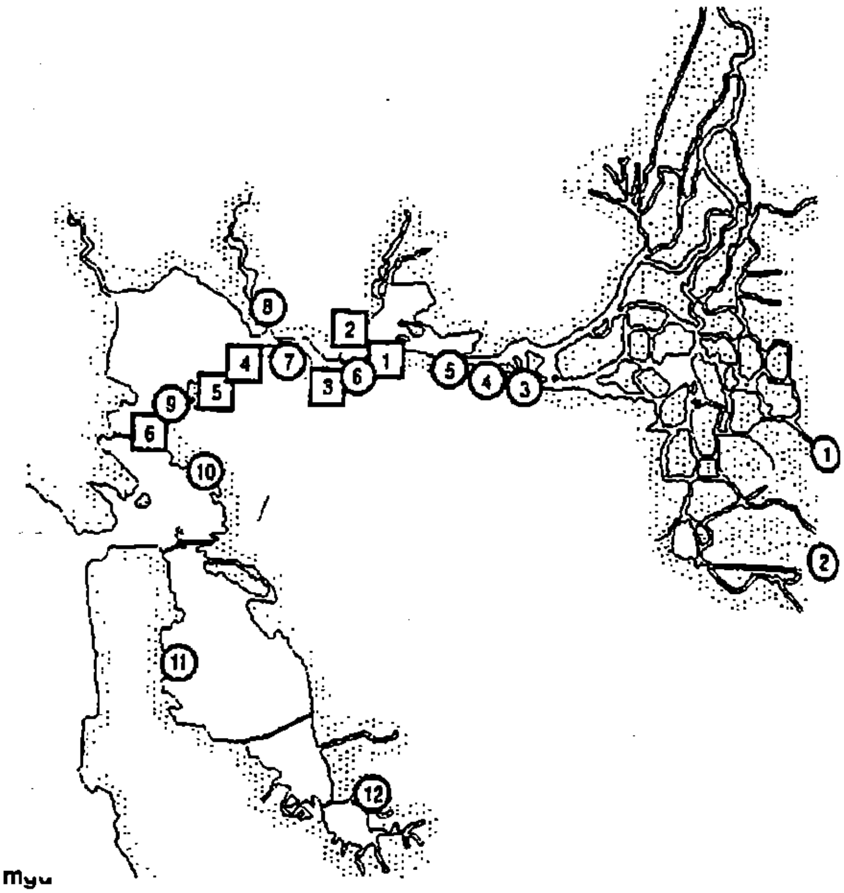
For many pollutants, urban and nonurban runoff contributes much larger quantities than do municipal and industrial discharges combined. Urban runoff is water from urban areas that flows in streams and rivers to the estuary and includes water in storm drains. Recent studies in Sacramento and Santa Clara Counties have shown that urban runoff was a major source of trace elements and fecal coliform bacteria to the estuary. For example, more than 20 times as much lead enters waters of the Bay/Delta estuary in urban runoff than in effluent discharges (Montoya et al. 1988, cited in Monroe and Kelly 1992). The rainfall pattern has a significant effect on the quantity and quality of pollutants carried by urban runoff. Pollutants build up on road surfaces, lawns, and construction sites between the rainy seasons and between storms. The buildup is flushed out into the estuary through storm drains causing a peak load of pollutants during the first heavy rains of the season.

The chief pollutants of concern to the estuary from nonurban runoff are agricultural pesticides. For example, in the San Joaquin Valley alone, about 500 different pesticides totaling 50 million pounds were applied in 1982. As a result of this level of application, pesticide concentrations in some of the estuary's tributaries are significantly elevated. Estuary tributaries that receive agricultural drain water are especially at risk to receive elevated concentrations of pesticides, solvents used for pesticide application, and trace metals such as selenium.

Marine vessels are also sources of various pollutants to the estuary. The discharge of untreated sewage and gray water from commercial and recreational vessels has caused concern in various parts of the estuary. Vessel discharges, including release of bilge waters, are prohibited within the Bay. However, an unknown amount of wastes is believed to be illegally discharged directly into estuarine waters. This type of effluent contributes coliform bacteria, biochemical oxygen-demanding substances, nutrients, oil and grease, and suspended solids. In addition, the discharge of ballast water from large commercial vessels may introduce exotic species of aquatic organisms into the estuary. Accidental spills of petroleum products from ships are generally small and result from operator errors, handling accidents at terminals, and damage to ships.

In 1973, 171,000 gallons of crude were spilled in Oakland estuary. In 1988, more than 370,000 gallons of crude oil were accidentally discharged from the Shell Oil Refinery into Carquinez Strait. Although more than 50 miles of shoreline were affected by this later spill, approximately 80 percent of the oil was recovered.

Unlike the previous sources of pollutants to the estuary mentioned above, dredging and dredged material disposal do not represent a new source of pollutants, but the remobilization of pollutants previously discharged into the estuary. Approximately 6 million cubic yards of sediments from the Sacramento and San Joaquin Rivers enter the estuary each year. Because 70 percent of the estuary is less than 18 feet deep and existing sediments are resuspended by currents and wind-driven waves, maintenance dredging is necessary to maintain adequate water depths in navigation channels, turning basins, docking slips, and marinas.



1 Refineries	mgd
1. Tosco	4.4
2. Exxon	2.2
3. Shell Oil	4.3
4. Union Oil	2.5
5. Pacific Refining	0.2
6. Chevron USA (a)	16.7

② Other Industries	mgd
1. McCormick and Baxter	0.2
2. Libbey-Owens-Ford	0.2
3. USS Posco	20.0
4. Dow Chemical	0.4
5. General Chemical	1.1
6. Stauffer Chemical	0.1
7. C&H Sugar	1.0
8. Mare Island Shipyard	0.5
9. Chevron Chemical	0.2
10. Stauffer Chemical	0.1
11. San Francisco Int'l Airport	4.0
12. New United Motors	0.9

Note:
(a) Flows from Chevron USA desreased substantially after 1986. Average flow in 1990 was 7 mgd.
(b) Discharges of less than 0.1 mgd are not shown. Names listed are those used during the period of study. Some facilities discharging greater than 0.1 mgd did not monitor toxic pollutants

From data in Gunther et al. 1987

N

Source: Monroe and Kelly 1992

INDUSTRIAL FACILITIES AND MEAN DISCHARGE VOLUMES TO THE BAY/DELTA ESTUARY, 1984-1986

Figure 3.2-2

Three sites in the estuary are in active use today for dredged material disposal: Alcatraz, San Pablo Bay, and Carquinez Strait. A fourth site in Suisun Bay is used only for sandy material excavated by the Corps from the Suisun Bay Channel. Dredged material may also be disposed of in the ocean at sites designated by EPA for this purpose. The principal environmental effects of dredged material disposal include the remobilization and uptake of toxic contaminants, increase in water column turbidity, and physical impacts on marine organisms that live in the sediments.

Pollutants Measured in Water, Sediments, and Biota of the Bay

Pollutants in Seawater

Existing information regarding concentrations of trace metals and organics in the estuary's waters is summarized in Table 3.2-1 and compared to existing RWQCB regulatory criteria. Compared to the amount of information available on the concentrations of trace metals, much less data are available on the concentrations of most organic pollutants in waters of the estuary. This lack of information is due in part to the technical difficulties of measuring concentrations of these pollutants at the detection limit of today's analytical tools. Most of the organic pollutants in estuarine waters occur in very low concentrations (parts per billion [ppb]) in natural waters. By examining the state's water quality objectives for estuarine waters listed in Table 3.2-1, it appears that several of the pollutants occurring in San Francisco Bay, including copper, lead, mercury, nickel, and tributyltin, may exceed the state's objectives.

Pollutants in Sediments

The sediments in nearly all parts of the San Francisco Bay estuary exhibit elevated concentrations of pollutants compared to coastal reference sites. Sediment loads of contaminants will depend on the rate of sedimentation that normally varies seasonally and tidally (Luoma 1990). Sites within the Bay where the highest concentration of pollutants in sediments are found include marinas and harbors, industrial waterways, and effluent discharge points. Where sufficient data exist to establish geographic and temporal trends, it appears that the concentrations of most pollutants in sediments increase along a gradient from north to south with the highest concentrations found in the southern reach. The exception to this pattern is the distribution of selenium and chromium in the estuary, which are found at their highest levels in San Pablo Bay. Table 3.2-2 summarizes available information on pollutant concentrations in sediments within the Bay or downstream from the Delta.

Pollutants in Biota

Many studies of pollutants in the estuary's biota have been conducted (Table 3.2-3). Pollutant concentrations have been measured in mussels, clams, fishes, waterbirds, and seals. According to the summary in Table 3.2-3 of pollutants in biota of the estuary, the levels of many pollutants found in animal tissues indicate that many pollutant concentrations exceed a state or international health safety level (Monroe and Kelly 1992). For example, the median international standard (MIS) is a general guideline of what other nations consider to be elevated contaminant levels in fish and shellfish tissue. Levels of arsenic, cadmium, chromium, copper, lead, mercury, and selenium in some Bay shellfish exceed the MIS. The State Department of Health Services has established maximum allowable residue levels (MARLs) to ensure that consumers of specified fish or wildlife species do not exceed the permissible intake level for particular contaminants. Levels of selenium in some Bay fishes and Bay ducks exceed the MARL. Figure 3.2-3 indicates known sites in the Bay where the highest concentrations of pollutants in shellfishes and ducks are found.

Where sufficient data are available to establish geographic trends in pollutant concentrations in the estuary's biota, they show that some contaminants are fairly uniform in biota throughout the Bay, whereas other contaminants are highest in biota from either the southern reach or the northern reach (Table 3.2-4). For example, chromium, mercury, and selenium concentrations in mussels are fairly uniform throughout the Bay, with high levels of selenium found in both the northern and southern reaches. On an estuary-wide basis, the concentrations of DDT (dichloro-diphenyl-trichloroethane) and PCB (polychlorinated biphenyls) in clams and PAH in fishes are lowest in San Pablo Bay compared to other embayments of the estuary. The general geographic trend is that biota located in the southern reach and in the peripheral areas at harbors, marinas, and industrial waterways have the highest concentrations of pollutants in their tissues.

Table 3.2-1

CONCENTRATIONS OF SELECTED POLLUTANTS IN WATERS OF THE BAY/DELTA ESTUARY (ppb)

Pollutant	Range of Total Concentrations[1]	State Water Quality Objective Downstream of Carquinez Strait	State Water Quality Objective Upstream of San Pablo Bay	Any Samples Exceeding State Water Quality Objectives?
Arsenic	0.5 - 4.5[2]	36 (4D) 69 (1H)	190 (4D) 360 (1H)	No
Cadmium	0.005 - 0.159	9.3 (4D) 43 (1H)	1.1 (4D) 3.9 (1H)	No
Chromium	0.540 - 3.600	- - -	- - -	- - -
Copper	0.9 - 7.2	- - -	6.5 (4D) 9.2 (1H)	Yes
Lead	0.15 - 3.54	5.6 (4D) 140 (1H)	3.2 (4D) 82 (1H)	Yes
Mercury	0.001 - 0.032	0.025 (4D) 2.1 (1H)	0.025 (4D) 2.4 (1H)	Yes
Nickel	1.22 - 11.28	7.1 (2D) 140 (Inst.)	56 (1D) 100 (Inst.)	Yes
Selenium	0.013 - 4.700[2]	- - -	- - -	- - -
Silver	0.003 - 0.100	2.3 (Inst.)	1.2 (Inst.)	No
Tributyltin	0.004 - 0.570	- - -	0.04 (1D) 0.06 (Inst.)	Yes
Zinc	1.4 - 17.4	58 (1D) 170 (Inst.)	38 (1D) 170 (Inst.)	No
PAH	- - -	15 (1D)	- - -	- - -
DDT	- - -	- - -	- - -	- - -
PCB	0.0004 - 0.0066	- - -	- - -	- - -

[1] All concentrations are from Flegal et al. 1991, except chromium, selenium, tributyltin, and PCB, which are from Davis et al. 1991.
[2] Concentrations of unfiltered samples.

Dashes indicate that either reliable data or water quality objectives do not exist

4D = Four-day average
1D = One-day average
1H = One-hour average
Inst. = Instantaneous value

Source: Monroe and Kelly 1992

Table 3.2-2

CONCENTRATIONS OF SELECTED POLLUTANTS IN SAN FRANCISCO BAY SEDIMENTS (ppm)

Pollutant	Mean	Range
Arsenic	---	13 - 66*+
Cadmium	1.06	0.02 - 17.3+
Chromium	89+	8 - 769+
Copper	51	1 - 1,500+
Lead	56+	1 - 10,000+
Mercury	0.5+	<0.01 - 6.80+
Nickel	---	84+ - 189*+
Selenium	---	0.001 - 0.035*
Silver	1.13	<0.01 - 16+
Tributyltin	---	0.003 - 0.09*
Zinc	100**	<100 - 1,255*
PAH	4.1	0.02 - 80.9
DDT and metabolites[1]	0.1	0.00025 - 1.96+
PCB	0.115	0.006 - 0.824

Dashes indicate data are not available.

1 Does not include data on extremely contaminated sediment in the Lauritzen Canal. The overall mean including the additional samples from the Lauritzen Canal is 7.5 ppm dry weight.

+ Exceeds levels found to have harmful effects on benthic organisms (Long and Morgan 1990)

From data in Long et al. 1988, Phillips 1987, SWRCB 1990***

Source: Monroe and Kelly 1992

Table 3.2-3

CONCENTRATIONS OF SELECTED POLLUTANTS IN BAY/DELTA ESTUARY BIOTA (ppm wet weight)

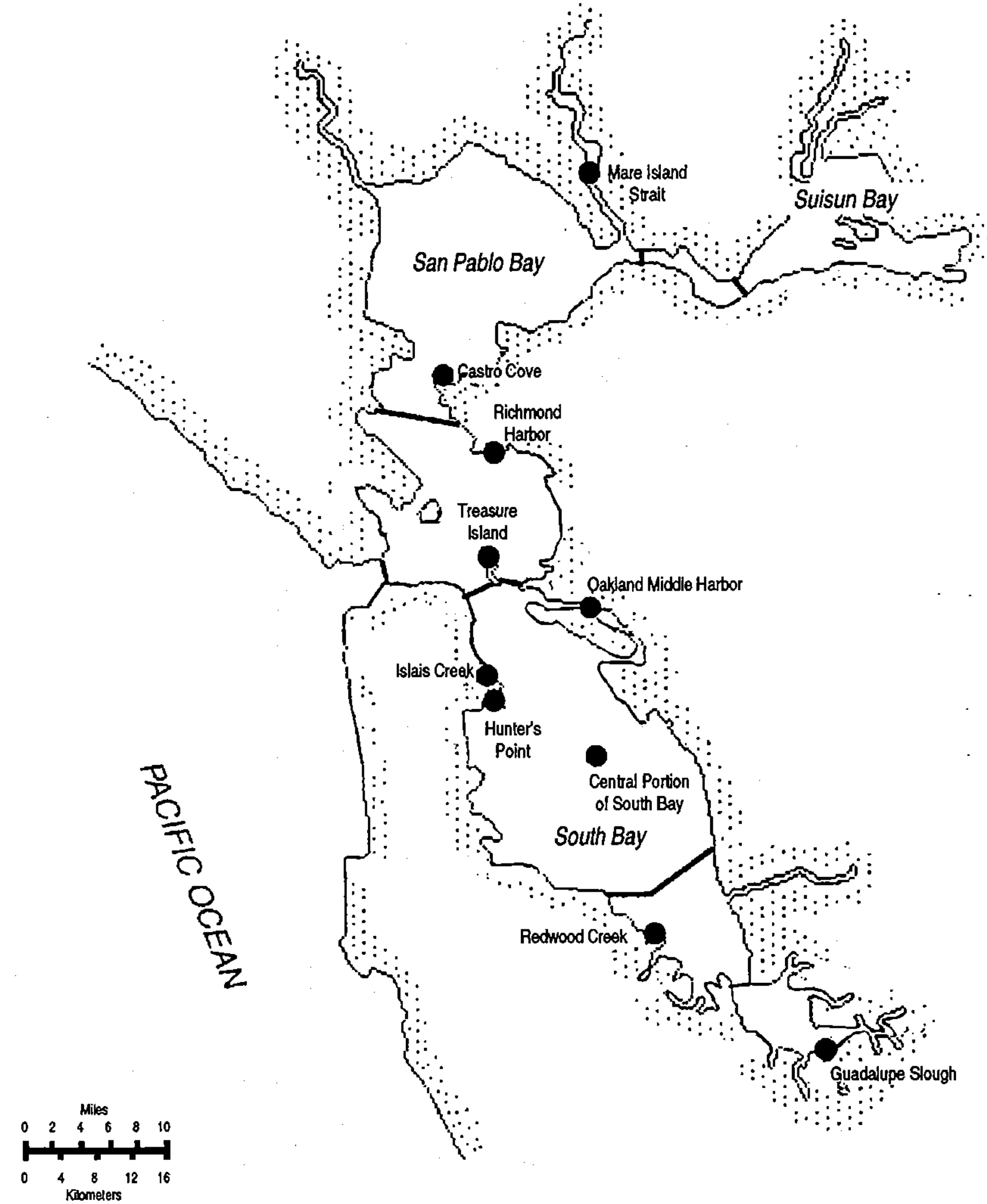
Pollutant	Mussel	Clam	Fish	Bird	Seal	Concentrations Exceeding Alert Levels*
Arsenic	1.16 - 2.16 (1,9)	- - -	0.13 - 1.20 (2)	- - -	0	Yes. Levels in some Bay shellfish exceed MIS.
Cadmium	0.11 - 4.91 (3)	- - -	0.03 - 0.48 (2)	4.17 (5)	<.06 - .33 (13)	Yes. Levels in some Bay shellfish exceed MIS.
Chromium	0.014 - 2.114 (3)	0.15 - 3.92 (4)	0.02 - 0.1 (2) 1.8 (striped bass) (7)	- - -	- - -	Yes. Levels in some Bay shellfish exceed MIS.
Copper	0.314 - 4.385 (3)	10 - 100 (6)	1.3 - 30 (2)	7.14 - 13.86 (5)	3.0 - 8.7 (13)	Yes. Levels in some Bay shellfish exceed MIS. Levels in some Suisun Bay and Delta fish exceed MIS.
Lead	0.03 - 74 (3)	- - -	0.02 - 0.2 (2)	64 - 102 (5)	0.13 - 1.22 (13)	Yes. Levels in some Bay shellfish exceed MIS.
Mercury	0.01 - 0.46 (3)	- - -	0.13 - 0.94 (2)	0.16 - 0.6 (2)	0.40 - 3.65 (13)	Yes. Levels in some Bay shellfish and Delta fish exceed MIS.
Nickel	0.5 - 2.4 (1, 11)	- - -	0.8 (2)	0.1 (8)	0.11 - 4.10 (13)	No alert levels established for tissue.
Selenium	0.19 - 0.66 (1)	0.3 - 1.30 (9)	0.28 - 22.0 (10)	24 - 58 (10)	2.07 - 6.49 (13)	Yes. Levels in some Bay shellfish exceed MIS. Levels in some Bay fish exceed MARL. Levels in some Bay ducks exceed MARL.
Silver	0.02 - 22.5 (3)	0.14 -28.57 (6)	0.13 - 0.94 (2)	0.33 - 3.70 (8)	- - -	No alert levels established for tissue.
Tributyltin	0.120 - 2.960 (1)	- - -	- - -	- - -	- - -	No alert levels established for tissue.
Zinc	11.0 - 45.8 (1)	- - -	16.0 - 43.0 (2)	21.6 (8)	- - -	No alert levels established for tissue.
PAH	0.025 - 13 (3)	- - -	0.017 - 14 (3)	- - -	- - -	No.
DDT and metabolites	<.002 - 3.21 (3)	- - -	0.020 - 5.18 (2)	- - -	5 - 34 (13)	Yes. Levels in some Delta fish exceed FDA action level.
PCB	0.009 - 0.657 (3)	- - -	0.05 - 6.99 (2, 12)	- - -	0.05 - 330 (13)	Yes. Levels in some Bay and Delta fish exceed FDA action level.

Note: Concentrations are shown for wet weight; data originally given for dry weight have been converted by dividing by seven. For seals, trace element data represent concentrations in dry whole blood; data for DDT and PCB represent concentrations in blood plasma lipids.

* The alert levels referred to in this table are the maximum tissue residue levels that are protective of human health. They include (1) the median international standard (MIS), which is a general guideline of what other nations consider to be elevated contaminant levels in fish and shellfish tissue; (2) the U.S. Food and Drug Administration (FDA) action levels, which represent maximum allowable concentrations for some toxic substances in human foods; and (3) the State Department of Health Service's maximum allowable residue levels (MARL), established to ensure that a consumer of specified fish or wildlife species does not exceed the permissible intake level for particular contaminants.

From data in:
(1) State Mussel Watch Program in SWRCB 1990
(2) State Toxic Substances Monitoring Program in SWRCB 1990
(3) Long et al. 1988
(4) Hayes and Phillips 1986 in SWRCB 1990
(5) Ohlendorf 1985 in SWRCB 1990
(6) Luoma et al., 1985 in SWRCB, 1990
(7) Saiki and Palawski, 1990 in SWRCB, 1990
(8) Ohlendorf et al., 1986 in SWRCB, 1990
(9) Girvin et al., 1975 in SWRCB, 1990
(10) CDFG 1991
(11) Risebrough et al. 1978 in SWRCB 1990
(12) NOAA 1987
(13) Kopec et al. 1991

Source: Monroe and Kelly 1992



Note: Sites indicated are those at which the concentration of at least one pollutant exceeds the health effects threshold, as defined in CBE, 1987

BAY AREA SITES EXHIBITING ELEVATED POLLUTANT CONCENTRATIONS IN SEDIMENTS OR BIOTA

Figure 3.2-3

Source: Monroe and Kelly 1992

Table 3.2-4

POLLUTANT TRENDS IN BAY/DELTA ESTUARY SEDIMENTS AND BIOTA

Pollutant	Trends in Sediments	Trends in Biota
Arsenic	Few sites highly contaminated. Data unavailable to determine geographic or temporal trend. (2)	Data unavailable to determine geographic or temporal trend. (2)
Cadmium	Ubiquitous in the Bay; patchy distribution. Possible increasing concentration from north to south. Highest concentrations in South Bay. Slight decrease in mean sediment concentrations since mid-1970s. (3)	Concentrations in mussels fairly uniform among various basins in S.F. Bay. Highest concentrations in South Bay. Possible general pattern of slightly decreasing concentrations in mussels during the 1980s. Wide variation in concentrations in biota from year to year. (3)
Chromium	Spread throughout system. Concentrations higher in basins than on periphery. Highest levels in San Pablo Bay. No temporal trend apparent. (3)	Concentrations in mussels highest in Central and South Bays. There are no Bay-wide temporal trends apparent among mussels. (3)
Copper	Spread throughout system. Concentrations higher on periphery than in basins. Data unavailable to determine temporal trend. (3)	Appears to be in similar concentrations in bivalves throughout S.F. Bay; very patchy distribution. Mean concentrations similar in basins and peripheral areas, but highest levels occur in peripheral areas. No temporal trends in concentrations in biota are apparent. (3)
Lead	Spread throughout system at low concentrations. Concentrations highest on peripheral areas. No temporal trend apparent. (3)	Concentrations in mussels highest in peripheral areas. Concentrations in mussels highest in Central and South Bays. Data unavailable to determine temporal trend. (3)
Mercury	Patchy distribution. Concentrations higher in peripheral areas. Highest mean concentrations on South Bay periphery. No temporal trend apparent. (1, 3)	Concentrations fairly uniform in biota throughout S.F. Bay. Highest levels in biota of South Bay. No significant temporal trend of increasing or decreasing concentrations. (3)
Nickel	Increasing concentrations from north to south. Highest concentrations in South Bay. No temporal trend apparent. (1)	Concentrations elevated in mussels from Carquinez Strait area and in clams from South Bay. In general, levels in biota poorly characterized. Data unavailable to determine temporal trend. (2)
Selenium	Few data available. Concentrations 3-44x than that in shales. Highest concentration in San Pablo Bay. Data unavailable to determine temporal trend. (2)	Concentrations in shellfish highest in northern and southern reaches of S.F. Bay. Concentrations in ducks in South and Suisun Bays are comparable to ducks from Kesterson National Wildlife Refuge that had reproductive problems. Recent increase in concentrations in North Bay scaup and sturgeon. (1, 4)
Silver	Increasing concentrations from Delta to South Bay. Highest concentration in Central and South Bays. No temporal trend apparent. (1, 3)	Concentrations in shellfish increase along gradient from Delta to South Bay. No significant temporal trend of increasing or decreasing concentrations in biota. (1, 3)
Tributyltin	Concentrations highest at marinas and harbors. No temporal trend apparent. (1)	Concentrations of TBT are highest in marinas and harbors throughout the estuary; however, data are unavailable to determine geographic and temporal trends in concentrations in biota. (2)
Zinc	Concentrations generally moderate and, with few exceptions, fairly uniform. Highest concentrations at sites in Central and South Bays. No temporal trend apparent. (1, 2)	Concentrations in biota are moderately elevated. Highest concentrations occur in biota inhabiting peripheral areas of Central and South Bays. High concentrations in Sacramento River water above the estuary cause mortality in young salmon. Data unavailable to determine temporal trend. (1, 2)

Table 3.2-4
(Continued)

POLLUTANT TRENDS IN BAY/DELTA ESTUARY SEDIMENTS AND BIOTA

Pollutant	Trends in Sediments	Trends in Biota
PAH	Concentrations higher in peripheral areas. Data unavailable to determine temporal trend. (3)	Concentrations in mussels highest in South Bay. Concentrations in fish highest in East Bay and lowest in San Pablo Bay. There is no apparent temporal trend in concentrations in biota. (3)
DDT	Concentrations higher in peripheral areas, with few exceptions. Data unavailable to determine long-term temporal trend. (3)	Concentrations in clams historically highest in Suisun Bay and Delta biota; lowest in San Pablo Bay. Concentrations in fish relatively similar at various sites, but somewhat lower in San Pablo Bay than in Delta. Concentrations in oysters, clams, and mussels have declined steadily since early 1980s. Possible decline in concentrations in striped bass. (3)
PCB	Widespread in system. Concentrations higher in peripheral areas. Concentrations lowest in San Pablo Bay. Data unavailable to determine temporal trend. (3)	Concentrations in clams and bottomfish highest in eastern Central and South Bays. Concentrations in San Pablo Bay typically low. There was an apparent peak in PCB levels in mussels in 1981, then a decline to current levels. Data are insufficient to determine trends in other biota. (3)

Table Sources: (1) SWRCB 1990, (2) Phillips 1987, (3) Long et al. 1988, and (4) CDFG 1991
Source: Monroe and Kelly 1992

Pollutants exerting the greatest detrimental impact on the estuary's biota are those with the greatest toxicity and persistence (Phillips 1987). Using bioassays, researchers have found evidence of toxicity in the estuary's ambient water, municipal and industrial effluents, runoff, and sediments (Monroe and Kelly 1992). A recent report prepared for the State Water Resources Control Board (SWRCB) on the ambient toxicity of the Bay and adjacent wetlands (Anderson et al. 1990, cited in Monroe and Kelly 1992) indicated that the toxicity of Bay waters far from the shoreline varied widely among the test species (minnow larvae, sea urchins, sand dollars, mussels, oysters, water fleas, and algae) and over time. The bioassays also indicated that the waters sampled from four of the five marsh sites indicated toxic effects. Unlike other urbanized estuaries on the West Coast (such as Puget Sound), relatively few sediment bioassays have been conducted in the Bay. Figure 3.2-3 shows areas where sediments have proven to be most toxic.

3.2.3 Water Quality at Unocal Marine Terminal

3.2.3.1 Circulation and Dispersion Capacity

Unocal's Marine Terminal is located on the east side of San Pablo Bay at Davis Point 1.8 miles downstream from the Carquinez Strait Bridge. San Pablo Bay is a region of mixing the saline waters of San Francisco Bay and freshwater inflow from the San Joaquin/Sacramento Delta. Because of the estuarine circulation, fresh water entering San Pablo Bay flows over the denser, more saline waters from San Francisco Bay. This phenomenon results in significant vertical density stratification of the water column that is most evident during the winter wet season when freshwater inflows increase through the Delta. Therefore, the overall conditions of salinity, water temperature, and density in San Pablo Bay are a function of this freshwater flow from the Delta and tidal changes. With 57 percent of the Bay shallower than 2 m (6.5 ft) at MLLW (Robilliard et al. 1989b), the shallow waters of San Pablo Bay are well mixed by winds and tidal mixing. In Carquinez Strait, vertical mixing can be reduced by the strong density gradient between fresh and saline waters.

There are limited measurements of the density stratification in San Pablo Bay (Robilliard et al. 1989b). The greatest salinity-controlled density stratification occurs in wet winter periods of heavy rainfall. Under these conditions, the salinity in San Pablo Bay ranges from 4 ppt at the water surface to about 10 ppt at a depth of 10 m (33 ft) (Robilliard et al. 1989b). According to Conomos (1979), under normal winter conditions, there is a change in salinity from 12 to 15 ppt salinity at 10 m (33 ft) in depth, and during a "dry" winter condition, there is a change in salinity from 17 to 20 ppt at 10 m (33 ft) in depth. Typical summertime conditions result in a salinity of 19 ppt at the surface and 21 ppt at 10 m (33 ft) in depth (Conomos 1979).

The water movements in San Pablo Bay over a tidal cycle have been described by Walters et al. (1985) as follows. At the beginning of the flood tide cycle, waters incoming from San Pablo Bay flow onto the shoals with some shoal water spilling into Carquinez Strait. As flood tide progresses, the water in San Pablo Bay becomes more saline and flows further into Carquinez Strait because of the small water volume over the shoals of San Pablo Bay. With the onset of ebb tide, the lower-salinity water on the shoals ebbs first followed by higher salinity water in Carquinez Strait, and finally followed by brackish water. Thus, over a tidal cycle, there is a double peak in salinity values found in the surface waters of San Pablo Bay.

Currents in San Pablo Bay are a function primarily of water level changes associated with tidal changes (Robilliard et al. 1989b). The mean tidal range in San Pablo Bay is 1.8 m (5.8 ft). Current reversal between flood and ebb tides tends to be abrupt in San Pablo Bay. This abrupt reversal results in slack tidal conditions occurring only during a very small fraction of the total tidal cycle (Robilliard et al. 1989b). Within San Pablo Bay, the ship channel and Carquinez Strait are the areas of maximum current speed. Current profile monitoring conducted by Entrix at the Unocal Marine Terminal on January 18 and 19, 1989, showed a minimum current range between 0.1 and 0.2 meter per second (m/sec) (0.2 and 0.4 nautical mile per hour [kt]) and a sustained maximum current range of between 1.4 and 1.5 m/sec (2.8 and 3.0 kt) during ebb tide conditions. Under flood tide conditions, the minimum current speed was between 0.2 and 0.3 m/sec (0.4 and 0.6 kt), and the maximum current speed was between 0.9 and 1.0 m/sec (1.8 and 2.0 kt) (Robilliard et al. 1989b). Although a counter-clockwise, tidally driven horizontal flow has been inferred from current meter data at Suisun Bay, the horizontal circulation pattern in San Pablo Bay is unknown (Walters et al. 1985). The geometry of San Pablo Bay suggests a clockwise circulation driven by tidal currents. However, due to its shallow depth, horizontal circulation is believed to have an important wind-driven component as suggested by observations of substantial wind setup in San Pablo Bay (Walters et al. 1985).

The residence time (freshwater replacement time) for San Pablo Bay has been calculated for conditions of high Delta flow (10,000 cubic meters per second [m^3/sec]) and conditions of low Delta inflow (100 m^3/sec). Based on a high river inflow, the residence time was calculated to be 0.8 day, and under low river inflow the residence time was calculated as 25 days (Walters et al. 1985). Walters et al. (1985) also calculated the hydraulic replacement time for San Pablo Bay. The hydraulic replacement time is, theoretically, the time required to replace the water volume of a subarea under consideration. For San Pablo Bay under conditions of high flow, the hydraulic replacement may be as rapid as 0.8 day, and under conditions of low flow, it was calculated to be 84 days. Thus, during the winter or periods of high freshwater inflow, the residence time is a function of rapid hydraulic replacement. During periods of low flow, usually summer, other mechanisms such as dispersion and estuarine circulation become more important.

3.2.3.2 Existing Outfalls in Project Vicinity

Five industrial dischargers, including Unocal, and four municipal dischargers contribute to the water quality of San Pablo Bay in the vicinity of the Proposed Project. Depending on the industrial process, specific types and quantities of pollutants will be present in the industry's effluent. In general, by examining the NPDES monitoring reports on industrial and municipal effluent discharges, it appears that oil and grease, suspended solids, sulfur compounds, nitrogen compounds (as ammonia), phenols, and trace metals are the most prevalent contaminants being discharged into San Pablo Bay from the industries and municipal treatment works described below.

Three of the five industries on the shores of San Pablo Bay are refineries including Unocal, the Pacific Refining Refinery, and the Chevron Richmond Refinery at Point San Pablo. The other two industries are the PG&E Oleum Power Plant and the C&H Sugar Refinery. The Pacific Refining Refinery produces gasoline and assorted hydrocarbon fuels. Treated effluent is discharged into San Pablo Bay through an outfall pipe located west of Lone Tree Point. The major products of the Chevron Richmond Refinery are gasoline, jet fuel, fuel oils for ships and power plants, and diesel. Treated effluent from the Chevron Refinery is discharged into San Pablo Bay from a deep water outfall. The PG&E Oleum Power Plant has a shallow-water outfall site on the west side of Davis Point for its treated effluent. The wastewater from the C&H Sugar Refinery is combined with municipal wastewater for secondary activated sludge treatment before discharge into Carquinez Strait through a diffuser outfall located directly beneath the Carquinez Bridge. In 1985, the Unocal Refinery contributed less than 5 percent of the total effluent volume discharged by the major industrial/municipal sources in the project vicinity (Jefferson Associates 1987). The major effluent volume is from municipal, public-owned treatment works including the Ignacio-Novato Sanitary District, the Vallejo Sanitary District, and the Central Marin and Rodeo public-owned treatment works.

Numerous other marine terminals and refineries are located in the Suisun Bay-Carquinez Strait, as presented in Section 2.4.2.1. They would also be expected to contribute to the water quality of San Pablo Bay, but to a lesser degree.

3.2.3.3 Receiving Water and Sediment Quality in Project Vicinity

San Pablo Bay is suspected to be a water quality-limited receiving water segment, but more data are necessary to make a final determination (San Francisco - RWQCB 1989, Order No. 89-002). Discharges by industry, municipal wastewater treatment facilities, urban runoff, and freshwater inflow from the Sacramento-San Joaquin Delta as well as the Petaluma, Sonoma, and Napa Rivers are the principal contributors to the water quality of San Pablo Bay. Contributions from the sea through the Golden Gate are minor.

<u>Receiving Water Quality</u>

Tidal exchange and seasonal fluctuations in wind and river inflow from the Delta greatly influence the mixing of dissolved substances and suspended sediments in San Pablo Bay. Suspended sediments play an important role in determining the overall water quality of bays and estuaries; they adsorb and release contaminants into the water column and scatter light which influences the amount of phytoplankton productivity. With regard to suspended sediments, San Pablo Bay is a known major repository of suspended sediments introduced into San Francisco estuary by Delta flow. It has been estimated that roughly half of the suspended sediment brought in by Delta inflow is deposited in San Pablo Bay and in Central Bay, with the remainder being transported out to sea through the Golden Gate (Krone 1979; cited in Jefferson Associates 1987). Thus, in the shallower areas of San Pablo Bay, where large quantities of bottom sediments would be expected to be deposited, wind-generated waves and tidal exchange cause the resuspension and redistribution of suspended sediments to deeper water areas of San Pablo Bay.

Historical total suspended solids (TSS) concentrations in San Pablo Bay and the northern reach of the estuary ranges from 20 to 100 mg/L in the winter (December through April) and from 5 to 35 mg/L in the summer (July through October) (Conomos and Peterson 1977; cited in Jefferson Associates 1987). Industrial discharges contribute to the TSS loading of San Pablo Bay, but their contribution is small, accounting for only a few thousand tons per year. The Unocal Refinery contributes less than 5 percent of the TSS load discharged from all of the major municipal and industrial sources in the vicinity of the project (Jefferson Associates 1987). There are no data on the TSS concentration in receiving waters near the Unocal Refinery.

In San Pablo Bay, the supply of nutrients is dominated by Delta inflow during the winter (except for ammonia) with significant amounts of ammonia and phosphorus contributed by industrial and municipal discharges in the summer. Summer and winter surface water concentrations of ammonia average from 70 to 140 micrograms per liter (ug/L), nitrite plus nitrate ranges from 210 to 350 ug/L, and phosphorus ranges from 60 to 120 ug/L (Conomos et al. 1979). A 1986 survey of surface water nutrient levels near the Chevron Richmond Refinery at Point San Pablo showed ammonia concentrations averaging less than 25 ug/L (Jefferson Associates 1987). The receiving water concentration of ammonia in the immediate vicinity of the Unocal Marine Terminal diffuser averaged 130 mg/L, with a minimum value of 10 mg/L and a maximum value of 400 mg/L in 1991. In this last case, the monitoring results at the Unocal Marine Terminal are evidently dominated by ammonia discharges from the Refinery.

San Pablo Bay is generally near 100 percent oxygen saturation for surface waters during both the summer and winter. During the August 1986 survey of water quality in the vicinity of the Chevron Richmond Refinery, the dissolved oxygen concentration ranged from 8.7 mg/L for surface waters and decreased to 7.6 mg/L at a water depth of 14 m (46 ft) (Jefferson Associates 1987). The receiving water concentration of dissolved oxygen in the immediate vicinity of the Unocal Marine Terminal diffuser averaged 8.4 mg/L, with a minimum value of 7.3 mg/L and a maximum value of 9.8 mg/L in 1991.

Limited data are available on dissolved metals or organic contaminants in the waters of San Pablo Bay. Sources of dissolved metals to San Pablo Bay include those from the Pacific Ocean and the Delta, aerial fallout, surface stormwater runoff, and municipal and industrial discharges. Of these, the major sources of dissolved metals are from the Delta and municipal and industrial dischargers. The most comprehensive report on dissolved metal levels in San Pablo Bay comes from Eaton 1979 (cited in Jefferson Associates 1987) who found concentrations for dissolved copper between 1.5 and 3.1 ug/L, nickel between 0.8 and 2.2 ug/L, zinc between 1.1 and 3.3 ug/L, and cadmium between 0.17 and 0.20 ug/L in July and September 1975 and March 1976. Other historical measurements of total metal concentrations in waters of San Pablo Bay include the analysis of influent cooling water to the PG&E Oleum Power Plant (CBE 1983, cited in Jefferson Associates 1987), a study of total metals at Mare Island (Smith et al. 1980, cited in Jefferson Associates 1987), and a study of the levels of dissolved and total metals at three proposed deepwater outfall sites near Point San Pablo for the Chevron Richmond Refinery (Jefferson Associates 1987). These data are summarized in Table 3.2-5 and include receiving water data for stations in the immediate vicinity of the Unocal Marine Terminal along the area in which the diffuser is installed. The analysis of samples for Point San Pablo was conducted using state-of-the-art, ultraclean techniques. As a result, the values from Point San Pablo are 25 to 60 times lower than historical data. The data in Table 3.2-5 imply that there are significant sources of dissolved metals being discharged into San Pablo Bay. Analysis of water samples collected near the Unocal Marine Terminal suggests that waters in the vicinity of the Terminal and the Refinery discharge are elevated in copper, chromium, lead, and zinc compared to other sites in San Pablo Bay.

There are some major differences in the relative contribution of metals from municipal and industrial discharges into San Pablo Bay. Based on a 1985 analysis of the NPDES monitoring reports from major

Table 3.2-5

TOTAL METAL CONCENTRATIONS IN PROJECT VICINITY

Trace Metal	Location	Concentration (ug/L)	State Objectives for Protection of Saltwater Aquatic Life (ug/L)
Arsenic	PG&E Intake[1] Mare Island[2] Pt. San Pablo[3] Unocal Marine Terminal Receiving Water Station (MTRWS)[4]	25 9.4 --- --- ---	36 (4 day) 69 (1-hour average)
Chromium	PG&E Intake Mare Island Pt. San Pablo Unocal MTRWS	43 3.8 1.01 28	50 (4 day) 1,100 (1-hour average)
Copper	PG&E Intake Mare Island Pt. San Pablo Unocal MTRWS	18 5.5 2.55 55	2.9 (1-hour average)
Lead	PG&E Intake Mare Island Pt. San Pablo Unocal MTRWS	2.4 11.1 0.304 18 to 20	5.6 (4 day) 140 (1-hour average)
Nickel	PG&E Intake Mare Island Pt. San Pablo Unocal MTRWS	21 21 3.83 4 to 6	8.3 (4 day) 75 (1-hour average)
Silver	PG&E Intake Mare Island Pt. San Pablo Unocal MTRWS	4 2.4 --- ---	2.3 (instantaneous maximum)
Mercury	PG&E Intake Mare Island Pt. San Pablo Unocal MTRWS	--- --- 0.015 ---	2.1 (1-hour average)
Selenium	PG&E Intake Mare Island Pt. San Pablo Unocal MTRWS	--- --- <0.116 <1.0	71 (4 day) 300 (1-hour average)
Zinc	PG&E Intake Mare Island Pt. San Pablo Unocal MTRWS	--- 32.8 2.19 57	45 (4 day) 86 (1-hour average)

1 CBE 1983
2 Smith et al. 1980
3 Jefferson Associates 1987
4 NPDES Monitoring Report 1991 Annual Summary, Stations C19-C22

industrial and municipal dischargers, the Unocal Refinery contributed approximately 25.5 percent of the chromium, 2.2 percent of zinc, 1.3 percent of nickel, 4.6 percent of lead, and 0.5 percent of copper (Jefferson Associates 1987). In contrast, the Chevron Richmond Refinery contributed about 35 percent of chromium and zinc, 10 percent of the copper, and from 55 to 60 percent of the nickel and lead. Currently, the Unocal Refinery contributes an even lower percentage relative to other municipal and industrial dischargers due to technological improvements implemented since 1985 at the Refinery to further reduce the levels of contaminants in the Refinery's effluent. Unocal began operating a new wastewater treatment facility in early 1989. This new facility employs advanced primary, secondary, and tertiary levels of treatment for process water and stormwater through a wastewater equalization system, or API separators, dissolved air flotation cells, or activated sludge systems, clarifiers, and media filters. Refinery water quality has improved as a result.

Sediment Quality

No extensive chemical quality measurements on San Pablo Bay sediment have been made. Most of the data on sediment chemistry are from NPDES monitoring reports from municipal and industrial facility operators located at San Pablo Bay.

To satisfy its regulatory requirements, the Unocal Refinery changed the location of its process wastewater discharge from an old across-the-beach outfall (Waste 004) at eastern San Pablo Bay to a new deepwater diffuser outfall under the Unocal Marine Terminal wharf (Waste 002). Operation of the new outfall commenced on January 31, 1989. Provisions of the reissued discharge permit for the new outfall required that baseline work be conducted prior to discharge at the diffuser outfall. This provision (Phase 1 Receiving Water Monitoring Program) (Ballaine and Robilliard June 1989) included collection and analysis of surface sediments from the area near the new outfall and from the area near the old outfall. Phase 2 studies include longer term outfall studies comprising a combination of continuations of Phase 1 studies as well as new studies, such as the effluent plume dilution and dispersion (Robilliard 1989; MacGinnis 1990).

Table 3.2-6 presents a compilation of trace metal surface sediment chemistry data for San Francisco Bay developed by Entrix (Ballaine and Robilliard 1989) to establish sediment reference values for the San Pablo Bay Area near the Unocal discharge. In general, the highest mean concentrations of trace metals were found for the San Francisco Bay region samples, followed by San Pablo Bay and Carquinez Strait/Suisun Bay samples, respectively. The lowest mean value for each of the chemicals listed in Table 3.2-6 was selected by Entrix (Ballaine and Robilliard 1989) as a reference value to compare against future Unocal data sets to identify concentrations that are greater than reference values. Surface sediment data from the Unocal local area were collected by Entrix on three separate occasions (Entrix 1987, Ballaine and Robilliard 1989, McGinnis 1990). The results of their collective analyses of surface sediment samples showed that except for selenium and mercury, surface sediments in the local area generally have lower levels of chromium, copper, lead, and zinc than surface sediments from other parts of San Francisco Bay.

Unocal performs maintenance dredging to reestablish water depths necessary for safe approach and berthing operations at its Marine Terminal. The Corps plans to issue a 5-year permit to perform maintenance dredging of 90,000 cubic yards annually (B. Smith, personal communication 1992). Dredged material is disposed of at the Carquinez Strait Dredged Material Disposal Site (DMDS, SF-9), which is primarily a dispersive disposal site. The dispersion of sediments released at the Carquinez DMDS have been found to be rapid and widespread (Sustar 1982).

Sampling and chemical testing of sediments at the Marine Terminal site and at the disposal site were completed in 1987 (Brown and Caldwell 1987) and in 1990 (MEC Analytical Systems Inc. 1990) in support of dredging permit applications. Sediments at the Marine Terminal in 1990 were found to consist primarily of sand (>90 percent) and a small fraction of silt/clay (<5 percent). Sediments at the disposal site were found to consist of gravel (15.3 percent), sand (16.1 percent), silt (31.7 percent), and clay (36.9 percent) (MEC Analytical Systems, Inc. 1990). Table 3.2-7 lists the chemical analyses results for sediments collected in 1990. Chemical analysis of the sediments dredged from the Marine Terminal in 1990 indicated higher levels of water soluble sulfides (0.050 ppm), cadmium (0.053 to 0.065 ppm), chromium (52.6 to 58.5 ppm), lead (11.5 ppm), and zinc (16.2 to 22.2 ppm) than reference sediments collected at the Carquinez Strait disposal site. No organic pesticides, PCBs, phenols, PAHs, or phthalates were detected in the dredged material, and organotins were detected at <13.2 ppb in all three areas sampled. In 1987, lead was detected in sediments at the Marine Terminal at 11

Table 3.2-6

REGIONAL SURFACE SEDIMENT CHEMISTRY DATA (mg/kg, dry weight)

Location		Chromium	Copper	Lead	Mercury	Nickel	Selenium	Zinc
San Francisco Bay	Mean	89	51	56	0.5	·100	NA	·100+
	SE	4.8	2.0	8.3	0.02	—	—	—
	n	396	879	1314	1097	—	—	—
	Ref.	1	1	1	1	2	—	2
San Pablo Bay	Mean	84	45	32	0.45	81	NA	102
	SE	2.7	3.2	3.8	0.05	2.7	—	8.4
	n	17	58	112	112	3	—	3
	Ref.	3/4	1	1	1	3	—	3
Carquinez Strait/Suisun Bay	Mean	NA	39	29	0.23	84	0.3	134
	SE	—	2.7	1.9	0.03	3.4	0.005	6.4
	n	—	78	89	57	7	46	13
	Ref.	—	1	1	1	5	5	5

SE: Standard error
n: Number of samples

Ref.: Reference
1 Long et al. 1988
2 Phillips 1987
3 Chapman et al. 1986
4 NOAA Status & Trends: chromium data for San Pablo Bay were mean = 280 mg/kg, SE = 68 mg/kg, and n = 17
5 Johns et al. 1988

NA: Not available

Source: McGinnis 1990

Table 3.2-7

SUMMARY OF SEDIMENT CHARACTERIZATION AT UNOCAL MARINE TERMINAL

	Sample Areas			Carquinez Reference Sediment	Achieved Detection Limits[2]	Required Detection Limits[3]
	1	2	4			
Grain Size (%)						
Gravel	0.2	0.7	0.3	15.3		
Sand	97.6	90.3	98.3	16.1		
Silt	0.9	4.0	0.1	31.7		
Clay	1.2	5.0	1.2	36.9		
Total Organic Carbon (%)	0.108	0.294	0.122	1.415		0.1
Solids (%) (Dry Wt.)	75.8	75.8	78.0	49.6		
Sulfides (mg/kg)						
Total	<29.0	<29.0	<28.2	<44.4	22	1.00
Water Soluble	0.005	0.005	0.050	<0.010	0.005	0.10
Organic Contaminants (µg/kg)						
Tributyltin	<13.2	<13.2	<12.8	<20.2	10	1.00
Dibutyltin	<13.2	<13.2	<12.8	<20.2	10	1.00
Monobutyltin	<13.2	<13.2	<12.8	<20.2	10	1.00
Cyanide (mg/kg)	0.331	0.781	0.337	1.11		0.10
Grease and Oil (mg/kg)	18.3	<13.2	<12.8	55.8	10	0.10
TRPH (mg/kg)	16.2	<13.2	<12.8	12.9	10	0.10
Metals (mg/kg)						
Arsenic (As)	0.328	3.04	0.373	5.99		0.10
Mercury (Hg)	0.042	0.075	0.036	0.171		0.02
Selenium (Se)	<0.124	<0.119	<0.128	<0.202	0.090	0.10
Cadmium (Cd)	0.065	<0.024	0.053	<0.040	0.018	0.10
Chromium (Cr)	52.6	58.5	42.3	51.4		0.10
Copper (Cu)	8.28	19.0	8.42	44.2		0.10
Lead (Pb)	11.5	10.6	9.42	11.2		0.10
Nickel (Ni)	43.4	45.5	43.2	46.4		0.10
Silver (Ag)	<0.100	<0.095	<0.103	<0.161	0.072	0.02
Zinc (Zn)	22.2	19.0	16.2	10.5		1.00

[1] All chemical analyses are given as dry weight basis unless noted.
[2] Detection limits are given as wet weight basis since the dry weight values are arithmetically derived.
[3] Detection limits required by RWQCB.
ND = None Detected at the achieved detection limit.

Source: DA Permit No. 15825E52A, Attachment A to 15 ppm and zinc at 42 to 52 ppm (Brown and Caldwell 1987). These levels are below the values that have been found to have toxic effects on benthic organisms (Long and Morgan 1990). Nickel, however, was found at between 48 to 52 ppm, which is at the threshold at which toxic effects are considered to be likely (Long and Morgan 1990).

3.2.3.4 Pollutants in Biota in Project Vicinity

Bioaccumulation of trace metals and organic compounds is generally greatest with benthic invertebrates, particularly shellfish. Bioaccumulation is the uptake of a chemical by an organism in concentrations greater than the concentration found in the ambient environment. Biological factors such as the organism's size, age, sex, reproductive period, metabolic clearing rates, and body lipid content can affect the degree of accumulation. Environmental factors such as the grain size of sediments, pH of the water, and the amount of organic carbon content of the sediments can also affect the availability of chemical constituents to organisms.

Under the California State Mussel Watch Program, shellfish have been analyzed fairly extensively for trace metals and organic compounds in San Pablo Bay, particularly along the eastern shore between Crockett and Rodeo. The marine mussels *Mytilus edulis* and *M. californianus* are collected from pristine areas of low contamination and transplanted to numerous sites in San Francisco Bay. Four principal State Mussel Watch stations are in the San Pablo Bay region: Station 298.00 at Suisun Bay, Station 300.20 at Mare Island, Station 301.40 at the Unocal Oil Outfall, and Station 302.00 at Point Pinole. Table 3.2-8 provides the monitoring results at these four stations from 1977 to 1990. From these summary tables, it appears that in San Pablo Bay cadmium and selenium are above MIS concentrations for edible shellfish.

In waterfowl, the selenium concentration is of particular concern. The California EPA has issued a health advisory for the consumption of diving ducks caught in Suisun Bay, San Pablo Bay, and San Francisco Bay. Although the level of selenium in waterfowl may cause reproductive stress, the restriction only applies to diving ducks because the selenium tissue burdens in other waterfowl and shorebirds are not elevated to levels that cause human health risks. Recent data suggest a linkage between selenium concentrations in waterfowl and concentration in waterfowl prey species such as bivalves (White et al. 1988, cited in RWQCB February 18, 1992, Notice of Public Hearing - Regional Monitoring Plan).

The bioaccumulation of petroleum-related organic compounds has received little attention in the general literature. Potential components of the Chevron Refinery effluent considered to have a significant bioaccumulation potential included naphthalenes, anthracenes, phenanthrenes, alkylbiphenols, pyrene and fluoranthene, amylbenzenes, monosaturated alkanes, methyllindane, ethylanisole, dibenzothiophene, benzothiophenes, and some thiocyclenes (Jefferson Associates 1987).

3.2.4 <u>Outer North Coast</u>

3.2.4.1 Introduction

Nearshore marine water quality along the northern California coast is considered to be good (Winzler and Kelly 1977). The quality of ocean waters adjacent to San Francisco Bay is also generally considered to be good, although nearshore waters have been affected by the quality of water discharged through Golden Gate. Nearshore areas along the San Francisco shore are affected by ocean discharge of municipal wastewater from the Richmond-Sunset treatment plant and storm drain outflows (Winzler and Kelly 1977). One reason why the water quality of the north coast is good is that the coastal communities north of San Francisco are relatively small and their waste discharge is limited, with the exception of waste load discharges from the wood and wood products industry in the Eureka area. Watersheds that drain directly into marine waters can locally influence the temperature, salinity, dissolved oxygen, and turbidity characteristics of nearshore waters, as well as contribute to the sediment and contaminant loading of these waters. Many streams and rivers in the north coast area carry substantial sediment loads during the winter rainy season. Presently, most of the reported water quality problems within the North Coast basin are intermittent or transitory; hence, in general, the present water quality meets or exceeds the water quality objective set forth in the Water Quality Control Plan for the North Coast Region (RWQCB 1988). Coastal waters of the North Coast Region support 10 existing beneficial uses: navigation, contact and noncontact water recreation, commercial and sport fishing, wildlife habitat, marine habitat, fish migration, fish spawning habitat, and shellfish harvesting. The North Coast Water Quality

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Table 3.2-8

SAN PABLO BAY SUMMARY (1977-1990) MUSSEL WATCH TRACE METALS RESULTS THAT EXCEED MEDIAN INTERNATIONAL STANDARDS OR STATE HEALTH ADVISORY LEVEL (ppm)

Station Number	Station Name	Sample Type	Sample Date	Arsenic (1.4)	Cadmium (1.0)	Chromium (1.0)	Copper (20)	Lead (2.0)	Mercury (0.5)*	Selenium (0.3)	Zinc (70)
298.0	Suisun Bay	FWC	01/21/87	---	---	---	---	---	---	0.43	---
	---	FWC	12/29/87	---	---	1.16	---	---	---	0.36	---
300.2	Mare Island	RBM	01/31/85	---	1.12	1.00	---	---	---	---	---
	---	TCM	11/26/85	---	---	---	---	---	---	0.54	---
	---	TCM	12/30/88	---	---	---	---	---	---	0.38	---
301.4	Unocal Outfall	TCM	01/28/88	---	1.23	---	---	---	---	1.93	---
	---	TCM	12/30/88	---	1.37	---	---	---	---	3.10	---
302.0	Point Pinole	TCM	01/27/81	---	2.76	---	---	---	---	---	---
	---	---	02/02/82	---	2.51	---	---	---	---	---	---
	---	---	12/07/82	---	1.48	---	---	---	---	---	---
	---	---	12/14/83	---	1.04	---	---	---	---	---	---
	---	---	12/07/85	---	1.41	---	---	---	---	---	---
	---	---	01/14/87	---	1.42	---	---	---	---	0.59	---
	---	---	12/30/88	---	1.24	---	---	---	---	0.54	---

Median International Standards are listed in the heading.
FWC = Freshwater Clam TCM = Transplanted Mussel
RBM = Resident Bay Mussel * = Median Int. Std. and State (Cal-EPA) Health Advisory Level

Control Plan also identifies three potential beneficial uses of ocean waters in the region: industrial service supply, industrial process supply, and preservation of habitat for rare and endangered species.

This section focuses on the types and amounts of pollutants entering marine waters of the North Coast Region from nonpoint sources or ocean outfalls that empty into the Pacific Ocean or enclosed bays.

3.2.4.2 Regional Discharge Sources

Table 3.2-9 lists the types and volumes of wastewater from regulated ocean outfalls and wastewater discharges along the northern outer coast. In this discussion, a major discharge is defined by the volume of effluent flow per day; municipal discharge flows greater than 0.5 mgd and industrial discharge flows greater than 0.05 mgd are considered to be major. The majority of ocean and bay outfalls are from municipal wastewater treatment facilities; however, the greatest volume of wastewater to the outer North Coast Region is cooling water discharged into Humboldt Bay.

Municipal and Industrial Outfalls

Industrial sources within the north coast are primarily associated with the wood and wood products industry. The production of wood products and sawmill operations all contribute to the industrial wasteload. Because the industrial sources are widely scattered within the North Coast Region and their wastes are often combined with municipal wasteloads, an assessment of their contribution to the total waste stream into waters of the Region is not readily available. The major industrial discharges into coastal waters of the north coast include cooling waters from the Pacific Gas and Electric Facility and wastewater from the wood products industries in Humboldt County.

Within the major population centers (Fort Bragg, Eureka, and Crescent City), effluent loads from wastewater treatment plants contribute to the wasteloads of major drainages on the north coast. An average of 9.3 mgd of wastewater is discharged into northern California waters from the three major municipal wastewater dischargers (Table 3.2-9). In these same population centers, light industry wasteloads are often combined with municipal wastewater treatment.

Recreational facilities, particularly campgrounds, are numerous in the north coast. They represent a small, but significant, point source of pollutants to coastal drainages (Winzler and Kelly 1977).

Nonurban Runoff

The largest contributor of contaminants in surface runoff is runoff from forest lands, followed by runoff from agricultural lands (Winzler and Kelly 1977). Agricultural runoff is a source of impairment to waters of Tomales Bay and the Russian River.

Logging and associated activities combined with soil erosion from highway construction, gravel removal, mining, and overgrazing all contribute to the sedimentation of major drainages. The waste loads from these sources may decrease over time if better source control measures are implemented.

Harbors

Numerous small craft harbors are situated along the north coast; however, only a few provide adequate refuge in all weather. Harbors for deep draft vessels presently exist only in Humboldt Bay and San Francisco Bay. There is little information available on the quantity and types of pollutants these harbors contribute to coastal waters along the north coast. Most of the pollutants into harbor waters would be oil-contaminated waters that are accidentally or carelessly discharged from bunkering and from routine engine maintenance operations. Release of bilge waters may also contribute oily materials and other pollutants.. In addition, waste discharges from pleasure craft are usually untreated and go directly into the marine environment. These untreated wastes introduce pathogenic bacteria and viruses into marine waters, where fish and shellfish can act as carriers or concentrate the pathogenic bacteria and viruses in their tissues. Toxic substances, especially tributyltin in vessel antifouling paints have contributed to pollution problems in harbors. TBT is highly toxic to aquatic life (Class et al. 1988).

Table 3.2-9

WASTEWATER OUTFALLS - NORTH CALIFORNIA COAST[1]

Facility	Location	Flow (mgd)[2,3]
Municipal - Crescent City	Del Norte County	1.86
Municipal - City of Elk STP	Humboldt County	5.24
Humboldt County Resort at Shelter Cove	Humboldt County	0.13
Industrial - Louisiana Pacific Pulp Mill	Humboldt County	25.90
Industrial - Simpson Paper Co.	Humboldt County	25.40
Municipal - U.S. Navy at Centerville	Humboldt County	0.041
Cooling Water - Pacific Gas and Electric	Humboldt County	75.00
Municipal - City of Ft. Bragg	Mendocino County	2.20
Municipal - Mendocino Sanitation District	Mendocino County	0.30
Municipal - Mendocino CWWD No. 2 at Anchor Bay	Mendocino County	0.044
Industrial - California Fish Growers	Sonoma County	6.50
Municipal - U.C. Bodega Marine Lab	Sonoma County	1.50

[1] Source: T. Wikstrom, Regional Water Quality Control Board, North Coast Region 1992
[2] Both facilities in Sonoma County are considered to be minor discharges by the RWQCB because their discharge is recirculated seawater from animal rearing pens or seawater aquaria.
[3] mgd = million gallons per day; peak effluent flow during wet weather.

Vessel Traffic

The principal marine traffic routes in the study area are discussed in Section 3.1. Vessel traffic includes both coastwide and overseas trade. As a result of the discovery of oil on the north slope of Alaska and concern for marine accidents involving vessels transporting crude oil to Pacific Coast refinery ports, several studies on marine traffic in the study area have been prepared. Because the greatest density of domestic merchant traffic along the Pacific Coast is between Los Angeles and San Francisco, most of the pollutants entering waters of the north coast would originate predominantly from overseas vessel traffic and from oil tankers transporting crude oil from Alaska. The number of accidental spills, both small and large, would be proportional to the number of vessel trips in the area, but independent of the traffic density (SLC et al. 1986). The USCG has regulations (33 CFR 155) prescribing procedures, methods, equipment, and other requirements to prevent and contain oil discharges from vessels. Vessels may be inspected by the USCG, and operational procedures amended to ensure the safety and cleanliness of navigable waterways under USCG jurisdiction.

3.3 BIOLOGICAL RESOURCES

3.3.1 Introduction

This section presents, in detail, those aspects of the biological resources within the study area that could be affected by the Proposed Project. First, an overview of the regulatory setting for biological resources within the region is presented (Section 3.3.2). Next, Section 3.3.3 presents a discussion of the distribution and abundance of marine and estuarine life in San Francisco Bay, San Pablo Bay, Carquinez Strait, and Suisun Bay. Particular emphasis is placed on the northern reach of the San Francisco Bay estuary ecosystem because the Unocal Marine Terminal is located in San Pablo Bay. Section 3.3.4 focuses on the marine and estuarine resources in the vicinity of the Unocal Marine Terminal at Rodeo. Finally, an overview is presented in Section 3.3.5 of the marine life of the outer coast of northern California. The outer coast discussion focuses on particularly sensitive and ecologically or commercially important marine organisms as well as sensitive marine habitats.

3.3.2 Regulatory Setting

The biological resources of the San Francisco Bay-Delta estuary and the northern California outer coast are overseen by several federal, state and local agencies. Federal agencies directly responsible for the protection of biological resources are the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). The Environmental Protection Agency (EPA) is also concerned with the protection of marine and estuarine life through the regulation of water quality standards.

The California Department of Fish and Game (CDFG) is responsible for the protection of biological resources at the state level. The CDFG is responsible for the protection of species officially listed as threatened or endangered by the State of California, candidates for listing as threatened or endangered, and California Species of Special Concern. The CDFG also regulates fishing and hunting and protects the quality of the habitat for California's biological resources. In addition, the CDFG administers the California Oil Spill Prevention and Response Act. The California Coastal Commission is responsible for coastal zone management along the coast with the exception of San Francisco Bay. The California Coastal Commission endeavors to ensure that the biological productivity of coastal resources is maintained, enhanced, and restored for commercial, recreational, scientific, and educational purposes. The California State Water Resources Board sets water quality standards for the protection of aquatic life. These standards are overseen on a local level by the San Francisco Regional Water Quality Control Board.

The San Francisco Bay Conservation and Development Commission (BCDC) is responsible for coastal zone management within the San Francisco Bay—Delta estuary. The BCDC regulates dredging, filling, and land use in San Francisco Bay below the line of highest tidal action as well as 100 feet inland of the line of highest tidal action.

Legislation applicable to the protection of biological resources in San Francisco Bay-Delta estuary and the northern California outer coast include the following:

- National Environmental Policy Act of 1969 and amendments,
- USFWS - Endangered Species Act of 1973 and amendments,
- California Endangered Species legislation, California Administrative Code Title 14 Section 670.5, 1970,
- CDFG Code Section 1601-1603,
- The Federal Oil Pollution Act of 1990,
- California SB 2040 - Oil Spill Prevention and Response Act,
- Migratory Bird Treaty Act,
- Marine Mammal Protection Act,
- California Coastal Act of 1976 as amended 1983,
- Marine Protection Research Sanctuary Act of 1972, and
- Coastal Zone Management Act of 1972.

3.3.3 San Francisco Bay, San Pablo Bay, Carquinez Strait, and Suisun Bay

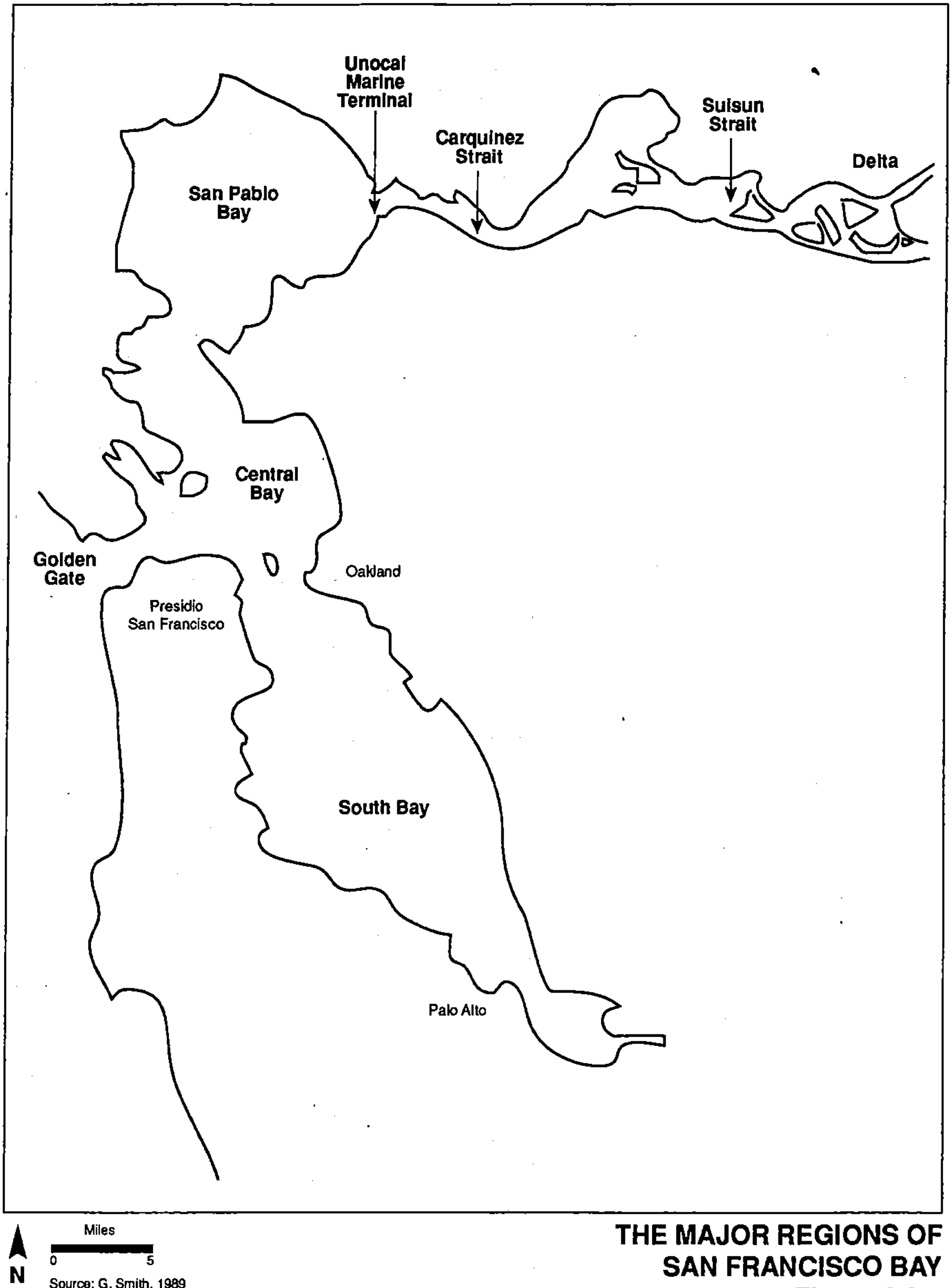
San Francisco Bay estuary, which extends from the mouth of Coyote Creek near the City of San Jose in the south to Chipps Island at the eastern end of Suisun Bay, is the largest coastal embayment on the Pacific Coast of the United States (Figure 3.3-1). It has a surface area of 1,240 km^2. San Francisco Bay is located at the mouth of the Sacramento-San Joaquin River System which carries runoff from 40 percent of the surface area of California (Nichols et al. 1986). The Bay is characterized by broad shallows with an average depth of 6 m MLLW (Conomos et al. 1985). The deepest sections of the Bay are channels such as at Golden Gate (110 m depth) and Carquinez Strait (27 m depth) whose depths are maintained by strong tidal currents. Of the historical marsh area of 2,200 km^2 surrounding San Francisco Bay and the Sacramento-San Joaquin Delta, all but 125 km^2 have been diked or filled (Josselyn 1983).

San Francisco Bay estuary has two distinct estuarine reaches, the northern reach and the southern reach. The northern reach lies between the Golden Gate and the confluence of the Sacramento-San Joaquin River System. The northern reach is considered a typical estuary, dominated by seasonally variable river inflow. Ninety percent of the freshwater inflow into San Francisco Bay comes in through the northern reach from the Sacramento River (Davis 1982). The southern reach, or south Bay, consists of the portion of San Francisco Bay south of the Golden Gate. The southern reach receives only minor amounts of freshwater inflow and is a tidally oscillating lagoon type estuary (Monroe and Kelly 1992). Between the two reaches is the central Bay, bounded by the Richmond-San Rafael, Oakland, and Golden Gate Bridges. It is deeper than the two reaches and is more oceanic in character because of the large influx of ocean water through the Golden Gate (Davis 1982).

Net transport into and out of San Francisco Bay is primarily by the estuarine circulation created by freshwater inflow from the Sacramento River system (Davis 1982). Estuarine circulation is driven by the density difference between the freshwater in the upper layers and the saltwater near the bottom. The downstream flow of the freshwater surface layer induces an upstream flow of more saline water along the bottom (Monroe and Kelly 1992). Circulation of San Francisco Bay is discussed in greater detail in Section 3.2. The point where the bottom current moving upstream exactly cancels out the downstream flow is an area of zero net movement called the null zone, entrapment zone, or critical zone (Chadwick 1982). This convergence is a point where suspended particles, including sediment and planktonic diatoms, accumulate. High abundances of zooplankton that are important food sources for larval and juvenile fishes are associated with this entrapment zone (Nichols et al. 1986). Thus, this null zone and its associated entrapment zone have great biological importance to the marine resources of San Francisco Bay. During moderate outflow conditions, the null zone is located in Suisun Bay and landward; during high outflow conditions, it is located in Carquinez Strait seaward (Smith 1987). During periods of low outflow, the null zone is in the deeper waters of the Sacramento River (Monroe and Kelly 1992).

The San Francisco Bay estuary has been profoundly modified by human activities including diking and filling, introduction of exotic species, reduction of freshwater inflow, and waste disposal and introduction of toxic contaminants (Nichols et al. 1986). Approximately 95 percent of the historic tidal marshland of the San Francisco Bay estuary has been diked or filled (Josselyn 1983). Nearly all common macroinvertebrates present in the inner shallows of the Bay, as well as many planktonic invertebrates, algae, and fishes, are introduced species (Nichols et al. 1986). Some of these introductions were unintentional through oyster culture or ship traffic (Carlton 1979); others, such as the striped bass, were intentional. The freshwater inflow to San Francisco Bay is less than 50 percent historic levels (Monroe and Kelly 1992). Diversion of water from the Sacramento-San Joaquin River system away from San Francisco Bay has had profound effects on the marine resources of the Bay, most noticeably on the anadromous fishes such as striped bass and salmon, which live part of their lives in the open ocean but depend on the rivers for spawning. Finally, waste disposal and introduction of contaminants to the Bay have been implicated in the decline of aquatic resources such as the striped bass (Whipple et al. 1987).

Types of aquatic habitat in the San Francisco estuary region that would be most subject to oil contamination should a spill occur include open water, rocky shore, intertidal mudflats, and tidal salt, brackish and freshwater marshlands. Open water habitat includes about 900 km^2 of deeper water that is bounded by the lowest low tide line. Natural rocky shore habitat is primarily found on Yerba Buena, Angel, Alcatraz



THE MAJOR REGIONS OF SAN FRANCISCO BAY
Figure 3.3-1

Islands, Red Rock, and the Brothers, and along the shoreline of Tiburon Peninsula, Belvedere, Dumbarton Narrows, San Pablo Point, and the north and south sides of the Golden Gate. Artificial riprap and rubble, which supports a rocky shore biota, occurs throughout the Bay (see Figure D-1 in the Appendix). Intertidal mudflats are portions of the mud bottom that are alternately exposed and covered during the tidal cycle. The combined areal extent of rocky shore and intertidal mudflats in the San Francisco Bay region is about 250 km^2. Tidal salt marsh, brackish marsh, and freshwater marsh are characterized by sparse to dense stands of emergent vegetation. Tidal marshlands in the San Francisco Bay estuary region have an areal extent of less than 150 km^2 (calculations of area made from 1985 National Wetlands Inventory data).

3.3.3.1 Plankton

The term plankton refers to all the organisms that drift with the currents and includes the phytoplankton, drifting plants such as diatoms and dinoflagellates, and the zooplankton that are comprised of slightly mobile animals such as small crustaceans, swimming mollusks, jellyfish, and free-swimming larvae of fishes and bottom animals. Planktonic communities are characterized by patchiness in distribution, composition, and abundance (MMS 1983).

The phytoplankton consists of the single celled floating plants that form the base of most marine food chains. As discussed in the introduction to this section, the San Francisco estuary consists of distinct regions and each has its characteristic phytoplankton community and unique variations in phytoplankton biomass and primary productivity (Cloern et al. 1985). Table D-1 in Appendix D lists the common phytoplankton of each region of San Francisco estuary during different seasons. Figure 3.3-2 compares the timing of the spring blooms in the different regions of San Francisco estuary.

The phytoplankton community in the central Bay is similar to that in the open ocean (Cloern 1979). Peak phytoplankton growth occurs from March to June as it does in coastal waters (Davis, 1982). The assemblage is dominated by typical coastal forms such as *Chaetoceros* spp., *Nitzschia* spp., *Rhizosolenia* spp. and *Skeletonema costatum* (Cloern 1979). It is likely that the spring bloom in central Bay results from the dispersion of planktonic diatoms into San Francisco Bay from offshore blooms during the upwelling season.

In the southern reach, the phytoplankton is dominated by small flagellates (Davis 1982). A bloom occurs in March and April and is related to the salinity stratification which occurs where low salinity water intrudes into the south Bay during periods of peak outflow from the Delta. This stratification keeps the phytoplankton in the surface layers where they obtain adequate sunlight for rapid growth. Because nutrients are adequate throughout the year in the southern reach, light is thought to be the limiting factor in this part of the Bay (Davis 1982). The bloom species in south Bay are usually diatoms including *Cyclotella* spp., *Thalassiosira* spp., and *Skeletoma costatum* (Herbold et al. 1991). At other times of the year, it is the small flagellates such as *Chroomonas* and *Cryptomonas*, which are most abundant.

Phytoplankton distribution in the northern reach is characterized by an extremely high population in the null zone (Davis 1982). Typically, a bloom occurs in San Pablo Bay in spring (Cloern 1979). Part of this bloom is related to the dispersion of marine phytoplankton into San Pablo Bay, but densities are typically higher than in central Bay. Cloern (1979) suggested that as marine phytoplankton enter San Pablo Bay, they become trapped in the null zone and are dispersed laterally into the warm, shallow waters of San Pablo Bay where light levels are high and rapid growth occurs. In July and August, as the null zone moves upstream in response to decreased outflow from the Delta, a bloom typically develops in Suisun Bay (Davis 1982). The phytoplankton is again concentrated in the null zone and, again, consists primarily of neritic diatoms, usually *Skeletoma costatum* and *Thalassiosira decipiens*.

However, seasonal succession in Suisun Bay has been shown to differ from the other embayments (Cloern et al. 1985). Freshwater taxa (chlorophytes, *Melosira* spp., *Cyclotella* spp.) are common during periods of high river flow. These freshwater species are replaced by the marine assemblage dominated by *Skeletoma costatum* and *Thalassiosira decipiens* in summer. There have been recent reductions in the abundance of phytoplankton in Suisun Bay, apparently because of intensive filter feeding by the recently introduced Asian clam, *Potamocorbula amurensis* (Herbold et al. 1991). In 1990, chlorophyll concentrations in Suisun

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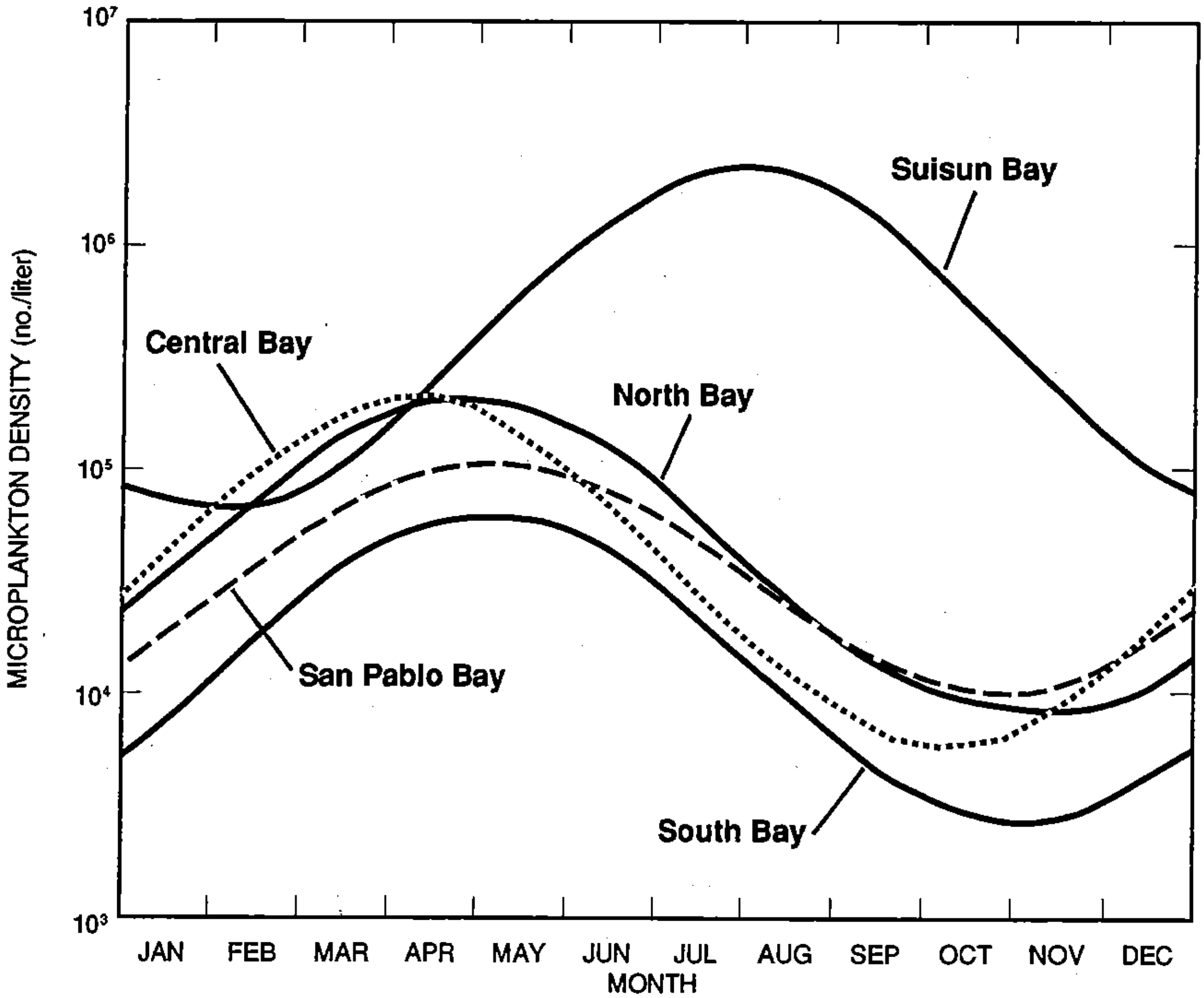


Source: Cloern, 1979

SEASONAL VARIATION OF TOTAL MICROPLANKTON DENSITY IN DIFFERENT PARTS OF THE SAN FRANCISCO ESTUARY

Figure 3.3-2

Bay did not exceed 3 $\mu g/l$, which are some of the lowest values of record (Lehman and Hymanson 1991).

Although the San Francisco Bay estuary system receives large inputs of nutrients from sewage discharges, river flow, and stormwater runoff, the Bay does not exhibit the excessive plant growth typical of eutrophication (Luoma and Cloern 1982). Red tides (blooms of toxic dinoflagellates that can poison shellfish) have been observed in the ocean waters outside of San Francisco Bay but have not been recorded inside the Bay itself.

The zooplankton are the small, floating animals that form vital middle links in many aquatic food chains. They feed on phytoplankton and are, in turn, eaten by larger invertebrates and by fishes.

The most abundant zooplankton species in San Francisco Bay is the copepod, *Acartia clausi*. Standing stocks as high as 150,000 individuals per square meter have been recorded in the southern reach (Davis 1982). In the northern reach, this coastal species is found with zooplankton species characteristic of brackish waters (Painter 1966). Overall, three species (*Acartia clausi*, *Eurytemora affinis*, and *Neomysis mercedis*) have been found to be the most abundant species both in the channels and in the shallow flats of San Pablo and Suisun Bays. Overall, the shallow flat areas of San Pablo Bay and the Grizzly Bay portion of Suisun Bay support more zooplankton than comparable depths over deep water. Dominant zooplanktors distribute themselves in the estuary according to salinity. *Acartia clausi* is found in more saline water. *Eurytemora affinis* is always most abundant near freshwater in salinities less than 10 parts per thousand.

Most species of copepods have shown pronounced long-term declines in abundance in the San Francisco Bay estuary system (Herbold et al. 1991). Only the marine species *Acartia* has not declined. This species tends to be least abundant when outflow is high and most abundant when salinity in Suisun Bay is greatest, the conditions present for the last several years. Invasion of the western Delta and Suisun Bay by the introduced copepods, *Sinocalanus doerri*, in 1978 and *Pseudodiaptomus forbesi* in 1987, was followed by declines in *Eurytemora affinis* and the almost complete elimination of *Diaptomus* spp. Most copepods, including *Acartia*, have been at low abundance in Suisun Bay since the arrival and spread of the Asian clam, *Potamocorbula amurensis*, during the last 5 years.

The opossum shrimp, *Neomysis mercedis*, is an especially important zooplankton species in the northern reach because it is the dominant species in the diet of young-of-the-year fishes (Orsi and Knutson 1979). This species is most abundant at salinities up to 10 parts per thousand and is almost never found at salinities greater than 20 parts per thousand (Davis 1982). *Neomysis* is found in most abundance in Suisun Bay and the western Delta (Herbold et al. 1991). *Neomysis* is 10 to 250 times more abundant in the null zone than upstream or downstream. Small *Neomysis* feed primarily on the great abundance of diatoms which are concentrated in the null zone. Larger individuals prefer copepods, especially *Eurytemora affinis*. *Neomysis* shows extremely large seasonal fluctuations in abundance from mean densities of less than 10 per cubic meter to almost 1,000 per cubic meter (Herbold and Moyle, 1989). The location of the null zone determines the annual fluctuations in *Neomysis* abundance. When Delta outflows are low, the null zone is in the deep channels of the Sacramento River; light levels are low, diatom levels are low and, hence, *Neomysis* abundance is also low. When outflows are high, phytoplankton populations spread out into the broad shallows of Suisun Bay; light levels are high and a bloom occurs providing more food for opossum shrimp (Herbold and Moyle 1989). Populations of *Neomysis* were lower throughout the last decade than in earlier years (Herbold et al. 1991). All of the factors associated with low abundance of this shrimp have been unfavorable in recent years: outflow has been low; densities of its principal prey, *Eurytemora affinis*, have been low; salinities have been high; and chlorophyll concentrations in Suisun Bay have been low.

3.3.3.2 Benthos

__Hard Bottom__

Natural rocky shore habitat in San Francisco Bay estuary is found primarily at Yerba Buena, Angel Island, Alcatraz Island, Red Rock and the Brothers, and along the shoreline of Tiburon Peninsula, Belvedere Dumbuton Narrows, San Pablo Point, and the north and south sides of the Golden Gate Bridge.

Table D-2 in Appendix D lists plant and animal species found during a spring and a winter survey of the rocky habitat at Point Blunt on Angel Island, and Table D-3 is a species list for the rocky intertidal at Alcatraz. Most of the species found in both of these areas are typical of rocky shoreline habitats on the outer coast. However, the Bay mussel, *Mytilus edulis*, rather than the open coast California mussel, *M. californianus*, was found.

In addition to the natural rocky habitat near the Golden Gate and in central Bay, manmade hard substrate in the form of riprap and docks and pilings occurs throughout the Bay. Figure D-1 in Appendix D shows the distribution of both natural and manmade hard substrate in San Francisco Bay. Manmade substrate is populated by many of the same species as natural rock, but the marine communities tend to be less diverse. Dock pilings at Ayala Cove on Angel Island are dominated by Bay mussels, acorn barnacles (*Balanus glandula* and *B. cariosus*), and hydroids (*Obelia longissima*) (Chan 1974). Plants include sea lettuce (*Ulva* spp), brown algae (*Desmerestia* spp. and *Cystoseira osmundacea*), and the red alga, *Polyneura latissima*.

Approximately 162 species of benthic macroalgae have been reported from San Francisco Bay (Nichols and Pamatmat 1988). Macroalgae are most commonly found growing in hard bottom areas (rock outcrops, coarse sediments and manmade structures) of the central and northern regions of the Bay. The richest localities are Fort Point, Lime Point-Point Cavallo, and Point Blunt on Angel Island (Silva 1979). The macroalgae flora of the bay consists both of endemic cool temperate Pacific Coast species and of species with wide distribution (Silva 1979). The most widely distributed species are the green algae, *Enteromorpha clathrata*, *E. intestinalis*, *E. linza*, *Ulva lactuca*, *Cladophora sericea*, and two red algae, *Polysiphonia denudata* and *Antithamnion kylinii* (Nichols and Pamatmat 1988).

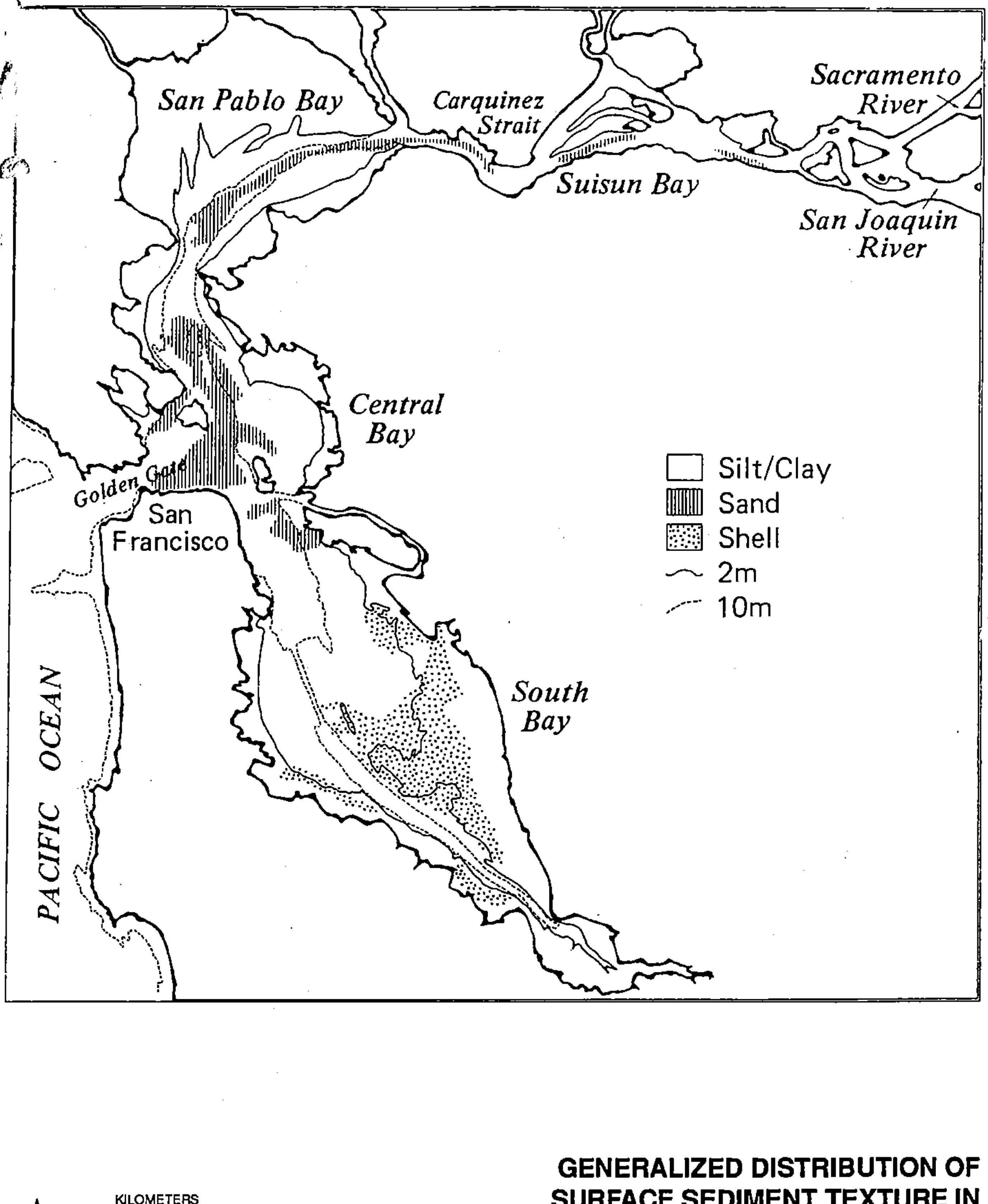
Soft Bottom

With the exception of the limited areas of natural rocky shores and the man-made rip rap, most of the substrate throughout the San Francisco Bay estuary consists of soft bottom. Figure 3.3-3 shows the surface sediment texture throughout the San Francisco Bay estuary. The substrate throughout most of the estuary is silt/clay. Sand occurs in the areas of strongest tidal currents and shell deposits are found in south Bay. Figure 3.3-4 shows the general bottom depths throughout the estuary. With the exception of central Bay, the northern portion of south Bay, and the ship channels, most of the estuary is relatively shallow. Along most of the shore, intertidal mudflats grade into expanses of shallow water, which are less than 2 m deep.

As was true for the plankton community, each of the Bays of San Francisco estuary has its own characteristic soft bottom benthic community (Davis 1982). The distribution of soft bottom benthic species in San Francisco Bay is most closely correlated to temporal variations in salinity (Nichols and Pamatmat 1988). The greatest number of species is found in the central Bay. The benthic community of the central Bay most closely resembles that of the open ocean. Away from the marine environment of the central Bay, the benthos is characterized by low diversity and dominated in abundance by a few species that are common to many North American estuaries and are tolerant of wide variations in salinity. Because most of the estuary is dominated by these few opportunistic species, the species compositions of the intertidal mudflats, the shallow subtidal, and the ship channels are similar. In general, the shallow subtidal supports a greater number of species than either the intertidal mudflats or the ship channels.

The physical environment of the central Bay consists of a stable salinity regime resembling that of the open ocean. Strong tidal currents create a dynamic bottom consisting of large sand waves that reverse direction on each tide. The benthic fauna is dominated by species found in sandy sediments along the open coast (Nichols and Pamatmat 1988).

In San Pablo Bay, salinity seldom falls below 5 parts per thousand (ppt). The broad shallow intertidal reaches of northern San Pablo Bay are dominated by the clam, *Macoma balthica*. The benthic community of the shallow subtidal expanses of San Pablo Bay is dominated by *Macoma balthica* and by another bivalve mollusk, *Mya arenaria*. Other common benthic organisms in the subtidal include the mollusks, *Gemma gemma*, *Musculista senhousia*, *Tapes philippinarum*, and *Ilyanassa obsoleta*; the amphipods, *Ampelisca abdita*, *Grandidierella japonica*, and *Corophium* spp.; the polychaetes, *Streblospio benedicti*, *Heteromastus filiformis*, *Glycinde* sp., and several species of *Polydora*, as well as several kinds of oligochaetes. With the exception of *Glycinde*, which is a native polychaete, and *Macoma balthica*, whose origin is in question (Nichols and Pamatmat 1988), these are all introduced species (Carlton 1979). Recently, another introduced species, the Asian clam, *Potamocorbula*



Source: Nichols and Thompson1985b

GENERALIZED DISTRIBUTION OF SURFACE SEDIMENT TEXTURE IN SAN FRANCISCO BAY
Figure 3.3-3

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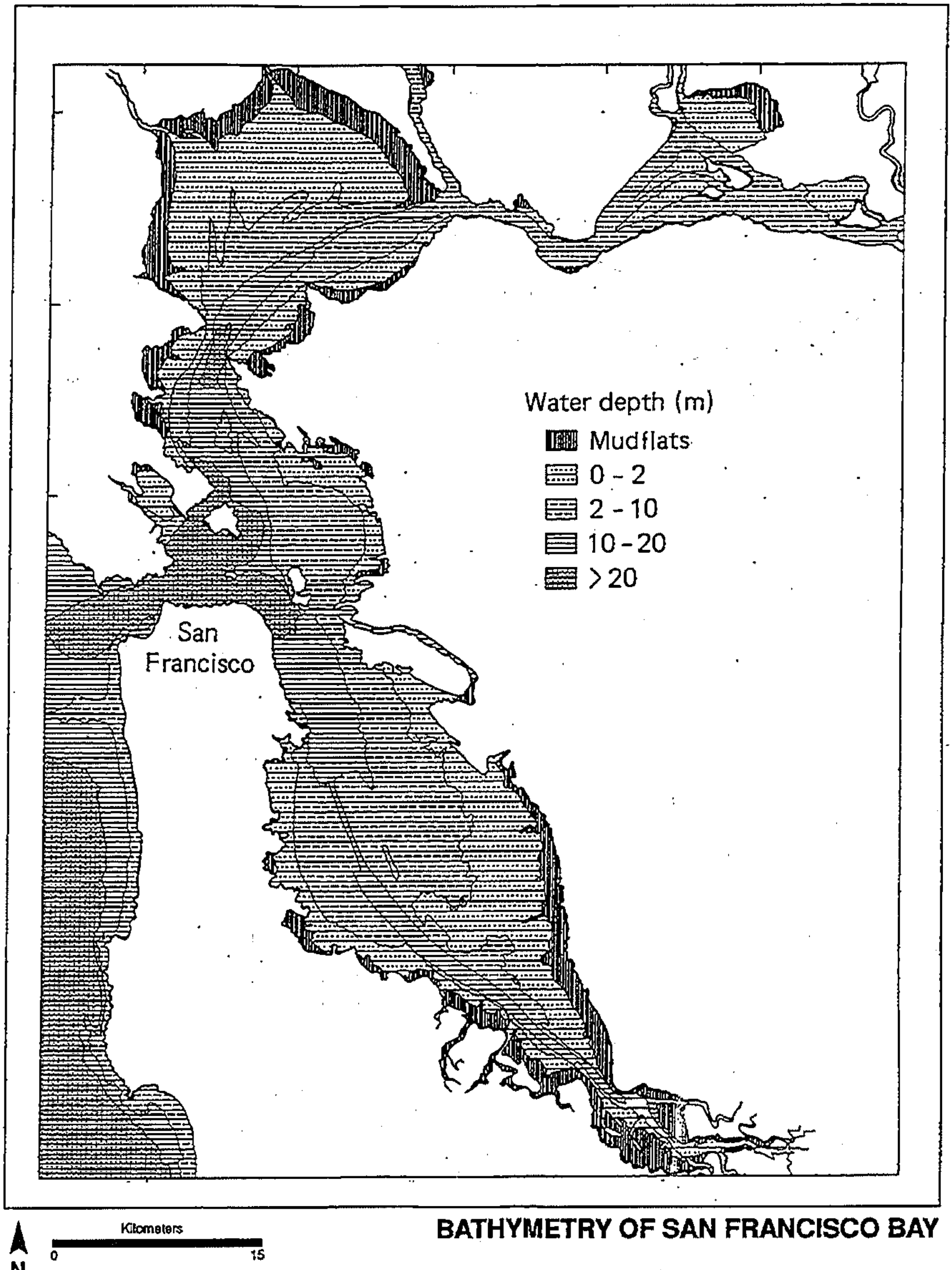


Source: Nichols and Pamatmat, 1988

BATHYMETRY OF SAN FRANCISCO BAY

Figure 3.3-4

amurensis, has become dominant in the shallow subtidal of San Pablo Bay (Robilliard et al. 1989).

Suisun Bay is a brackish water embayment characterized by islands and sub-bays intersected by tide and river scoured channels. Fewer than 10 permanent macrobenthic species are found here because the region is inundated by freshwater each winter (Nichols and Pamatmat 1988). The species found here include the mollusks, *Macoma balthica* and *Mya arenaria* (and when river inflow is particularly high, the freshwater species *Corbicula fluminea*); the amphipods, *Corophium stimpsoni* and *C. spinicorne*; and the polychaete worms, *Nereis succinea* and *Limnodrilus hoffmeisteri*. During periods of low river flow and increased salinity, freshwater intolerant species, such as the polychaete, *Streblospio benedicti*, and the amphipod, *Ampelisca abdita*, may extend into Suisun Bay (Nichols and Pamatmat 1988). As was true for San Pablo Bay, Suisun Bay has recently been invaded by the Asian clam, *Potamocorbula amurensis* (Carlton et al. 1990). Since May 1987, the Asian clam has been the most abundant benthic macrofaunal organism in the Grizzly Bay portion of Suisun Bay (Nicholas et al. 1990).

In the intertidal and shallow subtidal portions of the south Bay, *Gemma gemma*, *Ampelisca abdita* and *Streblospio benedicti* are the overwhelming numerical dominants, although large numbers of individuals of other species sometimes appear (Nichols and Pamatmat 1988). Where the bottom of the south Bay is covered with shell deposits from the Pacific oyster industry, which flourished in the later half of the nineteenth century, invertebrates associated with hard bottoms, such as *Crepidula* spp., *Urosalpinx cinera*, *Mogula manhattensis* and *Musculista senhousia*, are found. The introduced bivalve, *Tapes philippinarum*, is also common in the shelly deposits.

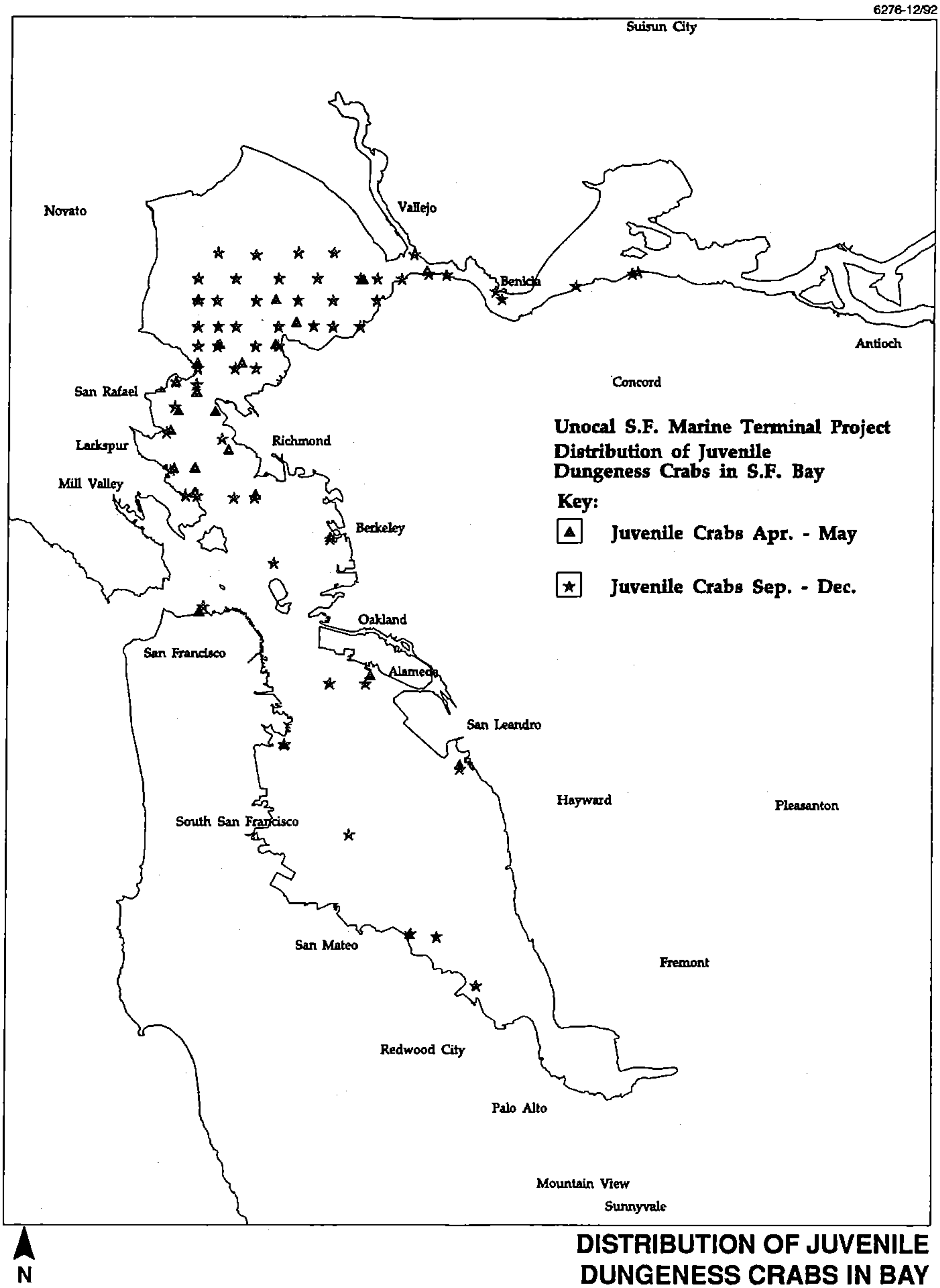
Introduced Species

Almost all the common benthic invertebrates in San Francisco Bay are introduced species. Over 100 species of exotic marine invertebrates have been introduced into San Francisco Bay by man over the last 130 years (Carlton 1979; Nichols and Pamatmat 1988). Primary mechanisms of introduction include transport of fouling, boring, and ballast-dwelling organisms by ships, and introduction of epizoic and nestling invertebrates in commercial oysters. This process of invasion of the San Francisco Bay ecosystem by foreign species continues to this day. The euryhaline bivalve mollusk, *Potamocorbula amurensis*, a native of China, Japan, and Korea, has recently appeared and became very abundant in San Francisco Bay (Carlton et al. 1990). This clam, which was first collected in 1986, appears to have been introduced as larvae in the seawater ballast of cargo vessels. Within 2 years, it spread throughout the estuary where it reached densities at some sites of over 10,000 individuals per square meter.

Documentation of the replacement of nature by exotic species is not extensive, but there is some concrete evidence of negative effects on native species by introduced ones. Nichols and Pamatmat (1988) suggest that the range of the native hornsnail, *Cerithidea californica*, is restricted mainly to marsh pannes by competitive interaction with and predation by the introduced mudsnail, *Ilyanassa obsoleta*. Nichols et al. (1990) have found that the recently introduced Asian clam, *Potomacorbula amurensis*, may have permanently displaced the native benthic community in parts of Suisun Bay.

Special Interest Species

Special interest benthic species in San Francisco Bay include crustaceans, Dungeness crab and grass shrimp, and a plant, eelgrass. San Francisco Bay is an important nursery area for Dungeness crabs (Tasto 1979; Herbold et al. 1991). The mouth of San Francisco Bay is a major settling area. Dungeness crabs enter San Francisco Bay as juveniles. In one study (Tasto 1979), 80 percent of the young-of-the-year crabs entered the San Francisco Bay complex to use it as a nursery ground. Bottom current is the most likely mechanism in the entrance of juvenile Dungeness crabs into the Bay (Tasto 1983). Dungeness crabs enter the Bay during May or June and leave the Bay by August or September of the following year when their carapace width is 90 to 120 mm (Herbold et al. 1991). Dungeness crabs are particularly abundant from Richardson's Bay upstream through Suisun Bay, showing greater abundance upstream in years of low outflow. Figure 3.3-5 shows the distribution of juvenile Dungeness crabs in San Francisco Bay. San Pablo Bay is the area of most consistently high numbers of juvenile Dungeness crabs. The abundance of Dungeness crabs is thought to be related to conditions outside the Bay (Herbold et al. 1991). The diet of juvenile Dungeness crabs in San



DISTRIBUTION OF JUVENILE DUNGENESS CRABS IN BAY
Figure 3.3-5

Francisco Bay consists primarily of molluscs and detritus (Tasto 1983).

The smaller epibenthic fauna of San Francisco Bay is dominated by four species of shrimp known as grass shrimp (Herbold et al. 1991). Grass shrimp include three native species (*Crangon franciscorum*, *C. nigricauda*, and *C. nigromaculata*) and one introduced species (*Palaemon macrodactylus*). *Crangon franciscorum* (California bay shrimp) are most abundant in lower salinities with young occurring in water that is almost fresh; *C. nigricauda* (blacktail bay shrimp) prefer salinities of 25 ppt or more; and *C. nigromaculata* (blackspotted bay shrimp) are seldom found at salinities below 30 ppt (Herbold et al. 1991). *Palaemon macrodactylus* is found only in the Upper Bay, particularly Suisun Bay, Suisun Marsh, and the western Delta.

Figure 3.3-6 shows the fluctuations in abundance of the grass shrimp and a less abundant species, *Heptacarpus*, over a 10-year period. The level of river discharge and accompanying salinity regime have been found to be important controlling factors on the survival and growth of *C. franciscorum* (Hatfield 1985). *Crangon franciscorum* seems to exhibit a straightforward response to river outflow alone while the other species appear to respond more to Bay salinity (Herbold et al. 1991). *Crangon franciscorum* seems to show a long-term decline in abundance. In 1990, *C. franciscorum* represented only 22 percent of the total shrimp abundance index in the northern reach compared to 83 percent of the index between 1980 and 1986 (Armor et al. 1991). The abundance of the other species of Crangon is tied more to marine events. *Palmaeon macrodactylus*, despite a distribution tied to lower salinity water, shows no apparent change in abundance with outflow. *Heptacarpus* is apparently favored by higher salinities in the Bay.

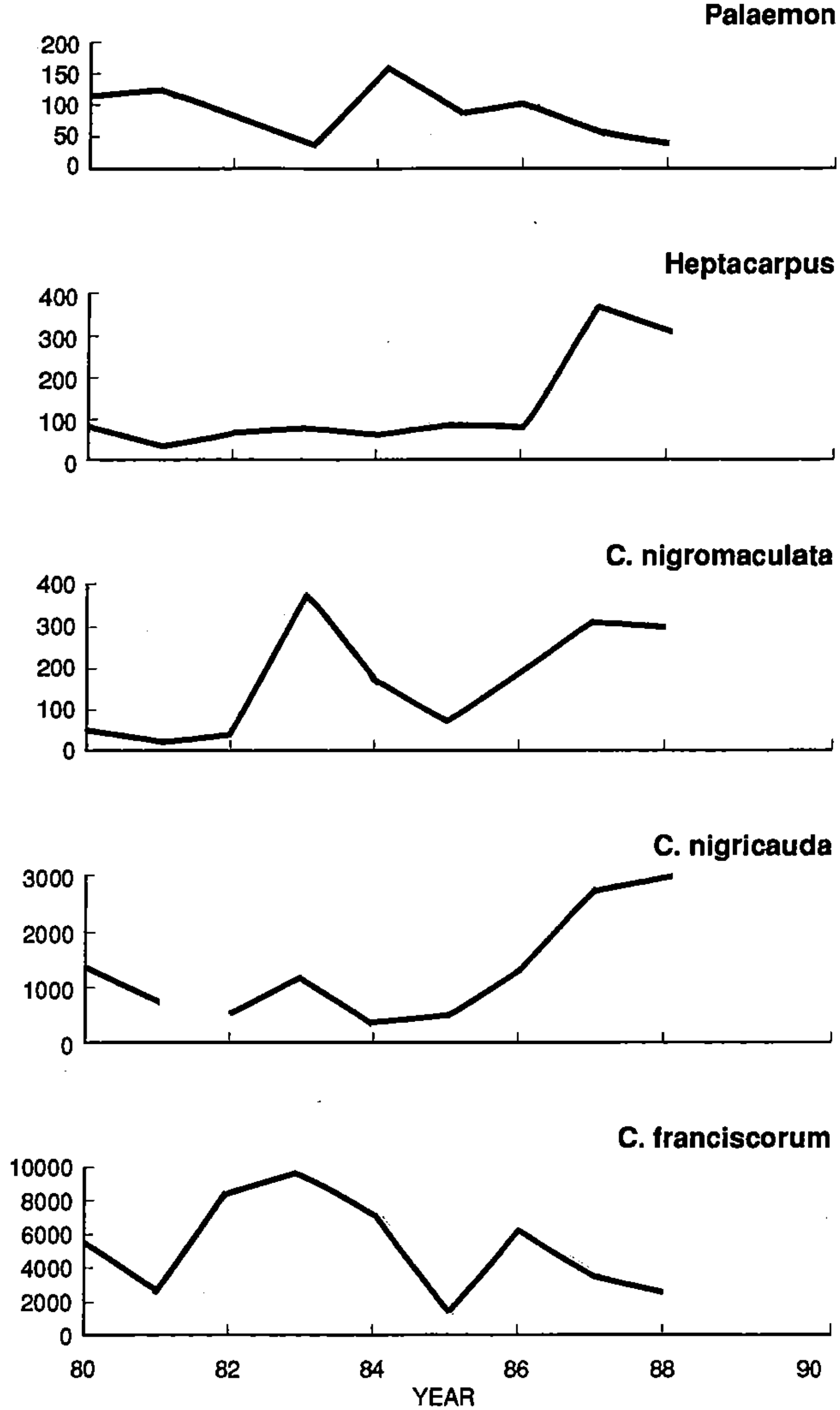
Eelgrass (*Zostera marina*) is an important shallow subtidal and intertidal flowering plant of bays and estuaries. Eelgrass beds are recognized as a particularly valuable type of marine habitat (Michael Brandman Assoc. 1990). They enhance the physical and biological environment where they occur by a number of means (Phillips 1988). Their dense rhizome and root structures help stabilize the substrate, and their erect leafy shoots are sufficiently dense to produce an erect leaf mass that forms a leaf baffle that retards currents and traps particulate matter. Thus, the sediments in an eelgrass bed are nutrient-rich. The eelgrass meadow forms a nursery and a refuge for a very high diversity of plants and animals. A variety of plants and animals live on the blades. The leaves form the basis for a grazing foodchain while the detritus particles from the dead and decaying leaves form the basis of an extensive detritus foodchain. Eelgrass beds support a higher abundance and diversity of fishes than comparable nonvegetated soft bottom areas (Hoffman 1986). In Hoffman's study, the mean number of fish species collected at eelgrass stations was approximately double the number at noneelgrass stations. Although no species were identified in this study as uniquely associated with eelgrass, some species such as shiner serfperch (*Cymatogaster aggregata*) were far more abundant in eelgrass beds than in unvegetated areas.

Major eelgrass beds in San Francisco Bay are shown on Figure 3.3-7. Because of the small scale of this figure, only the largest beds appear. Based on a 1987 suvey by the southwest region of the National Marine Fisheries Bureau, there are approximately 1,161 acres of eelgrass in San Francisco and San Pablo Bays (Echeverria and Rutten 1989). The principal investigators stated that they felt the study mapped most, if not all, of the eelgrass community in San Francisco/San Pablo Bay. The northern extent of eelgrass distribution in the Bay ecosystem is in lower San Pablo Bay, near Point San Pablo. The southern extent is in south San Francisco Bay at Coyote Point, where a small eelgrass bed of about 6 acres occurs near the yacht harbor.

3.3.3.3 Fishes

Over 100 species of fish have been recorded from the San Francisco Bay estuarine system (Armor and Herrgesell 1985). These species vary in the way they use the Bay from those that spend their entire lives in the Bay to those that spend only part of their life cycle there. The only species of fish confined entirely to the Bay-Delta estuary is the Delta smelt (*Hypomesus transpacificus*), although the ecologically similar longfin smelt (*Spirinchus thaleichthys*) occurs very rarely outside the Golden Gate (Herbold et al. 1991). All other species maintain at least part of their population outside the San Francisco Bay-Delta estuary system.

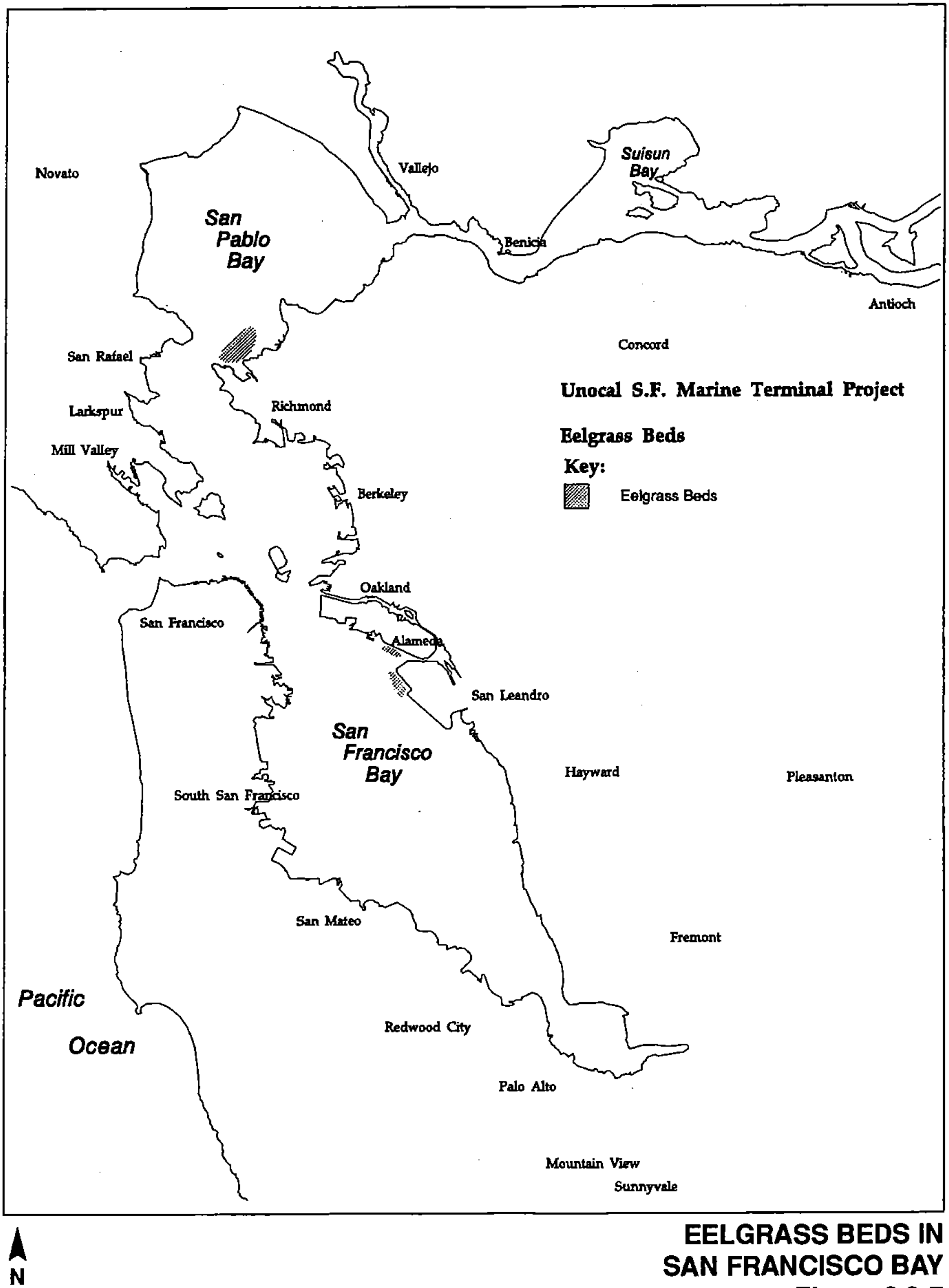
Marine species include those which are only seasonally present and those that maintain at least part of their population in San Francisco Bay year-round. Seasonal species comprise many of the most abundant species found in the Bay (Herbold et al. 1991).



ABUNDANCE INDICES OF 5 SPECIES OF SHRIMP IN OTTER TRAWLS OF THE BAY STUDY 1980-1989 (DATA FROM HERRGESELL 1990)

Figure 3.3-6

Source: From Herbold, Jassby and Boyle 1991



EELGRASS BEDS IN SAN FRANCISCO BAY
Figure 3.3-7

Northern anchovy (*Engraulis mordax*) is usually the most abundant fish species in the Bay. Populations of Northern anchovy typically exceed those of other fishes by a factor of 2 to 10 times (Herbold et al. 1991). Pacific herring (*Clupea harengus*) is often the second most abundant species. Anchovy and herring populations both tend to show large seasonal fluctuations in abundance. All life stages of Northern anchovy are found in San Francisco Bay. Northern anchovy enter the Bay as adults and may stay for as long as 9 months. Pacific herring enter the bay for spawning, and adults only tend to be abundant in the Bay for a few months. Other seasonal species, including the starry flounder (*Platichthys stellatus*) and English sole (*Parophrys vetulis*), spawn offshore and rely on bottom currents to carry their offspring into the Bay.

The three most abundant resident marine species in San Francisco Bay are shiner perch (*Cymatogaster aggregata*), bay gobies (*Lepidogobius lepidus*), and staghorn sculpins (*Leptocottus armatus*) (Herbold et al. 1991).

Two key benthic flatfishes that support important fisheries in the Bay are the California halibut (*Paralichthys californica*) and the Pacific halibut (*Hippoglossus stenolepi*). Another important species in Bay waters is the leopard shark (*Triakis semifasciata*).

Anadromous species are those that spend their adult lives in the open ocean and come into freshwater to spawn. Anadromous species use the San Francisco Bay estuary on their way up the rivers to spawn and as a rearing area for juveniles on their way down from their birthplace in the river to the open ocean (Herbold et al. 1991). Native anadromous species include Chinook salmon (*Oncorhynchus tshawaytscha*), steelhead trout (*Oncorhynchus mykiss gairdneri*) and both green and white sturgeon (*Acipenser medirostris* and *A. transmontanus*). Introduced anadromous species include striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*). Anadromous species are sensitive to a wide variety of environmental perturbations, including upstream alteration of spawning habitat, interference with access to spawning habitat, changes in flow patterns, and conditions in the estuary that reduce its value as a nursery site for outmigrating young (Herbold et al. 1991).

Ichthyoplankton (fish eggs and larvae) distribution in San Francisco estuary was studied between 1980 and 1985 in an extensive California Department of Fish and Game field sampling program of fish and selected invertebrate distributions in the estuary (CDFG 1987). This program found that during the years of the study, over 90 percent of the larval fish catch consisted of Pacific herring, northern anchovy, unidentified smelts, yellowfin goby and longfin smelt. Striped bass was also among those making up 90 percent of the catch in 1980 and 1983. Pacific herring were the most common larval species in all years except 1980 and 1984. When considered as a group, gobies were in the top three most abundant species in all years, and the most abundant in 1980 and 1984.

Table 3.3-1 summarizes use of the bay by the most important fish species. In this section, we discuss patterns of fish distribution in each of the major regions of San Francisco Bay, followed by a brief discussion of important species. Most of this section was based on the 1991 Status and Trends Report on Aquatic Resources of the San Francisco estuary by Herbold et al. Other references are cited where appropriate.

South Bay

The fishes of south Bay include species characteristic of California lagoon estuaries with narrow salinity fluctuations, as well as truly marine species that invade seasonally (see Table D-4 in Appendix D). Fish assemblages of south Bay are dominated by Northern anchovy for most months of the year except winter. Other abundant species are Pacific herring, shiner perch, jacksmelt, topsmelt, and striped bass. Topsmelt, bay gobies, bat rays, walleye surfperch, brown smoothhound, leopard sharks, and especially, white croaker, are species more common in south Bay than elsewhere in the San Francisco estuary system. Species composition in south Bay tends to be variable.

Central Bay

The central Bay is characterized by a rich assortment of fish species including components from the open ocean, the lagoon-like environment of south Bay, and the more freshwater influenced San Pablo Bay. The most abundant species are northern anchovy, shiner perch, Pacific herring, and jacksmelt (Table D-4). Anadromous species, including Chinook salmon, striped bass, and American shad, pass through on a

Table 3.3-1

REPRESENTATIVE FISHES OF SAN FRANCISCO BAY AND THE DELTA

Species	Species Origin	Species Type	Life History			Center of Population	Importance of Species	Preferred Habitat	Use of Bay or Delta	Major Food Source		Recent Population Trend
			Spawning Time	Spawning Location	Nursery Area					Adult	Juvenile	
Pacific herring	N	M	Fall-Winter	Bay	SSFB-SPB	Ocean	Commercial, Forage	Pelagic	Bay-Spawning, Nursery	P	P	Variable
Longfin smelt	N	E	Winter-Spring	Rivers	Delta, Bay	SPB	Forage	Pelagic	Bay-Nursery, Residence	P	P	Variable, recently down
Pacific staghorn sculpin	N	E	Fall-Winter	Bay, Ocean	Bay	CSFB-SPB	Forage	Littoral/ Demersal	Bay-Nursery Residence	F,B	B	Variable
Starry flounder	N	E	Winter	Ocean	SB-Delta	Ocean-Bay	Commercial, Recreation	Demersal	Bay-Nursery, Residence	B	B	Down
Speckled sandab	N	M	All Year	Ocean	Ocean-CSFB SPB SSFB	Ocean	Forage	Demersal	Bay-Nursery, Residence	B	B	Variable
English sole	N	M	Winter	Ocean	Ocean-Bay	Ocean	Commercial	Demersal	Bay-Nursery	B	B	Variable
White croaker	N	M	Summer-Fall	Ocean	Ocean-CSFB	Ocean	Forage	Demersal	Bay-Residence	B	B	Up
Yellowfin goby	I	E	Winter	Bay	SB-Delta	SPB-SB	Forage, Commercial	Demersal	Bay-Residence	B	B	Down
Plainfin midshipman	N	M	Spring-Summer	Bay	SSFB-SPB	SSFB-SPB	Forage	Demerasal	Bay-Nursery, Residence	B	B	Up
Bay goby	N	M	Summer-Fall	Bay	SSFB-SPB	CSFB	Forage	Demersal	Bay-Nursery, Residence	B	B	Variable
Topsmelt	N	M	Summer	Bay	SSFB-CSFB	SSFB	Forage	Littoral/ Pelagic	Bay-Residence	B	B	Variable
Jacksmelt	N	M	Spring-Summer	Bay, Ocean	SSFB-CSFB	Ocean	Recreation, Forage	Pelagic	Bay-Spawning, Nursery	F	P	Variable
Northern anchovy	N	M	Spring-Summer	Bay, Ocean	Bay, Ocean	Ocean	Commercial, Forage	Pelagic	Bay-Spawning, Nursery	P	P	Variable

Table 3.3-1
(Continued)

REPRESENTATIVE FISHES OF SAN FRANCISCO BAY AND THE DELTA

Species	Species Origin	Species Type	Life History			Importance of species	Preferred Habitat	Use of Bay or Delta	Major Food Source		Recent Population Trend
			Spawning Time	Spawning Location	Nursery Area				Adult	Juvenile	
Pacific lamprey	N	A	Spring	Rivers	Rivers, Upper Delta	Parasite, Forage	Pelagic	Upper Delta-Nursery, Migration	F	B veg.	Down
White sturgeon	N	A	Spring	Rivers	Estuary	Recreation	Demersal	Delta-Residence	P	P	Down
American shad	I	A	Spring	Rivers, Upper Delta	Rivers, Delta	Recreation	Pelagic	Bay & Delta-Nursery, Migration	P	P	Down
Threadfin shad	I	FW	Spring	Delta	Delta	Forage, Bait, Commercial	Pelagic	Delta-Residence	P	P	Down
Steelhead trout	N	A	Spring	Rivers	Rivers	Recreation	Pelagic	Bay & Delta-Migration	P	P,B, insects	Down
Chinook salmon	N	A	All months, greatest nos. in fall	Rivers	Rivers, Upper Delta	Recreation, Commercial	Pelagic	Delta-Nursery, Migration, Bay-Migration	F,P	P, insects	Down
Delta smelt	N	E	Spring	Delta	Delta, Suisun Bay	Forage	Pelagic	Delta-Spawning, Nursery, Residence	P	P	Down
Splittail	N	E	Spring	Delta	Delta, Suisun Bay	Recreation, Forage	Pelagic	Delta-Spawning, Nursery, Residence	P	P	Down
Carp	I	FW	Spring	Delta	Delta	Recreation	Pelagic	Delta-Spawning, Nursery, Residence	P	P	Down?
Sacramento sucker	N	FW	Spring	Rivers	Rivers	Educational	Demersal	Delta-Nursery	B	B	?
White catfish	I	FW	Spring-Summer	Delta	Delta	Recreation	Demersal	Delta-Spawning, Residence	B	B	Down
Striped bass	I	A,E	Spring	Rivers, Delta	Delta, San Pablo Bay	Recreation	Pelagic/ Demersal	Delta-Spawning, Nursery, Bay-Nursery	P,B,F	P	Down
Blugill	I	FW	Spring	Delta	Delta	Recreation	Littoral	Delta-Spawning, Nursery	P,B	P,B	?
Black crappie	I	FW	Spring	Delta	Delta	Recreation	Pelagic	Delta-Spawning, Nursery, Residence	P,F	P	?
Largemouth bass	I	FW	Spring	Delta	Delta	Recreation	Littoral	Delta-Spawning, Nursery, Residence	F,B	P,B	?

Table 3.3-1
(Continued)

REPRESENTATIVE FISHES OF SAN FRANCISCO BAY AND THE DELTA

Species	Species Origin	Species Type	Life History			Importance of species	Preferred Habitat	Use of Bay or Delta	Major Food Source		Recent Population Trend
			Spawning Time	Spawning Location	Nursery Area				Adult	Juvenile	
Tule perch	N	E	Spring, live bearer	Delta, marsh sloughs	Delta, marsh sloughs	Educational	Littoral	Delta-Nursery	B,P	B,P	Down?

Species Code
N = native
I = introduced
E = estuarine
M = marine
A = anadromous
FW = freshwater
Source: Monroe and Kelly 1992

Nursery Area Code
SSFB = South San Francisco Bay
CSFB = Central San Francisco Bay
SPB = San Pablo Bay
SB = Suisun Bay

Major Food Source Code
P = plankton
B = benthos
F = fish
Pelagic = open water
Littoral = shoreline
Demersal = bottom

seasonal basis. Pacific herring, which occur in other portions of the Bay, mostly spawn in central Bay around Tiburon and Angel Island. Young-of-the-year English sole in San Francisco Bay are most abundant in central Bay. The California and Pacific halibuts are both important bottom fishes in the central Bay, Golden Gate Bridge area.

San Pablo Bay

The fishes of San Pablo Bay consist of resident estuarine species including white sturgeon, longfin smelt, starry flounder, striped bass and staghorn sculpin, and marine species such as white croaker, bay goby, jacksmelt and shiner perch which invade in dry years or during the spring and summer months. San Pablo Bay is also used as a nursery ground for English sole and Pacific herring. Anadromous species such as Chinook salmon and American shad pass through during their migrations. American shad are usually found in the shallow water of the north side of the embayment, while salmon are usually found on the channel side. Most of the characteristic species of San Pablo Bay, especially sturgeon, striped bass, and longfin smelt, have undergone severe declines in recent years. The reduced river flows and higher salinities have led to an increase in abundance of marine species such as white croaker and queenfish.

Suisun Bay

Carquinez Strait appears to represent a significant break in the distribution of fish species in San Francisco Bay estuary. Of the major regions of San Francisco Bay, Suisun Bay has the most distinctive fish assemblage. Species characteristic of Suisun Bay include Delta smelt, longfin smelt, striped bass, and yellowfin goby. All these species declined in the last decade. These declines are thought to be primarily a result of decreased outflows. Extended drought conditions, coupled with record rates of Delta diversions, resulted in restriction of the null zone to the deeper channels in the upstream end of the Delta. These conditions have resulted in lower productivity in the null zone and movement of the fish larvae away from this zone.

White sturgeon are usually found in the Honker Bay portion of Suisun Bay. Marine species, especially northern anchovy and Pacific herring, that are dominant in other parts of San Francisco Bay are greatly reduced in abundance in Suisun Bay. Jacksmelt, bay goby, and white croaker are nearly absent in Suisun Bay. Suisun Marsh supports high densities of native fishes including Sacramento splittail and tule perch that are not abundant elsewhere in the Bay.

Important Fish Species of San Francisco Bay

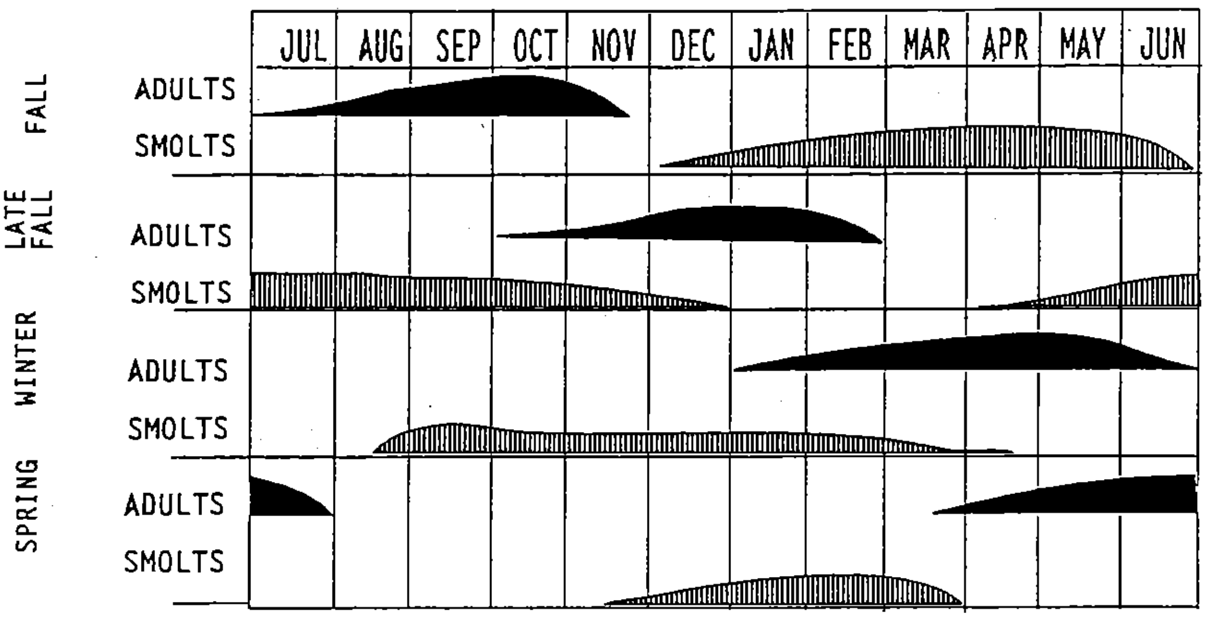
Anadromous Species

Chinook Salmon (*Oncorhynchus tshawytscha*)

Chinook salmon move from the Pacific Ocean through San Francisco Bay to the tributaries and upper reaches of the Sacramento River and, to a lesser extent, to the San Joaquin River where they spawn and die. When they are about 1 year old, the smolts move downstream through the estuary to the ocean; they remain between 1 and 4 years before they return to the river to spawn (Jefferson Assoc. 1987). The species is divided into four genetically distinct stocks with seasonally different runs. Figure 3.3-8 shows the four runs of Chinook salmon through the estuary. All four runs have shown severe and continuing declines in numbers in the past century and are maintained in large part through hatchery production. The primary causes of the decline are dams and diversions upstream of the estuary, but it has also been demonstrated in recent years that passage through the Delta is a major source of mortality, especially when outflows are low. The fall run now accounts for 90 percent or more of the 200,000 to 1,000,000 salmon of the California ocean fishery. The winter run was listed as endangered by the state after its population was estimated to be less than 500 fish. Moyle and Yoshiyama (1992) have recently presented evidence that the spring-run also has declined so precipitously that it warrants listing. See Section 3.3.3.7 for additional discussion of the Chinook salmon.

Striped Bass (*Morone saxatilis*)

The striped bass was introduced in 1879 and was successful enough to support a commercial fishery until 1935, when commercial fishing of striped bass was banned. The striped bass spawns in the Sacramento-San Joaquin Rivers at salinities of 0 to 0.5 parts per thousand. At salinities greater than 1 part per thousand, egg survival declines significantly (Jefferson Assoc. 1987). After spawning, the adults move back downstream to the Bay and ocean where they remain until the following breeding season.



PERIODS OF MIGRATION FOR THE FOUR RUNS OF CHINOOK SALMON THROUGH THE SACRAMENTO-SAN JOAQUIN RIVER SYSTEM (MODIFIED FROM USFWS 1987)

Figure 3.3-8

Source: From Herbold, Jassby and Moyle 1991

Juvenile striped bass migrate downstream to the Delta and the Bay where they remain during their first year. The striped bass population has declined significantly in recent years. Hydrological changes in the Delta seem to be the primary cause of this decline (Herbold et al. 1991), but there may be other factors such as the accumulation of toxic contaminants and reduction of the larval food supply.

American Shad *(Alosa sapidissima)*

American shad populations in San Francisco Bay rapidly increased following the species' introduction in 1871. American shad spend most of their adult lives in the ocean, except for a brief spawning run into freshwater. Most of the shad in the area around San Francisco Bay spawn in the Sacramento River or its tributaries. Spawning migrations begin in March and peak spawning occurs in late May or June. Most of the young migrate downstream rapidly after hatching. By December, most are gone, but a few remain as long as a year. Many adults die after spawning, but some return to the ocean and spawn again in later years. American shad spawn least successfully in dry years and their numbers have declined with the recent drought.

Sturgeon *(Acipenser transmontanus* and *Acipenser medirostris)*

Two species of sturgeon inhabit the San Francisco estuary-Delta system, the white sturgeon and the green sturgeon. The white sturgeon is much more abundant in San Francisco estuary than the green sturgeon, partly because the green sturgeon spend a greater portion of their lives in the ocean. Recruitment of white sturgeon appears to be greatest in years of high outflow and the population has declined in recent years.

The San Francisco Bay estuary supports the southernmost reproducing population of green sturgeon which spawn in the Sacramento River (Moyle and Yoshiyama 1992). The largest spawning population of green sturgeon in California is in the Klamath River Basin. Moyle and Yoshiyama (1992) have recently presented evidence to suggest that the green sturgeon should be listed as threatened.

Nonanadromous Species

Northern Anchovy *(Ergraulis mordax)*

The Northern anchovy is the most abundant fish in San Francisco Bay. Northern anchovy are seasonally present in San Francisco Bay. They tend to enter the Bay in April of most years and migrate out to the ocean in the fall. In San Pablo and Suisun Bay, anchovy abundance peaks later and drops more rapidly than in central and south Bay. Most of the population spawns in the ocean, but spawning within the Bay has also been reported. Larval anchovies begin to appear in the Bay early in the spawning season of February through June. Northern anchovy show large fluctuations in numbers in response to both marine and estuarine conditions, but there are no obvious trends in recent years.

Pacific Herring *(Clupea harengeus)*

Pacific herring enter San Francisco Bay in late fall and winter to spawn and then return to the ocean. Most of the spawning in San Francisco Bay occurs in intertidal and shallow habitats of the Tiburon Peninsula and Angel Island although some spawning occurs on aquatic vegetation near Berkeley and Richmond. Smaller young tend to be widely distributed in shallower habitats in south, central, and San Pablo Bays. As they grow, they move to deeper waters closer to the Golden Gate. Most young Pacific herring emigrate from the Bay between April and August. Since 1974, there has been a trend toward increasing biomass of spawning herring.

Delta Smelt *(Hypomesus transpacificus)*

Delta smelt are endemic to the upper reaches of the San Francisco Bay estuary. This species feeds exclusively on zooplankton, spawns in fresh water, and usually only lives one year. Their population has declined dramatically and they have been recently listed by the USFWS as threatened under the Endangered Species Act. Delta smelt inhabit surface and shallow waters of the main river channels and Suisun Bay. During times of exceptionally high outflow from rivers, Delta smelt may be washed into San Pablo Bay but they do not establish permanent populations there. Overall, Delta smelt concentrate near or immediately upstream of the null zone. Since 1984, the null zone has been located mainly in the channels of the rivers in all months of the year. Shift of the null zone into the Delta channels is a result of low Delta outflow. The shift in the location of the null zone coincides with an upstream shift and narrowing of the location of the Delta smelt population to the deeper water of the main river channels (Figure D-2 in Appendix D). The movement of the null zone to the river channels not only decreases the amount of area that can be occupied by smelt but also results in a decreased plankton productivity and, hence, lower food supply. Although the recent high diversions of fresh water, coupled with drought conditions, are the most likely cause of the decline in the Delta smelt population, other factors which may contribute include toxic compounds in the water, displacement of native copepods by exotic species, and invasion of the estuary by the Asian clam, *Potamocorbula amurensis*. See Section 3.3.3.7 for additional discussion of the Delta smelt.

Longfin Smelt (*Sprinchus thaleichthys*)

Longfin smelt are much more widely distributed than Delta smelt. They also differ from Delta smelt in that a considerable proportion of the population survives into the second year. Adult longfin smelt are broadly distributed throughout the Bay, but use the river channels of the Delta for spawning. Longfin smelt have definite seasonal migrations. They spend early summer in San Francisco and San Pablo Bays, move into Suisun Bay in August and, in winter, congregate for spawning at the upper end of Suisun Bay and in the lower reaches of the Delta (Moyle and Yoshiyama 1992). Like Delta smelt, longfin smelt populations in San Francisco Bay have declined during the last decade. Although longfin smelt are widely distributed in Pacific coast bays and estuaries only two populations are known from California: (1) in the San Francisco Bay estuary, and (2) in Humboldt Bay and the Eel River (Moyle and Yoshiyama 1992). The population found in the San Francisco Bay estuary may be a species or subspecies distinct from other populations. Recently, Moyle and Yoshiyama (1992) have argued that the longfin smelt should be considered for listing.

3.3.3.4 Marshes and Diked Wetlands

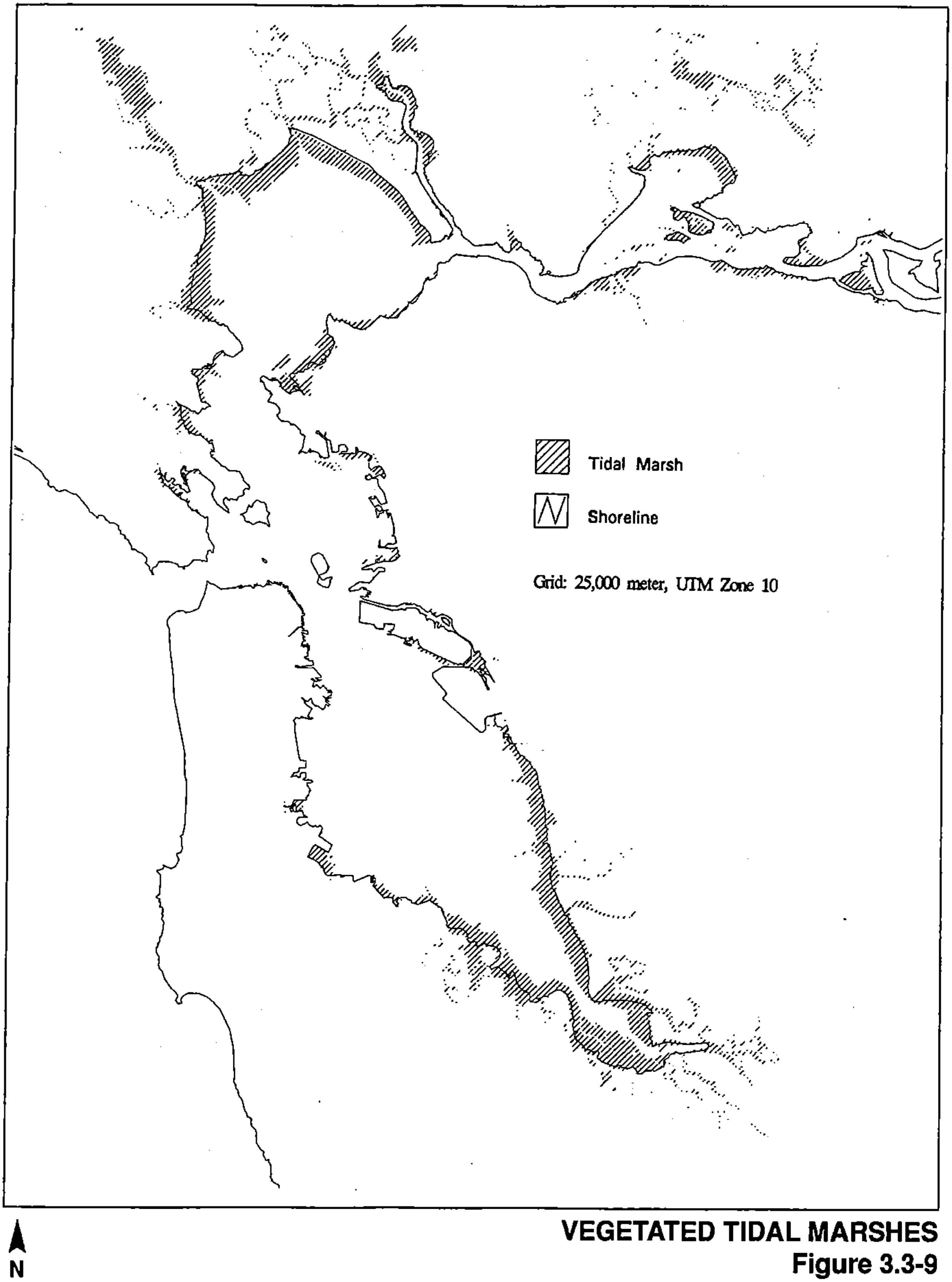
Figure 3.3-9 shows the location of tidal marshes in San Francisco Bay. Three types of tidal marshes are found in the San Francisco Bay estuary: salt marsh, brackish marsh and freshwater marsh. These marshes are exposed to the rise and fall of tides and are characterized by emergent vascular plants. Tidal cycles affect the vertical extent of marshes as well as the inundation period and tidal flushing of marshes. The formation of tidal marshes is the result of sedimentation patterns and vegetation growth along the edges of the San Francisco Bay region. The primary source of sediments comes from the flow of the Sacramento and San Joaquin Rivers. Currents and wave action furtber affect the deposition of sediments in the estuary. The mixing of ocean waters and freshwater flows is a major factor in determining the sediment salinity in tidal marshes in the San Francisco Bay region (Josselyn 1983).

Dominant plant species define the three marsh types, and zonation patterns of the dominant species within the marshes are apparent. Differences in species composition between tidal marshes and plant zonation within marshes are based on plant physiological responses to physical factors of inundation, salinity, and sedimentation. In addition, interspecific competition can be a significant factor determining plant distributions in tidal marshes. Since most marsh plants reproduce vegetatively, each species can respond relatively quickly to favorable physical conditions and, therefore, seasonality also can affect the patterns of plant distribution in the tidal marshes (Josselyn 1983).

The following sections describe the dominant species and general patterns of plant zonation within each type of tidal marsh. The major tidal marshes of San Francisco, San Pablo and Suisun Bays, and Carquinez Strait are presented in Table 3.3-2. Rare, threatened, and endangered species that occur in tidal marshes of the San Francisco Bay region are discussed in Section 3.3.3.7.

Salt Marsh

Pacific cordgrass (*Spartina foliosa*) and perennial pickleweed (*Salicornia virginica*) are the dominant emergent plant species of the salt marsh. Cordgrass is found in the low salt marsh between mean tide level and mean high water level where it survives relatively long periods of inundation. Few other vascular plants grow in association with cordgrass, but some micro- and macroalgae are present (Josselyn 1983). Pickleweed tolerates the higher salinity and waterlogged soils of the middle marsh between mean high water and mean higher high water. This species will also grow with cordgrass at its upper range.



VEGETATED TIDAL MARSHES
Figure 3.3-9

Table 3.3-2

MAJOR TIDAL MARSHES OF SAN FRANCISCO, SAN PABLO, AND SUISUN BAYS*

Name/County	Marsh Type	USGS 7.5' Quad
Richardson Bay/Marin	Salt/tidal flat	San Francisco North
Muzzi Marsh/Marin	Salt	San Rafael
Corte Madera Ecological Reserve/Marin	Salt	San Rafael
Corte Madera Creek/Marin	Salt	San Quentin
China Camp State Park/Marin	Salt	Petaluma Point
Gallinas Creek south/Marin	Salt	Petaluma Point
Gallinas Creek north/Marin	Salt	Petaluma Point
West San Pablo Bay/Marin	Salt	Petaluma Point
Novato Creek/Marin	Salt/slough	Petaluma Point
Black John Slough/Marin	Salt/slough	Petaluma River
Petaluma River/Marin, Sonoma	Salt	Petaluma River
Petaluma Marsh Wildlife Area/Sonoma	Salt/brackish	Petaluma River
Petaluma Marsh north/Sonoma	Salt/brackish	Petaluma River
Midshipman Point/Sonoma	Salt	Petaluma Point, Sears Point
North San Pablo Bay/Sonoma	Salt	Sears Point
North San Pablo Sloughs and Creeks/Sonoma, Napa	Brackish	Sears Point, Mare Island, Cuttings Wharf
Southhampton Bay/Solano	Salt/brackish	Benicia
Joice Island south/Solano	Brackish	Vine Hill
Joice Island north/Solano	Brackish	Fairfield South
Suisun and Peytonia Sloughs/Solano	Brackish	Fairfield South
Hill Slough/Solano	Brackish	Fairfield South, Denverton
Grizzly and Honker Bays/Solano	Brackish	Fairfield South, Honker Bay
Montezuma and Nurse Sloughs/Solano	Brackish	Fairfield South, Honker Bay
Grizzly Island/Solano	Brackish	Fairfield South, Honker Bay
Roe Island/Solano	Brackish	Fairfield South, Denverton
Ryer Island/Solano	Brackish	Vine Hill

Table 3.3-2
(Continued)

MAJOR TIDAL MARSHES OF SAN FRANCISCO, SAN PABLO, AND SUISUN BAYS*

Name/County	Marsh Type	USGS 7.5' Quad
McAvoy/Contra Costa	Brackish	Honker Bay
Port Chicago/Contra Costa	Brackish	Vine Hill
Avon and Hastings Sloughs/Contra Costa	Brackish	Vine Hill
Point Edith/Contra Costa	Brackish	Vine Hill
Martinez/Contra Costa	Brackish	Vine Hill, Benicia
Martinez Shoreline Park/Contra Costa	Brackish	Benicia
San Pablo and Wildcat Creeks/Contra Costa	Salt	San Quentin
Hoffman Marsh/Contra Costa	Salt	Richmond
Emeryville Crescent/Alameda	Salt	Oakland West
San Leandro Bay/Alameda	Salt	San Leandro
Hayward Shoreline/Alameda	Salt	San Leandro
Mount Eden and Alameda Creek/Alameda	Salt	Redwood Point
Pond 3/Alameda	Salt	Newark
Dumbarton Point north/Alameda	Salt	Newark
Dumbarton Point and Newark Slough/Alameda	Salt	Newark
Mowry Slough/Alameda	Salt	Mountain View
South San Francisco Bay Sloughs/Alameda, Santa Clara	Salt/brackish	Mountain View
Mountain View, Palo Alto Bay lands/San Mateo	Salt	Milpitas
Greco Island/San Mateo	Salt	Redwood Point
Belmont Slough/San Mateo	Salt	Redwood Point

* Adapted from Joselyn 1983

Pickleweed is often host to the parasitic plant dodder (*Cuscuta salina*) which appears as orange threads covering the pickleweed zone. Several other vascular plants commonly are found growing in association with pickleweed, either as patches within the marsh or at the upper boundary of the pickleweed zone (Josselyn 1983). These plants include sea arrowgrass (*Triglochin maritima*), fleshy Jaumea (*Jaumea carnosa*), annual pickleweed (*Salicornia europa*), marsh gum-plant (*Grindelia humulis*), and marsh rosemary (*Limonium californicum*). Beyond the upper boundary of the pickleweed, salt-tolerant plants such as alkali heath (*Frankenia grandifolia*), salt grass (*Distichlis spicata*), and fat hen (*Atriplex patula*) become dominant in the upper marsh (Cohen 1990). Salt marsh habitat is found throughout the south and central San Francisco and San Pablo Bays (Table 3.3-2).

Brackish Marsh

Brackish marshes are common in Suisun Bay where the freshwater inflow from the Sacramento and San Joaquin Rivers affects salinity. Brackish marshes also are found where local freshwater discharges occur along the Petaluma and Napa Rivers, and in the south bay along Coyote Creek and Mud, Aliso, and Guadalupe Sloughs in former salt marsh areas. As with salt marshes, there are three major zones in the brackish marsh. Species from both salt and freshwater wetlands occur in brackish marshes, and the species composition of marshes is indicative of local conditions. As conditions become more or less saline, species composition at different marsh elevations can change. California bulrush (*Scripus californicus*) dominates the low marsh and replaces Pacific cordgrass around the Carquinez Strait into Suisun Bay where it is found growing from above mean low water (Josselyn 1983). As the water freshens toward the inflow of the Sacramento and San Joaquin Rivers, this species is found at somewhat lower elevations below mean low water in the marsh. The middle marsh is dominated by alkali bulrush (*Scirpus robustus*) in San Pablo Bay and the Carquinez Strait. In Suisun Bay, the species composition of the middle marsh also includes Olney's bulrush (*Scirpus olneyi*), common cattail (*Typha latifolia*) and narrow-leaved cattail (*Typha angustifolia*). Depending on the salinity of the marsh, the species composition of the high marsh varies. In high saline conditions, the dominant species include pickleweed, saltgrass, fat-hen, and gumplant. In less saline conditions, the high marsh is dominated by baltic rush (*Juncus balticus*) and brass buttons (*Cotula coronopifolia*). The extent of the high marsh zone has been diminished due to the extensive diking in Suisun Marsh; areas of high marsh are found at Joice Island, Roe Island and areas along the south shore of Suisun Bay (Josselyn 1983). The Suisun Marsh is the largest brackish marsh on the West Coast.

Freshwater Marsh

Although historically abundant in the Sacramento-San Joaquin Delta, tidal freshwater marshes have been reduced due to diking, flood control and general development of the delta area. Some freshwater marsh communities occur upstream of Suisun Bay along a few channel banks of the Sacramento-San Joaquin Delta. Areas of freshwater marsh also occur in the upper reaches of the Petaluma and Napa Rivers. The characteristic distribution of vegetation results in three zones: low, middle and high freshwater marsh. The low marsh between mean tide level and mean lower low water is dominated by California bulrush and common reed grass (*Phragmites communis*). In the middle marsh between mean high water and mean tide level, common cattail, common bulrush (*Scripus acutus*) and common reed grass are present. The high marsh above, mean higher high water, supports arroyo willow (*Salix lasiolepis*) and blackberries (*Rubus* sp.).

Diked Wetlands

Diked wetlands include areas that have been altered to preclude natural tidal action. The largest area of diked wetlands exists in the northern part of Suisun Bay and in the Sacramento-San Joaquin Delta. The wetlands in the Suisun Bay are largely made up of brackish marshes. These marshes are dominated by alkali bulrush, saltgrass, pickleweed, bulrushes and brass buttons (Department of Water Resources 1984; Josselyn 1983). Diked wetlands in the Delta consist mainly of farmed wetlands, vernal pools, and other seasonal wetlands. Other diked wetlands occur in the San Francisco Bay, including freshwater ponds and lagoons, nontidal salt and brackish marshes and salt ponds.

3.3.3.5 Avifauna

A total of 174 bird species in the San Francisco Bay Area are known to use open waters or coastal habitats that might be contacted by oil spills (about two-thirds of the entire avifauna). However, only a few species are restricted to the waters or tidal mudflats and marshes; others may be commonly found also in diked or farmed wetlands, salt ponds, and woodlands that are less likely to be contacted by spills. Habitat types where contamination by oil is a clear possibility include open water, rocky shore, intertidal mudflats, and tidal marshes. Each has a characteristic fauna (Table 3.3-3). The avifauna of open water includes loons and grebes, pelicans and cormorants, gulls and terns, and a variety of waterfowl including ducks and scoters. Rocky shores provide foraging habitat for turnstones and oystercatchers, and roosts for cormorants, pelicans, gulls, and terns. Intertidal mudflats are predominately populated by shorebirds, and the mudflats of San Francisco Bay are of critical importance in the winter as feeding/staging areas for migrating shorebirds on the Pacific Flyway. Tidal salt and brackish marshes provide essential habitat to support clapper and black rails, herons and egrets, the salt-marsh yellowthroat, and salt marsh song sparrows. Brief discussions of major bird groups follow.

Loons and Grebes

Loons are most common in the area from October through about April. Three species, the red-throated, Pacific, and common loon, occur and all are found predominantly in deeper open waters of central San Francisco Bay. Five species of grebes occur in the area. The pied-billed grebe is a fairly common resident found chiefly in sheltered freshwater areas. The horned grebe is a winter visitor found commonly in open saltwater tidal parts of San Francisco, San Pablo, and Suisun Bays. Eared grebes are abundant winter visitors found predominantly in salt ponds of south San Francisco Bay and Napa Marsh. Western and Clark's grebes are also abundant from October through May, especially in open waters of the central Bay near narrows and islands. Loons and grebes are often casualties of oil spills because of their diving habit and because they form large flocks when foraging or resting on the water at night. See also Section 3.3.3.7 for common loon species account.

Pelicans

California brown pelicans are common post-breeding residents of San Francisco Bay. From about May through November, they can be found foraging in open waters of the central Bay and in San Pablo Bay or roosting on breakwaters, pilings, and salt pond dikes. American white pelicans occur as late-summer/fall migrants and winter visitors. They are locally common from July through December on open waters of the Bays, salt ponds, and diked wetlands. See also Section 3.3.3.7 for species accounts.

Colonial Waterbirds and Seabirds

Waterbirds and seabirds that nest in colonies in the San Francisco Bay Area include cormorants, herons, egrets, gulls, terns, and alcids. They are found in a variety of habitats that afford protection against predators and disturbance. Gulls and terns nest on salt pond levees, while cormorants nest on bridges and towers. Herons and egrets may nest in trees near aquatic feeding areas. Except for cormorants and gulls, species may use colony sites in one year but not the next as changes occur in nearby food availability or disturbance. The location of colonies occupied in 1989-90 are shown on Figure 3.3-10. Estimates of numbers of colonial nesting species are provided in Table 3.3-4.

Double-crested cormorants have large and growing populations on or near the cross-Bay bridges (see Section 3.3.3.7 for species account). Brandt's cormorants in the Bay are primarily transients and winter residents, but a small colony has become recently established on Yerba Buena Island. Pelagic cormorants breed on The Needles near the Golden Gate Bridge and on Yerba Buena Island.

Great blue herons are relatively common in low-salinity salt ponds. Their distribution is not completely known, but includes sites in most tidal marshes where trees or brush occur for nesting.

Great egrets have nesting populations at Mallard Slough and Bair Island in the south Bay, on the Marin Islands, in Suisun Marsh on Grizzly Island, Joice Island, Bohannan, and Simmons Island, on Sherman Island in the Delta, and near Jepson Prairie in Solano County. Snowy egrets are abundant in the San Francisco Bay Area and nest at Mallard Slough and

Table 3.3-3

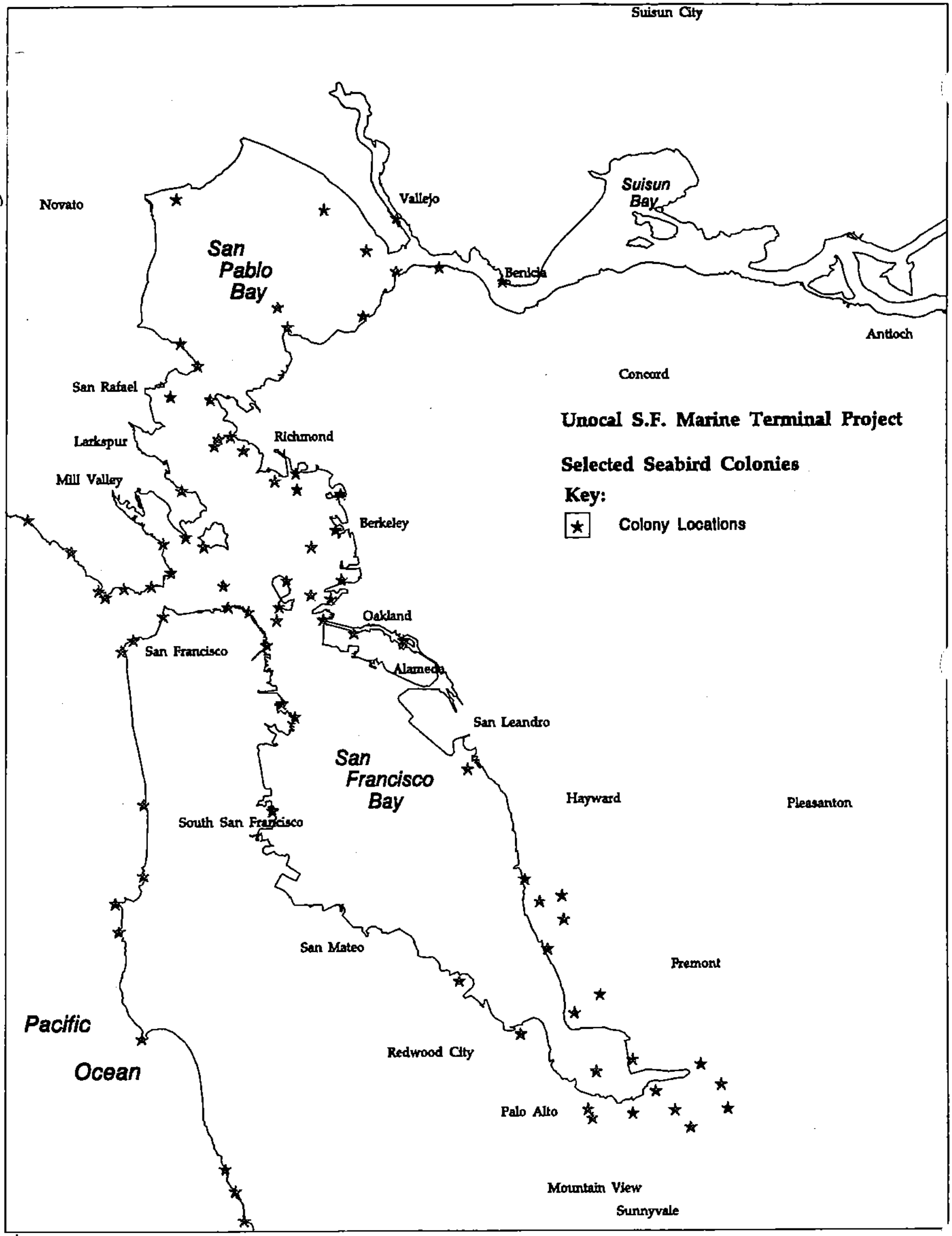
CHARACTERISTIC BIRD FAUNA OF HABITAT TYPES MOST SUSCEPTIBLE TO IMPACT FROM OIL SPILLS

Typical Species	Seasonal Status
OPEN WATER	
Red-throated loon	Winter resident
Common loon	Winter resident
Horned grebe	Winter resident
Western grebe	Winter resident
Clark's grebe	Winter resident
Brown pelican	Summer, fall resident
Double-crested cormorant	Year-round resident
Pelagic cormorant	Year-round resident
Canvasback	Winter resident
Scaup spp.	Winter resident
Surf scoter	Winter resident
American coot	Year-round resident
Western gull	Year-round resident
Glaucous-winged gull	Winter resident
Caspian tern	Summer resident
Forster's tern	Year-round resident
ROCKY SHORE	
Brown pelican	Summer, fall resident
Black oystercatcher	Year-round resident
Wandering tattler	Winter resident
Spotted sandpiper	Winter, spring resident
Black turnstone	Winter resident
Surfbird	Winter resident
Elegant tern	Summer, fall migrant
INTERTIDAL MUDFLATS	
Western grebe	Winter resident
Great blue heron	Year-round resident
Great egret	Year-round resident
Snowy egret	Year-round resident
American wigeon	Winter resident
American avocet	Summer, winter resident
Willet	Year-round resident
Marbled godwit	Year-round resident
Western sandpiper	Winter resident
Dunlin	Winter resident
Dowitcher spp.	Winter resident
Forster's tern	Year-round resident

Table 3.3-3
(Continued)

CHARACTERISTIC BIRD FAUNA OF HABITAT TYPES MOST SUSCEPTIBLE TO IMPACT FROM OIL SPILLS

Typical Species	Seasonal Status
TIDAL SALT AND BRACKISH MARSHES	
Great blue heron	Year-round resident
Great egret	Year-round resident
Snowy egret	Year-round resident
Northern pintail	Summer, winter resident
Northern harrier	Year-round resident
Black rail	Year-round resident
California clapper rail	Year-round resident
Virginia rail	Year-round resident
Sora	Year-round resident
American coot	Year-round resident
Willet	Year-round resident
Short-eared owl	Year-round resident
Common yellowthroat	Year-round resident
Song sparrow	Year-round resident
TIDAL FRESHWATER MARSH	
Pied-billed grebe	Year-round resident
American bittern	Year-round resident
Virginia rail	Year-round resident
Sora	Year-round resident
Common moorhen	Year-round resident
American coot	Year-round resident
Marsh wren	Year-round resident
Source: USFWS 1992	



WATERBIRD AND SEABIRD COLONIES IN SAN FRANCISCO BAY

Figure 3.3-10

Table 3.3-4

ESTIMATES OF NUMBERS OF NESTING COLONIAL WATERBIRDS AND SEABIRDS IN THE 1990 BREEDING SEASON

Species	Nesting Pairs
double-crested cormorant	1,185
Brandt's cormorant	63
pelagic cormorant	58
great blue heron	160
great egret	350
snowy egret	950
black-crowned night-heron	1,000
Western gull	1,623
California gull	2,221
Caspian tern	1,409
Forster's tern	1,775
California least tern	89
pigeon guillemot	46
Sources: Carter et. al. 1990; Stenzel et al. 1989; and sources of unpubl. data cited in USFWS 1992	

Bair Island, on West Marin Island, Brook's Island, possibly Red Rock, and in the Delta on Brown's Island.

Black-crowned night-herons are common in the Bay Area but they are difficult to census and their distribution is not completely known. Large colonies in the south Bay are established on Bair Island and at Mallard Slough, and in the north Bay on West Marin Island. Other colonies are found on Alcatraz Island, Brooks Island, Red Rock, and several sites farther inland. Approximately 70 percent of the San Francisco Bay night-heron population nests in or near the north Bay.

Western gulls nesting in the San Francisco Bay Area account for about 10 percent of the species' total in central and northern California (Carter et al. 1990). The largest colonies are located on Alcatraz Island and Alameda Naval Air Station breakwater. Other colonies are found on Red Rock, Brooks Island, West Marin Island, East and West Brothers Islands, the San Francisco-Oakland bridge, Yerba Buena Island, and San Francisco piers. The California gull, which has nested in the San Francisco Bay Area only since 1981, is now the area's most abundant nesting species with large growing colonies at two sites within the San Francisco Bay National Wildlife Refuge in the south Bay (Santa Clara County).

Three species of terns have colonies in the San Francisco Bay Area: Caspian, Forster's, and the California least tern (Endangered). Caspian terns are a common summer resident nesting in primarily in salt ponds. Colonies in the south Bay are established west of Coyote Hills, on Bair Island, Mowry Slough, Turk Island, and the Baumberg area. In the central and north Bay, Caspian terns nest at the Alameda Naval Air Station and on Brooks Island. Forster's terns also nest predominantly in salt ponds. In the south Bay, colonies are located near Mountain View, Alviso, the Baumberg area, and Redwood City. Nesting also occurs in salt ponds of the Napa Marsh. California least terns are designated as Endangered on Federal and State Lists. Substantial numbers of nesting pairs are counted on colonies at Alameda Naval Air Station and Oakland International Airport, but nesting attempts have also been recorded at a few other sites (see Section 3.3.3.7 for species account).

The pigeon guillemot is the only alcid species breeding in the San Francisco Bay Area, where it nests on Alcatraz Island.

Waterfowl

The open waters and wetlands of San Francisco Bay constitute one of the most important staging areas and wintering areas for migrating waterfowl on the Pacific Flyway. The fauna consists of dabbling ducks, diving ducks, mergansers, geese, and swans. Dabbling ducks are present year-round and include mallard, Northern pintail, gadwall, American wigeon, green-winged teal, cinnamon teal, and northern shoveler. Diving ducks include surf, white-winged, and black scoters, redhead, canvasback, ring-necked duck, greater and lesser scaup, common goldeneye, Barrow's goldeneye, bufflehead, and ruddy duck. Mergansers are relatively uncommon, but include common, hooded, and red-breasted species. Geese using the Bays include snow goose, Ross goose, the greater white-fronted goose, and Canada goose (both cackling and the Aleutian Canada goose). Of these species, a few mallards, gadwalls, northern pintails, cinnamon teals, and ruddy ducks nest in tidal marshes, and diked and seasonal wetlands. Aerial censuses indicate that the winter population of waterfowl in San Francisco Estuary (including Suisun Bay) numbers about 193,000 birds (USFWS 1992). The greatest numbers of waterfowl are found in the San Pablo Bay Area (30 percent of the total) and south Bay salt ponds (23.6 percent of the total). Scaup and scoters account for 90 percent or more of waterfowl in open water areas of San Francisco and San Pablo Bays, while dabbling ducks, especially the northern shoveler and the ruddy duck, account for about 70 percent of numbers in south Bay salt ponds. Scaup and canvasbacks are the most abundant species in Suisun Bay, while canvasbacks and ruddy ducks are the most abundant species in salt ponds of San Pablo Bay. The winter distribution of waterfowl is shown on Figure 3.3-11.

<u>Rails and Cranes</u>

The tidal marshes of San Francisco Bay support two listed species of rails-the California black rail (State Threatened) and the California clapper rail (Federal and State Endangered); accounts for these species are provided below in Section 3.3.3.7. Yellow rails, Virginia rails, and sora also occur, especially in brackish and freshwater marshes. Greater and lesser sandhill cranes are winter residents with large roosts at locations in the Delta.

<u>Shorebirds</u>

At least 34 species of shorebirds are found in the San Francisco Bay Area, including plovers, oystercatchers, stilts and avocets, sandpipers, and phalaropes with a winter/spring population of up to 1,000,000 birds (Page et al. 1990). Only the snowy plover, killdeer, black oystercatcher, black-necked stilt, American avocet, and spotted sandpiper nest in the area. Other species nest elsewhere, but use the San Francisco Bay as a critical staging or overwintering area for migrating shorebirds. Mudflats are the primary foraging grounds for shorebirds, although foraging also occurs on rocky shores by a few species. Approximately 60 to 90 percent of total numbers occur in the south Bay, perhaps reflecting the abundance of foraging habitat relative to other parts of the Bay Area. Only 2 to 3 percent occur in the central Bay. The winter population in San Pablo Bay accounts for 16 to 26 percent of the area total. The San Francisco-San Pablo Bay system is recognized as a staging/wintering area of hemispheric importance (Western Hemisphere Shorebird Reserve Network, April 1990); impacts of oil spills may affect most of the world population of several species.

<u>Hawks, Falcons, Eagles, and Vultures (Order Falconiformes)</u>

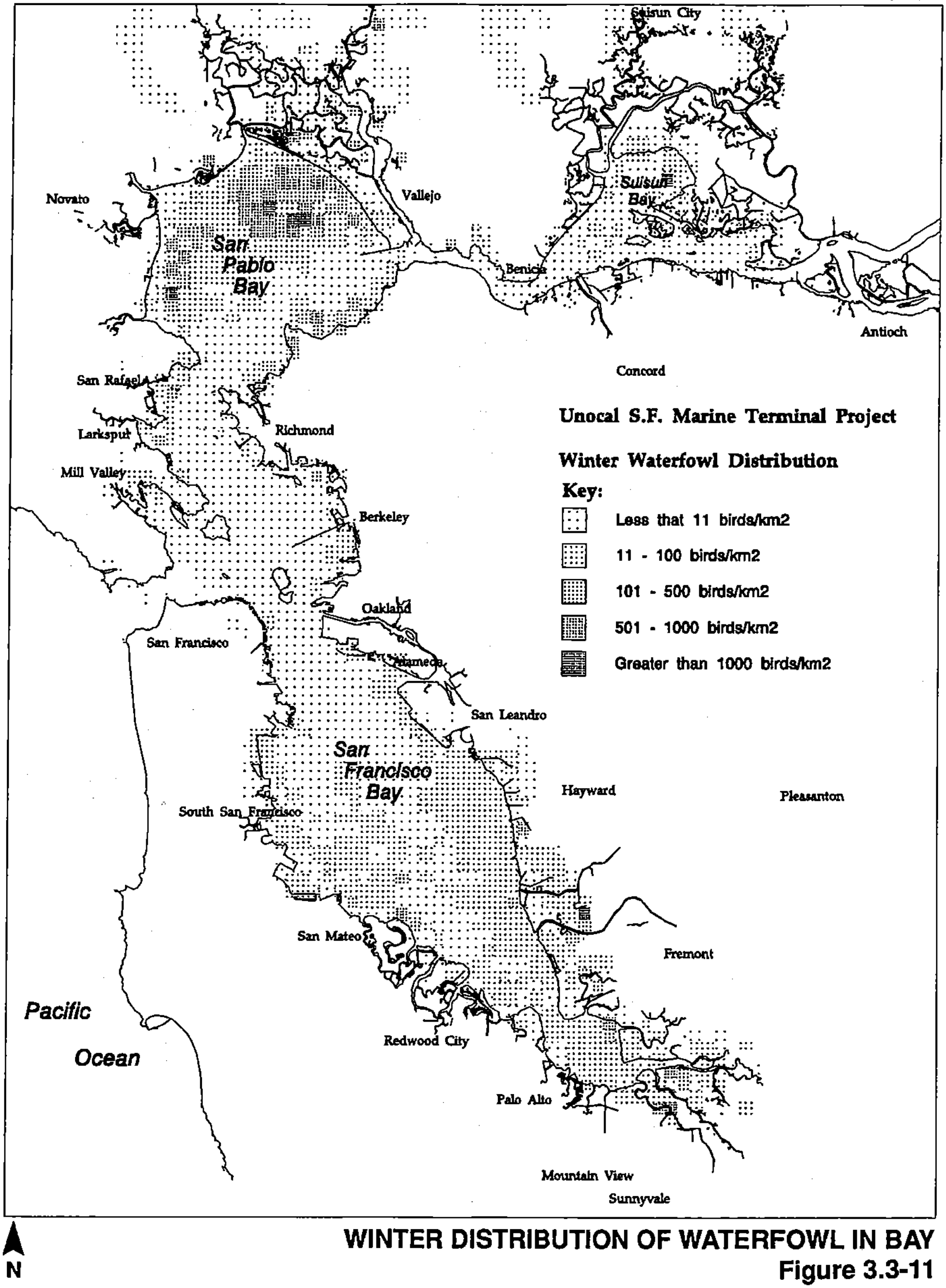
The avifauna of wetlands surrounding San Francisco Bay includes 15 species of hawks, falcons, eagles, and vultures, 10 of which are listed as California Species of Special Concern. Two species, the bald eagle and the peregrine falcon, are classified as Endangered Species by the USFWS and the CDFG. All these species may be subject to impacts of oil spills by ingesting contaminated prey or scavenged carcasses (see Section 3.3.3.7).

3.3.3.6 Marine Mammals of San Francisco and San Pablo Bays

<u>Open Water</u>

Three species of marine mammals can be included in the resident fauna of the San Francisco Bay region: the harbor porpoise, the harbor seal, and the California sea lion. Gray whales and humpback whales may occasionally wander into the Bays but do not typically occur there. Visits of these species have occurred in recent years as migrating animals strayed into the Bays during coastwise migration in the winter/spring (gray whales) or fall (humpback whales).

The harbor porpoise was once a common species in the Bay and apparently still uses these waters, but



WINTER DISTRIBUTION OF WATERFOWL IN BAY
Figure 3.3-11

sightings today are rare (Szczepaniak and Webber 1985). Individual animals almost certainly come and go within a larger range that includes waters off the outer coast. No data exist to describe the species' seasonal distribution in waters of San Francisco and San Pablo Bays. The abundance of harbor porpoises is apparently greatest near the Golden Gate and the outer coast (Huber et al. 1985).

Harbor seals use the San Francisco Bay region for foraging, resting and breeding. Abundance in open waters is probably greatest near the rocks and intertidal mudflats or sloughs of southern and central San Francisco Bay used as haul-out sites. The foraging range includes at least San Pablo Bay and may include Suisun Bay as well. No systematic data have been collected to describe their open-water distribution.

California sea lions have become a conspicuous part of the San Francisco Bay marine mammal fauna since about 1985. This species has a large and growing population breeding in the summer on island rookeries of the Southern California Bight (Bonnell and Dailey 1993). A portion of the population, mostly adult and subadult males, migrate northward in the fall to exploit runs of herring and anadromous fishes in northern California and the Pacific Northwest. Relatively small numbers establish themselves in the San Francisco Bay Area (less than 2,000 animals) and are most abundant in the late fall through mid-spring.

Rocky Shore and Intertidal Mudflat

Most of what is known about the seasonal abundance of pinnipeds is known from counts of their numbers on land. Pinnipeds haul-out on land to rest, molt, breed, and give birth to pups. Sites used for hauling-out vary little over the years; new sites are infrequently established, but traditional ones may be abandoned due to chronic disturbance. Harbor seal numbers on land increase through the spring as the 2- to 3-month breeding season gets underway.

Peak numbers on land occur in June and July when animals spend more time on land undergoing an annual molt. Thorough aerial/ground censuses are made in early summer by the CDFG. Survey data indicate that harbor seals use 14 haul-out sites; not all sites are necessarily occupied at the time of any single survey (Figure 3.3-12). Four sites are rocky shore and most of the remainder are intertidal mudflats or sloughs.

Farthest from the outer coast is a site on Tubbs Island in San Pablo Bay; however, this site is not consistently occupied. Numbers at each site vary widely between years due to date, time of day, tide, and degree of disturbance. Maximum count at each site is presented in Table 3.3-5. Pups have been counted by CDFG at Mowry Slough, Greco Island, and Calaveras Point in the south Bay, and at Castro Rocks in the central Bay. Fancher and Alcorn (1982) found pups to represent about 20 percent of total numbers at Mowry Slough in 1980, a proportion consistent with groups on the outer coast (Bonnell et al. 1983; Allen et al. 1989). However, at other sites, relatively few pups are counted, suggesting that these sites are used more for resting between feeding bouts than for breeding.

Two sites in central San Francisco Bay have received greatest use in the winter during spawning runs of Pacific herring. Strawberry Spit in Richardson Bay was used predominantly in the winter until disturbance and changes in the herring spawning distribution led to temporary abandonment (major habitat restoration measures have recently occurred), and Yerba Buena Island provided a haul-out site for about 300 animals during the winter of 1989-90 (USFWS 1992; Allen 1991; Sarah Allen, personal communication).

Total numbers counted in the San Francisco Bay region have averaged 362 animals on May-June censuses conducted from 1982-1991. The greatest total count was 574 animals in May-June of 1987. Since 1983, harbor seal counts on haul-out sites in the San Francisco Bay region accounts for 2.1 percent of the State's total count. While the California population has been growing at 6 percent or more per year, counts in San Francisco Bay have been declining (Hanan et al. 1992; Allen 1991).

California sea lions on land are nonbreeding migrants, typically adult and subadult males, and are most abundant here in the winter. In recent years, over 600 California sea lions have been counted at Pier 39 in San Francisco (Sarah Allen, National Parks Service, personal communication) and are occasionally seen at other scattered locations close to the Golden Gate and the outer coast.

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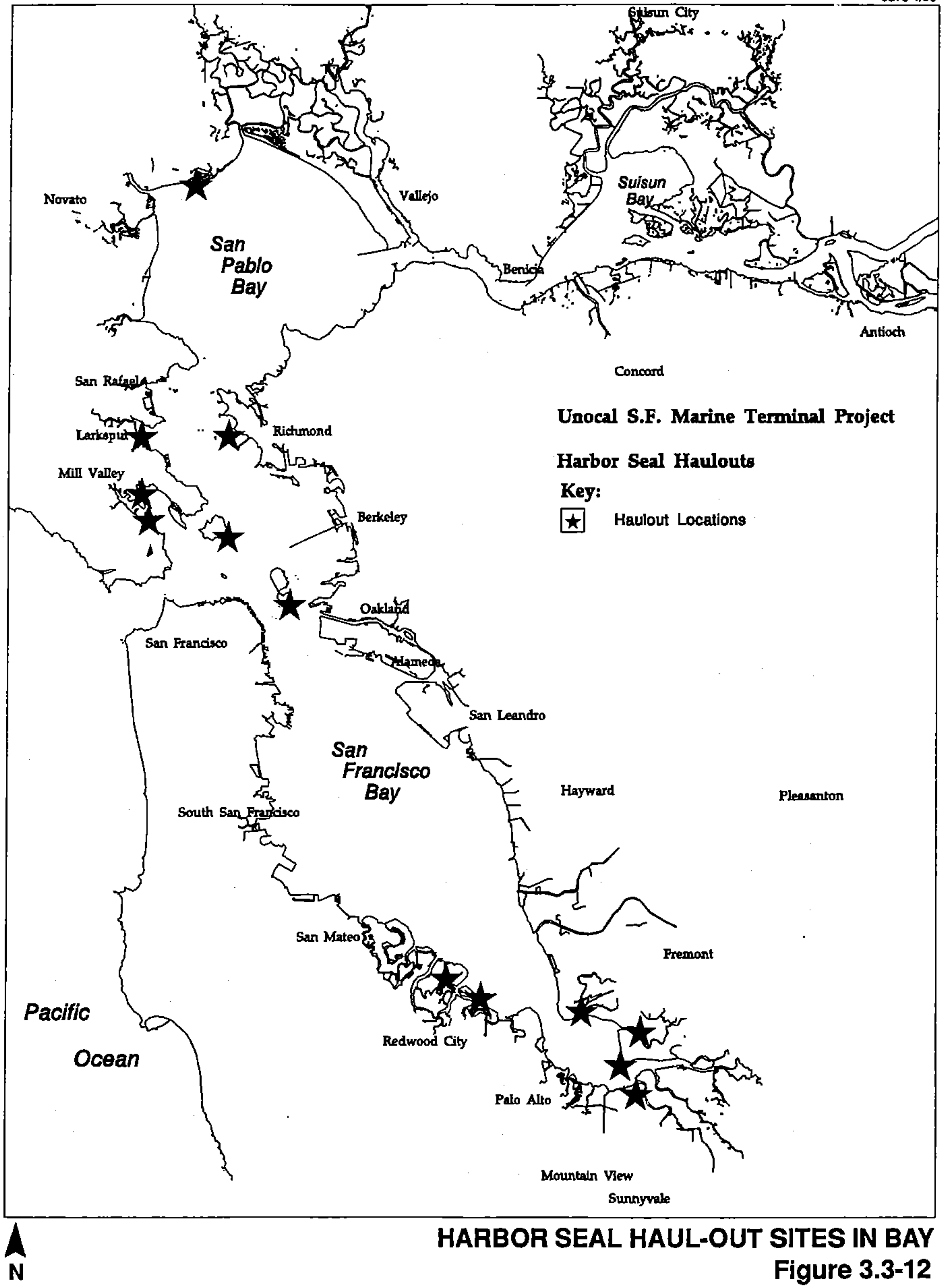


HARBOR SEAL HAUL-OUT SITES IN BAY
Figure 3.3-12

Table 3.3-5

HARBOR SEAL HAUL-OUT SITES IN SAN FRANCISCO AND SAN PABLO BAYS; DATA FROM MAY-JUNE AERIAL CENSUSES CONDUCTED BY CDFG

Haul-Out Site	County	Maximum Count
Guadalupe Slough	Santa Clara Co.	67
Calaveras Point	Alameda Co.	98
Mowry Slough	Alameda Co.	328
Plummer Creek	Alameda Co.	53
Greco Island	San Mateo Co.	74
Corkscrew Slough	San Mateo Co.	17
Yerba Buena Island	San Francisco Co.	65
Pt. Blunt, Angel Island	Marin Co.	18
Pt. Blunt Lighthouse	San Francisco Co.	13
Sausalito Small Craft Harbor	Marin Co.	30
Strawberry Spit	Marin Co.	97
Muzzi Marsh	Marin Co.	14
Castro Rocks	Contra Costa Co.	123
Tubbs Island	Sonoma Co.	34

Source: Hanan et al. 1992

3.3.3.7 Rare/Threatened/Endangered Species

Sensitive Vegetation

The sensitive plant species which occur in tidal wetlands in the San Francisco Bay region are presented in Table 3.3-6. Sensitive species associated with nontidal wetlands, such as vernal pools, are not included in this summary. The following section provides information on specific habitats, life history and documented locations of the sensitive plants listed in Table 3.3-6.

Suisun Marsh Aster (*Aster chilensis* var. *lentus*)

This herbaceous perennial species is found in tidal salt and brackish marshes around Suisun Bay in Solano County. It flowers from June through October. It is a federal Category 2 species and a California Native Plant Society (CNPS) 1B species. According to the Natural Diversity Data Base (CDFG 1992), many populations have been documented in the area occurring with dominant species such as the common reed, and bulrushes as well as other sensitive species such as the delta tule pea (*Lathyrus jepsonii* ssp. *jepsonii*), and the soft-haired bird's beak (*Cordylanthus mollis* ssp. *mollis*). Populations range from the marsh adjacent to Bull Island in the lower Napa River through the Carquinez Strait on Benicia Point, north into the Suisun Slough, north of Grizzly Bay, and in the eastern part of the Suisun Bay on Brown and Van Sickle Islands, at the confluence of the San Joaquin and Sacramento rivers, and up into the Sacramento River on Sherman Island.

Suisun Thistle (*Cirsium hydrophilum* var. *hydrophilum*)

This perennial herb is found in brackish marshes and in peaty soils around Suisun Bay in Solano County. It flowers from July through September. It is a federal Category 1 species and a CNPS 1B species. According to the Natural Diversity Data Base (CDFG 1992), only one population is known to occur in the Suisun Slough north of Grizzly Bay, and was last seen in 1974. Subsequent attempts to locate the population failed. Dominant species associated with the Suisun thistle were bulrushes, cinquefoil (*Potentilla* sp.), and rushes.

Table 3.3-6

RARE THREATENED OR ENDANGERED PLANT SPECIES OF TIDAL MARSHES OF SAN FRANCISCO BAY REGION

Common Name/Scientific Name	Status			Habitat
	State	Federal	CNPS	
Suisun Marsh Aster *Aster chilensis* var. *lentus*	---	C2	1B	Brackish Marshes
Suisun Thistle *Cirsium hydrophilum* var. *hydrophilum*	—	C1	1B	Brackish Marshes
Soft-haired Bird's Beak *Cordylanthus mollis* ssp. *mollis*	CR	C1	1B	Salt and Brackish Marshes
Delta Tule Pea *Lathyrus jepsonii* ssp. *jepsonii*	—	C2	1B	Salt, Brackish and Freshwater Marshes
Mason's lilaeopsis *Lilaeopsis masonii*	CR	C2	1B	Brackish Marshes

Federal Status (determined by USFWS)
FE = Federally listed, endangered
C1 = Designation as endangered is pending
C2 = Possibly endangered but more information needed
C3B = Previously considered as a candidate but taxonomic validity is in question
C3C = Previously considered as a candidate but does not appear to be threatened at this time

State Status
CT = State listed, threatened
CE = State listed, endangered
CR = State listed, rare

California Native Plant Society (CNPS) Status
1A = Presumed extinct in California
1B = Rare throughout the range of the species
2 = Rare in California but common elsewhere
3 = More information needed before assignment to Categories 1, 2, or 4
4 = Limited in distribution; does not appear to be threatened at present but must be monitored

Sources: USFWS 1991; California Natural Diversity Database 1992; Mason 1957

Soft-Haired Bird's Beak (*Cordylanthus mollis* ssp. *mollis*)

This branched annual is found in the coastal salt and brackish marshes of San Françisco Bay region. It flowers from July to November. It is a Federal Category 1 species, a state-listed rare species, and a CNPS 1B species. According to the Natural Diversity Data Base (CDFG 1992), several populations occur in the San Pablo Bay, including the Tule Slough on the Petaluma River, in northern San Pablo Bay near Tubbs Island, in the upper Napa River marsh, and on the southern edge of San Pablo Bay east of Pinole Point. Several populations are found on the north side of the Carquinez Strait at Benicia, and in the Montezuma and Suisun Sloughs north of Grizzly Bay. Dominant species associated with the soft-haired bird's beak include salt grass, pickleweed, fleshy Jaumea and, occasionally, bulrushes.

Delta Tule Pea (*Lathyrus jepsonii* ssp. *jepsonii*)

This perennial species is found in freshwater, brackish and saltwater marshes in Suisun and San Pablo Bays. It flowers from May through June. It is a Federal Category 2 species and a CNPS 1B species. According to the Natural Diversity Data Base (CDFG 1992), a majority of the populations are concentrated on the islands between Grizzly and Suisun Bays, with some populations occurring in the upper region of Honker Bay and all along the shore at Brown Island in the eastern Suisun Bay. Populations also are documented in upper Grizzly Bay and on Joyce Island along the Montezuma Slough. Carquinez Strait has populations on both shores. Other populations occur in the marshes of the Napa River. Dominant species often associated with the delta tule pea include common bulrush, horsetails (*Equisetum* sp.), wild grape (*Vitus* sp.), rose (*Rosa californica*), willows (*Salix* sp.), and hibiscus (*Hibiscus californicus*), and other sensitive species such as the Suisun aster and the soft-haired bird's beak.

Mason's Lilaeopsis (*Lilaeopsis masonii*)

This low, tufted perennial inhabits marshes and brackish flats made up of moist sand and mud in Solano County. It flowers from June through August. It is a Federal Category 2 species, state-listed as rare, and is a CNPS 1B species. According to the Natural Diversity Data Base (CDFG 1992), populations range from the Napa River above the salt evaporators, north of San Pablo Bay, to the northern reaches of the Suisun and Montezuma Sloughs north of Grizzly Bay, with a majority of the populations found at the convergence of the Sacramento and San Joaquin Rivers, including Brown's Island and the lower Sherman Marsh and throughout the Delta, with populations extending up both the San Joaquin and Sacramento Rivers.

Sensitive Fishes

Table 3.3-7 lists fish species in San Francisco Bay that appear on CDFG and/or USFWS species lists as Endangered, Threatened, a Candidate for Endangered or Threatened, or a Species of Special Concern. Several other fish species including the longfin smelt and the green sturgeon, may be added to these lists in the near future. Sensitive fishes considered here include the Delta smelt, the tidewater goby, the Sacramento splittail, and the winter and spring runs of the Chinook Salmon. The Delta smelt and the Chinook salmon were discussed in Section 3.3.1.3. These species and the other sensitive fish species are discussed further.

Delta Smelt (*Hypomesus transpacificus*)

The Delta smelt is one of the few remaining native species found in the upper reaches of San Francisco Bay and the Delta (Monroe and Kelly 1992). Its range extends from around Isleton on the Sacramento River and Mossdale on the San Joaquin River downstream to Suisun Bay. During periods of high river flow, some individuals are washed into San Pablo Bay, but they do not establish permanent populations there. Prior to their sharp decline in abundance in 1984, Delta smelt concentrated in the shallow water areas of the null zone in Suisun Bay or the rivers immediately above it. Since 1984, the null zone has been located upstream of Suisun Bay in the deeper river channels and the Delta smelt population has also moved upstream.

Since 1980, the Delta smelt population has exhibited a general decline. Numbers of this species now seem to be critically low. The Delta smelt has been listed as threatened by both the federal government and the State of California.

Chinook Salmon (*Oncorhynchus tshawytscha*) - Winter Run and Spring Run

After maturing in the ocean, adult Chinook salmon migrate through the San Francisco estuary to spawn in the streambed gravels of the Sacramento River and its tributaries and in the San Joaquin River tributaries (Monroe and Kelly 1992). As discussed in Section 3.3.3.3, there are four genetically distinct runs designated by the season in which they enter fresh water to spawn: a fall run that enters fresh water during July through November and begins spawning in October, a late-fall run that moves upstream during October through February and begins spawning in January, a winter run that moves upstream during January through June and begins spawning in April, and a spring run that moves upstream during March through July and begins spawning in August. Although the size of each of the four Chinook salmon runs has fluctuated since the mid-1960s and although all four runs have declined in the 1980s, the Sacramento River winter run has exhibited the most steady decline. By 1991, fewer than 200 fish were estimated to return to the river to spawn in this run (Monroe and Kelly 1992). The winter run is considered to be at a critically low level and is listed as threatened under the federal Endangered Species Act and as endangered under the Sate of California Endangered Species Act. The spring run has also

Table 3.3-7

SPECIAL STATUS FISH SPECIES OF SAN FRANCISCO BAY

Common Name/*Species Name*	Category	Habitat
Delta smelt *Hypomesus transpacificus*	Federal Threatened, State Threatened	Open water of Delta, Suisun Bay
Chinook salmon *Oncorhynchus tshawytscha* Winter run	Federal Threatened, State Endangered	Open water of Delta- Nursery, Migration Bay- Migration
Spring run	California Species of Special Concern	Open water of Delta- Nursery, Migration Bay Migration
Coho salmon *Oncorhynchus kisutch*	California Species of Special Concern	May be found in some tributary streams to the Bay
Tidewater goby *Eucyclogobius newberryi*	Federal Proposed Threatened, State Threatened	Brackish water of lagoons and lower stream reaches
Sacramento splittail *Pogonichthys macrolepidotus*	Federal Candidate 2, California Species of Special Concern	Brackish and freshwater sloughs of lagoons of Delta Suisun Marsh, Suisun Bay

declined markedly since the mid-1980s. The spring run of Chinook salmon is listed as a State of California Species of Special Concern.

Coho Salmon (*Oncorhynchus kisutch*)

Coho salmon are widely distributed in streams along the Northern and Central California coast (Moyle and Yoshiyama 1992). In California, principal populations are found in the Klamath, Trinity, Mad, Noyo, and Eel Rivers, as well as in smaller coastal streams south to Scott Creek and Waddell Creek in Santa Cruz County. Presently, there are probably less than 5,000 wild Coho salmon spawning in California each year, and many populations have fewer than 100 individuals. The decline in Coho salmon is probably related to a number of factors including the degradation of coastal streams, the catastrophic effects of floods and drought on an already declining population, the introgression of genetic integrity by planting of hatchery fish, introduced diseases and overharvesting. Coho salmon are principally found outside the San Francisco Bay estuary, but small numbers may be found in the San Francisco estuary tributary streams (Herbold et al. 1991).

Tidewater Goby (*Eucyclogobius newberryi*)

The tidewater goby is endemic to California and lives in the brackish water habitats from southern California to the Smith River, Del Norte County (Moyle et al 1989). This species is found in shallow lagoons and lower stream reaches where the water is brackish (salinities usually less than 10 ppt) to fresh. In the San Francisco Bay estuary in the past, tidewater gobies were distributed in brackish water habitats around Central Bay and San Pablo Bay. However, in San Francisco Bay and associated streams, at least 9 out of 10 previously identified populations have disappeared, and a 1984 survey of streams of the Bay drainage did not record any populations (Moyle et al. 1989). The tidewater goby has been proposed for listing as threatened by the Federal government and is listed by the State of California as a threatened species.

Sacramento Splittail (*Pogonichthys macrolepidotus*)

The Sacramento splittail is a California Central Valley endemic and was once distributed in lakes and rivers throughout the Central Valley (Moyle et al. 1989). Splittail are now largely confined to the Delta, Suisun Bay, Suisun Marsh, Napa Marsh, and other parts of the Sacramento-San Joaquin estuary. Splittail are primarily freshwater fish but they can tolerate moderate salinities and can live in water with salinities as high as 10 to 12 ppt. In the past, they were often caught by striped-bass fisherman in Suisun Bay during periods of high tidal flow. During the past two decades, however, the Sacramento splittail is mostly found in slowmoving sections of rivers and sloughs. The abundance of this species in the Delta system is strongly tied to outflows because spawning occurs over flooded vegetation. When outflows are high, reproductive success is high; when outflows are low, reproduction may fail. The Sacramento splittail is a Federal Candidate 2 and a California Species of Special Concern.

Sensitive Birds, Mammals, Reptiles, and Amphibians

There are 38 listed species of birds, six species of mammals, and five species of amphibians or reptiles that occur or have occurred in habitats vulnerable to oil spills (Table 3.3-8). These are species to which oil spills or other impacts would be most damaging because they already have small or isolated populations persisting in an altered environment. Because these species are rare, information on their distribution is often limited to records of sightings at scattered locations. The present status of those species that require or are restricted to open water, rocky shore, intertidal mudflats, or tidal marshes is further described.

Birds

The following species of rare/threatened/endangered birds may be most susceptible to contact by oil spills because of their foraging habits, reliance on intertidal mudflats and tidal salt marshes for nesting habitat, use of open water, or the known impacts in previous oil spills.

Common Loon (*Gavis immer*)

The common loon's breeding habitat in the western states in limited to Idaho. Winter numbers in California and Oregon have declined 11 percent from 1965-69 to 1975-79. Winter visitors to San Francisco Bay are found in most deeper openwater areas. Common Loons seen during Christmas Bird Counts ranged from 21 to 83 (Oakland count, 1984-89) and 10 to 40 (Marin count, 1975-89) (USFWS 1992).

American White Pelican (*Pelecanus erythrorhynchos*)

The American white pelican is a late summer/fall migrant through the area and a winter visitor. The species nests in large inland lakes in the western states and Canada; only remnant colonies exist in California in the Klamath Basin and Honey Lake area. During fall and winter, white pelicans are locally common in large openwater areas including salt ponds. Surveys of South Bay salt ponds in August of 1984 recorded 3,147 birds. A survey of Suisun Bay conducted in mid-June of 1990 found scattered flocks of 3 to 72 birds at several sites, including Benicia, the mouth of Pacheco Creek, Middle Ground Island, and Pittsburg Point (USFWS 1992).

California Brown Pelican (*Pelecanus occidentalis californicus*)

The California brown pelican breeds in the spring on islands of the Southern California Bight and Mexico. Following the breeding season, brown pelicans migrate northward. The species reaches its peak abundance in central California in August through September (Briggs et al., 1983a). In the Bay, brown pelicans forage over deep open water and roost on many breakwaters and piers and, occasionally, on salt-pond dikes. The number of brown pelicans using the Bay is not completely known, but a few sites have been censused: 401 at Alameda Naval Air Station in June 1984; on spring censuses in 1988-90, up to 130 birds at Hunter's Point, Angel Island, East Sister Island, West Brother Island, north of Point San Pablo, the Brooks Island breakwater, and the Mare Island breakwater (USFWS 1992). Roost sites in San Francisco/San Pablo Bays are shown on Figure 3.3-13.

Double-Crested Cormorant (*Phalacrocorax auritis*)

This species nests in the San Francisco Bay Area, predominantly on bridges, towers, and other man-made structures. Locations of colonies are shown on Figure 3.3-10. The colony breeding on the San Francisco-Oakland Bridge numbered 465 pairs in 1990, making it the second largest in the state. The rapidly growing colony on the Richmond-San Rafael Bridge had 422 breeding pairs in 1990. At other sites,

Table 3.3-8

SPECIES OF BIRDS, MAMMALS, REPTILES, AND AMPHIBIANS OF SPECIAL STATUS ON FEDERAL AND STATE LISTS THAT INHABIT OPEN WATERS, ROCKY SHORE, MUDFLATS, AND/OR TIDAL MARSHLANDS OF SAN FRANCISCO BAY ESTUARY

Common Name/*Scientific Name*	Category	Habitat
Birds		
Common loon *Gavis immer*	State Species of Special Concern, Federal Management Concern, Federal Sensitive Bird Species	Open water
American white pelican *Pelecanus erythrorhynchos*	State Species of Special Concern, Federal Sensitive Bird Species	Open water
California brown pelican *Pelecanus occidentalis californicus*	Federal Endangered, State Endangered	Open water
Double-crested cormorant *Phalacrocorax auritis*	State Species of Special Concern	Open water, rocky shore, tidal marshes
Least bittern *Ixobrychus exilis*	Federal Candidate 2, State Species of Special Concern	Tidal marshes
White-faced ibis *Plegadis chihi*	Federal Candidate 2, State Species of Special Concern, Federal Management Concern, Federal Sensitive Bird Species	Tidal brackish/freshwater marshes
Aleutian Canada goose *Branta canadensis lucoparcia*	Federal Threatened, Federal Sensitive Bird Species	Open water, tidal brackish/ freshwater marshes
Fulvous whistling duck *Dendrocygna bicolor*	Federal Candidate 2, State Species of Special Concern, Federal Sensitive Bird Species	Tidal brackish marshes
Barrow's goldeneye *Bucephala islandica*	State Species of Special Concern	Open water and tidal brackish marshes
Osprey *Pandion haliaetus*	State Species of Special Concern	Open water
Northern harrier *Circus cyaneus*	State Species of Special Concern	Tidal marshes
Sharp-shinned hawk *Accipiter striatus*	State Species of Special Concern	Tidal brackish/freshwater marshes
Cooper's hawk *Accipter cooperii*	State Species of Special Concern	Tidal brackish/freshwater marshes
Ferruginous hawk *Buteo regalis*	Federal Candidate 2, State Species of Special Concern	Tidal brackish/freshwater marshes
Bald eagle *Haliaeetus leucocephalus*	Federal Endangered, State Endangered	Open water, tidal brackish/ freshwater marshes
Golden eagle *Aquila chrysaetos*	State Species of Special Concern	Tidal marshes
Merlin *Falco columbarius*	State Species of Special Concern	Tidal brackish/freshwater marshes

Table 3.3-8
(Continued)

SPECIES OF BIRDS, MAMMALS, REPTILES, AND AMPHIBIANS OF SPECIAL STATUS ON FEDERAL AND STATE LISTS THAT INHABIT OPEN WATERS, ROCKY SHORE, MUDFLATS, AND/OR TIDAL MARSHLANDS OF SAN FRANCISCO BAY ESTUARY

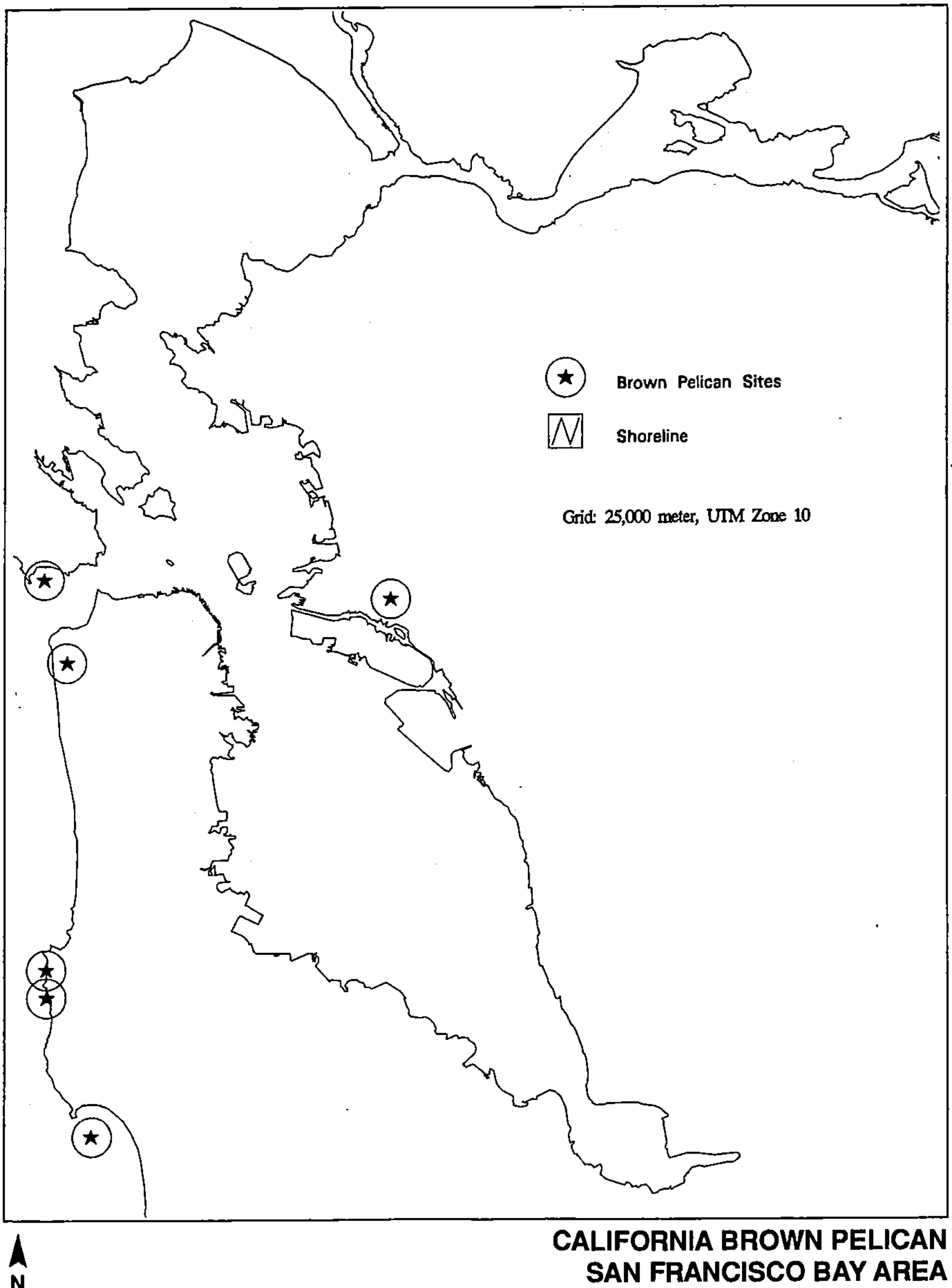
Common Name/*Scientific Name*	Category	Habitat
American peregrine falcon *Falco peregrinus anatum*	Federal Endangered, State Endangered	Tidal marshes
Prairie falcon *Falco mexicanus*	State Species of Special Concern	Tidal freshwater marshes
Yellow rail *Coturnicops noveboracensis*	State Species of Special Concern	Tidal marshes
California black rail *Laterallus jamaicensis conturniculus*	State Threatened, Federal Candidate 1, Federal Management Concern	Tidal salt marshes
California clapper rail *Rallus longirostris obsoletus*	Federal Endangered, State Endangered	Tidal salt marshes
Greater sandhill crane *Grus canadensis tabida*	State Threatened	Tidal brackish/freshwater marshes
Western snowy plover *Charadruis alexandrinus nivosa*	Federal Threatened, State Species of Special Concern	Intertidal mudflat
Long-billed curlew *Numenius americanus*	Federal Candidate 2, State Species of Special Concern	Intertidal mud, tidal marshes
California gull *Larus californicus*	State Species of Special Concern	Open water, intertidal mud, tidal marshes
Elegant tern *Sterna elegans*	State Species of Special Concern	Open water, rocky shore, intertidal mudflat
California least tern *Sterna antillarum browni*	Federal Endangered, State Endangered	Open water, tidal salt marshes
Marbled murrelet *Brachyramphus marmoratus*	State Endangered, Federal Threatened	Open water
Burrowing owl *Athene cunicularia*	State Species of Special Concern	Tidal salt/brackish marshes
Long-eared owl *Asio otus*	State Species of Special Concern	Tidal marshes
Short-eared owl *Asio flammeus*	State Species of Special Concern, Federal Sensitive Bird Species	Tidal marshes
Black swift *Cypseloides niger*	State Species of Special Concern	Rocky shore
Saltmarsh common yellowthroat *Geothlypis trichas sinuosa*	Federal Candidate 2, State Species of Special Concern	Tidal salt marshes
Alameda song sparrow *Melospiza meladia pusillula*	Federal Candidate 2, State Species of Special Concern	Tidal salt marshes

Table 3.3-8
(Continued)

SPECIES OF BIRDS, MAMMALS, REPTILES, AND AMPHIBIANS OF SPECIAL STATUS ON FEDERAL AND STATE LISTS THAT INHABIT OPEN WATERS, ROCKY SHORE, MUDFLATS, AND/OR TIDAL MARSHLANDS OF SAN FRANCISCO BAY ESTUARY

Common Name/*Scientific Name*	Category	Habitat
Suisun song sparrow *Melospiza melodia maxillaris*	Federal Candidate 2, State Species of Special Concern	Tidal salt marshes
San Pablo song sparrow *Melospiza melodia samuelis*	Federal Candidate 2, State Species of Special Concern	Tidal salt marshes
Tricolored blackbird *Agelaius tricolor*	Federal Candidate 2, State Species of Special Concern	Tidal brackish/freshwater marshes
Mammals		
Saltmarsh wandering shrew *Sorex vagran halicoetes*	Federal Candidate 1, State Species of Special Concern	Tidal marshes
Suisun ornate shrew *Sorex ornatus sinuosus*	Federal Candidate 1, State Species of Special Concern	Tidal marshes
Saltmarsh harvest mouse *Reithrodontomys raviventris*	Federal Endangered, State Endangered	Tidal salt/brackish marshes
San Pablo vole *Microtus californicus sanpabloensis*	Federal Candidate 2, State Species of Special Concern	Tidal brackish marshes
Humpback whale *Megaptera novaeangliae*	Federal Endangered	Open Water
Amphibians		
Tiger salamander *Ambystoma tigrinum*	Federal Candidate 1, State Species of Special Concern	Tidal freshwater marshes
Calif. red-legged frog *Rana aurora draytoni*	Federal Candidate 2, State Species of Special Concern	Tidal freshwater marshes
Foothill yellow-legged frog *Rana boylii*	State Species of Special Concern	Tidal freshwater marshes
Reptiles		
San Francisco garter snake *Thamnophis sirtalis*	Federal Endangered, State Endangered	Tidal freshwater marshes
Western pond turtle *Clemmys marmorata*	Federal Candidate 2, State Species of Special Concern	Tidal freshwater marshes

Source: Code of Federal Regulation, Title 50, Parts 17.11 and 17.12 (April 15, 1990) and Annual Notices of Review; USFWS Sensitive Bird Species List; USFWS Migratory Nongame Birds of Management Concern List; CDFG Natural Diversity Data Base, Special Animals, December 1992; USFWS 1992.



CALIFORNIA BROWN PELICAN
SAN FRANCISCO BAY AREA
Figure 3.3-13

76 nests were found in utility towers near the San Mateo Bridge, 153 nests in dead trees and duck blinds on Russ Island salt ponds of Napa County, 20 nests on San Pablo Bay radar targets, and 28 nests on a transmission tower at Donlon Island near Antiock (Carter et al. 1990). While generally safe from impacts of oil spills when on nests, double-crested cormorants are vulnerable to spills as they forage for small fish in open-waters of the Bays.

California Black Rail (*Laterallus jamaicensis conturniculus*)

The California black rail's habitat of tidal marshes has been greatly reduced and fragmented. The species presently breeds only in San Pablo Bay, Suisun Bay, and the lower Delta. Highest densities of California black rails occur in the Petaluma River Wildlife Management Area, along Black John and Fagan sloughs and Coon Island in Napa marsh, and in tidal marshes along the shore of San Pablo Bay. They require tidal marshes that include higher elevational zones not subject to extreme and frequent tidal action (USFWS 1992). Location of occurrence listed in the CDFG Natural Diversity Database that might be subject to oil spills include Giant Salt Marsh and Wildcat Creek Marsh in Contra Costa County; Southampton Marsh, Avon-Port Chicago Marsh, and Benicia State Recreation Area in Solano County; and Day Island, Novato Creek, Gallinas Creek, and China Camp Marshes in Marin County.

California Clapper Rail (*Rallus longirostris obsoletus*)

The California clapper rail remains year-round in the San Francisco Bay Area where it continues to suffer severe habitat loss due to human encroachment on tidal marshes and predation by red foxes. Preferred habitat is characterized by close proximity to tidal flow (habitat traversed by tidal sloughs), and cover of pickleweed with extensive stands of Pacific cordgrass at lower elevations and gumplant and wrack at higher elevations. California clapper rails feed on molluscs in mud-bottomed sloughs near cover. The population in the San Francisco Bay Area from 1981-1987 was estimated at only about 1,500 birds (Harvey 1988), but is believed to number fewer than 500 at present (USFWS 1992). Distribution of California clapper rail habitat from Gill (1979) is shown on Figure 3.3-14. The CDFG Natural Diversity Database lists California clapper rails in the following areas in 1986 or more recently (or date not specified): marshes at the mouth of Wildcat Creek (Contra Costa Co.), Triangle Marsh in Corte Madera (Marin Co.), marshes of Fly Bay, Edgerly and Coon Islands, and Mud Slough (Napa County), fringing marshes of White Slough (Napa and Solano Counties), McInnis Park and adjacent bay tidelands (Marin Co.), mouth of Petaluma River (Marin Co.), confluence of Napa Slough and Sonoma River, Rush Ranch (Solano Co.), south fork of Gallinas Creek (Marin Co.), Napa and Hudeman Sloughs (Napa and Sonoma Co.), and Ryer Island (Solano Co.).

California Least Tern (*Sterna antillarum browni*)

The California least tern was listed as Endangered on Federal and State lists in 1970 because of its small population on drastically reduced nesting habitat. In the Bay Area, the species currently has major nesting effort only at Alameda Naval Air Station and Oakland International Airport in Alameda County. However, peripheral sites also exist where sporadic nesting effort occurs. These sites may be used in one year and not the next, but have the potential to become important new colonies (Harry Carter, USFWS, personal communication 1992). Two sites used in 1987-1989 were Allied Chemical Company property in Port Chicago and the PG&E plant in Pittsburg. In 1990, 89 pairs attempted to nest in the San Francisco Bay Area (Carter et al. 1990). The CDFG Natural Diversity Database also lists recent nesting efforts at several sites not occupied in 1989 and 1990: Bair Island (San Mateo County), the Leslie salt ponds south of Coyote Hills Slough (Alameda County), and Baumberg salt ponds (Alameda County). California least terns forage near their colonies in eelgrass beds where they are vulnerable to oil spills.

Western Snowy Plover (*Charadruis alexandrinus nivosa*)

In San Francisco Bay, snowy plovers nest almost exclusively on levees and islands of salt ponds and in dry salt ponds of the south Bay (Warriner et al. 1986). A survey in June 1978 resulted in a count of 351 adult birds, but subsequent June counts have been lower (Page and Stenzel 1981 USFWS 1992). Almost all snowy plover nesting occurs in the south Bay. The winter population of snowy plovers numbers at least 350 birds, most of which are found in the vicinity of salt ponds in the Baumberg area of the south Bay (Page et al. 1986). At any time of year, snowy plovers foraging on intertidal mudflats are vulnerable

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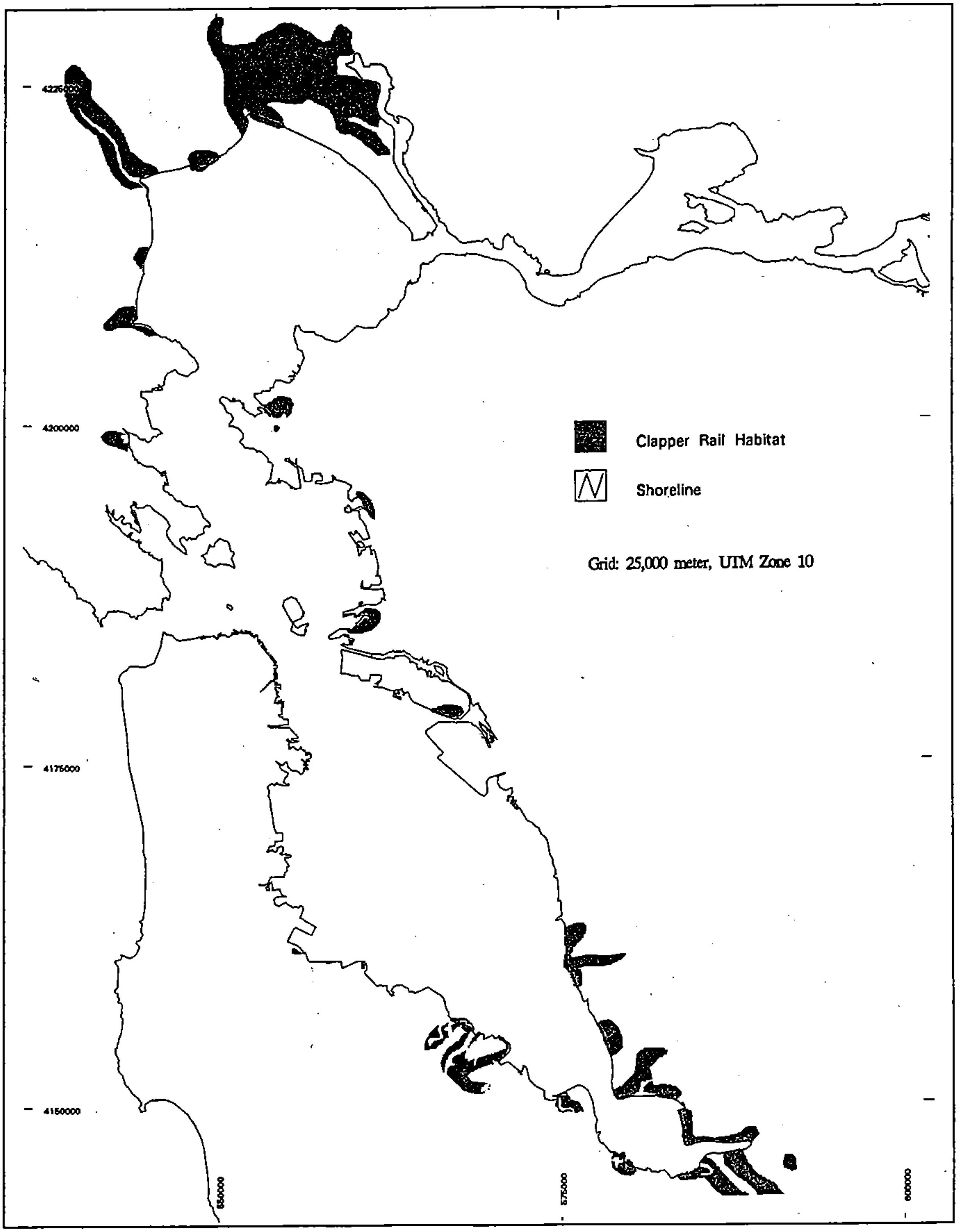

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CLAPPER RAIL HABITAT
Figure 3.3-14

to impacts of oil spills reaching the south Bay. The CDFG Natural Diversity Database lists western snowy plovers as occurring since 1986 in San Mateo County near Belmont and Redwood City, and at Bair Island in Alameda County near Hayward.

Long-Billed Curlew *(Numenius americanus)*

Long-billed curlews do not breed in the San Francisco Bay Area. They are most abundant in the fall and winter, and numbers decline in the spring. A fall 1988 census resulted in a count of 2,300 long-billed curlews (PRBO unpublished data, presented in USFWS 1992). Based on earlier surveys, the winter population may be about one-third that number.

American Peregrine Falcon *(Falco peregrinus anatum)*

Peregrine falcons in the San Francisco Bay and Delta prey to some extent on terns, shorebirds, and seabirds. In this part of their range, they forage predominantly in wetlands surrounding the Bay. Winter populations in the area are estimated at 10 to 20 birds; a few nesting attempts have been noted (USFWS 1992). Because of the possibility of ingestion of oil-contaminated prey or scavenged carcasses, the peregrine falcon as well as other raptors is at risk of oil spills.

Mammals

Suisun Ornate Shrew *(Sorex ornatus sinuosus)*

The Suisun shrew is an inhabitant of tidal marshes of northern San Pablo and Suisun Bays and, historically, ranged as far east as Grizzly Island and as far west as the mouth of Sonoma Creek, the Petaluma River, and Tubbs Island (Western Ecological Services Company 1986b, as cited in USFWS 1992). The species presently may be found only on Grizzly Island (Williams 1983). Suisun shrews inhabit the middle-to-high marsh elevations where deposited litter and driftwood provide shelter and forage. An important adjunct of habitat is that higher upland areas exist where animals can move during extreme high tides. While some tidal marshes in San Pablo Bay exist with access to higher marshland vegetation, most are broken into small, isolated units with little elevational gradient. Diked marshes may provide suitable cover for these shrews and are more available in Suisun Marsh than elsewhere (Western Ecological Services Company 1986b, cited in USFWS 1992). The CDFG Natural Diversity Database lists occurrences at Lake Chabot, Sears Point Road NW of Vellejo, Southampton Bay in Solano County, Suisun City salt marsh, near Cordelia salt marsh, near Napa River and Highway 37, near White Slough and Highway 37, South and Dutchmans Sloughs, and at Mare Island Naval Shipyard at the mouth of Carquinez Strait.

Saltmarsh Wandering Shrew *(Sorex vagran halicoetes)*

This species prefers tidal salt marshes with dense cover of pickleweed and sufficient driftwood to provide soil moisture adequate for habitat and invertebrate food resources. It is apparently limited to the southern San Francisco Bay where it inhabits marshes 2 to 3 m above the high water line (Findley 1955). For the purposes of this EIR, the present distribution is defined by past records of observations and captures, including fringing marshes of Santa Clara, Alameda, Contra Costa, San Mateo, and San Francisco Counties (Williams 1986). The CDFG Natural Diversity Database lists occurrences in the saltmarsh at the west approach to the Dumbarton Bridge, on Bair Island near Redwood Point, in Alameda Creek, at Giant Marsh in Contra Costa County, in San Pablo Creek salt marsh north of Richmond, at Arrowhead (Melrose) Marsh north of Oakland Airport, at Oakland Airport, at Ravenswood Point in San Mateo County, and at Johnson and Hayward Landings in Alameda County.

Saltmarsh Harvest Mouse *(Reithrodontomys raviventris)*

The saltmarsh harvest mouse is endemic to salt and brackish marshes where its preferred habitat is the higher tidal wetlands that provide access, if necessary, to refugia during extreme high tides (USFWS 1992). The preferred habitat is typically dominated by pickleweed, along with a diverse mixture of vegetation characterizing the transition zone. Saltmarsh harvest mice are also able to use diked marshes and adjacent grasslands during the late spring (Geissel et al. 1988). Two subspecies exist in the area: the northern inhabiting San Pablo and Suisun Bays, and the southern inhabiting central and southern San Francisco Bay. At present, suitable habitat is only about 5 percent of that historically available, and conservation of the species focuses on habitat protection and restoration. The CDFG Natural Diversity Database lists occurrences at 52 sites in saline emergent wetlands of Solano, Contra Costa, Alameda, San Mateo, Marin, Sonoma, and Napa Counties.

San Pablo Vole *(Microtus californicus sanpabloensis)*

It is unclear whether the San Pablo vole is a separate subspecies of *Microtus californicus*. Until a determination can be made, it remains a Federal Candidate Species (Category 2) despite a greatly restricted habitat. San Pablo vole populations are presently found in three widely isolated fragments in salt marshes along the south shore of San Pablo Bay in Contra Costa County (Western Ecological Services Company 1986c, cited in USFWS 1992). The CDFG Natural Diversity Database indicates occurrences in Giant Marsh and adjacent grasslands, San Pablo Creek and associated saltmarsh, and Wildcat Creek and marsh at creek mouth.

Humpback Whale *(Megaptera novaeangliae)*

The humpback whale is a Federally listed Endangered Species that feeds in the Gulf of the Farallones in the fall. One individual has entered San Francisco Bay in October 1985 and again in October 1990 ("Humphrey"). Sightings of individual whales have been made regularly near the mouth of the Bay over the past decade (Sarah Allen, personal communication). See discussion in Section 3.3.5.7.

Amphibians and Reptiles

The amphibian and reptile fauna of the brackish and freshwater marshes in the San Francisco Bay region includes five species that are listed as Rare/Threatened/Endangered (or Candidate) or California Species of Special Concern (Table 3.3-8). While all may use tidal marshes as habitat, they are not limited to marshes nor are they necessarily present wherever that habitat-type occurs. Because of their rarity, distributional data are limited.

California Tiger Salamander *(Ambystoma tigrinum)*

This species may typically be out of reach of oil spills; found in some tidal freshwater marshes, it more commonly occurs at higher elevations. For survival, it requires vernal pools for breeding and access to rodent burrows for hibernation and estivation (citations in USFWS 1992). The CDFG Natural Diversity Database lists its present range to include San Francisquito Creek in San Mateo County.

California Red-Legged Frog *(Rana aurora draytoni)*

The California red-legged frog is rare in the San Francisco Bay region, and has only a few relict populations in surrounding coastal mountains and the delta. It prefers fresh and brackish marshes and riparian habitats. In the San Francisco Bay region, red-legged frogs are present in the Santa Cruz Mountains, the San Francisco State Fish and Game Region in San Mateo County, in canals at the San Francisco International Airport, and in northern Contra Costa County at the Concord Naval Weapons Station, Marsh and Kellogg Creeks, and in the Los Vaqueros area (citations in USFWS 1992). The CDFG Natural Diversity Database also indicates occurrence in Golden Gate Park, the Presidio, and other sites near the City of San Francisco.

Foothill Yellow-Legged Frog *(Rana boylii)*

This species prefers partially shaded, shallow streams with riffles of rock or gravel. They are, therefore, impacted by watershed management practices that result in alteration of natural stream habitat (Hayes and Jennings 1989, cited in USFWS 1992). They are believed extirpated in the Delta, but still common in the Mount Diablo Range and the hills east of Petaluma (USFWS 1992).

San Francisco Garter Snake *(Thamnophis sirtalis)*

The San Francisco subspecies of the common garter snake is the only amphibian or reptile occurring in the San Francisco Bay region that is listed as Endangered (both Federal and State lists). It is known to occur in tidal freshwater marshes but may be more common at higher elevations. It has been recorded in recent years in the San Francisco State Fish and Game Refuge (San Mateo County), near Crystal Springs Reservoir, Sharp Park Golf Course in Pacifica, Mori Point, Cascade Ranch, Sanchez Canyon in Hillsborough, San Francisco International Airport, and in irrigation ponds along the San Mateo coast (USFWS 1992, CDFG Natural Diversity Database).

Western Pond Turtle *(Clemmys marmorata)*

The western pond turtle is a Candidate for Federal listing by the USFWS. Habitat requirements include backwater areas with abundant vegetation, logs for basking, and open sunny slopes well away from riparian zones for egg deposition (USFWS 1992).

3.3.4 Marine Terminal

3.3.4.1 Plankton

There are minimal site-specific plankton data for the Marine Terminal. Unocal biological studies have focused on benthic invertebrate and fish communities. Plankton populations in the vicinity of the Terminal would be expected to show the general patterns for San Pablo Bay discussed in Section 3.3.3.1. The Interagency Ecological Studies Program for the Sacramento-San Joaquin estuary does have a phytoplankton monitoring station at Pinole Point approximately 5 miles to the southwest of the Unocal Marine Terminal (Lehman and Hymanson 1991). Chlorophyll concentrations peaked three times during 1990 but did not exceed 8 ug/L. The small peaks, measured in March, June and August, were produced by mixed phytoplankton communities composed of cryptophytes, the green alga *Chlorella* spp., diatoms, flagellates and dinoflagellates. Figure D-3 in Appendix D shows the monthly chlorophyll concentration at this station during 1990. Figure 3.3-15 shows chlorophyll trends in San Pablo Bay since 1970. Chlorophyll concentrations measured during 1990 were relatively low and less variable than those measured between 1980 and 1986, but they were similar to those measured between 1970 and 1973 (Lehman and Hymanson 1991).

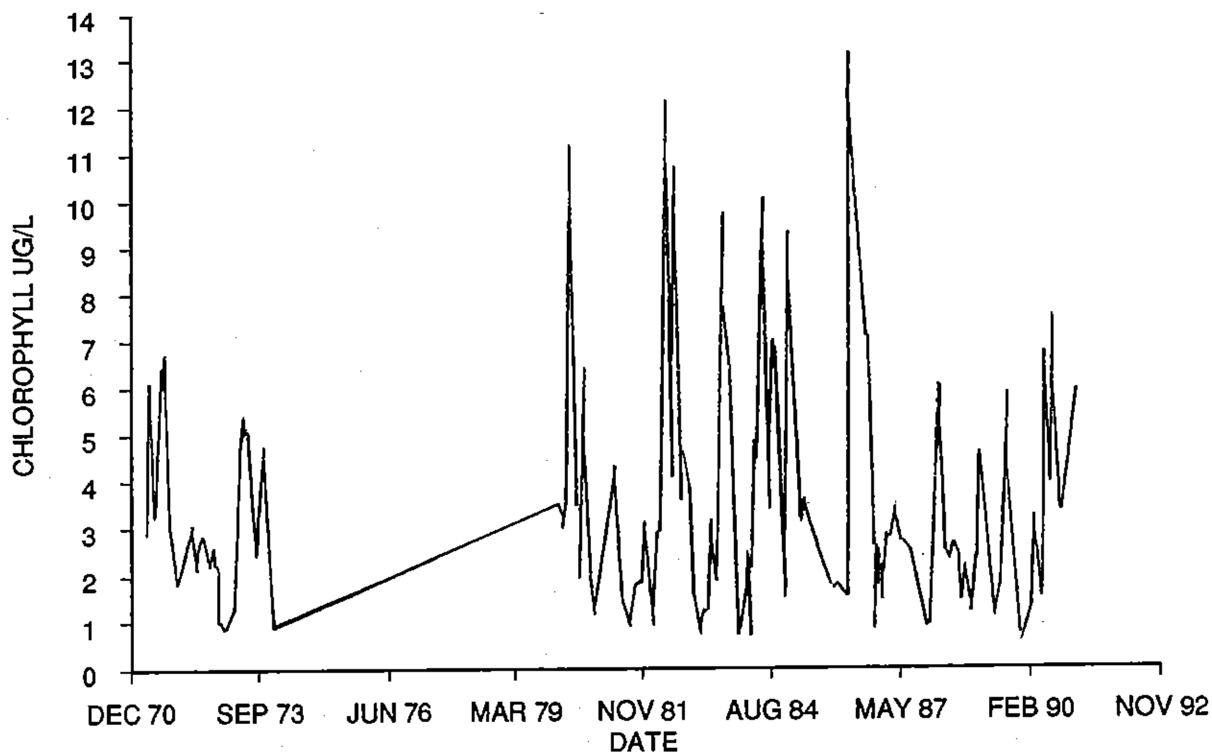
3.3.4.2 Benthos

Benthic habitats in the vicinity of the Unocal Marine Terminal consist of intertidal riprap and gravel beach (Entrix 1991) and subtidal fine sand (Robilliard et al. 1989a). Unocal has conducted site-specific subtidal benthic biological sampling programs in the vicinity of the Marine Terminal. These studies were for the EIR for a treated process wastewater outfall and diffuser system from the Unocal San Francisco Refinery (Entrix 1987) and for the Receiving Water Monitoring Program for the outfall (Robilliard et al. 1989a; Robilliard and Jahn 1990).

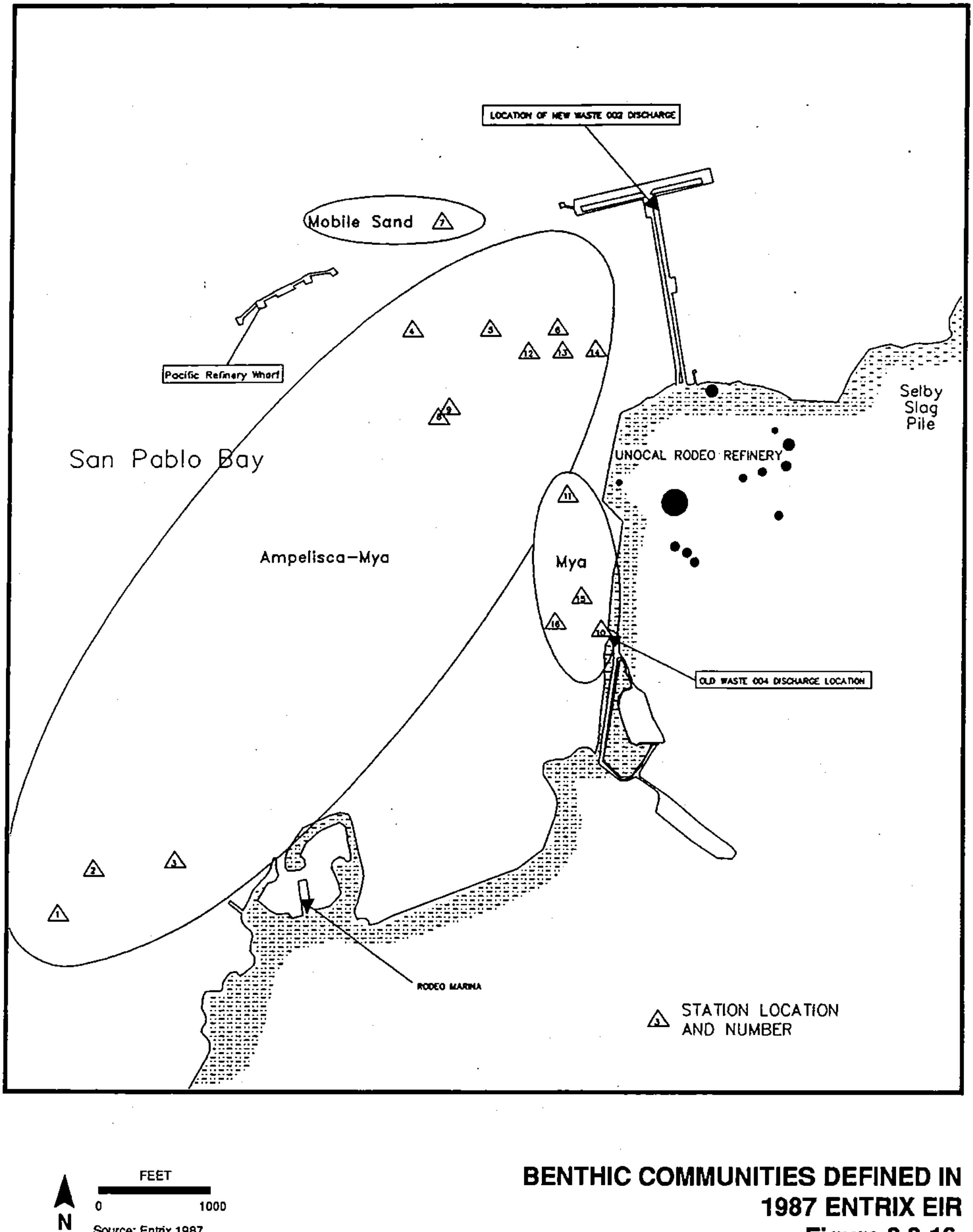
Figure D-4 in Appendix D shows the location of stations that were sampled by Entrix (1987) in September of 1986 to provide data for the outfall EIR. Table D-5 in Appendix D shows the number of each kind of infaunal invertebrate that was collected at each station. The most abundant species were the amphipods, *Ampelisca abida* and *Grandidierella japonica* and the clam *Mya arenaria*. These data suggested that there were three distinct bottom communities in the study area as shown on Figure 3.3-16. The offshore *Ampelisca-Mya* community contained the greatest variety of species and the highest number of individuals. This community occurred at all the offshore stations (1-3, 4-6, 8-9, 12-14) of the shelf. The inshore *Mya* community (at the inshore Stations 10, 11, 15, and 16) had fewer species and *Mya* was the only abundant species. The coarse shifting sand at the edge of the deep ship channel (Station 7) contained only a few individuals of two species, *Ampelisca abida* and the tanaid amphipod *Sinelobus sanfordi*. The investigators referred to this species-poor community as the "mobile sand community." All of the abundant species recorded in this study are introduced species and not native to the San Francisco Bay estuary. They all have opportunistic life histories. They are adapted to invading disturbed areas and persisting in stressful environments. *Ampelisca* has a highly variable population structure and quickly recolonizes habitats in other parts of San Francisco Bay.

Entrix compared the data they recorded in their 1986 survey with previous studies in the area. They found that the faunal patterns they observed were markedly different from those found in previous investigations. Until 1982, the small clam, *Gemma gemma*, was the numerical dominant throughout the study area. The reduction in *Gemma gemma* was apparently caused by strong flooding in January 1982 and the fall of 1983. Monitoring programs of waste discharges from a Unocal outfall (Marine Research Center 1980, 1981, 1982, 1983, 1984 in Entrix 1987) documented this marked change in community composition.

Entrix (Robilliard et al. 1989a) again sampled the benthic community in the vicinity of the Unocal Marine Terminal in January 1989. The locations of the stations are shown in Appendix D, Figure D-5. The mean density of each kind of organism at each station is shown in Table D-6. Figure D-6 shows the community patterns according to the way Cluster Analysis grouped stations in the area, and Table D-7 shows the relative abundance of species in each Cluster Group. Just as *Gemma gemma* had been replaced by



CHLOROPHYLL TRENDS IN SAN PABLO BAY
Figure 3.3-15



Source: Entrix 1987

BENTHIC COMMUNITIES DEFINED IN 1987 ENTRIX EIR
Figure 3.3-16

Mya arenaria in the early 1980s, this study showed that another profound change in community composition in the area had occurred between 1986 and 1989. The Asian clam, *Potomocorbula amurensis,* which was recently introduced to San Francisco Bay from Asia, was by far the most abundant organism. It accounted for 55 percent of all the individual organisms collected. The polychaete worm *Tharyx* sp. was the second most abundant species. Together, *Potamocorbula* and *Tharyx* accounted for over 80 percent of all the individual organisms collected. The community dominants, *Mya arenaria, Ampelisca abdita* and *Grandidierella japonica,* found in the 1986 study were rare or absent in the 1989 samples.

The 1989 study used Cluster Analysis to divide the benthos into four groups (Figure D-6, Appendix D). Further analysis defined these cluster groups into two communities which were related to sediment grain size parameters. These communities are the Davis Point community (Groups 1 and 2) which occupied the relatively well-washed fine sand along the edge of the shipping channel and the Rodeo Flat community (Groups 3 and 4) which occupied the more mixed sediments of the tidal flat. The Davis Point community was characterized by low species diversity. The numerical dominant was *Potomocorbula.* The Davis Point community was similar to the one called the "mobile sand" community in the 1987 study because it was characterized more by the absence of many of the species found on Rodeo Flat than by the presence of any particular species.

The Rodeo Flat community was characterized by comparatively high species diversity and high abundance. The dominant species were *Potamocorbula amurensis* and *Tharyx* sp.

In October 1989, Entrix (Robilliard and Jahn 1990) did additional benthic infaunal sampling at six stations located 2,000 to 3,000 feet south of the Unocal Marine Terminal. The samples at these stations were designed to provide further information on the Rodeo Flats benthic community. Results of that study are presented in Appendix D, Table D-8. Like the January 1989 samples, the samples in the October 1989 survey were dominated by the Asian clam, *Potamocorbula amurensis,* and the polychaete *Tharyx* spp. These two species combined accounted for over 85 percent of the individual organisms collected. Most species became more abundant in the October samples compared to the January samples. The increase in abundance corresponds to the typical spring and summer recruitment period.

In addition to sampling the benthic infaunal community, Entrix sampled benthic epifaunal invertebrates in the vicinity of the Unocal Marine Terminal (Keegan et al. 1989). In contrast to the infauna, which are small animals that live in the sand, the epifauna live on top of the substrate. The most abundant epifaunal invertebrates that Entrix caught in otter trawls in the vicinity of the Unocal Terminal were cranganid shrimp. These shrimp, commonly known as bay or grass shrimp, make up about 91 percent of the crustacean catch in the trawls. The cranganid shrimp include three species of the genus *Crangon: C. franciscorum, C.nigricauda,* and *C. nigromaculata.* Of these three species, over 90 percent were *C. franciscorum.* The oriental shrimp, *Paleamon macrodactylus,* was a minor component of the catch. Dungeness crab (*Cancer magister*) was abundant throughout the area and accounted for nearly 8 percent of the entire crustacean catch. Few rock crabs (*Cancer productus* and *C. antennarius*) were collected.

3.3.4.3 Fishes

The location of the Unocal Marine Terminal in southeastern San Pablo Bay near Carquinez Strait is in an area that is important to many of the fishes of the San Francisco estuary system. San Pablo Bay and Carquinez Strait provide important foraging and nursery habitat for migrating and resident fish species (Entrix 1987). The area is also important for many of the small forage fish which provide a food base for the larger species. The area is vital for anadromous fishes because Carquinez Strait is the corridor through which all adult anadromous fishes migrating upstream to spawn in the Sacramento and San Joaquin River systems must pass. Table 3.3-9 lists important fish species which are found near the Marine Terminal. As part of the Interagency Ecological Studies Program for the Sacramento-San Joaquin estuary, the CDFG has sampled fish populations throughout the San Francisco estuary. This program includes stations in the vicinity of the Unocal Marine Terminal. Entrix (1987) summarized the results of the CDFG fish collections near the Unocal Marine Terminal (Table D-9). A total of 47 fish taxa were collected at these stations between 1980 and 1985. Three forage species (northern anchovy, Pacific herring, and longfin smelt) were the most abundant species captured. Striped bass were

Table 3.3-9

IMPORTANT FISH SPECIES AND LIFE STAGES NEAR MARINE TERMINAL

Species	Res/Mig[1]	Life History Stages	Months	Nursery Habitat
Striped bass	M	Juvenile	All	Oligohaline, Tidewater "Null Zone"
		Adult	All	
Chinook salmon	M	Juvenile	Feb-Jun & Fall	Estuarine Shallow and Open Waters
		Adult	Fall-Spring	
American shad	M	Juvenile	Aug-Dec	Estuarine
		Adult	Feb-Jun	
Pacific herring	M	Juvenile	Feb-Jun	Estuarine, Pelagic
Northern anchovy	M	Juvenile	Jun-Sep	Estuarine, Inshore Bays
		Adult	Feb-Apr	
White sturgeon	M	Juvenile	All	Upper Estuary, Demersal
		Adult	Winter-Spring	
Starry flounder	R	All	All	Upper Estuary to Freshwater, Demersal
Longfin smelt	M	Juvenile	Apr-Jun	Estuarine, Lower Water Column
		Adult	Oct-Apr	

[1] R = Resident M = Migratory
Source: Entrix 1987

abundant in otter trawl and beach seine collections. Juvenile Chinook salmon were rarely captured in the offshore samples but were the second most abundant fish collected in the beach seine samples. The prevalence of juvenile salmon in the beach seines reflects the daytime use of nearshore habitats during their out migration. Starry flounder were abundant in the otter trawl samples.

Seasonal data from the CDFG study for stations near the Unocal Marine Terminal are summarized in Tables D-10 and D-11, Appendix D. Table D-10 summarizes the most abundant species caught in midwater trawls and in otter trawls for a deep station in the ship channel. Midwater trawls at this station are dominated by northern anchovies in all seasons of the year, with Pacific herring commonly occurring in the catch from April to December (CDFG 1992). Striped bass are a regular feature in the fish assemblage from October to March. Jacksmelt commonly occur in the months from April to September. Juvenile Chinook salmon regularly occur in the trawls from April to June. In the otter trawl samples which collect demersal fish, staghorn sculpin is a regular part of the catch year round and longfin smelt is the most frequently encountered species in all seasons of the year.

At the shallower CDFG station (Table D-11), American shad and striped bass are regularly collected in the midwater trawl samples (CDFG 1992). Jacksmelt are caught from April to September, and Pacific herring are only abundant from April to June. Longfin smelt are common from January through March. Striped bass, longfin smelt, starry flounder, and staghorn sculpin are collected in the otter trawl samples at this station. Northern anchovy and shiner perch are captured primarily from April to September. The number of species and number of individuals falls drastically in the season from October to December. However, striped bass are caught regularly at this time of year.

Data on fish eggs and larvae are available from the CDFG studies, as well as from studies of fish plankton entrained in the cooling water intake of the PG&E Oleum power plant. The two most abundant species caught in the CDFG plankton samples between 1980 and 1985 (Table D-11) were northern anchovy and Pacific herring.

The PG&E monitoring program was conducted between April 1978 and April 1979, a relatively dry year. As a result, most of the entrained ichthyoplankton (fish eggs and larvae) was dominated by marine species (PG&E 1983 in Entrix 1987). Pacific herring larvae accounted for 55.5 percent of all entrained fish larvae followed by gobies (17.5 percent), northern anchovy (2.4 percent), smelts (2.0 percent), silversides (2.0 percent), and striped bass (1.3 percent). Over 99 percent of all entrained fish eggs were identified as northern anchovy.

Entrix (Keegan et al. 1989) conducted site specific fish sampling around the Unocal Marine Terminal in January and February 1989. The methods they used to collect fishes included beach seine, gill net and otter trawl. A total of 30 taxa of fish and crustaceans were caught in the beach seine program. Abundant species included staghorn sculpin, yellowfin goby, English sole and northern anchovy. Neither striped bass nor salmonids were common in the beach seine samples. Thirteen juvenile striped bass and five steelhead were collected in the beach seine samples. Thirteen fish species were collected by gill net. The gill net samples were dominated by jacksmelt, white croaker, striped bass and Pacific herring. Twenty-one species of fish were collected in the otter trawls. Juvenile speckled sanddab accounted for 61 percent of the catch. Pacific staghorn sculpin and striped bass were about equally abundant and together accounted for about 22 percent of the catch. Juvenile English sole and northern anchovy accounted for a combined total of about 7 percent of the catch. All the remaining species each contributed 1 percent or less to the catch.

In May through August 1989, Entrix conducted additional sampling of fishes by gill net and beach seine in the vicinity of the Unocal Marine Terminal (Keegan et al. 1989). Silversides were abundant in May and striped bass in July. Most of the striped bass were juveniles which recruited to the shore zone in June and July from upstream spawning grounds. One juvenile steelhead was taken in May and single catches of king salmon smolt were taken at two stations in June. Sixteen species of fish were taken in the gill net survey. Northern anchovy and striped bass accounted for over 95 percent of the entire catch.

3.3.4.4 Tidal Marshes and Diked Wetlands

No salt marshes are found in the vicinity of the Unocal Marine Terminal (Entrix 1991). The shoreline around the Terminal consists primarily of rubble with a gravel beach to the east. Important salt marsh habitat is located across San Pablo Bay from the Terminal along the north shore of San Pablo Bay.

3.3.4.5 Avifauna

The wharves of the Unocal Marine Terminal at Davis Point are used by Western Gulls for nesting and roosting (Carter et al. 1990). A census by boat on June 18, 1990, found 11 nests and 25 birds at this site (CA Colony No. SFB-CC-06; USFWS Colony No. 404-064). A few nests of Western Gulls have also been found nearby along the southern shore of the Carquinez Strait between Selby and Eckley (two nests) and on the Hercules Wharf (one nest). Western Gulls also have been reported nesting at four other sites within 10 km of the Marine Terminal: Pinole Point (one), on markers for the East San Pablo Bay ship channel (three), sites in Mare Island Strait (10), and on the Northeast San Pablo Bay beacon (four). A double-crested cormorant nest was also found at the latter site. Other gulls that winter in the area are glaucous-winged, herring, thayers, and glaucous gulls.

Most birds that occur on the water near the Marine Terminal are ducks. Scaup and scoters are by far the most abundant, constituting, on average, over 90 percent of all waterfowl counted on open waters of

San Pablo Bay on winter surveys conducted in 1987 to 1990 (USFWS 1992). Canvasback were the third most abundant duck in San Pablo Bay representing about 3.5 percent of the total. The winter distribution of these ducks is shown on Figure 3.3-11. Densities are quite low near the Marine Terminal. Scaup are present in San Pablo Bay from late-fall through early-spring at a mean density of over 100 birds/km^2 (USFWS unpubl. data). Densities are greatest in north-central parts of the bay in shallower waters and decline toward the ship channel and the Carquinez Strait. Density of scaup within 2 km of the Marine Terminal average about 12 birds/km^2; greater concentration of birds occurs along this portion of the bayshore in waters east of Point Pinole. Scoters are found predominantly in the central-west portion of San Pablo Bay, again in shallower waters, where they have mean densities in the winter of over 20 birds/km^2. However, within 2 km of the Marine Terminal, mean density is only about 6 birds/km^2. Canvasback are rare in the eastern waters of San Pablo Bay and the Strait, but are found in low densities of about 2 birds/km^2 along the west side of Mare Island.

The bayshore margin of southern San Pablo Bay from Carquinez Strait to Pinole Point includes portions with intertidal mudflats that may be used for foraging by shorebirds. Stenzel and Page (1988) reported over 36,000 shorebirds from Mare Island to Point San Pablo - about 4 percent of the San Francisco Bay Area total. The most abundant species in San Pablo Bay are Long-billed curlews, dunlin, semipalmated plovers, killdeer, willets, and marbled godwits (USFWS 1992). Most species are migrants that reach peak numbers in fall through spring. The killdeer is the only abundant species that nests in the San Pablo Bay Area. Intertidal mudflats along this portion of the shore may also support a few herons and egrets.

About 2 km to the north, across the Bay, tidal marshes are found along Mare Island. These marshes are bounded by mudflats and seasonal wetlands, and may support numbers of rails, herons, egrets, American coot, saltmarsh yellowthroat, and saltmarsh song sparrows.

3.3.4.6 Marine Mammals

Harbor seals may occasionally be seen in the waters of San Pablo Bay and Carquinez Strait foraging for fish. The nearest haul-out site is located on Tubbs Island (Sonoma County) about 16 km (10 nm) to the northwest, but Castro Rocks 24 km (13 nm) from the Terminal is the second largest haul-out site in the Bay. California sea lions may occasionally forage into San Pablo Bay and Carquinez Strait. One sea lion was seen swimming past the Unocal Terminal during the EIR preparers' site visit in March 1992.

3.3.4.7 Rare/Threatened/Endangered Species

No rare/threatened/endangered species of plants, birds, mammals, amphibians, or reptiles are known to occur in the immediate vicinity of the Marine Terminal. However, tidal marshes across the Bay may support populations of several species on federal or state lists, and beacons and radar targets of the ship channel are used for nesting by double-crested cormorants (a State of California Species of Special Concern).

Two sensitive fish species may occur near the Marine Terminal, the Delta smelt and the Chinook salmon winter and spring runs. See Section 3.3.3.7 for a discussion of these species. A few individuals of Delta smelt have been collected in fish surveys near the Terminal (Table D-9, Appendix D). The majority of the Delta smelt population is to the east of the Terminal in Suisun Bay and the lower Delta. In wet years, however, low numbers of this species are found in San Pablo Bay. Chinook salmon are a small but regular part of the catch in fish surveys near the Marine Terminal. Juveniles are common in the shallow water areas.

3.3.5 Outer Coast

The outer coast of California from San Francisco Bay to the Oregon border comprises a productive and diverse environment for marine life. Compared to the southern California coastline which has been subjected to intense human activity, the marine environment of the north coast is relatively pristine. The area includes bays, estuaries, dramatic rocky headlands, and offshore reefs and kelp beds. The marine life of the central and northern California coastal zone has been summarized in Winzler and Kelly (1977). This section contains a brief discussion of marine resources along the northern coast of California and identifies areas that are particularly unique or significant.

3.3.5.1 Plankton

Northern California is characterized by particularly productive coastal waters (BLM 1980). This high productivity is related to coastal upwelling of nutrient rich water which occurs during spring and summer when northerly winds prevail. This upwelling process acts as an upward conveyer of deepwater nutrients which renew the surface water and help bring about large phytoplankton blooms, rich zooplankton production and abundant fisheries production. The most intense upwelling areas along the northern California coast are shown on Figure 3.3-17. Lower phytoplankton productivity occurs during late summer, fall, and winter. The winter months, when predominant currents run from south to north, are the least productive periods. The general seasonal pattern for phytoplankton off the northern California coast is, thus, low winter productivity followed by a spring bloom and relatively high numbers during the summer (Riznyk 1977).

Dominant species of phytoplankton tend to change seasonally and from year to year (Riznyk 1977). The most frequently occurring phytoplankton genera in northern California waters are *Rhizosolenia*, *Chaetoceros*, *Nitzchia*, and *Bacteriastrum*. The major diatom that blooms prolifically in the Gulf of the Farallones is *Chaetoceros* spp. (Chan 1974). *Chaetoceros* forms the primary base of the marine food pyramid during spring to early summer months. In the late summer (August) to fall months (September and October), the reddish bloom of the dinoflagellate, *Ceratium* spp., is very evident (Chan 1974). Diatoms and dinoflagellates serve as key food sources for invertebrate zooplankton and larval fishes.

Zooplankton off the northern California coast show an early summer population peak in response to the spring phytoplankton bloom which provides a rich source of food (BLM 1980). Figure 3.3-18 shows zooplankton volume in summer months. The richest areas were from Marin County north, with the area between Humboldt Bay and southern Del Norte County being especially rich.

In the shallow surface waters of the Gulf of the Farallones, there are prolific daytime swarms of the euphausiid, *Thysanoessa spinefera*. These breeding swarms of euphausid shrimps, which proliferate along the northern California coast during the spring and summer months, are an important food source for anadromous fish such as the Chinook salmon (Smith and Adams 1988).

3.3.5.2 Benthos

Much of the coastline of northern California consists of rocky substrate. Table 3.3-10 shows the amount of rocky shore along the northern California coast. The percentage of rocky compared to sandy beach ranges from 32 percent in Humboldt County to 77 percent in Sonoma County. In comparison, the mainland coastline of Santa Barbara County in Southern California is only 24 percent rocky shore. Communities of intertidal organisms have been found to be considerably different in different locations in northern California (Kinnetic Laboratories, Inc. 1992). In particular, rocky shores exhibit community diversity

Table 3.3-10

AMOUNT OF ROCKY SHORE ALONG NORTHERN CALIFORNIA COAST

County	Miles		Percent of Total County Shore	
	Rocky Shore	Sandy Beach	Rocky Shore	Sandy Beach
Del Norte	20	25	44	56
Humboldt	39	82	32	68
Mendocino	82	36	70	30
Sonoma	47.7	14.3	77	23
Marin	34	36	49	51
San Mateo	25	31	45	55
Santa Cruz	20.5	20.5	50	50
Source: BLM 1980				

and complexity that are generally higher than in other types of coastal biological communities; variation among locations is often extreme. Figure 3.3-19 shows the shoreline type and offshore rocks (stacks). Just as there is much rocky intertidal habitat along the coast of northern California, there is also much rocky subtidal. The location of offshore reefs, offshore rocks, and subtidal hard bottom substrate roughly correlates with the sections of coast that have rocky intertidal habitat. Major offshore reefs include St. George Reef off Crescent City, Tolo Bank about 40 miles north of Fort Bragg, Cordell Bank offshore from Point Reyes, and the area around the Farallones (BLM 1980). Figure 3.3-20 shows Areas of Special Biological Significance, Marine Reserves, and other biologically significant intertidal and subtidal areas along the northern California coast. Table 3.3-11 lists and discusses briefly important intertidal and subtidal babitats (exclusive of estuaries which are discussed in Section 3.3.5.4) along the northern California coast.

The most species-rich intertidal areas are those of the protected outer rocky shore (Winzler and Kelly 1977). The protected open coast lies within open bays or along a shoreline protected by a headland, an offshore island or an offshore rocky reef. Kelp beds also tend to diminish the force of waves breaking on shore. Along the northern California coast, these protected open coast areas include the leeward side of Bodega Head and Point Reyes, at Half Moon Bay and at Año Nuevo Island. The diverse marine life of the protected outer coast rocky intertidal is described in Ricketts, Calvin and Hedgpeth (1985). Characteristic species of the protected outer coast rocky intertidal habitat include the feather boa kelp (*Egregia menziesii*), rockweeds especially *Fucus distichus*, red algae of the genus *Gigartina*, the aggregate sea anenome (*Anthopleura elegantissima*), and giant green anenome (*Anthopleura xanthogrammica).*

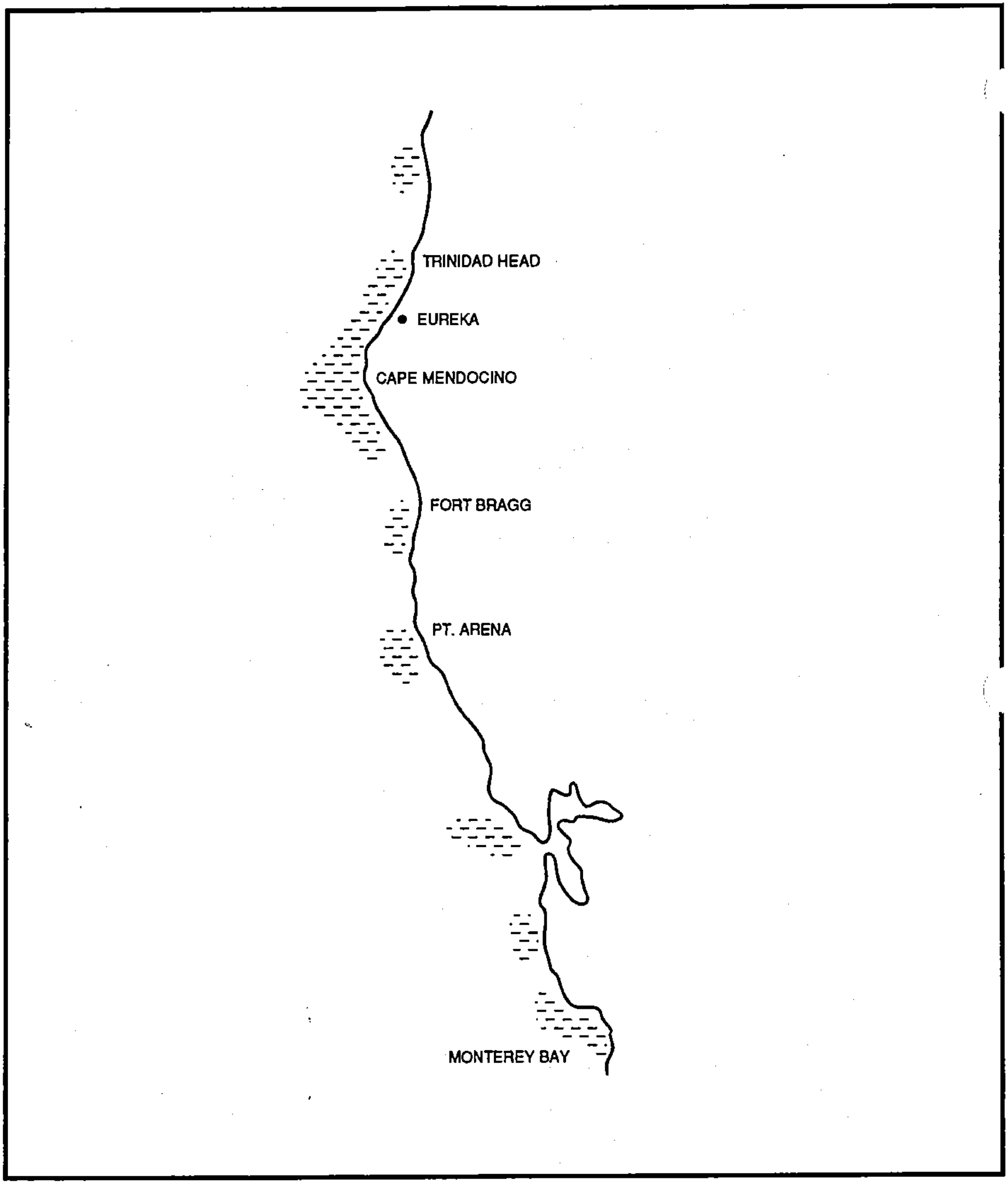
The unprotected rocky shore is an environment of relentless pounding surf. These rigorous conditions of heavy surf present a habitat in which only those plants and animals with special adaptations to withstand the brutal wave shock can live. Because of the demanding physical conditions of the unprotected rocky shore, diversity is much lower than on the protected coast. The most representative association in this habitat is the mid-intertidal mussel bed community dominated by the California mussel (*Mytilus californianus*), the gooseneck barnacle (*Pollicipes polymerus*), and the ochre sea star (*Pisaster ochraceus*) (Winzler and Kelly 1977; Ricketts, Calvin, and Hedgpeth 1985).

Deep offshore reefs are usually covered with dense diverse growths of marine invertebrates. There is often a wide diverse sponge assemblage; on some offshore banks, such as Cordell Bank off Point Reyes, populations of the hydrocoral, *Allopora californica*, can be found (G. Chan, personal observation).

Figure 3.3-21 shows the locations of kelp beds along the northern California coast. Most of the kelp along the northern California coast occurs from Mendocino County south. Seasonal bull kelp, *Nereocystis leutkeana*, has been observed to grow prolifically on submerged and tidal rocks off Trinidad Head in Humboldt County (Boyd 1979). Kelp beds are sparse and isolated between Cape Vizcaino and Cape Mendocino, probably because of turbidity from the many streams which run off into the area (USFWS and Institute of Marine Sciences 1986). Large dense kelp beds occur along a 12- to 15-mile stretch of coastline between Cape Vizcaino and Bruhel Point and for approximately 40 miles from Laguna Point to Elk Creek. The kelp beds in this area are primarily composed of the annual bull kelp, *Nereocystis*, and lie mostly between ½ and ¾ mile offshore. Between Saddle Point and Point Arena, the kelp beds are sparse and scattered. South of Point Arena, the kelp beds again form a nearly continuous band for a distance of about 60 miles down the coast to Fort Ross Reef in Sonoma County.

Although *Nereocystis* is the dominant kelp along this northern coast, giant kelp (*Macrocystis* spp.) occurs as far north as Bear Harbor, which is 6 miles south of Point Delgada at the border between Mendocino County and Humboldt County. In some places within this area, *Macrocystis* is locally abundant. Most *Macrocystis* along the north coast is considered to be *Macrocystis integrifolia* (USFWS and Institute of Marine Sciences 1986). *Macrocystis* is generally found in the lee of points. From Fort Ross south there is little kelp until Año Nuevo Point at the border between San Mateo and Santa Cruz counties. Between Point Año Nuevo and Santa Cruz, *Macrocystis* stands are patchy and interspersed with significant stands of *Nereocystis* (Van Blaricom in BLM 1980). The relative abundances of these two types of kelp in this area can change dramatically from year to year, depending on the severity of winter storm seasons.

Sandy intertidal and shallow subtidal communities along the northern California outer coast are dominated by a relatively few species adapted to an environment of constantly shifting sands. Characteristic sandy intertidal species include beach hoppers (*Orchestoidea*



MAJOR UPWELLING AREAS DURING UPWELLING SEASON (FEBRUARY-JUL

Figure 3.3-17

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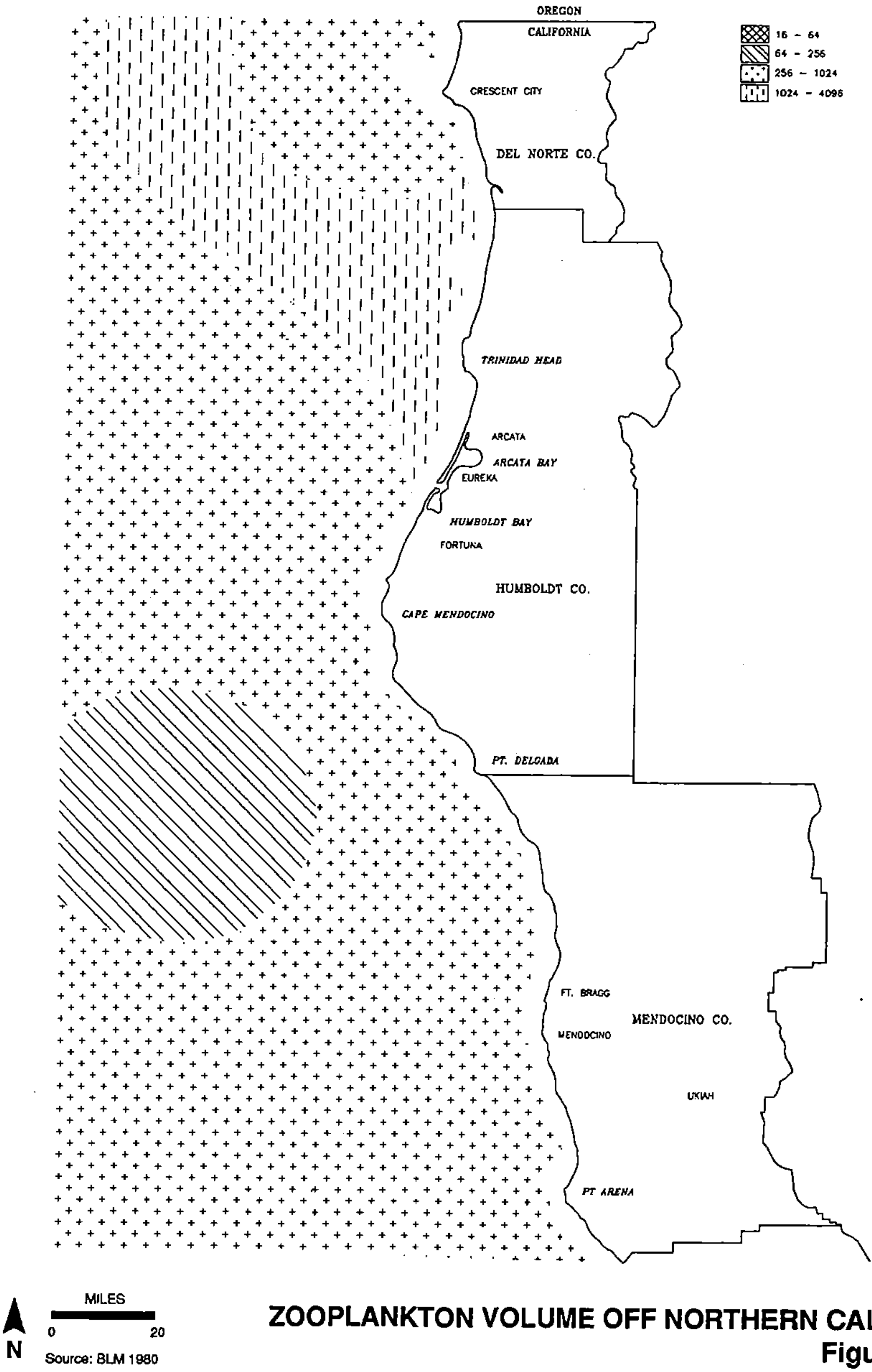
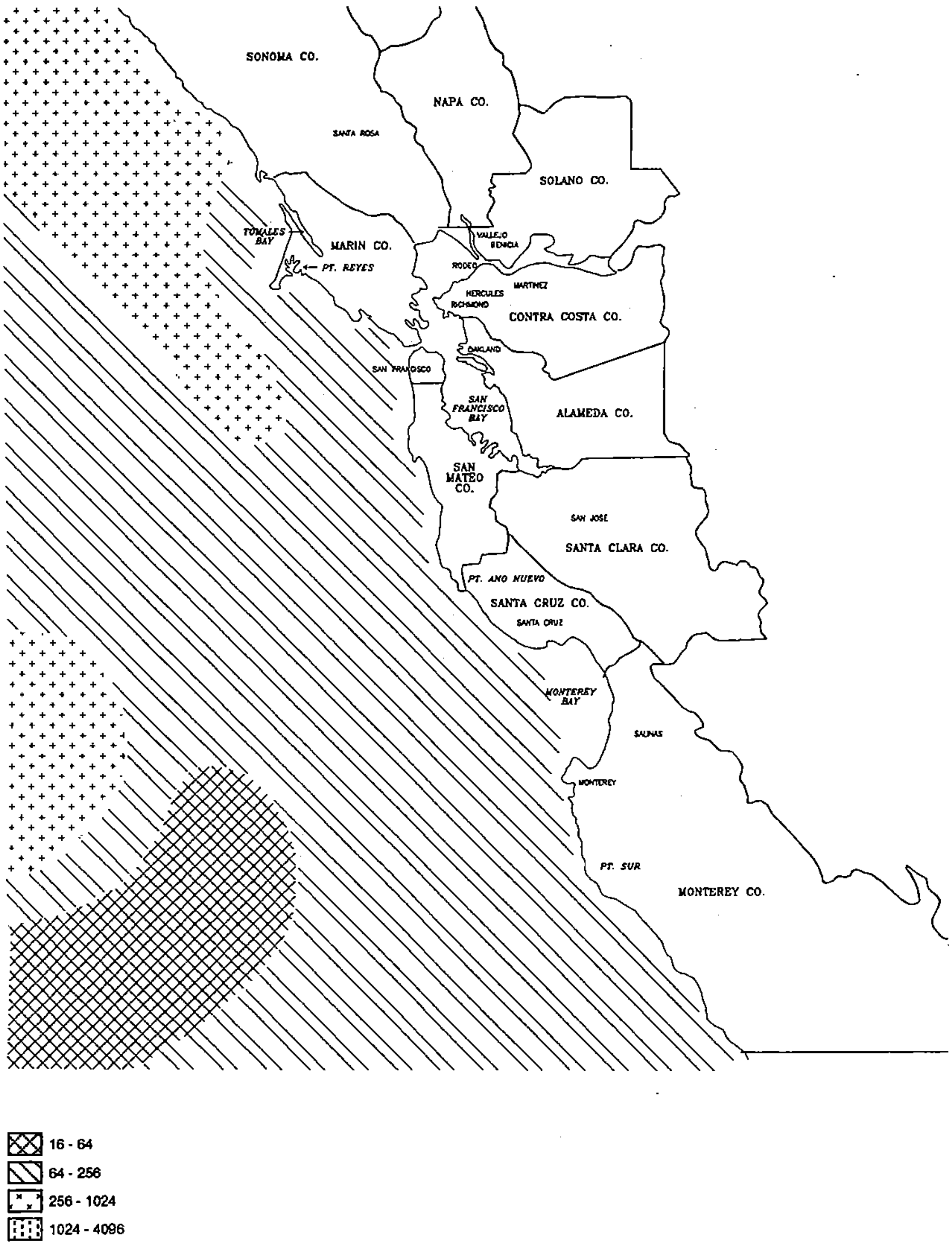
Source: BLM 1980



Source: BLM 1980

ZOOPLANKTON VOLUME OFF NORTHERN CALIFORNIA
Figure 3.3-18



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Source: BLM 1980

ZOOPLANKTON VOLUME OFF NORTHERN CALIFORNIA

Figure 3.3-18 (cont.)

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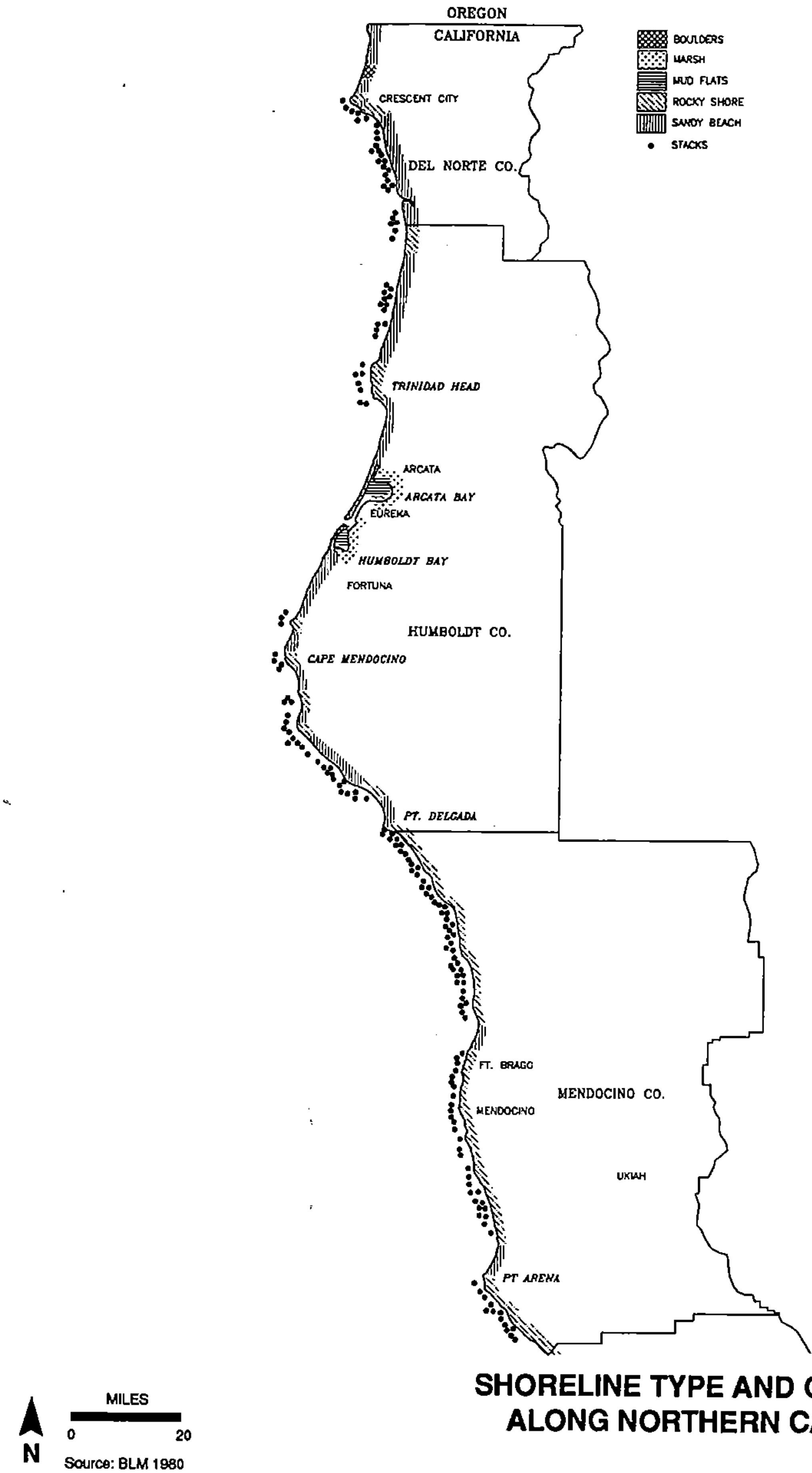

SHORELINE TYPE AND OFFSHORE ROCKS ALONG NORTHERN CALIFORNIA COAST

Figure 3.3-19

SHORELINE TYPE AND OFFSHORE ROCKS ALONG NORTHERN CALIFORNIA COAST
Figure 3.3-19 (cont.)

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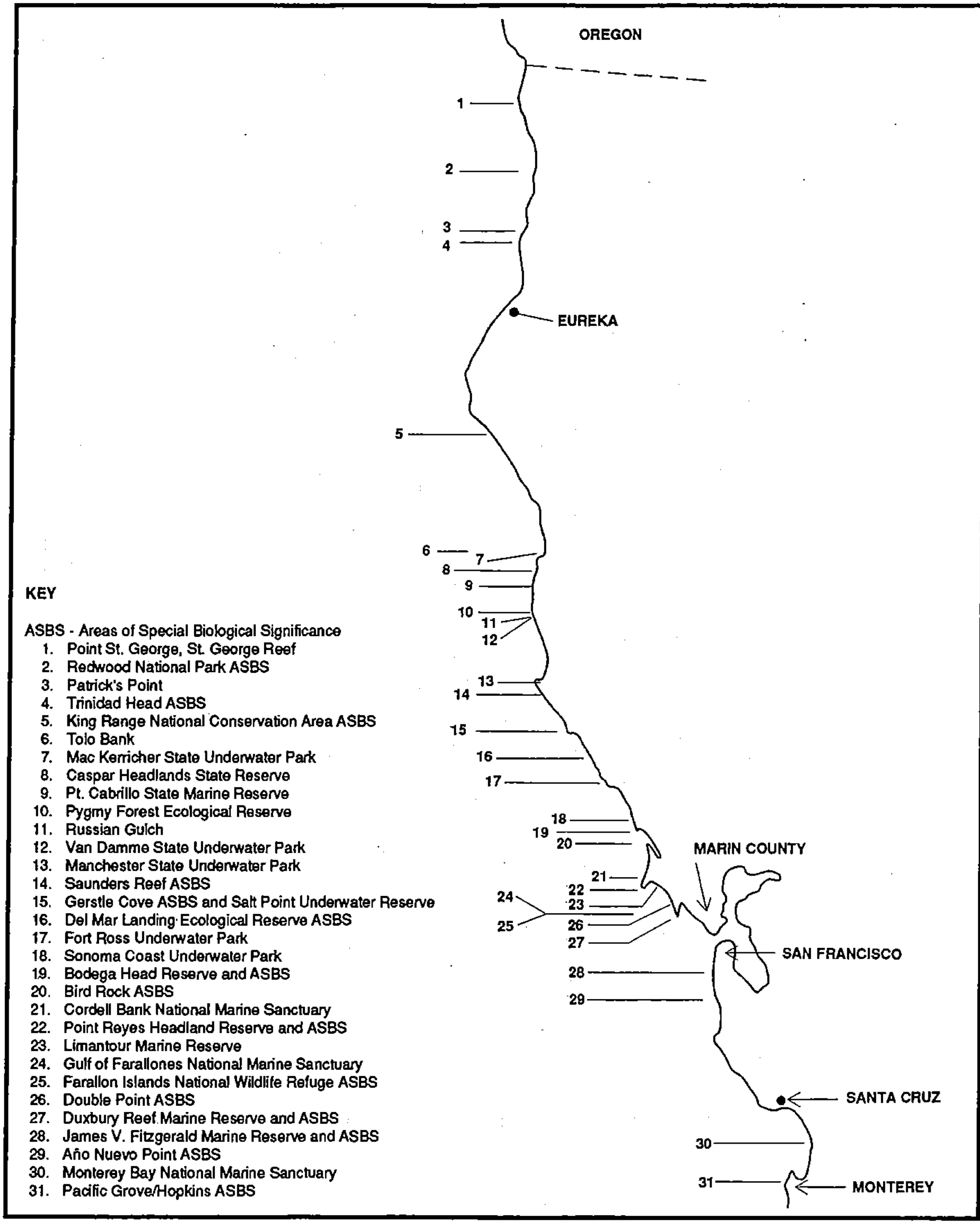


SIGNIFICANT INTERTIDAL AND SUBTIDAL AREAS ALONG NORTHERN CALIFORNIA COAST

Figure 3.3-20

Table 3.3-11

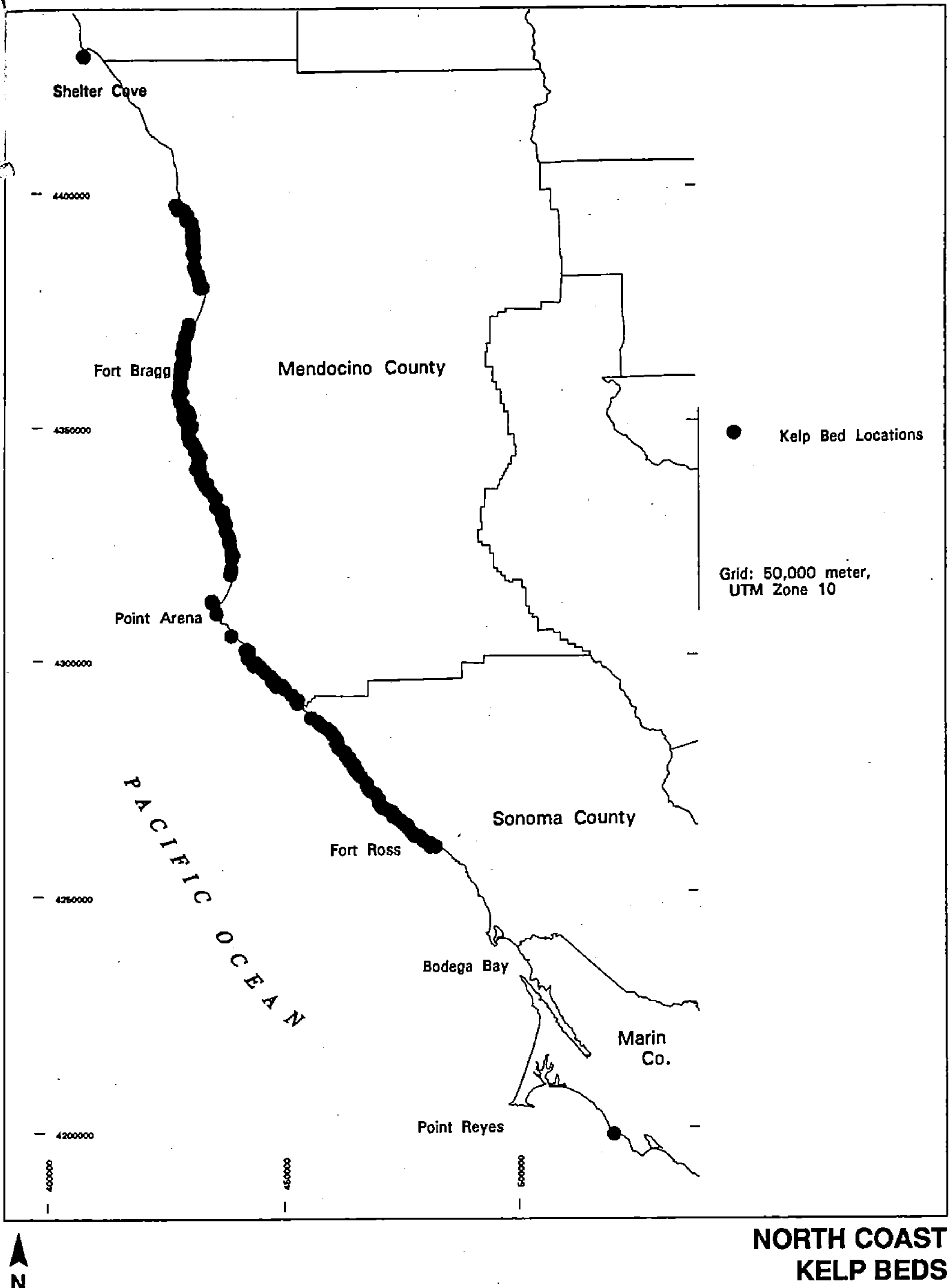
UNUSUAL OR PRODUCTIVE ROCKY INTERTIDAL AND SUBTIDAL AREAS, INCLUDING AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE (ASBS) WITH SOME ROCKY INTERTIDAL IMPORTANCE, IN NORTHERN CALIFORNIA

Rocky Intertidal Area	Characteristics
Redwoods National Park ASBS (including Gold Bluff)	Actually sandy beach but with numerous large stacks near shore.
Point St. George, Pebble Beach (Crescent City)	Possibly the greatest concentration of stacks ranging in size from one meter diameter to actual vegetation supporting island, one supporting a tree.
Patrick's Park (including Wedding Point)	Rich intertidal area.
Trinidad Head ASBS	Kelp area, Dungeness crab.
Point Delgada (King Range ASBS, near Shelter Cove)	Rich area consisting of various gradations of exposed though partly sheltered areas. Red abalone and Dungeness crab. Unusual because most of rocky intertidal to north and south relatively sparse.
Tolo Banks	Significant subtidal offshore banks.
Mackerricher State Underwater Park	Rich subtidal waters including significant abalone resources.
Caspar Headlands, State Beach and Reserve	Offshore rocks and rocky intertidal with rich marine resources including abalone.
Point Cabrillo Reserve	Offshore rocks, fish and game research.
Area just north of Fort Bragg to Fort Ross	Most extensive intertidal in terms of "shoreline development' in central and northern California. Most of area not visited so extent of horizontal intertidal reefs, tilted bedding plains, etc., not known. Area contains following:
(1) Pygmy Forest Ecological Staircase ASBS	Subtidal terraces at various depths.
(2) Russian Gulch	Rich intertidal with much intertidal surface area consisting of coves forming steep intertidal cliffs.
(3) Van Damme State Park	Rocky headlands.
(4) Manchester State Underwater Park	Significant offshore submerged reef, arena rocks with pristine subtidal community including kelp, southern limit of soft coral "sea strawberry."
(5) Saunders Reef ASBS	Nearshore subtidal kelp area, contains giant kelp (*Macrocystis* sp.).
(6) Del Mar Landing ASBS	
(7) Gerstle Cove (including Salt Point) ASBS	Salt Point itself with smaller intertidal population than Russian Gulch, subtidal red abalone.
(8) Fort Ross Underwater Park	Broad flat shelves
Sonoma Coast Underwater Park	Diverse intertidal plant and animal communities, large offshore rocks.
Bodega Head ASBS	Most northern granite outcrop rocky intertidal, wide intertidal shelf at base of backing cliffs provides large intertidal area. May reflect transition zone between temperature and boreal geographic fauna.

Table 3.3-11
(Continued)

UNUSUAL OR PRODUCTIVE ROCKY INTERTIDAL AND SUBTIDAL AREAS, INCLUDING AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE (ASBS) WITH SOME ROCKY INTERTIDAL IMPORTANCE, IN NORTHERN CALIFORNIA

Rocky Intertidal Area	Characteristics
Double Point ASBS	Primarily bird and pinniped haul-out area, large mussels, subtidal population of red abalone.
Bird Rock ASBS	Large stack, primarily bird area, red abalone.
Point Reyes Headland ASBS	Red abalone.
Duxbury Reef ASBS	Largest flat intertidal reef extends over one mile from Bolinas Headlands, large mussel beds, abundant areas included rare hemichordate worm, *Meloglossus* sp.
Farallon Islands ASBS	Pinniped rookery, giant rocks with mussel beds.
James V. Fitzgerald Marine Reserve ASBS	Highly productive intertidal stretch of 5 miles. Many stacks, but much of intertidal backed by sandy beach. Reef is 363 acres is size with rocky intertidal and subtidal beach.
Bean Hollow State Beach	Intertidal reef which appears to have an even better developed community than Fitzgerald Reserve.
Cordell Bank	Significant offshore reef, purple coral (*Allopora californica*).
Año Nuevo Point ASBS	Large boulder like colonies of intertidal polychaete (*Dodcecaria fewkesi*).
Monterey Bay National Marine Sanctuary	Submarine Canyon, significant kelp beds, and intertidal and subtidal resources.
Pacific Grove/Hopkins ASBS	Hopkins Marine Station, second oldest marine life refuge in California (established 1931), rich kelp beds with diverse associated fish and invertebrate community.



NORTH COAST KELP BEDS
Figure 3.3-21

corniculata and *O. benedicti*), lugworms (*Arenicola* spp.), mole crabs (*Emerita analoga*), and razor clams (*Silqua patula*) (Winzler and Kelly 1977). Species diversity increases with increasing depth in the outer coast subtidal. Species lists from offshore sand bottom studies are contained in Winzler and Kelly (1977).

3.3.5.3 Fishes

Because of the high productivity of its coastal waters and its many diverse habitats, the north coast of California is extremely rich in marine fish life. The area supports a number of important commercial and recreational ocean fisheries. Fisheries of the north coast are discussed in Section 3.4 of this document. Figure 3.4-6 shows the important fisheries areas of the north coast. To a large extent, important fisheries babitats are correlated with other significant biological habitats discussed elsewhere in this section. For example, offshore reefs and kelp beds (discussed in Section 3.3.5.2) are important to rockfishes (*Sebastes* spp.), lingcods, kelp greenlings, and some kinds of surfperch; river mouths are important to anadromous fishes; and estuaries are important to starry flounder, which spend their younger years in estuaries. This section very briefly discusses the fishes of northern California by habitat type. For more detail, see DeWitt and Welsh (1977) and MBC (1987). DeWitt and Welsh contains a table (Table VI-1) that lists all the fishes of northern and central California and gives their general habitat and depth and geographic distribution. The MBC report discusses the ecology of important fishes of California.

<u>Water Column</u>

Particularly important water column fishes in northern California waters include Northern anchovy, Pacific herring, and Pacific hake.

Northern anchovy are one of the most abundant fishes off California. They are an important prey item for larger fishes, birds and marine mammals. Northern anchovy are widespread throughout the study area but they tend to be most abundant from San Francisco Bay south (MBC 1987).

Pacific herring spawn throughout intertidal and subtidal locations along California's coast, but Tomales Bay and San Francisco Bay have the largest spawning populations. In California, the herring spawn in the bays primarily from December to February. The adhesive eggs are laid on vegetation, rocks, and pilings in large masses (Barnhart 1988).

Pacific hake eggs, larvae, juveniles and adults are pelagic. Juveniles are generally restricted to waters overlying the continental shelf and slope where they occur from the surface to depths of 200 m (MBC 1987). Adults are found from the surface to 914 m, but are most common between 50 and 500 m and most abundant at depths between 90 and 180 m. Over the shelf and slope, Pacific hake are most common 10 to 30 m above the bottom, although they may be found several hundred meters off the bottom. The coastal subpopulation of Pacific hake undertake an extensive annual migration from spawning areas in the south to feeding areas in the north (MBC 1987). Pacific hake are found moving up the northern California coast from the south in late spring and downcoast again in fall. The waters offshore Cape Mendocino are an area of high concentration of Pacific hake (MBC 1987).

<u>Rocky Areas and Kelp Beds</u>

Rocky areas and kelp beds are generally places of high concentrations of fishes. The attraction of fishes to reefs and kelp is apparently the result of several factors including attraction to solid objects, schooling behavior, visual orientation, and availability of food and shelter (DeWitt and Welsh 1977).

Kelp beds and important rocky babitat offshore northern California are discussed in Section 3.3.5.2 and shown on Figure 3.3-21. Over 30 species of rockfish, *Sebastes* spp., are found in central and northern California coastal areas. Rockfishes are important in the diet of anadromous fishes and also are important in the local sport and commercial fisheries (Pearson 1980). Other common fishes in rocky areas are a variety of small sculpins (*Family Cottidae*), surfperch (*Family Embiotocidae*), and lingcods and greenlings (*Family Hexagrammidae*). Table 3.3-12 lists the most commonly taken sport fishes in rocky bottom habitats of central and northern California.

<u>Flatfishes</u>

Flatfishes are especially adapted for life on soft bottoms. They are one of the most important groups of fishes taken in the commercial trawl fishery. The major species in the trawl catch are Dover sole, English sole, petrale sole, rex sole, starry flounder, Pacific sanddab, arrowtooth flounder, and (from San Francisco south) California halibut. Table 3.3-13 lists the range and fishing areas of commercial flatfishes, and Table 3.3-14 lists their spawning times and movements.

Estuaries

Coastal estuaries are important habitats for marine fishes. Many marine species spend part of their lives within coastal estuaries. Estuaries provide a warm, calm, highly productive environment (Boesch and Turner 1984). Estuaries and wetlands of the northern California coast are discussed in Section 3.3.5.4. Table 3.3-15 lists marine fishes collected in eight Northern California estuaries. Juvenile Dungeness crab use Humboldt Bay, the Eel River estuary, Tomales Bay and, to a less extent, the Klamath River estuary as a nursery (Emmett et al. 1991).

Anadromous Fishes

The northern California coastline is especially important to anadromous fishes. Anadromous fishes begin their life in freshwater, use the estuarine environment as juveniles, and then move into the open ocean. Upon reaching sexual maturity, they return to the coastal streams to spawn. Most anadromous species have declined precipitously throughout this century because of damming and channelization of rivers, diversion of water, overfishing, and other forms of human interference.

Important salmonid anadromous fishes in northern California include king or Chinook salmon, silver or Coho salmon, pink salmon, steelhead rainbow trout, coastal cutthroat trout and brown trout. Of the three species of northern California salmon, Chinook and Coho are the most abundant (DeWitt and Welsh 1977). Figure 3.3-22 shows the major salmon coastal streams as well as the major ports for salmon landing in northern California.

Steelhead trout spawn in a wide variety of freshwater habitats in California and occur as far south as southern California. Coast cutthroat trout and brown trout occur in coastal waters of the northern California coast. Native populations of anadromous cutthroat trout occur in the lower reaches of streams from the Eel River northward (Dewitt and Welsh 1977). Brown trout occurs, as an introduced species in the Trinity River tributary to the Klamath River.

In addition to the anadromous salmonids, two other introduced species of anadromous fish occur in the study area. These are the striped bass and the American shad. American shad spawn in the Sacramento, San Joaquin, Eel, Klamath, and Trinity Rivers in northern California (Dewitt and Welsh 1977). The only significant striped bass populations in California are in the Sacramento Delta - San Francisco Bay Area. During the summer months there may be aggregations of striped bass feeding on anchovies in the surf zone from San Francisco to Pacifica beaches (G. Chan, personal observation). Some small populations of striped bass exist in the Russian and Salinas rivers and in Elkhorn Slough.

3.3.5.4 Coastal Wetlands and Estuaries

Along the northern California coast, coastal wetlands provide a habitat with a great deal of ecological importance. Unlike southern California wetlands that have been decimated by development so that less than 10 percent of their historic area remains, northern California still has a substantial amount of functional wetland habitat. In coastal wetlands north of San Francisco there are still approximately 3,147 hectares of salt marsh, 4,199 hectare of tidal flats and 10,518 hectare of open water (BLM 1980). Approximately 79 percent of the estuaries north of San Francisco are important fish nursery areas and 62 percent are at the entrance of anadromous fish streams (BLM 1980). Coastal wetlands along the northern California coast include several major bays and major river mouths. Table 3.3-16 lists the northern California estuaries of ecological importance and indicates each one's use as a bird foraging area, fish nursery area, or anadromous fish spawning route. Table 3.3-17 shows the size of the opening and dimensions of major types of estuarine habitat for each of these coastal wetlands.

3.3.5.5 Avifauna

The avifauna of the outer coast consists of more than 100 species of seabirds and shorebirds, about 35 of which are abundant in a given season (Briggs et al. 1983). Most have cool-water affinities, but the fauna also includes a few subtropical species particularly in the late-summer and fall. Total abundance of marine

Table 3.3-12

MOST COMMONLY TAKEN SPORT SPECIES IN ROCKY BOTTOM HABITATS, OREGON-POINT ARGUELLO

Species	Tide Pool	Shallow Rock	Kelp Bed	Shallow Reef
Monkeyface eel	X			
Rock eel	X			
Dwarf perch	X			
Greenlings	X juvenile			
Cabezon	X juvenile	X	X	X
Kelp greenling		X	X	X
Striped seaperch		X	X	
Rainbow seaperch		X		
Jacksmelt		X	X	
Walleye surfperch		X		
Rock greenling		X		
Black and yellow rockfish		X	X	
Grass rockfish		X	X	
Calico surfperch		X		
Kelp rockfish			X	
Pile perch			X	
Lingcod			X	X
Blue rockfish			X	X
Kelpfish			X	
Copper rockfish			X	
Rubberlip rockfish			X	
Black rockfish			X	X
Gopher rockfish			X	X
Olive rockfish			X	X
Canary rockfish				X
Brown rockfish				X
Vermilion rockfish				X
Rosy rockfish				X
Yellowtail rockfish				X
Turkey-red rockfish				X

Source: Dewitt and Welsh (1977)

Table 3.3-13

RANGE AND FISHING AREAS OF COMMERCIAL FLATFISHES

Species	Range	Main Fishing Areas
Dover sole	Baja California - Bering Sea	Eureka, Fort Bragg, San Francisco area, Monterey
English sole	S. California - Alaska	Eureka, Fort Bragg, San Francisco area, Monterey
Petrale sole	Baja California - Alaska	Fort Bragg, Eureka, Crescent City
Rex sole	Santa Barbara - Alaska	Monterey, San Francisco area
Pacific sanddab	S. California - Alaska	
Arrowtooth sole	N. California - Alaska	Eureka to Monterey
California halibut	Baja California - Washington	Morro, Monterey, San Francisco Bay

Source: DeWitt and Welsh 1977

Table 3.3-14

SPAWNING TIMES AND MOVEMENTS OF ADULT AND LARVAL FLATFISHES

Species	Period of Spawning	Depth Range (In Fathoms) and Movement of Adults	Movements of Larvae
Dover sole	Nov-May	Spring-Summer inside 140 F. Fall-Winter outside 140-600 F.	Eggs and larvae move south and inshore young fish may move back north.
English sole	Oct-May	Inside 200 F. Some fish with coastwise movements	Young fish found in protected inshore waters and estuaries.
Petrale sole	Nov-May	Spring-Summer inshore and north 10-150 F. Fall-Winter offshore and south 150-200 F.	Not known
Rex sole	All Year	Occur in shallows to 350 F.; little known of movements	Not known
Starry flounder	Nov-Feb	Move to estuaries to spawn, occur from bays to 150 F.	Not known
California halibut	Feb-July	Occur mainly 0 to 25 F. Some onshore-offshore movement	Eggs demersal, larvae pelagic, movements not known.
Source: DeWitt and Welsh 1977			

Table 3.3-15

FISHES COLLECTED IN EIGHT NORTHERN CALIFORNIA ESTUARIES[1]

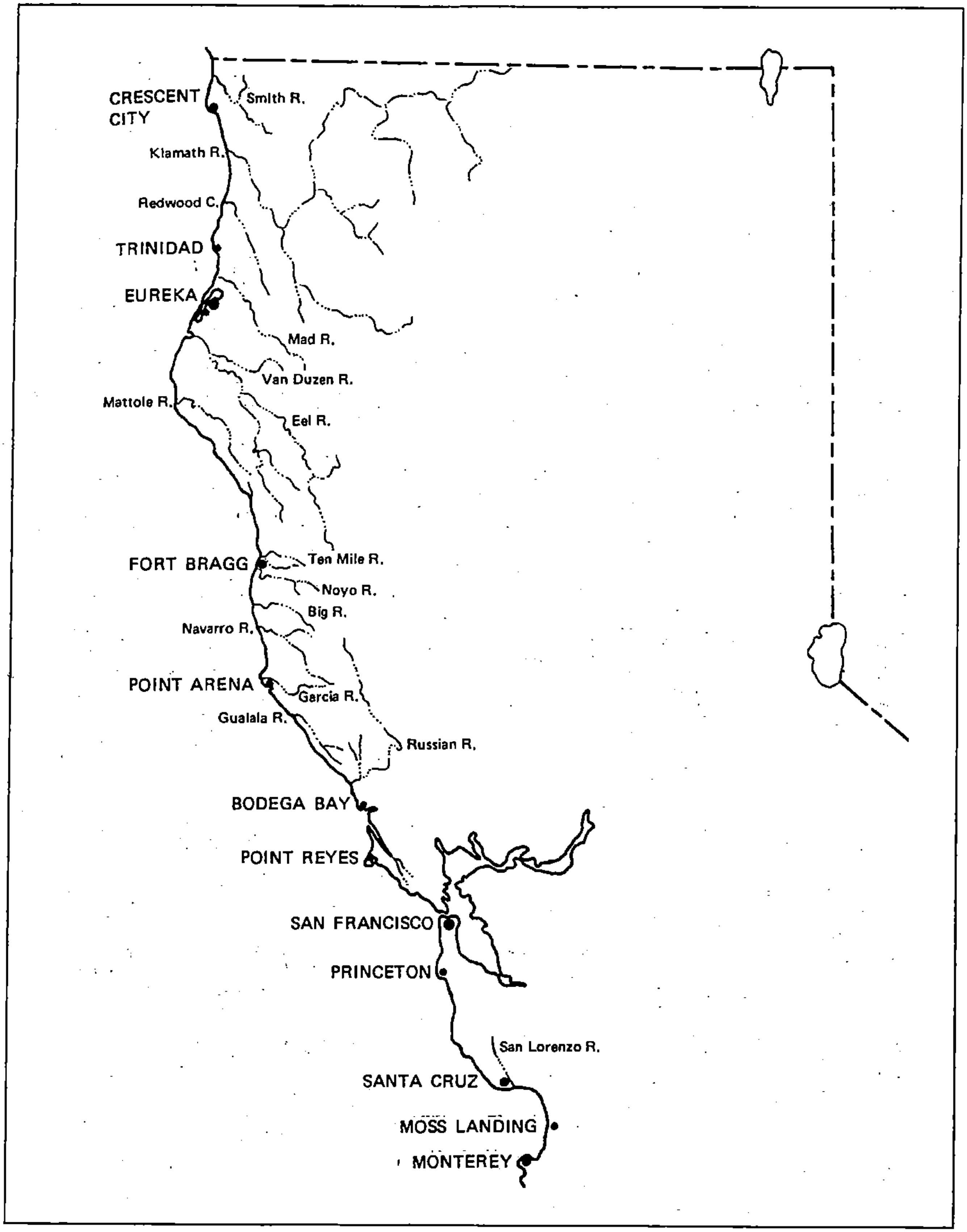
Species[2]	Smith River	Lake Earl	Klamath River	Stone Lagoon	Big Lagoon	Mad River	Eel River	Garcia River
Pacific lamprey	x	x		x	x	x	x	x
Green sturgeon	x	x	x		x	x	x	
White sturgeon			x[3]					
American shad	x		x				x	
Pacific herring	x	x		x	x		x	
Pacific sardine							x	
Northern anchovy	x				x		x	
Pink salmon			x			x		x
Chum salmon	x							
Silver (Coho) salmon	x	x	x	x	x	x	x	x
King (Chinook) salmon	x	x	x		x	x	x	x
Cutthroat trout	x	x	x	x	x	x	x	
Rainbow trout/steelhead	x	x	x	x	x	x	x	x
Brown trout			x					
Surf smelt	x			x	x		x	
Night smelt					x			
Longfin smelt				x	x	x	x	x
Eulachon (candlefish)	x		x					
Sucker (*Catostomus* sp.)	x							
Pacific hake					x			
Pacific tomcod					x		x	
Topsmelt	x	x			x		x	
Jacksmelt					x			
Threespine stickleback	x	x	x	x	x	x	x	x
Bay pipefish	x	x			x		x	x
Striped bass			x					x
Redtail surfperch	x			x	x	x		
Shiner surfperch	x	x		x	x	x	x	
Striped surfperch				x				

Table 3.3-15
(Continued)

FISHES COLLECTED IN EIGHT NORTHERN CALIFORNIA ESTUARIES[1]

Species[2]	Smith River	Lake Earl	Klamath River	Stone Lagoon	Big Lagoon	Mad River	Eel River	Garcia River
White surfperch				x	x			
Rubberlip surfperch								x
Pile surfperch				x	x		x	
Saddleback gunnel	x			x	x		x	
Arrow goby					x			
Tidewater goby		x[4]			x			
Black rockfish	x							
Rockfish sp.					x			
Kelp greenling							x	
Coastrange sculpin (*Cottus aleuticus*)							x	
Prickly sculpin (*C. asper*)	x	x			x		x	
Buffalo sculpin				x	x			
Staghorn sculpin	x	x	x	x	x	x	x	x
Cabezon				x	x		x	
Tidepool snailfish					x			
Mottled sandab					x			
Speckled sandab				x	x		x	
English sole		x			x			
Starry flounder	x	x	x	x	x	x	x	x
California tonguefish					x			

[1] Primarily from Hayes 1960; Fry 1973; Monroe and Reynolds 1974; Monroe, et al. 1975; Waldvogel 1975
[2] Source - Dewitt and Welsh 1977
[3] Personal communication, L. B. Boydston, CDFG.
[4] Personal communication, Camm Swift, Los Angeles County Museum.



Source: DeWitt and Welish, 1977

MAJOR SALMON STREAMS IN CALIFORNIA
Figure 3.3-22

Table 3.3-16

ESTUARIES OF ECOLOGICAL CONCERN IN CENTRAL AND NORTHERN CALIFORNIA

Estuary	Opening to Sea	Bird Feeding Area (+)	Important Marine Fish Nursery (I)	Important Anadromous Fish Spawning Route
Smith River Delta	Open year round	+	I	+
Lake Earl/Lake Talawa	Intermittently open	+	I	+
Klamath River	Open year round	+	I	+
Redwood Creek	Intermittently open	+	I	+
Stone Lagoon	Intermittently open	+	I	+
Dry Lagoon	Intermittently open	+	-	-
Big Lagoon	Intermittently open	+	I	+
Mad River	Intermittently open	+	I	+
Humboldt Bay (including Arcata Bay)	Open year round, constant width due to jetties	+	I	+
Eel River	Open year round	+	I	+
Mattole River	Intermittently open	+	I	+
Little River	Intermittently open	+	-	- some use
Ten Mile River	Intermittently open	+	I	+
Noyo River	Open year round, width permanent due to jetties	+	I	+
Big River	Open year round	+	I	+
Albion River	Open year round	+	I	+ some use
Navarro River	Open year round (nearly closes)	+	I	+
Garcia River	Open year round	+	I	+
Gualala River	Intermittently open	+	I	+
Russian River	Intermittently open	+	I	+
Salmon Creek	Intermittently open	+	-	some use
Bodega Bay	Open year round, constant width maintained by jetties	+	I	-
Estero Americano	Intermittently open	+	I	-
Estero San Antonio	Intermittently open	+	I	-
Tomales Bay	Open year round	+	I	+
Abbotts Lagoon	Intermittently open	+	-	-
Drakes Estero/Limantour Estero	Open year round	+	I	some use
Bolinas Lagoon	Open year round	+	I	some use

Table 3.3-16
(Continued)

ESTUARIES OF ECOLOGICAL CONCERN IN CENTRAL AND NORTHERN CALIFORNIA

Estuary	Opening to Sea	Bird Feeding Area (+)	Important Marine Fish Nursery (I)	Important Anadromous Fish Spawning Route
Rodeo Lagoon	Intermittently open	+	-	some use
San Francisco Bay Complex	Open year round	+	I	+
San Gregorio Creek	Intermittently open	+	-	some use
Pescadero Creek	Intermittently open	+	I	+
Gazos Creek	Intermittently open (open most of the year)	+	-	+
Scott Creek	Intermittenly open	+	-	some use
Baldwin Creek Ponds	Intermittenly open	+	-	some use
Source: BLM 1980				

Table 3.3-17

WIDTH OF ENTRANCE AND AREAL DIMENSIONS OF MAJOR HABITATS OF IMPORTANT ESTUARIES IN CENTRAL AND NORTHERN CALIFORNIA
(all number are metric - meters and hectares)

Estuary	Width of Entrance		Salt Marsh	Mud Flat	Sand Flat	Eelgrass	Open Water Channels	Other
	Normal	Maximum-Min.						
Smith River	50 m[e]	3460±[d,f]	47 373	122 93		-	-[a,c] 1549[b]	
Lake Earl/ Lake Talawa	0[d]	500m[d] - 0[d]	550 895	- -		-	1057[a,c] 142[b]	
Klamath River	250[g]	<1000 - 1450[d]	532	67			1721[b]	
Stone Lagoon	0[d,g]	1480[d] - 0 (Beachead)	69				142[b]	
Dry Lagoon	0[d]	500m[d] - 0 (Beachead)	32				-[b]	
Big Lagoon	0[d,g]	5380m[d] - 0 (Beachead)	231				354[b]	
Humboldt Bay	640[d]	640[d] - 640[d]	243+ (16 Freshwater) 202	2916 2025			3645[c] 1822[b]	
Eel River Delta	210 480[d]	4850[d] (Beachead)	283	202			1000[b,c]	
Ten Mile River	125[d]	550[d] - 0	27 (18.6+8.5 brackish) 13.5	0.9 40	2.4	0.5[e]	16[b]	
Big River (narrow) (wide)	65-[d] 375	300 - <65[d]	38 25+ (23 brackish) 18	6 36	8	0.65[e]	49[b]	
Albion River (narrow) (wide)	31-[d] 190	190 - <31[d]	20	8			30[b]	
Garcia River	50[d]	300 - 50[d]	8				19[b]	
Gualala River	21[d]	850 - 0	9				32[b]	
Russian River	50[d]	750 - 50[d]	40				81[b]	
Salmon Creek	0[d]	100 - 0[d]	2				8[b]	
Bodega Bay	110[d]	110 - <110	20	202			138[b] 340[b]	

Table 3.3-17
(Continued)

WIDTH OF ENTRANCE AND AREAL DIMENSIONS OF MAJOR HABITATS OF IMPORTANT ESTUARIES IN CENTRAL AND NORTHERN CALIFORNIA
(all number are metric - meters and hectares)

Estuary	Width of Entrance		Salt Marsh	Mud Flat	Sand Flat	Eelgrass	Open Water Channels	Other
	Normal	Maximum-Min.						
Estero Americano	0[d]	290 - 0[d]	49				89[b]	
Estero San Antonio (narrow) (wide)	 100[d] 300	360 - 0[d]	30				32[b]	
Tomales Bay	650[d]	1950 - <650 (Beachead)	178	1175			2410[b]	
Drakes-Limantour Estero Drakes Limantour Combined	 340[d] 130[d] 440-110[f]	 110[f] - <340m[d] 4250 - <130m[d] 4850[f] - <400m	81	235			522[b]	
Bolinas Lagoon (narrow) (wide)	 100[d]- 300	 3600 - <100[d] (Beachead)	61	292			150[b]	
San Francisco Bay (Pt. Bonita-Land's End)[d] (Golden Gate)	 3600m 1600m	-	1296	16848[b]				
San Pablo-Suisun Bays San Pablo Suisan							10449 (salt ponds)	20218[b]
San Gregorio Creek	45[d]	200 - <45[d]						
(Pescadero Creek - Butano Creek) Pescadero Marsh	100m[d]	240 - 0[d]	20				30[b]	
Laguna Creek	0[d]	200 - 0[d] (Beachead)						
Baldwin Creek	0[d]	150 - 0[d] (Beachead)						

[a] Central-Northern California characterization for BLM-USFWLS by Stokes and Jones (1980)
[b] California Fish and Game (1973) Coastal County Resources
[c] California Fish and Game Wetland Study Series - see reference
[d] USGS 7-½ inch Quad Maps
[e] BLM Field Observations
[f] California Department of Navigation and Ocean Development (1980) - Assessment and Atlas of Shoreline Erosion
[g] Johnson (1972) Tidal Inlets of the California, Oregon, and Washington Coasts

Source: BLM 1980

birds varies greatly from year to year as a result of oceanographic conditions. During the intense El Nino-Southern Oscillation of 1982-1983, December and January bird biomass declined 69 percent compared witb the previous two years (Briggs et al. 1983). Highest abundance occurs in waters over the continental shelf (less than 200 m depth), nearshore waters within sight of land, and on the shore. Table 3.3-18 summarizes the status, abundance, and areas of concentration of the most abundant species.

The nesting fauna includes 17 species that build nests, scrapes, or tunnels on isolated islands, rocks, and cliff-faces where terrestrial predators are absent or rare. The most numerous of the nesting species are the Common Murres, Cassin's Auklet, Brandt's Cormorant, and Western Gull (Carter et al. 1990). Common Murres have colonies at 21 locations from the Farallones Islands to Castle Rock off Crescent City, with a combined population of about 350,000. Cassin's Auklets have colonies at only three sites and have a northern California population of 41,000. Other alcids nesting along the northern California coast include the Pigeon Guillemot, with 8,300 birds distributed among 140 sites, the Rhinoceros Auklet, with 1,700 birds found at 23 sites, and the Tufted Puffin, with about 300 birds found at 13 sites. Alcid colonies and estimated numbers are listed in Appendix D, Table D-12. Figure D-7 shows the distribution of alcids at sea and the location of their colonies. A noncolonial alcid of the northern California coast is the Marbled Murrelet, which nests in old growth trees well-inland in coastal forests from Monterey Bay northward (see account of this listed species below in Section 3.3.5.7).

Brandt's cormorants have colonies at 50 locations with a nesting population in the north coast area of over 35,000 birds. Two other cormorant species also are abundant: the Pelagic cormorant and the double-crested cormorant with populations of about 11,000 and 6,500, respectively. Pelagic cormorants breed at nearly 140 sites, while the Double-crested Cormorant has colonies at only 20 sites. Western Gulls are the most ubiquitous nesting species along the northern coast, found at about 180 sites; recent censuses place the population at over 30,000 birds.

Other prominent nesting species are the storm-petrels. These birds nest in burrows on islands and rocks at 12 locations along the northern California coast (Appendix D, Table D-13). The Leach's storm-petrel is the most abundant with a nesting population of nearly 11,000 birds; largest colonies are located on Little River Rocks and Trinidad Bay Rocks (Carter et al. 1990). Ashy storm-petrels have a large colony of 4,000 birds on South Farallones Island, representing 85 percent of the world population of the species.

Large numbers of birds of several species use the area seasonally but do not have local breeding populations. These include migrants, peaking in fall and spring, or birds that over-winter in California waters. The winter fauna of loons, grebes, and scoters includes red-throated, Pacific, and common loons, horned, red-necked, eared, and western/Clark's grebes, and surf and white-winged scoters. These species are at greatest abundance close to shore in the Farallones Basin and in Monterey Bay (Figure D-8, Appendix D). Because they concentrate during the night on sheltered nearshore waters, loons, grebes, and scoters are especially vulnerable to contact by oil (see Section 3.3.5.7). Brown pelicans (endangered) are a summer-fall visitor with roosts at 30 or more locations along the outer coast (Figure 3.3-23; see Section 3.3.5.7).

In addition to seabirds, the avifauna of the northern California coast includes a variety of shorebirds. Black oystercatchers nest along the northern California coast at about 20 known locations; the species is not considered colonial and numbers at any single site rarely exceed 10 birds (Carter et al. 1990). During the remainder of the year, black oystercatchers are gregarious and forage in intertidal rocky areas for mussels, limpets and chitons. Shorebirds foraging on the mudflats and sandy beaches of the northern California coast are predominantly migrants and include the same species found in San Francisco Bay (described above in Section 3.3.3.5). Mudflats and sandy beaches along the north coast occur mostly in or near Humboldt Bay, the mouths of some larger rivers, Bodega and Tomales Bay, Point Reyes and nearby estuaries, and Bolinas (see also account of snowy plover in Section 3.3.5.7).

3.3.5.6 Marine Mammals

<u>Cetaceans</u>

The cetacean fauna off central and northern California is comprised of at least twenty species, but 90 percent of all numbers occur in schools of northern right-whale dolphins, Pacific white-sided dolphins, and Risso's dolphins (Dohl et al. 1983). Pacific white-sided

Table 3.3-18

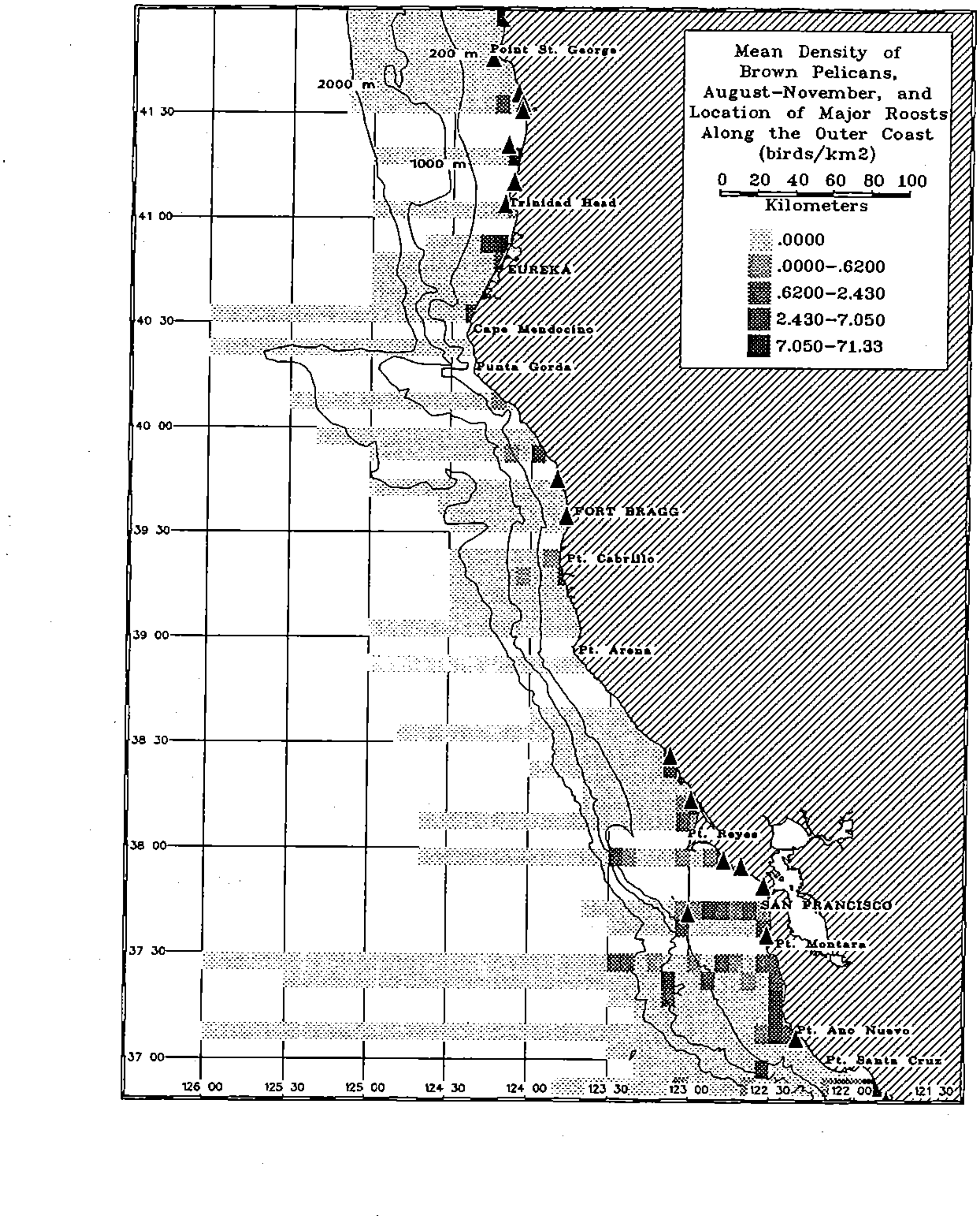
STATUS, SEASONALITY, ABUNDANCE, AND AREA OF GREATEST CONCENTRATION OF MOST ABUNDANT SEABIRD SPECIES FOUND OFF NORTHERN CALIFORNIA

Species	Months of Greatest Abundance	Peak Monthly Mean Density (birds/km2)	Peak Pop. On Shore (x1,000)	Area of Greatest Concentration
Nesting Residents				
Leach's storm-petrel	Mar. to Aug.	0.3 to 1.3	11.0	Slope and offshore waters north of Cape Mendocino, on colonies at S. Farallon Island, Little River, Trinidad Head, and Castle Rk.
Ashy storm-petrel	Mar. to Aug.	-	4.1	Monterey Bay to Bodega Bay.
Brandt's cormorant	May to Aug.	0.3 to 0.5	35.0	Gulf of the Farallones and adjacent shore.
Pelagic cormorant	None	--	11.0	Shoreline north from Point Reyes.
Western gull	July to Dec.	0.1	25.6	Shelf waters and shoreline form Monterey to Bodega esp. Farallon Is.
Common murre	Sept to Jan.	4.8 to 5.2	350.0	Shelf waters north of Eureka and from Pt. Reyes to Monterey; Castle Rk., Farallon Is., Trinidad Head, and Pt. Reyes.
Cassin's auklet	Nov. to Feb.	4.6 to 8.1	41.0	Slope waters of Monterey Bay to Ft. Bragg, esp. Cordell Bank/Ascencion Canyon, and Farallon Is.
Rhinoceros auklet	Dec. to Mar.	1.5 to 1.9	1.7	Slope and offshore waters - widespread.
Winter Visitors				
Pacific loon	Apr. to Nov.	0.8 to 1.6	1.0	Shelf waters and coast from Montara to Bodega.
Western grebe	Dec. to Mar.	--	24.6	Nearshore waters from Pt. Montara to Bodega.
Northern fulmar	Dec. to Mar.	1.8	--	Slope waters - widespread.

Table 3.3-18
(Continued)

STATUS, SEASONALITY, ABUNDANCE, AND AREA OF GREATEST CONCENTRATION OF MOST ABUNDANT SEABIRD SPECIES FOUND OFF NORTHERN CALIFORNIA

Species	Months of Greatest Abundance	Peak Monthly Mean Density (birds/km2)	Peak Pop. On Shore (x1,000)	Area of Greatest Concentration
Surf/white-winged scoter	Oct. to Mar.	--	17.4	Nearshore waters of Tomales Bay and north of Cape Mendocino.
California gull	Oct. to Mar.	1.4 to 2.5	4.5	Shelf waters and shoreline to Pt. Arena.
Herring gull	Dec. to Mar.	0.8 to 1.8	7.1	Shelf waters and shoreline - widespread.
Black-legged kittiwake	Dec. to Mar.	2.0 to 2.4	--	Slope and offshore waters - widespread.
Spring/Fall Migrants				
Red phalarope/ red-necked phalarope	Apr. to May Sept. to Nov.	15.2 to 17.6	19.3	Shoreline (spring), slope (fall), convergences in or bordering upwelling.
Bonaparte's gull	Apr. to May Nov. to Dec.	0.8 to 3.3	4.6	Shelf waters - widespread.
Common/Arctic tern	Apr. to May Aug. to Sept.	1.2 to 1.5	--	Slope of nearshore waters during migration.
Black-footed albatross	May to July	0.1 to 0.5	--	Slope waters north of Cape Mendocino.
Buller's shearwater	July to Oct.	0.9	--	Slope waters from Pt. Arena to Cape Mendocino, and Cordell Bank to Pt. Ano Nuevo.
Pink-footed shearwater	June to Aug.	0.8	--	Shelf waters north to Trinidad Head.
Sooty shearwater	May to July	17.3	20.0	Shelf waters north of Bodega Head.
Brown pelican	July to Dec.	0.1	25.6	Shelf waters and shoreline from Monterey Bay to Bodega Head.
Source: Briggs et al. 1983; Carter et al. 1990				



Source: Briggs et al. 1983 a, b

DISTRIBUTION OF BROWN PELICANS AT SEA, AUGUST THROUGH NOVEMBER, AND LOCATION OF ROOSTING SITES ALONG THE OUTER COAST OCCUPIED BY 100 BIRDS OR MORE

Figure 3.3-23

dolphins reach peak numbers of nearly 90,000 animals in the fall when they are found within 10 to 30 nm from land, predominantly south of Point Arena. Northern right-whale dolphins reach their maximum abundance of about 60,000 in the winter when they account for about 42 percent of all cetaceans. Concentrations occur over the head of Pioneer Canyon and the steep shelf break northward to the Farallones Islands. Risso's dolphins also reach peak numbers of about 30,000 in winter; however, most are found over the continental slope south of Point Montara (San Mateo Co.). Most calves of dolphin species are seen in fall and winter.

The pelagic distribution of these dolphin species is shown in Appendix D, Figure D-9. Dall's porpoises reach peak abundance of about 9,000 during the fall, when they are found in many small groups from Point Arena to Point Pinos. Harbor porpoises are found throughout the year from about Monterey Bay northward and have a central California population (to Cape Mendocino) estimated at about 11,500 animals (Barlow 1987). Harbor porpoise distribution is distinctly inshore (within a few km); however, sightings in the Gulf of the Farallones have been recorded as far as the Farallones Islands and Cordell Bank (Figure D-10). Other toothed whales that are relatively common off central and northern California are sperm whales (Endangered), found mostly in offshore waters, killer whales, and bottlenose dolphins (nearshore waters in Monterey Bay).

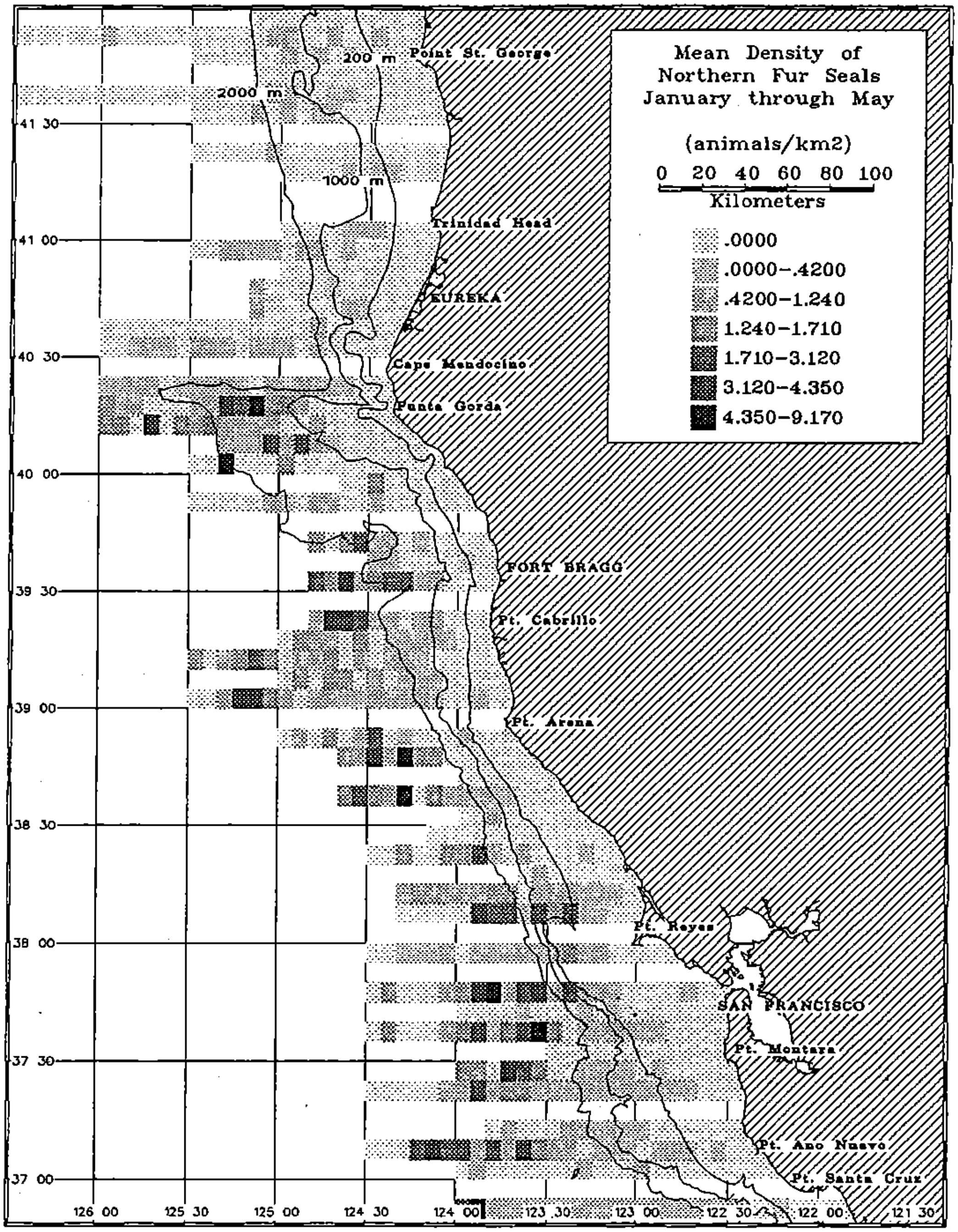
Gray whales are the most abundant baleen whales off the central and northern California coast. From December through April, most of the world population of about 21,000 animals migrate along the shore between feeding grounds in the Bering Sea to calving lagoons in Baja California The eastern Pacific population of gray whales has been growing at a rate of about 3.2 percent per year and presently has reached or exceeded pre-exploitation levels; the population has recently been delisted. Total numbers in 1987/1988 were estimated to be 21,113 animals (Breiwick et al. 1988). Gray whales typically summer on feeding grounds in the Bering Sea; however, small numbers (<12) are also found in the summer at several locations along the coast, including Saint George Reef, off the mouth of the Klamath River, off Big Lagoon and Patrick's Point, and in the Gulf of the Farallones (Dohl et al. 1983).

The southbound migration to calving grounds in Mexico occurs off California predominantly in December and January. Most animals are found within 3 to 4 km from shore, although a small portion of sightings (6.5 percent) are recorded at distances greater than 18 km (10 nm). Most whales seen farther from land are those taking a direct route from headland to headland across Monterey Bay and the Gulf of the Farallones. During the northbound migration, most males and females without calves pass central and northern California in March, followed by mother-calf pairs in April and May. Mean density of gray whales off California from December through March is shown on Figure D-11, Appendix D. Blue, fin, and humpback whales (all endangered) typically are found in greatest abundance off central and northern California in the summer and fall when they feed on euphausiid crustaceans in the Gulf of the Farallones and Monterey Bay (see Section 3.3.5.7).

Pinnipeds

Six species of pinnipeds occur off central and northern California, although one, the Guadalupe fur seal (threatened), is very rare in these waters (see discussion in Section 3.3.5.7). Each species has its season of greatest abundance in the area. Northern fur seals are common off central and northern California in the winter and spring when waters far offshore are occupied by thousands of migrants from the Pribilof Island rookeries (Bonnell et al. 1983; Figure 3.3-24). A colony of about 3,000 animals is found on San Miguel Island off Santa Barbara County (Antonelis et al. 1988); this is the only location in California where northern fur seals are typically seen on land. The eastern North Pacific population of northern fur seals declined at 4 to 8 percent per year in the 1980s due to entanglement in fishing nets (York 1987). The eastern North Pacific population of northern fur seals was most recently estimated to number over 800,000 (U.S. Department of Commerce 1987).

California sea lions are abundant off central and northern California in the fall, when numbers reach about 24,000 animals (Bonnell et al. 1983). Animals migrating into these waters are typically juvenile and adult males that feed on herring and salmonids in nearshore waters and rivermouths, and hake (Pacific whiting) farther offshore. The pelagic distribution of California sea lions is shown in Appendix D, Figure D-12. On shore, large numbers are found on rocks and breakwaters in the Monterey Bay Area, on Ano Nuevo Island, on the Farallones, at Bodega Rock and in Tomales Bay, and on many rocks off



Data source: Bonnell et al. 1983

DISTRIBUTION OF NORTHERN FUR SEALS AT SEA, JANUARY THROUGH MAY
Figure 3.3-24

Mendocino, Humboldt, and Del Norte Counties. They typically breed only on large rookeries on islands off southern California and Mexico (Bonnell et al. 1983). The California population has been growing at about 12 percent per year since 1983 and was estimated to have reached about 87,000 in 1986 (Bovang 1988).

Steller sea lions (threatened) presently have rookeries in California on Ano Nuevo Island, Southeast Farallones Island, Sugarloaf Rock off Cape Mendocino, and S.W. Seal Rock off Crescent City (Figure D-13; see discussion in Section 3.3.5.7).

Northern elephant seals have a world population of over 100,000 animals occupying a breeding range from mid-Baja California to Point Reyes. About 95 percent of the total numbers are associated with colonies in southern California and Mexico. In central and northern California, northern elephant seals breed on the mainland at Cape San Martin, at Ano Nuevo Island and adjacent mainland point, on the Farallones Islands, and at Point Reyes (Bonnell et al. 1983; Allen et al. 1989). Elephant seals also haul-out on the St. George Reef in Del Norte County, and at Simpson Reef in southern Oregon. The winter breeding population at Ano Nuevo Island and Point Ano Nuevo presently numbers about 4,000 animals and another 1,000 animals are found on the Farallones Islands. The northernmost breeding colony at Point Reyes began to develop in 1981 and, by 1989, included about 100 animals and produced 44 pups (Allen et al. 1989).

Harbor seals have a growing population of 30,000 animals in California, where they haul-out at hundreds of locations (Figure D-14, Appendix D). Maximum numbers on land occur in the late-spring when pups are born and in mid-summer when most adults undergo their annual molt. About one-half of the state's total are found from Monterey Bay northward. Important nursery locations in northern California are Bolinas Lagoon, Double Point, Drakes Estero, Point Reyes, Tomales Bay, Laguna Point north of Fort Bragg, Mistake Point, Sisters Rocks, Humboldt and Arcata Bays, and St. George Reef (Bonnell et al. 1983; Allen 1989).

<u>Sea Otters</u>

See discussion in Section 3.3.5.7.

3.3.5.7 Rare/Threatened/Endangered Species

<u>Fishes</u>

Tidewater Goby (*Eucyclogobius newberryi*) [Federal Proposed Threatened, State Threatened]

The tidewater goby is endemic to California and lives in brackish water habitats from southern California to the Smith River, Del Norte County (Moyle et al. 1989). This species is found in shallow lagoons and lower stream reaches where the water is brackish (salinities usually less than 10 ppt) to fresh.

Spring Chinook Salmon (*Oncorhynchus tshawaytscha*) [State Species of Special Concern]

In California, spring run Chinook salmon were once abundant in all major river systems but are now reduced to scattered populations in the Klamath, Trinity and Sacramento drainages with small numbers of individuals occasionally recorded in the Smith River, Redwood Creek, Mad River, Mattole River and Eel River (Moyle et al. 1989). Spring run Chinook salmon enter the rivers from March through May.

Winter Chinook Salmon (*Oncorhynchus tshawaytscha*) [Federal Threatened, State Endangered]

Winter run Chinook salmon spawn only in the Sacramento River (Moyle et al. 1989). Adult winter Chinook salmon move upstream more quickly than the spring run salmon and spend considerable time staging in the headwaters prior to spawning. Peak spawning occurs from May to June and the fry pass by the Red Bluff Diversion Dam from mid-September to mid-October. In contrast to the other Chinook salmon runs in which the spawning fishes are usually 4 to 5 years old, most winter run Chinook salmon only spend 3 years in the open ocean before they migrate into freshwater to spawn (Moyle et al. 1989).

Summer Steelhead (*Oncorhynchus mykiss gairdneri*) [State Species of Special Concern]

Summer steelhead are anadromous rainbow trout which enter streams to spawn from April to June (Moyle et al. 1989). Summer steelhead get their name because they enter the rivers in the spring, and then remain in deep pools throughout the summer to spawn in the fall.

The temporal and spatial isolation of these populations from other steelhead maintains their genetic integrity. Summer steelhead are most abundant in the Klamath and Eel River drainages (Moyle et al. 1989; Emmett et al. 1991) .

Coho Salmon (*Oncorhynchus kisutch*) [State Species of Special Concern]

Coho salmon do not have the genetically distinct, seasonally segregated runs typical of Chinook salmon and steelhead trout. In northern California, principal populations are located in the Klamath, Trinity, Mad, Noyo and Eel Rivers (Moyle et al 1989). Annual runs in the Eel River have been estimated at over 40,000 fish. The population has fluctuated widely in recent years but the trend in wild populations is down.

Pink Salmon (*Oncorhynchus gorbuscha*) [State Species of Special Concern]

Pink salmon are abundant in Alaska and Canada but rare in California where they are at the southern limits of their range. Pink salmon have been reported from a number of coastal steams in northern California, but spawning has only been reported in the lower Russian River (Moyle et al. 1989).

__Birds__

Listed species of birds found along the outer coast include three species that are designated threatened or endangered, and six others that are classified as California State Species of Special Concern. Among marine mammals, the sea otter, two species of pinnipeds, and six species of whales are designated as threatened or endangered on federal lists; only one of these is listed by the state. Federal lists also include four species of sea turtles that are known to occur off the northern California coast. The status of these species and their pattern of occurrence is described below; federal and state designations are from the Endangered Species Act of 1973, 50 CFR 17.11 and 17.12, Feb. 1991, and CDFG, Natural Heritage Division lists as of December 1991.

Marbled Murrelet (*Brachyramphus marmoratus*) [Fed. Threatened; State Endangered]

Marbled murrelets were once numerous along the coast of northern California including, probably, San Francisco Bay (Carter and Erickson 1988). Numbers are believed to have declined due to loss of old growth nesting habitat, and mortality from gill nets and oil spills (several were reported killed in a 1987 spill in the Golden Gate [Carter and Erickson 1988]). In the coast range of California, marbled murrelets are believed to nest in old growth trees of forests from northern Santa Cruz County to the Oregon line (Sowls et al. 1980). Egg laying, hatching, and fledgling occur from May into September; adults are present in the area year-round. Marbled murrelets forage in the open coastal waters on small fish and crustaceans. Briggs et al. (1983a) recorded sightings at sea predominantly in fall and winter; all sightings were within 35 km (14 nm) of shore. In the fall, sightings were widespread, while in winter, sightings were predominantly north of Point Arena.

American Peregrine Falcon (*Falco peregrinus*) [Federal Endangered; State Endangered]

Peregrine falcons are found along most of the outer coast year-round. The California nesting population of 100 or more birds is supplemented from fall through spring by birds that nest elsewhere. Locally, peregrine falcons nest predominately on high cliffs in forest or coastal habitats (USFWS 1992). Peregrine falcons have been observed regularly in small numbers on the Farallones Islands and prey on seabirds on the water north and east of the Islands (Sarah Allen, personal communication).

California Brown Pelican (*Pelecanus occidentalis*) [Federal Endangered; State Endangered]

Brown pelicans presently nest on islands off southern California and Mexico. Off northern California, they are summer-fall visitors that reach a peak abundance from July through October (Briggs et al. 1983b). On the outer coast, they are abundant both along the shore and in neritic waters. Most forage within about 20 km (11 nm), but they have been recorded as far as 88 km (48 nm) from shore (Briggs et al. 1983a). Brown pelicans occupy many roosts along the shore; 27 sites have roosting populations of 300 or more. Roosting sites used by 1,000 birds or more are Ano Nuevo Island, South Farallones Island, Bird Island in Marin

County, and Bird Rock near Bodega Bay (Briggs et al. 1983a,b).

Common Loon (*Gavia immer*) [State Species of Special Concern]

The common loon is an uncommon migrant and winter visitor found predominantly in protected nearshore waters, bays, and estuaries. Largest numbers along the outer coast occur during the April-May spring migration; few birds are found in the area during the summer (Briggs et al. 1983a). In the winter, common loons may predominantly be found in bays rather than along the open coast.

California Gull (*Larus californicus*) [State Species of Special Concern]

The California gull is abundant along the shore and in neritic waters from late-summer through mid-spring. They forage to at least mid-slope (1,000 m isobath) and are most concentrated in early fall off Eureka and in early winter from Monterey Bay to Point Arena (Briggs et al. 1983a). Concern for this species is based primarily on the impacts of the habitat decline in the Mono Lake nesting colony, the main contribution to the California population.

Rhinoceros Auklet (*Cerorhinca monocerata*) [State Species of Special Concern]

Rhinoceros auklets have their largest colonies in the area on Castle Rock off Crescent City and on South Farallones Island. Smaller numbers are found at 20 or more other sites. The total nesting population of northern California is estimated at 1,662 birds, of which 92 percent are found on the Castle Rock and South Farallones Island colonies (Carter et al. 1990). Offshore of northern California, rhinoceros auklets become seasonally abundant in the winter with arrival of birds nesting farther north (Briggs et al. 1983a). Greatest numbers are found south of about Bodega Head. They generally forage over or beyond the shelf break (>200 m depth), but substantial numbers may be found closer inshore over a near submarine canyons, such as Monterey Bay or near nesting colonies (Briggs et al. 1983a).

Tufted Puffin (*Fratercula cirrhata*) [State Species of Special Concern]

Tufted puffins have their largest nesting colonies on Prince Island, Castle Rock, Green Rock, Fish Rocks, and South Farallones Island. The total nesting population is estimated at 272 birds (Carter et al. 1990). The species is uncommon at sea off northern California, with most sightings recorded in March and April beyond the shelf break (Briggs et al. 1983a). In other months, sightings were closer to land and predominantly south of Bodega Head.

Double-Crested Cormorant (*Phalacrocorax auritus*) [State Species of Special Concern]

This cormorant is uncommon as a nesting species except north of Cape Mendocino where about 60 percent of the state's population occurs. The nesting population numbers about 6,400 birds occupying 20 colonies along the outer coast; greatest numbers occur on Prince Island, Little River Rock, the Russian River Rocks, and on South Farallones Island (Carter et al. 1990). During the fall, the population shifts southward and largest numbers on coastal roosts and offshore are found from Monterey Bay to Tomales and Bodega Bays (Briggs et al. 1983a).

Western Snowy Plover (*Charadrius alexandrinus*) [Fed. Threatened; State Species of Special Concern]

Along the coast of northern California, snowy plovers nest on sand or pebble substrate above the high-tide line on beaches backed by cliffs, bluffs, or dunes, small pocket beaches and rivermouths, sand spits, and the margin of estuaries, lagoons or salt flats (Page and Stenzel 1981). Surveys of these habitats were made by Point Reyes Bird Observatory from 1977 to 1980. Along the shore of Monterey Bay, snowy plovers nest from Marina Beach to the Moss Landing Western Salt Works, and at Pajaro Dunes. These beaches and salt flats support about 15 percent of the state's total of nesting pairs occurring on the outer coast. North of Monterey Bay, snowy plovers nest in small numbers at Wilder Ranch, in pocket beaches of Laguna and Waddell Creeks in Santa Cruz County, and Ano Nuevo State Reserve and the mouth of Pescadero Creek in San Mateo County. In Marin County, snowy plovers nest on beaches of the Point Reyes National Seashore and, to a lesser extent, on the spit of Bolinas Lagoon. Snowy plovers nest on beaches near Bodega Bay in

Sonoma County at least occasionally, and on dune-backed MacKerricher Beach in Mendocino County. The greatest numbers north of Monterey Bay occur on the Humboldt Bay spits, mouth of the Mad River, and Big Lagoon Bar. Nesting pairs at these and other sites in Humboldt County represent over 6 percent of the state's total. In Del Norte County, a few snowy plovers nest at Lake Talawa Beach and the spit at the mouth of the Smith River.

Mammals

Sea Otter (*Enhydra lutris*) [Federal Threatened]

Sea otters in California are a remnant of a pre-exploitation population that inhabited coastal waters along most of the North Pacific Rim from Mexico to Japan. Along the California coast, sea otters range northward to about Point Ano Nuevo. That portion of the population north of Monterey is comprised predominantly of nonreproductive males, although mother-pup pairs are occasionally seen (Estes and Jameson 1983; Bonnell et al. 1983). Counts by the USFWS and CDFG from 1982 to 1984 found 47 to 76 sea otters in this portion of the range, representing 4 to 6 percent of the population (Estes and Jameson 1983). Largest rafts have been seen in the vicinity of Sand Hill Bluff (36.0" 58.4'/122 deg. 09') and Soquel Point (36.0" 57.2'/121 deg. 59') where kelp beds are most extensive. Sea otters feed on macroinvertebrates in waters to a maximum depth of about 30 m and are typically seen within 1 to 2 km off shore. The spring distribution in the northern part of the range is shown on Figure 3.3-25.

Guadalupe Fur Seal (*Arctocephalus townsendi*) [Federal Threatened; State Threatened]

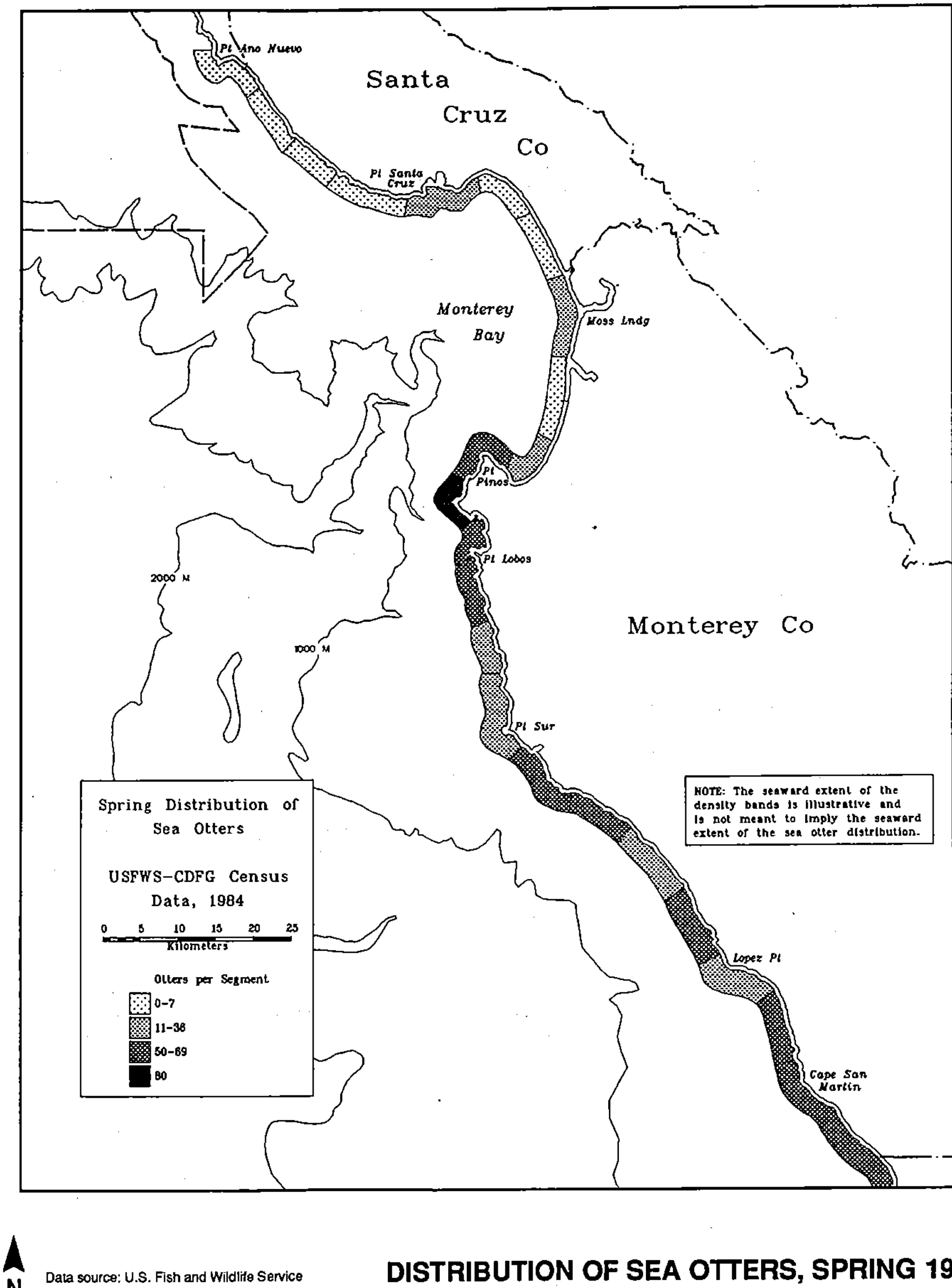
Historically, Guadalupe fur seals had a breeding range that included the Farallones Islands (Repenning et al. 1971). The species now has a total world population of only about 2,000, and breeding is limited to remote Isla de Guadalupe off Baja California (Fleischer 1987). During the winter, Guadalupe fur seals occupy a large pelagic range which, on the basis of strandings, includes waters offshore central and northern California (Webber and Roletto 1987). They have not been seen on marine mammal surveys except in southern California waters where they occurred over the slope and in deeper offshore waters (< 1,000 m depth).

Steller Sea Lion (*Eumetopias jubatus*) [Federal Threatened]

Steller sea lions (also known as northern sea lions) breed on four rookeries in California, and also occupy 50 other sites not used for reproduction. Most of the species' world population is found in Alaska (Loughlin et al. 1984). Significant declines in numbers of up to 50 percent have been noted throughout the range in the last 30 years. Causes of the decline are not yet known but may include incursion of fisheries on food resources, oceanographic changes, disease pollutants, or entanglement in fishing nets and debris (Merrick et al. 1987; Huber 1984). In California, counts on rookeries at Ano Nuevo Island, S.E. Farallones Island, Sugarloaf Rock off Cape Mendocino, and S.W. Seal Rock off Crescent City presently total about 2,000 animals during the peak of the summer breeding/pupping season (Bonnell et al. 1983, Bonnell, unpubl. data). Many animals move northward out of the state in the fall and winter. At sea, nearly 90 percent of all Steller sea lions seen on surveys were found in waters less than 400 m deep and within about 50 km (about 27 nm) from shore (Bonnell et al. 1983). Population estimates for the species range from 95,000 to 122,000 animals (U.S. Dept. of Comm. 1987).

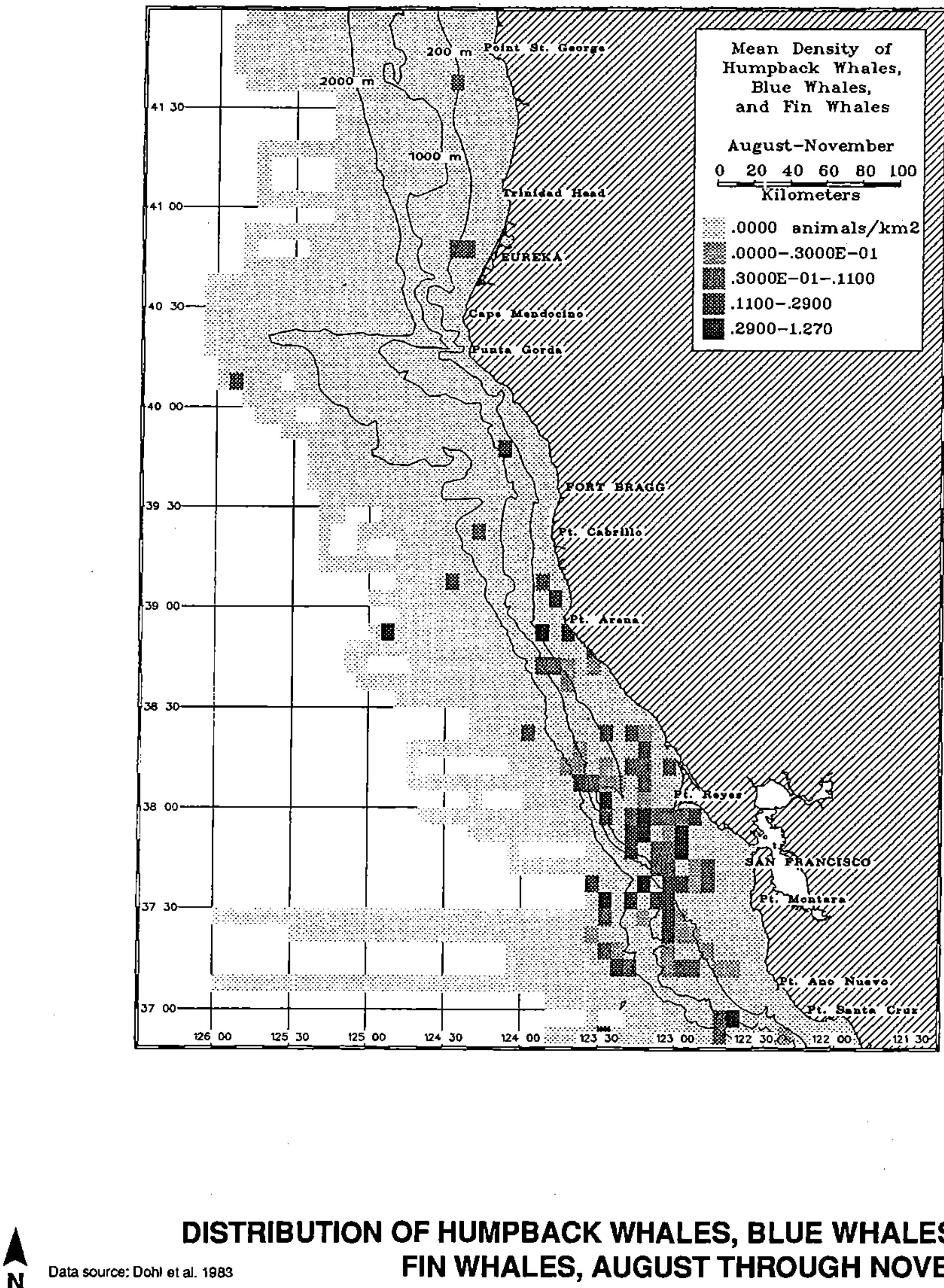
Humphack Whale (*Megaptera novaeangliae*) [Federal Endangered]

The eastern North Pacific stock of humpback whales winters off Mexico and has a summer feeding range extending from central California to at least Washington State (Green et al. 1992). Humpback whales are a common seasonal resident of shelf and slope waters from Monterey Bay to about Point Arena in the summer and fall, where they feed on euphausiid crustaceans and dense shoals of small fish. The area receiving greatest use extends over the shelf and slope (<2,000 m depth) from the latitude of Bodega Head in the north to about Ano Nuevo Point in the south (Dohl et al. 1983). From August through November, mean density in this area was 0.038 animals/km^2 (1980-1982 data). The distribution in these months is shown on Figure 3.3-26. The most persistent concentrations of feeding animals occur in the vicinity of Cordell Bank. The numbers of humpback whales using the waters of the Gulf of the Farallones National Marine Sanctuary in 1987 were estimated at 169 to 230 animals (Calambodkidis et al. 1988). The North Pacific population of humpback whales (all three stocks) is estimated at 1,200 to 2,100 (Baker et al. 1986; Darling and Morowitz 1986).



Data source: U.S. Fish and Wildlife Service

DISTRIBUTION OF SEA OTTERS, SPRING 1984
Figure 3.3-25



Data source: Dohl et al. 1983

DISTRIBUTION OF HUMPBACK WHALES, BLUE WHALES, AND FIN WHALES, AUGUST THROUGH NOVEMBER
Figure 3.3-26

Blue Whale (*Balaenoptera musculus*) [Federal Endangered]

Blue whales in the eastern North Pacific range from the Aleutians to Central America, and are found predominantly in waters beyond the shelf break. Greatest use of California coastal waters occurs during the fall southbound migration along the continental slope. The greatest concentrations are along the outer margin of Monterey Bay and the Gulf of the Farallones, where they are observed to feed on euphausiid crustaceans. Seventy-seven individuals were identified by photograph in the Gulf of the Farallones in 1987, although the peak number was estimated at 216 whales (Calambodkidis et al. 1988). The North Pacific population of blue whales is estimated to be 1,400 to 1,900 animals (Braham 1984).

Fin Whale (*Balaenoptera physalus*) [Federal Endangered]

The eastern stock of fin whales in the North Pacific is found from subtropical calving grounds off Mexico to the Gulf of Alaska and Bering Sea. The summer distribution includes waters from central California northward, while the winter distribution is shifted farther offshore and includes waters from central California to Baja California. Dohl et al. (1983) recorded 30 sightings of 56 animals on surveys off central and northern California. About one-third of the total was seen from Monterey Bay to Point Arena; no fin whales were seen north of Point Arena. Almost all sightings (93 percent) were recorded in the summer and fall, and 70 percent were over the shelf and slope. The North Pacific population is estimated at 14,600 to 18,600 animals (Ohsumi and Wada 1974).

Sei Whale (*Balaenoptera borealis*) [Federal Endangered]

Sei whales are found in pelagic waters throughout the North Pacific but are uncommon over the shelf and slope (<2,000 m depth). On aerial surveys off California, sei whales have been observed only twice: over Cortes Bank off southern California, and about 50 km off Point Sal in 600 m of water (Dohl et al. 1983). The population in the North Pacific is estimated at 22,000 to 37,000 animals (Ohsumi and Fukuda 1975).

Right Whale (*Eubaleana glacialis*) [Federal Endangered]

Historically, right whales ranged in the eastern North Pacific from Baja California to the Bering Sea. Whale hunting nearly extirpated the species, and the North Pacific population is believed to number no more than 200 animals at present (Braham and Rice 1984). Most sightings have been reported on winter calving grounds off Mexico or on high-latitude summer feeding grounds. However, a few sightings of single animals have also been made recently in California coastal waters. These were in the Santa Barbara Channel (Woodhouse and Strickley 1982) and, in 1986 and 1987, off Half Moon Bay (San Mateo County; T.P. Dohl, personal communication 1992).

Sperm Whale (*Physeter catodon*) [Federal Endangered]

Sperm whales are common year-round in deep waters off central and northern California. Dohl et al. (1983) reported 66 sightings of 218 animals on surveys conducted from 1980 through 1982. Of the total, 68 percent of sightings were made in waters 1,800 m or deeper. Groups of sperm whales occur infrequently within the Gulf of the Farallones (Sarah Allen, personal communication). The North Pacific population is estimated at 472,000 animals (U.S. Dept. of Commerce 1987).

<u>Reptiles</u>

Leatherback Sea Turtle (*Demochelys coriacea*) [Federal Endangered]

Leatherback turtles are relatively common off the coast, especially during the late-summer and fall when waters are warmest. Dohl et al. (1983) recorded 22 sightings on surveys off central and northern California, 1980 to 1983, including eight over shelf and shelf-break waters in the Gulf of the Farallones. On more recent surveys off Oregon and Washington, 16 sightings of leatherbacks were recorded (Green et al. 1992). In both studies, most leatherbacks were seen on surveys in July through October. While leatherback turtles have been seen as far as 100 km offshore, they may occur predominantly in waters over the shelf (<200 m depth).

Green Sea Turtle (*Chelonia mydas*) [Federal Endangered]

Historically, the green sea turtle is known to occur off northern California from sightings and strandings (Caldwell 1960, 1962; Carr 1952). A stranding off Humboldt County marks the northernmost record of the species (Smith and Houck 1984). In February 1989, a green turtle was captured in 50°F water off Point Sur and later transported to Mexican waters for release. On MMS-OCS surveys of central and northern California, five sightings of green turtles were recorded. While three were seen over the shelf in warmer waters off San Luis Obispo County, one was observed in offshore waters (>2,000 m depth) over the fan of the Monterey Canyon and another in offshore waters off Point St. George.

Loggerhead Sea Turtle (*Caretta caretta*) [Federal Endangered]

The Pacific loggerhead is known to occur in the area from sightings and strandings (Shaw 1947; Marquez 1969). In 1978, one was captured in the Southern California Bight, weighed and measured, and released (Guess 1981). A dead loggerhead was recently recovered in Alaska (Bane, G., Marine Turtle Newsletter No. 58). No loggerhead turtles were seen on MMS-OCS aerial surveys, 1980 to 1982, off central and northern California (Dohl et al. 1983).

Pacific Ridley Turtle (*Lepidochelys olivacea*) [Federal Endangered]

Pacific (olive) ridley turtles are known from California from sightings and strandings (Carr 1952; Caldwell 1960; Hubbs 1977). A recent stranding off Humboldt County marks the northernmost record for the species (Smith and Houck 1984). This species was not observed on MMS-OCS surveys off central and northern California, 1980 to 1981 (Dohl et al. 1983).

3.4 COMMERCIAL AND SPORTS FISHERIES

3.4.1 Regulatory Framework

3.4.1.1 Regulatory Setting

This section addresses commercial and sport fisheries, and the other related marine resource harvesting activities of kelp harvesting and aquaculture. Fisheries[1], kelp harvesting, and aquaculture activities depend on a healthy environment and responsible human activities to survive and flourish. This section focuses on two general aspects of governmental regulations: resource harvesting management and controls on human development. Explaining the regulatory framework helps in understanding the interrelationships between the two types of regulations that affect resource harvesting.

Development impacts can have a deleterious affect on the harvested resources or harvesting activities. If adverse impacts harm the resources to such an extent that they reduce the amount of productive habitat or populations, harvesting managers will likely respond by limiting harvests. A key example is the salmon fishery and fish declines resulting from timber harvesting and inland water development.

Fisheries, aquaculture, and kelp harvesting are overseen by several state and federal entities. CDFG, the California Fish and Game Commission, and the California Legislature are responsible for management of most of these resources within and outside state waters. CDFG licenses recreational and commercial fishermen, aquaculturists, and kelp harvesters; enforces regulations imposed by the legislature and commission; and reviews development project environmental reports to help ensure protection of resources and access to harvesting areas. CDFG also administers the California Oil Spill Prevention and Response Act. (Sections of direct relevance require compensation for lost access or damage to harvested resources and authorize training and use of mariners for oil spill response.) Salmon, groundfish, and northern anchovy are the management responsibility of the Federal Secretary of Commerce who relies on the Pacific Fisheries Management Council (PFMC), a regional entity with representatives from state and federal agencies for fisheries management guidance. These organizations impose seasonal, geographic, and gear limitations to help protect species from over-harvesting. For some fisheries, harvest quotas or bag limits are also used to help with management. National Marine Fisheries Service (NMFS) and CDFG enforce regulations imposed by Commerce.

Coastal zone development is regulated by the San Francisco Bay Conservation and Development Commission (BCDC) and the California Coastal Commission, which has authority along the coast, excluding San Francisco Bay. BCDC develops and implements a plan for the conservation and development of San Francisco Bay waters and the regulation of shoreline development, including commercial and recreational fishing facilities. The California Coastal Commission helps ensure that the biological productivity of coastal resources is maintained, enhanced, and restored for commercial, recreational, scientific, and educational purposes; and ensures that onshore commercial and recreational fishing facilities are protected and, where feasible, upgraded.

The SLC manages and protects important natural resources and uses on public lands, including tidelands. Commercial and recreational fishing, kelp harvesting, and aquaculture are all considered important uses by SLC. Permits are issued for development on tidelands, and mitigation is often required to help protect natural resources and access to those resources.

Other agencies with authority to regulate development and ensure protection of aquatic resources include the EPA, Corps of Engineers, USFWS, and the state and regional water quality control boards.

3.4.1.2 Data Collection and Methodology

The local project area encompasses San Francisco Bay and Delta east to Sherman Island, including the Unocal Marine Terminal. The regional project area includes the outer coast extending from Monterey north to the Oregon border. Several databases and maps are used to describe the fisheries, aquaculture operations, and kelp harvesting activities in these areas.

In the local project area CDFG catch and landings statistics, NMFS recreational fishing data, anecdotal

1. Fisheries are defined, by broad definition of the Federal Fishery Conservation and Management Act (FCMA) as fish, their habitat (the resources), and fishing activities.

information from interviews with knowledgeable individuals, and written materials help to describe commercial and recreational fisheries. No kelp harvesting or commercial aquaculture operations occur in the local project area.

In the regional area, CDFG port landing data and maps from several information sources are used to describe commercial fisheries. Recreational fisheries information sources include CDFG Commercial Passenger Fishing Vessel (CPFV) (charter boats), port landings, recreational fishing statistics from NMFS, fisheries maps, and other written documentation. Kelp harvesting and aquaculture activities are recorded by CDFG and pertinent information is included. A short description of the CDFG fisheries databases is provided to explain their uses and limitations.

To standardize fish landing reporting CDFG divides coastal and Bay waters into reporting blocks. The blocks for the local project area are depicted on Figure 3.4-1. CDFG provides both commercial and CPFV or charter boat fishery landings by fishing area, or block (where the fish are caught) and by port, or region (where the fish are landed). Landings data are recorded by fish dealers, processors, or CPFV operators. For commercial fisheries, data concerning species, weight, catch block, mode (gear type), and price paid to fisherman are provided to CDFG. CPFV operators report to CDFG the numbers of fish caught on their boats by passengers.

The collected fish landings data have their limitations. In regard to recreational data, CPFV landings is the only consistent database that records angler catches, despite the fact that catches from recreational private boats, shore/beaches, and piers make up about 78 percent of total recreational catches (U.S. Department of Commerce 1990).

In regards to commercial fisheries, the data may not be entirely accurate or complete for several reasons. In order to maintain the secrecy of good fishing locations, fishing operators may report catches in blocks other than those where the fish were actually caught. Also, catches often occur in more than one block, but may be reported for only one block. Finally, between 1987 and 1990, CDFG allowed a procedure where fishermen had the option of reporting the general area fished instead of a specific block, making it even more difficult to assign catches to specific areas. In 1990, CDFG eliminated that option and is now, again, requiring fishermen to report their catch landings by block. Because of these limitations, the CDFG data are supplemented by other information to better describe the fisheries.

All commercial landings data used in this report, are calculated from CDFG data. Only those species that together contribute a significant portion (about 95 percent or more of the landings) of the total harvest are included in the calculations.

3.4.2 San Francisco Bay, San Pablo Bay, Carquinez Strait, and Suisun Bay Fisheries

3.4.2.1 Historical Overview and Future Trends

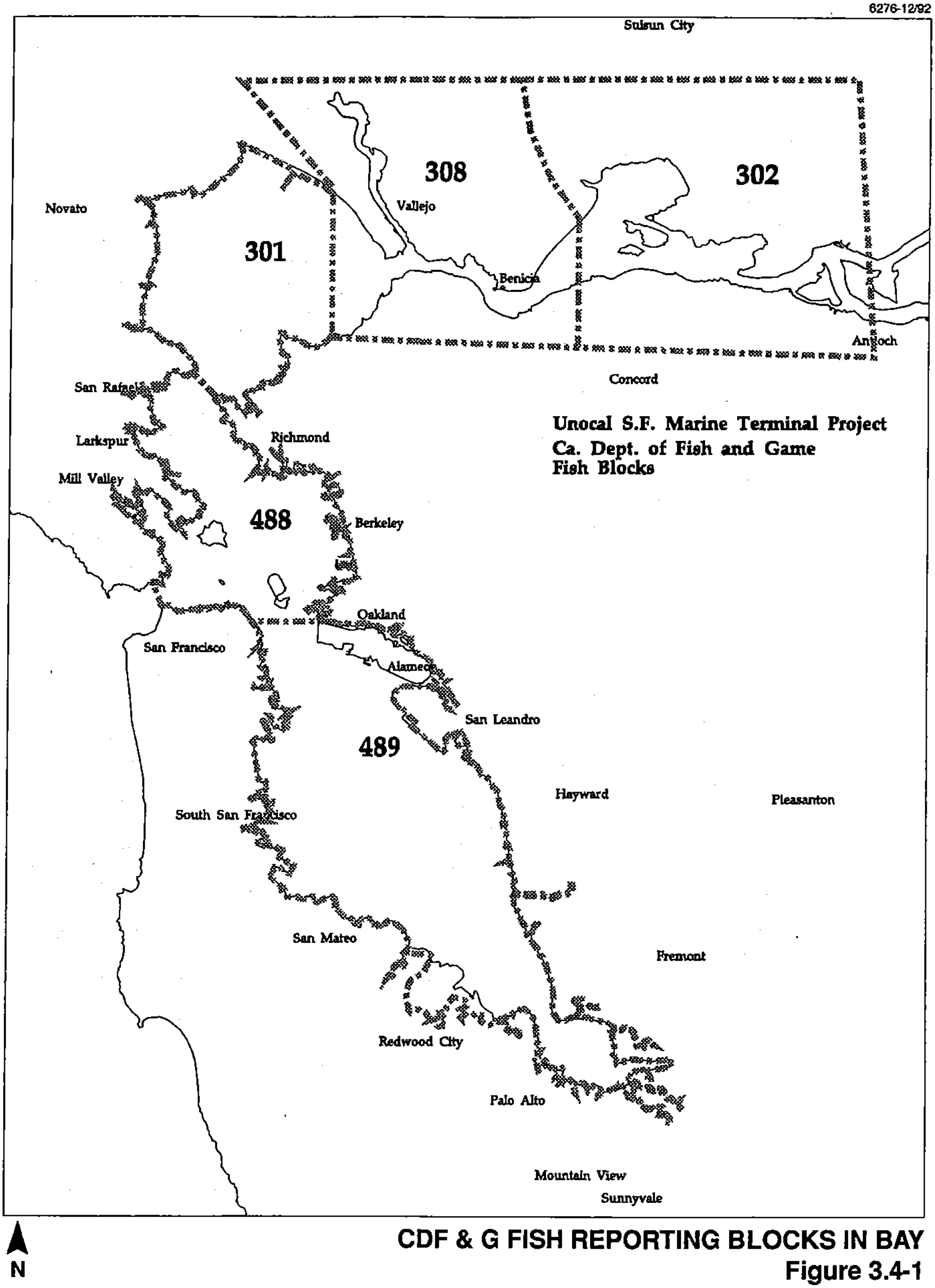
San Francisco Bay is California's largest estuary. The Bay is divided into three connecting bays: San Francisco Bay proper, San Pablo Bay, and Suisun Bay. These bays receive large volumes of fresh water runoff from the Sacramento and San Joaquin River systems; the systems drain California's Central Valley and have their sources in the Sierra Nevada. In general, most of San Francisco Bay is very shallow; it has an average depth of about 20 feet. There is also an extensive system of mudflats in San Pablo Bay and south San Francisco Bay (Squire and Smith 1977).

One of the environmental influences on San Francisco Bay fish is movement of the null zone, which marks the upstream edge of seawater influence. The location of this zone moves upstream and downstream depending on changes in fresh water flows from the Bay's tributaries. On the downstream side of the zone, saltwater fish predominate; fresh water fish are found on the upstream side. Therefore, fishing areas for some species generally cover broad areas of the Bay, but shift within the areas depending on the zone's location. Changes in tides, water conditions, seasons, and human activities also influence the Bay's fisheries.

Historical Summary

Neither fish nor fishing activities are static. For these reasons many fish spawning and feeding areas change from day to day and season to season. Therefore, fishermen are very mobile as they follow and hunt their prey.

For example, the key Bay commercial fishery, herring, is influenced by changing environmental conditions.



CDF & G FISH REPORTING BLOCKS IN BAY
Figure 3.4-1

When the modern fishery began in the 1970s, the shoreline off Sausalito was a key spawning and fishing area. Now, activity has shifted to the San Francisco shore, from Hunter's Point to China Basin (Arancio, personal communication 1992; Spratt, personal communication 1992). Continued movement and changes in the fishery can be expected over the life of the Proposed Project, and beyond.

In the 1800s, fish were a major resource of San Francisco Bay with primary species including Chinook salmon, sturgeon, striped bass, and Pacific herring. The San Francisco Bay-Delta region was the largest fishing center on the west coast. However, human use of the Sacramento River system and the Bay has taken a heavy toll. Adverse impacts on the Bay and fisheries began with siltation caused by hydraulic mining in the mid-1800s. As California's population grew, extensive land reclamation, dredging and filling, water pollution, dams, upstream water diversions, and other water developments altered the Bay to such an extent as to contribute significantly to the decline of Bay fisheries. Historically, over-fishing also took a toll on fisheries. However, in recent years, the other activities have been major causes of declines.

Intense fishing pressure for salmon after the 1880s reduced stocks so much that government intervened. By the 1970s, the Bay Area produced a consistent ocean sport salmon fishery, but stocks have continued to decline. Presently, the winter population is declared as threatened and endangered under the federal and state Endangered Species Acts. The primary causes are upstream water developments and diversions, fill and sedimentation, acid mine drainage and, possibly, agricultural runoff. Sturgeon and stripped bass were in high demand through the late 1880s and early 1900s. Over-fishing and mining contributed to declines in these species. Commercial fishing is currently prohibited, so fishing for these species is limited to sport only. Pacific herring has been an important commercial species since the mid-1800s and continues to be the primary commercial fishery in the Bay today. Other historical fisheries in the Bay included smelt, sole, sardine, American shad, northern anchovy, flounder, surfperch, elasmobranchs (rays), clams, Dungeness crabs, oysters, mussels, and bay shrimp (Smith and Kata 1979; Monroe and Kelly 1992). Today, although the major emphasis in the Bay is on sport fishing, many commercial fish landed in San Francisco area ports are dependent on the Bay/Delta estuary during some time of their lives. Notable examples are halibut, Dungeness crab, and English sole.

<u>Future Trends</u>

Although the life of the project is expected to be 40 years, fisheries trends were analyzed for the next 20 years. A 40-year projection is difficult to accurately project because environmental and other conditions are ever-changing.

For the upcoming season (winter 1993-1994) herring harvest projections are dismal, as the number of herring are on a steep decline possibly due to the recent drought and other environmental conditions. However, the long-term (over the next 20 years) prognosis for the fishery is good, after populations rebound, and if markets can be regained.

If San Francisco Bay restoration efforts are successful a resurgence of the dungeness crab fishery, once a thriving commercial Bay fishery, may occur. Expectations for the shrimp fishery remain as they are now; most of the product is used for bait for anglers, and little is reserved for direct human consumption. These markets are not expected to change much over the next 20 years.

Demand for recreational fishing, in general, may increase, as the Bay Area human population increases. However, recreational fisheries are on a general decline. As with commercial fisheries, recreational fishing growth is limited more by the supply of fish, then by the demand. Therefore, if the Bay's condition significantly improves, recreational fisheries will likely grow. The reverse situation is also possible.

There has been a recent plumet in the recreational salmon fishery that is expected to remain unstable due to watershed degradation, drought conditions, and listing of species as either endangered or threatened pursuant to the federal and/or state Endangered Species Acts. Watershed restoration is in its beginning stages; it remains to be seen whether restoration will improve the fishery.

3.4.2.2 Commercial Fisheries

Currently, Pacific herring is the only major commercial fishery within the Bay. The herring fishery is not only important locally, but is also critical to the state's fisheries; in 1990, herring ranked fifth in total state-wide landings and nearly all were caught in San Francisco Bay. Small fisheries also exist for Bay shrimp, brine shrimp in south Bay salt ponds, and crayfish (Delta). The remaining commercial activities are on a very small scale. One operator fishes for northern anchovy, and very small rod and reel operations target perch and smelt.

Details of recorded fish catches for those species representing about 95 percent, or more, of the catch in the bay from 1980 through 1990 are presented for south, central, and north Bays in Table E.1-1 (Appendix E.1). Figure 3.4-2 presents the primary commercial fishing areas.

For several CDFG blocks, catch data appear to be sporadic from year to year due to problems with the CDFG database, as explained in Section 3.4.1. As a result, block 300 catches provide a general overview of fish catches in the Bay and Delta regions, while data for other blocks provide more specific, but incomplete, information.

Pacific Herring

Currently, close to 99 percent of the herring landed in California ports are caught in San Francisco Bay. In the 1990-91 season, a total of 416 permits for San Francisco Bay were issued by CDFG (Spratt 1992). Most herring are caught in blocks 488 and 489, in the central portion of the Bay. From 1980 to 1990, over 47 million pounds of herring were landed in the Bay. Herring fisheries are tightly managed by CDFG by use of area closures, timing restrictions, and quotas. Regulations change annually based on the previous year's estimate of spawning biomass. Currently, CDFG allows harvest of about 15 percent of the estimated biomass (Spratt, personal communication 1992). Because of a recent significant decline in the spawning biomas, the fishery is likely to face a severely restricted or no season this upcoming harvest period.

Herring fishing activity occurs during spawning, generally from December through March, until quotas are filled. The focus of the herring fishery is the roe, which is exported to Japan. The two main fishing methods are gillnet and purse-seine (Figures E.1-1 and E.1-2), which catch the herring just prior to spawning. Another, albeit small, fishery is the roe-on-kelp method. Kelp is harvested from southern California and hung from barges in the Bay; herring spawn on the kelp, which is then landed and processed.

Shrimp

In 1965, this fishery developed to supply bay shrimp as live bait for sturgeon and striped bass sport fishing. Since then, the commercial harvest has been entirely by beam trawl (Figure E.1-3). A small percentage of catch is still consumed fresh, as food. In addition to Bay shrimp, brine shrimp are harvested from salt ponds. From 1985 to 1991, over 3.7 million pounds of shrimp were landed in the Bay.

In 1990, 14 vessels participated in the bay shrimp fishery. Fishing occurs year-round. Live tanks are used on all vessels and shrimp are transported to local bait shops by truck in either the tanks or iced-down wooden trays. Staghorn sculpin, yellowfin goby, and long jaw mudsucker are also caught in the nets and sold.

Key fishing locations include south Bay, northwestern San Pablo Bay, and Carquinez Strait and salt ponds in south Bay. Fishing also occurs in waters less than 20 feet deep in the channels of the estuary's shallow reaches.

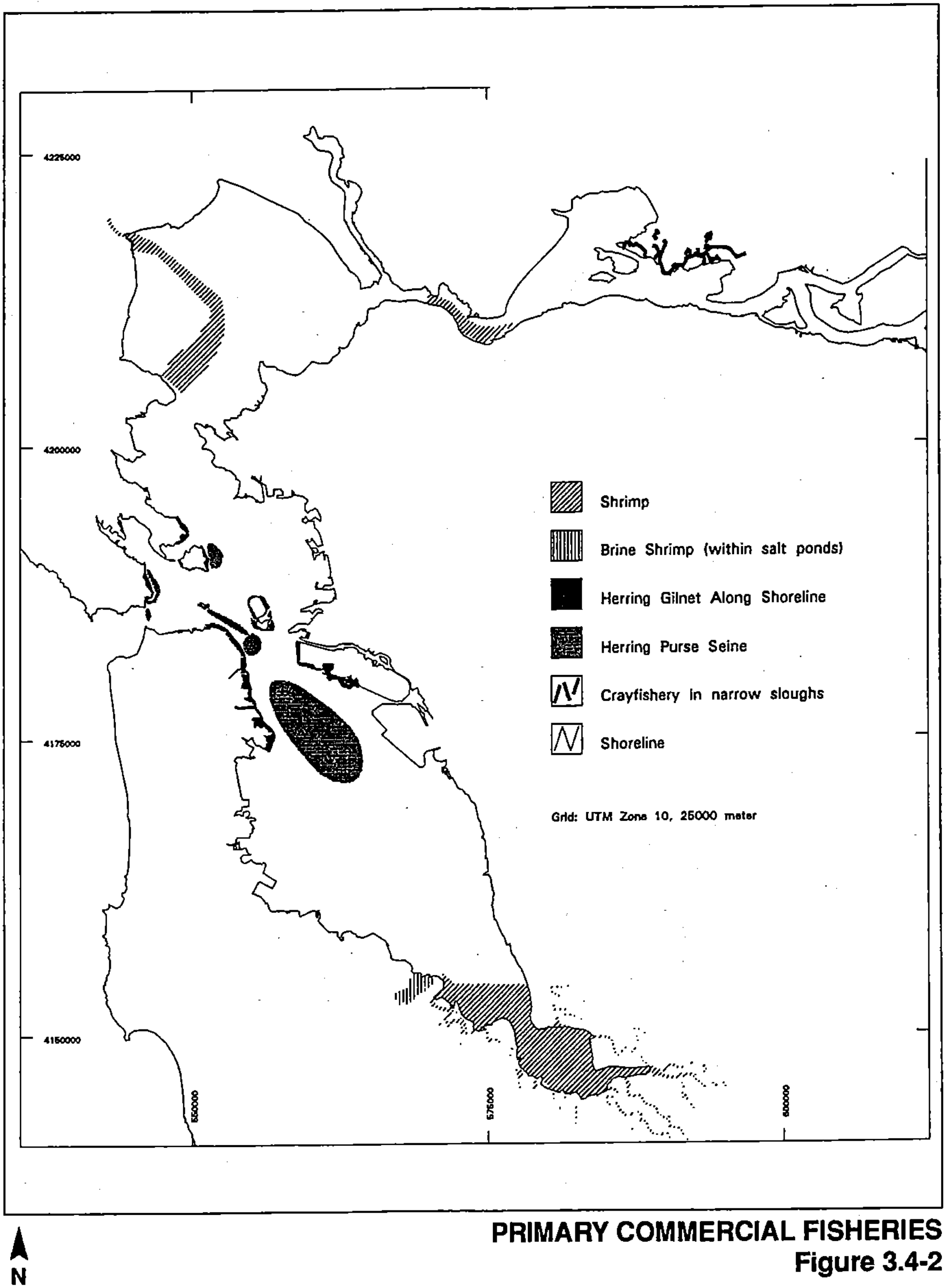
Regulation changes in the 1980s eliminated fishing in most of Suisun Bay in response to the high incidental catch and related mortality of small striped bass in shrimp trawls. No quota or season closure is in effect for the commercial fishery and landings are influenced primarily by demand.

Kelp Harvesting and Aquaculture Operations

No kelp harvesting or aquaculture operations exist in the Bay. Kelp is harvested off the southern California coast for the herring roe-on-kelp fishery previously described.

3.4.2.3 Recreational Fisheries

The Bay Area supports a wide variety of fishes for marine recreational fishing opportunities. A wide range of recreational fishing opportunities exist (i.e., charter fishing, private boat fishing, pier fishing, and beach/shore fishing). The Bay harbors about 140 boat launches, marinas, and piers for use by anglers (Section 3.10.3.2). The two most sought-after game



PRIMARY COMMERCIAL FISHERIES
Figure 3.4-2

fishes in the San Francisco Bay Area are striped bass and chinook salmon. Most salmon fishing takes place in the ocean outside the Golden Gate, while San Francisco Bay is home to the striped bass angler. Sturgeon is another popular sport fish (Davis 1982). Surfperch, bay shrimp, smelt, rockfishes, sharks, rays, clams, and others also offer a great deal to Bay Area anglers (Smith and Kata 1979; Squire and Smith 1977).

Table 3.4-1 presents the distribution of trips in the Bay by fishing mode and target species (U.S. Department of Commerce 1987); Figures 3.4-3 and 3.4-4 identify different recreational fishing areas and access points in the Bay. Appendix E.1 presents the different marinas and their associated facilities (Table E.1-2) and the fishing piers (Table E.1-3) in the Bay Area.

CPFV/Charter Fishing

Many marinas in San Francisco Bay harbor charter boats. As noted in Table 3.4-1, charter boat activity primarily targets striped bass, salmon, and rockfish in San Francisco Bay. Details of catches by fish block are included in Table E.1-4 of Appendix E.1. Table 3.4-1 also notes that approximately 17 percent of the Bay Area fishing activity is by charter boat. Charter boats operate mainly during salmon season, generally March 1 to October 31. Others target on sturgeon which are typically fished from November to May with peak season occurring from January through March. Some charter boats operate year-round targeting steelhead, rockfish, shark, rays, halibut, and other species (Figure 3.4-3). Between 1985 and 1990, the number of charter boats operating out of San Francisco Bay ranged from a high of 102 in 1985 to a low of 78 in 1990.

Private Boat Fishing

There are approximately 100 marinas in the Bay, and 73 provide launch facilities for private boat anglers. Table 3.4-1 identifies private fishing boat activity in the Bay. As noted in the table, private boat activity targets striped bass primarily in San Pablo Bay (Area D) and Suisun Bay (Area E); in San Francisco Bay anglers target mainly salmon and striped bass. However, many anglers do not target any particular species. The table also notes that approximately 48.4 percent of the total fishing activity is by private boat (U.S. Department of the Commerce 1987). Generally, private boat fishing patterns roughly mimic charter boat fishing patterns, recognizing that Table 3.4-1 indicates some differences. However, the data are based on a short survey (July 1985 to August 1986), which does not accurately reflect long-term fishing patterns.

Pier Fishing

Table 3.4-1 identifies some pier fishing activity in the Bay in Areas 7, 9, and 10. Public and private piers for the Bay are identified on Figure 3.4-3. As noted in the table, approximately 15.3 percent of the total fishing activity is from piers (U.S. Department of the Commerce 1987). Pier and shore catches primarily include starry flounder, surfperch, white croaker, sculpin, smelt, sole, lingcod, rockfish, and herring.

Beach/Shore Fishing

Table 3.4-1 identifies beach and shore fishing activity in the Bay. Beach/shore fishing areas are also identified on Figure 3.4-3. As noted in the table, beach/shore fishing activity targets striped bass primarily in the Suisun Bay-Carquinez Strait area (Area 5) although most anglers do not target any particular species. The table also notes that approximately 19.2 percent of the total fishing activity is from beaches (U.S. Department of the Commerce 1987). In addition to the species listed above, beachgoers dig for Japanese littleneck clams, but mainly in south Bay. It is assumed that beach/shore fishing occurs at all public access locations.

3.4.3 Fisheries Near the Unocal Terminal

3.4.3.1 Commercial Fisheries

The Unocal facility is located in CDFG fish block 308. This block encompasses the Carquinez Strait and lower reaches of the San Francisco Bay Delta. Reported landings for block 308 are scant. Only rockfish and bay shrimp were reported as landed for years 1980, 1986, and 1988 (the only years for which CDFG is available).

Current information indicates that shrimp trawling occurs in San Pablo Bay and into the Carquinez Strait (Afnison, personal communication 1992). Limited shrimping may occur near the Terminal; however, nearby key shrimping areas are located farther up the Strait and in northwestern San Pablo Bay. In 1989 and

Table 3.4-1

DISTRIBUTION OF TRIPS ACROSS GEOGRAPHICAL AREAS, BY FISHING MODE AND TARGET SPECIES, SAN FRANCISCO BAY AREA (July 1985 - August 1986)

Area	NoPart(1)	Salmon	SB-Other(2)	Rockfish-Lingcod
CHARTER BOAT FISHING				
D			12,767	
F				29,479
G	15,396	110,686		20,715
H				20,978
I				84,352

Area	NoPart	Salmon	SBass(3)	SB-Other	Rockfish-Lingcod	Other
PRIVATE BOAT FISHING						
B	22,599		13,454			13,453
C		13,696		22,305		14,021
D			20,295	53,777		31,339
E	27,773		74,236	63,369		
F		26,871			31,592	15,714
G		42,820	13,434		12,071	
H					10,683	
I	32,741	156,163			27,014	
North*	15,137	62,625			46,751	

Area	NoPart	Other	Rockfish-Lingcod
PIER FISHING			
7	10,558	17,718	
9		12,638	
10	17,182		
11	34,032		
12	28,291		
13	34,984	21,036	74,559

*North of Bodega Bay and South of the Oregon Border

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Table 3.4-1 (Continued)

DISTRIBUTION OF TRIPS ACROSS GEOGRAPHICAL AREAS, BY FISHING MODE AND TARGET SPECIES (July 1985 - August 1986)

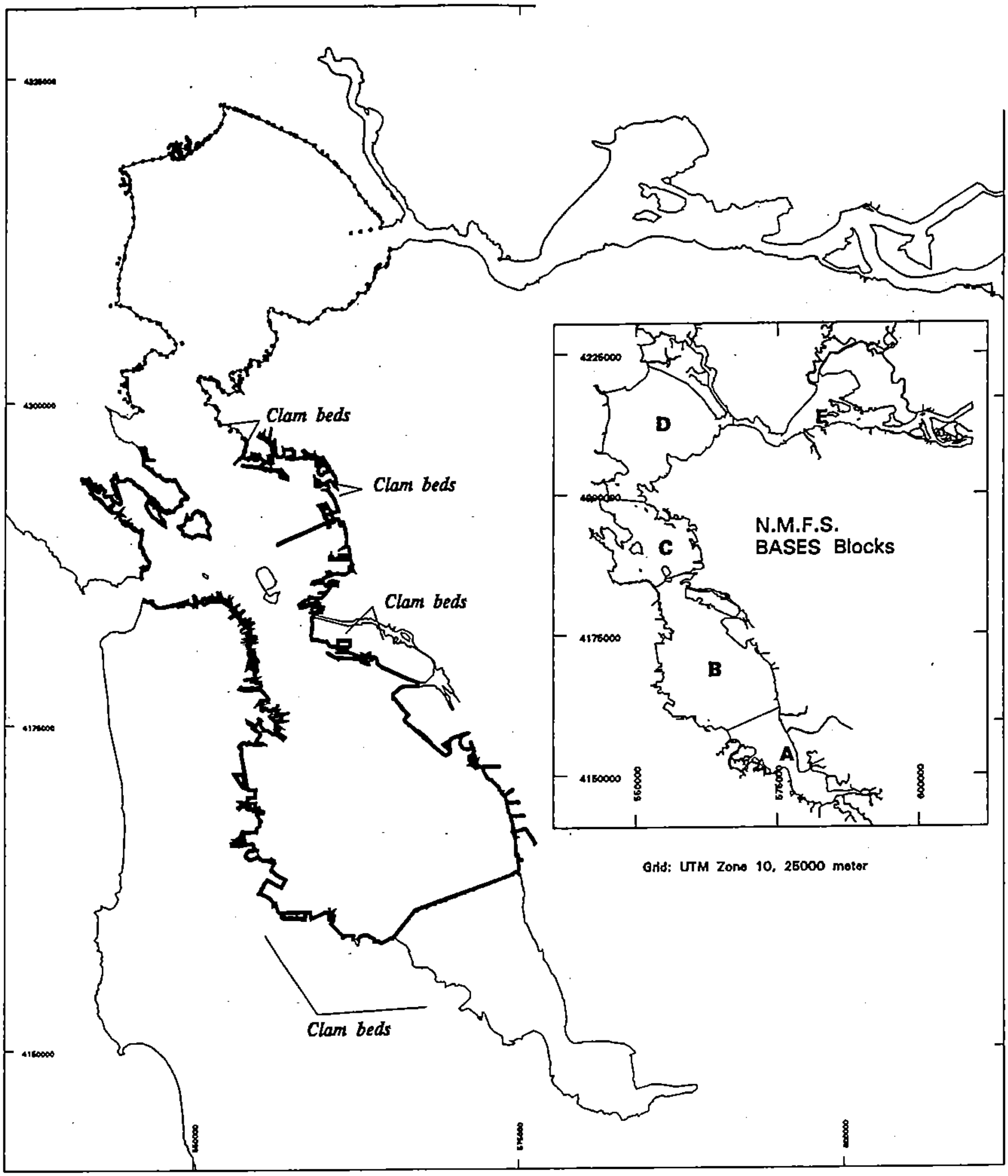
Area	NoPart	SBass	SB-Other	Rockfish-Lingcod	Rockfish-Other	Other
BEACH/SHORE FISHING						
2	12,373					
3	35,172					
5		31,704				
10	16,523					
11	25,513	12,646	18,506		22,581	
12	26,524			10,046		
13	26,135	13,093				

Note: Areas left blank denotes fewer than 10,000 trips. Geographical areas are depicted in Figure 3.4-6.

Target Species	Number of Trips				
	Charter (%)	Private (%)	Pier (%)	Beach (%)	Total
NoPart	6.7	24.8	32.7	35.9	489,215
Salmon	29.1	68.3	0.9	1.7	462,776
Striped bass	4.6	54.6	4.1	36.7	233,644
SBass/other	9.5	66.0	3.2	21.3	223,263
Rockfish	40.6	32.9	20.0	6.5	395,881
Rockfish/other	6.2	0	0	93.8	30,252
Other	7.8	57.5	25.8	8.9	244,142
All else (4)	10.1	54.9	14.3	20.7	371,711
Totals	17.1	48.4	15.3	19.2	2,450,884

Notes:
(1) NoPart = No particular species.
(2) SB-Other = Striped bass and other species.
(3) SBass = Striped bass.
(4) All else = A catch-all category that includes all target species groups other than those included in the subtotal.

Source: U.S. Department of the Commerce, Aug 1987.



Perch Fishing Areas

Perch and Smelt Fishing Areas

Note: Clam bed locations are shown on map.

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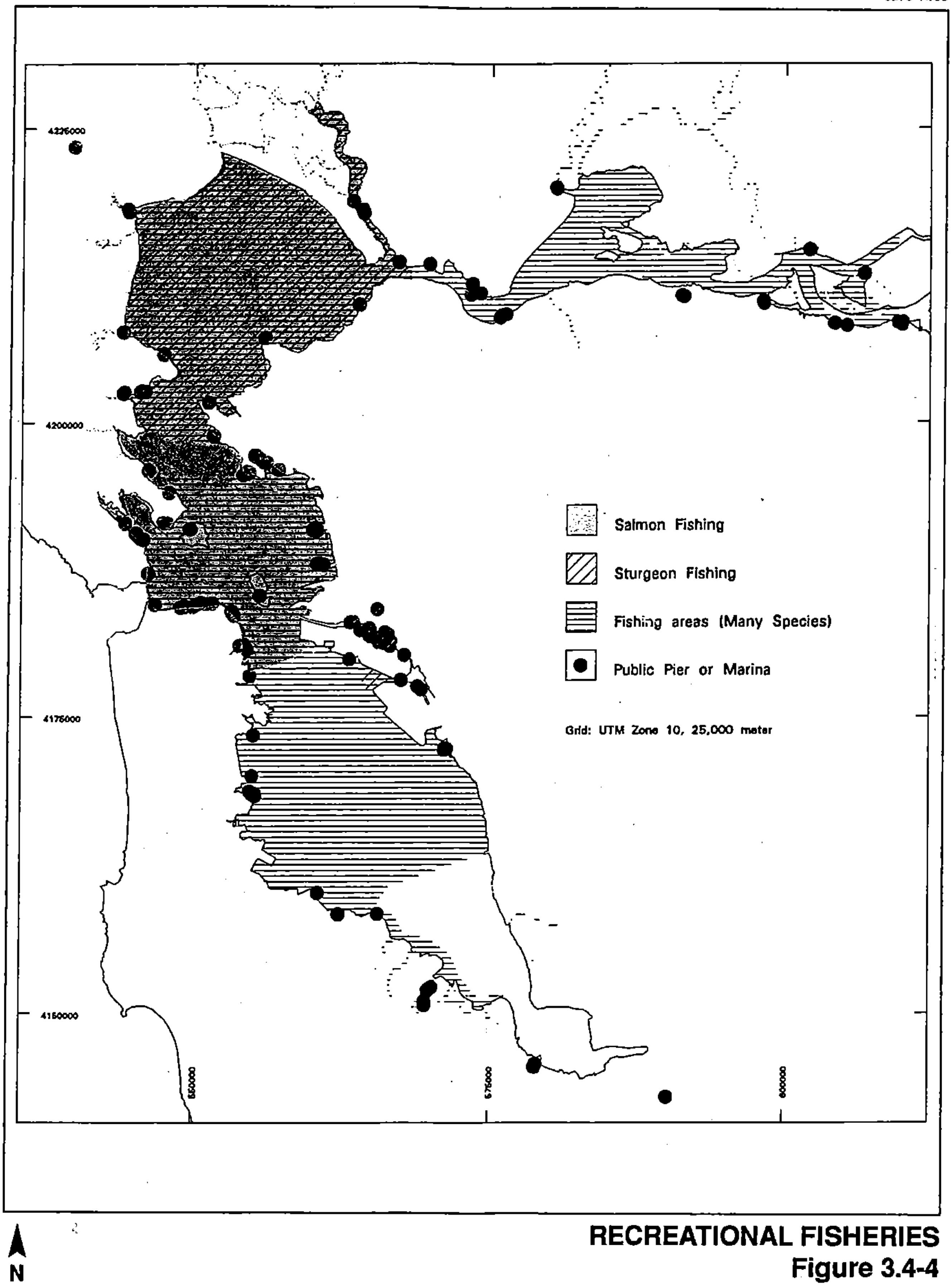
SAN FRANCISCO BAY AREA SHORELINE RECREATIONAL FISHING AREAS

Figure 3.4-3



RECREATIONAL FISHERIES
Figure 3.4-4

1990, an average of four vessels fished San Pablo Bay and two vessels fished Carquinez Strait. Limited perch fishing may occur close to the pier. Based on CDFG statistics and other information, commercial fishing activities near the Unocal Terminal appear to be light.

3.4.3.2 Recreational Fisheries

Charter/Private Boats

The Unocal Terminal is located within recreational fishing bases blocks D and 6. Three marinas are near the Unocal Terminal. One of the marinas is located about 3 miles south of the Terminal (Joseph's Fishing Resort) and the other two are about 3 and 6 miles northeast of the Terminal (Crockett Marine Service and Glen Cove Marina, respectively). These marinas account for approximately 3 percent of the total Bay marinas. Table 3.4-1 indicates that charter and private boats fish in bases block D, and Figure 3.4-3 shows that popular targets are bass, perch, salmon, and sturgeon.

Recorded charter boat catches in CDFG block 308, for years 1980 through 1991, show that striped bass, sturgeon, and flounder dominate the catches. Salmon is also caught in the block, but in limited numbers. Charter boat activity in block 308 is relatively light, when compared to activity throughout the San Francisco Bay region. Based on cumulative total catches for 1980 through 1991, catches in block 308 equalled about 4 percent of total catches in the Bay region. Private boat anglers are expected to follow similar fishing patterns.

Pier and Shore/Beach Fishing

Public piers, shoreline, and beach areas providing access to fishing are located throughout the Bay Area; however, access in the immediate area of the Terminal is limited. The Point Pinole Fishing Pier and Park is south of the site. Unocal personnel are allowed to fish off the Terminal. Statistics (Table 3.4-1) indicate no shoreside fishing activity on block 6; however, data in the table are based on a short, one-time survey. According to interviews and literature sources, shoreside anglers target the same species as boat anglers.

3.4.4 Coastal Fisheries

3.4.4.1 Commercial Fishing

A measure of the status of the commercial fishing industry in California are pounds landed into ports and harbors.

From 1980 through 1991, total pounds landed in northern California (Monterey to Oregon) by commercial fishermen was variable with a mean catch of 154.3 million pounds per year (Figure 3.4-5). Landings ranged from a low of 114 million pounds in 1985 to a high of 180.4 million pounds in 1988 (CDFG 1992). Approximately 2,500 northern California full-time commercial fishing vessels landed this fish (Korson 1989).

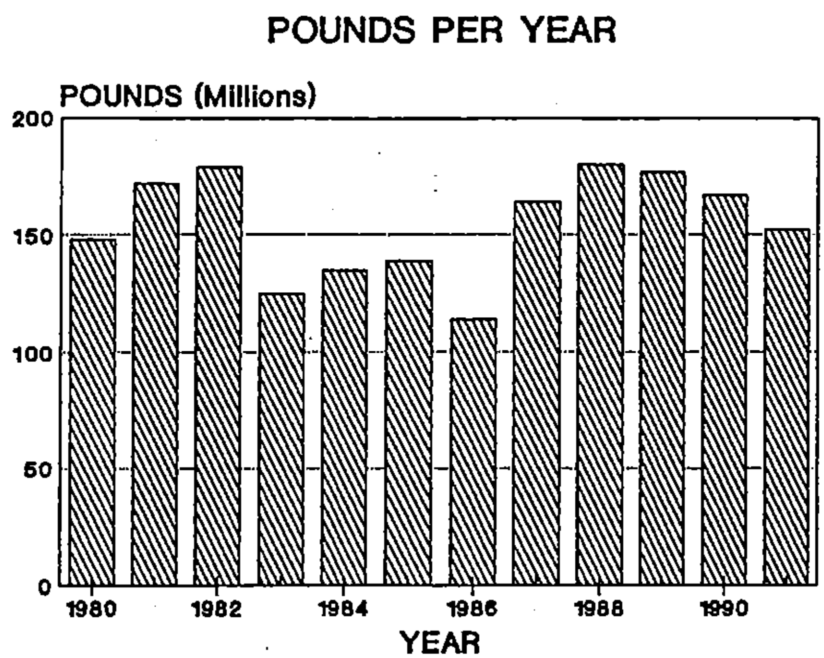
Figures 3.4-6 and 3.4-7 depict fishing areas, by species and fishing method, along the outer coast. Descriptions of fishing methods can be found in several references, including Joint Oil/Fisheries Committee of South/Central California (1986), Chambers Group, Inc. (1987), Aspen Environmental Group (1992), and others.

Monterey Area Ports

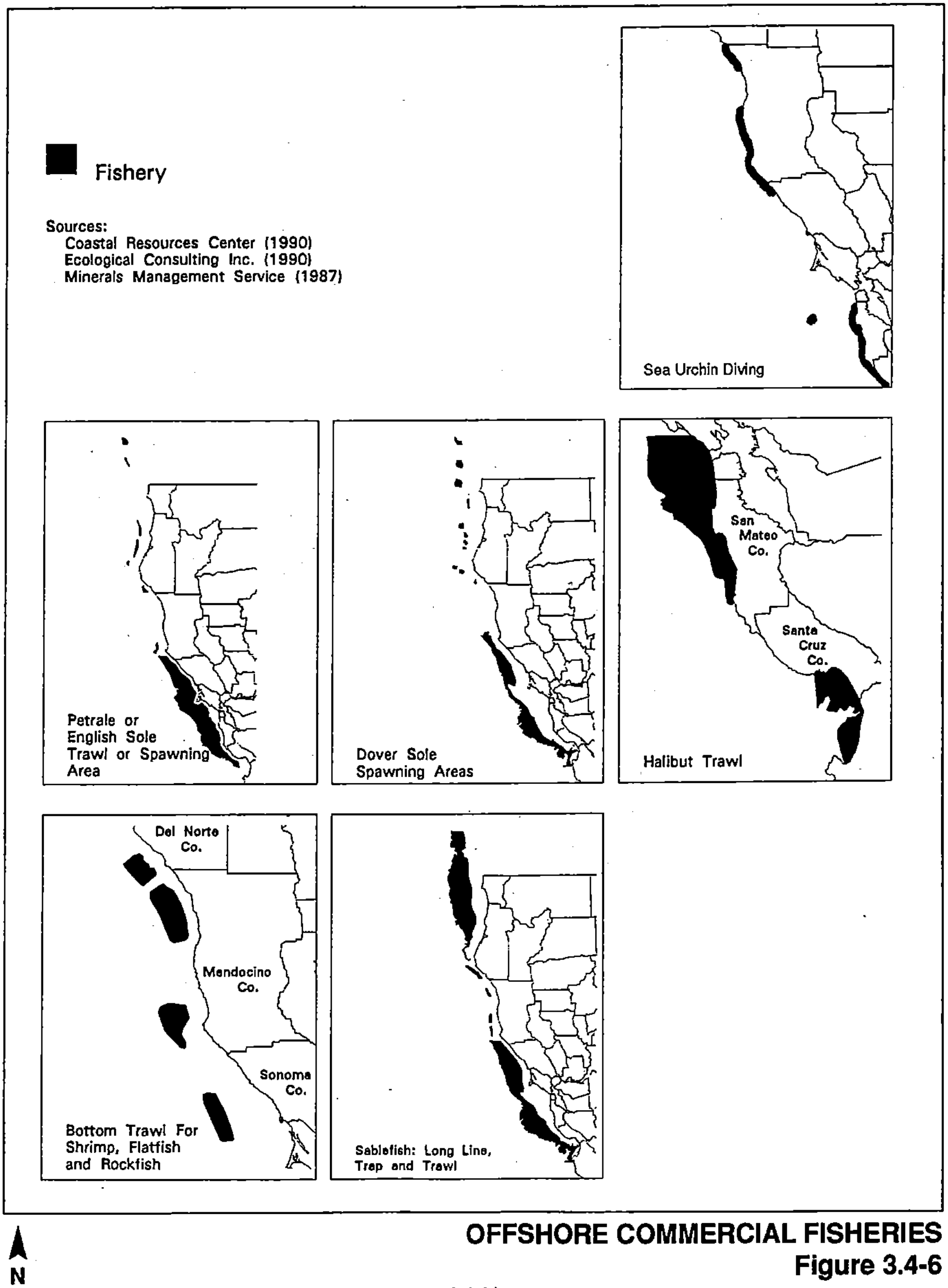
According to CDFG commercial landings data, predominant species landed in Monterey area ports include market squid, rockfishes, mackerel, Northern anchovy, sole, salmon, sablefish, tuna, lingcod, white croaker, swordfish, and others (CDFG 1992). Between 1980 and 1991, pounds landed by commercial fishermen were relatively stable with a mean catch of 36.2 million pounds per year.

Commercial fisheries off Monterey will likely experience change in the future. Expect similar trends (uncertain) in the salmon fishery as described for San Francisco Bay. Unless ongoing court challenges are successful, gill net fishing within three miles of shore (state waters) will cease in 1994. However, other fishing methods may gradually take over some of the fishing effort for halibut and rockfish. A growing "replacement" industry is the live fin and shell fish fishery for domestic and foreign markets.

As new PFMC regulations take effect, rockfish, flatfish and other trawl landings may either hold steady or decrease as entry of boats into the fishery is restricted. As sardine populations increase, that



NORTHERN CALIFORNIA COMMERCIAL FISH LANDINGS
Figure 3.4-5



OFFSHORE COMMERCIAL FISHERIES
Figure 3.4-6

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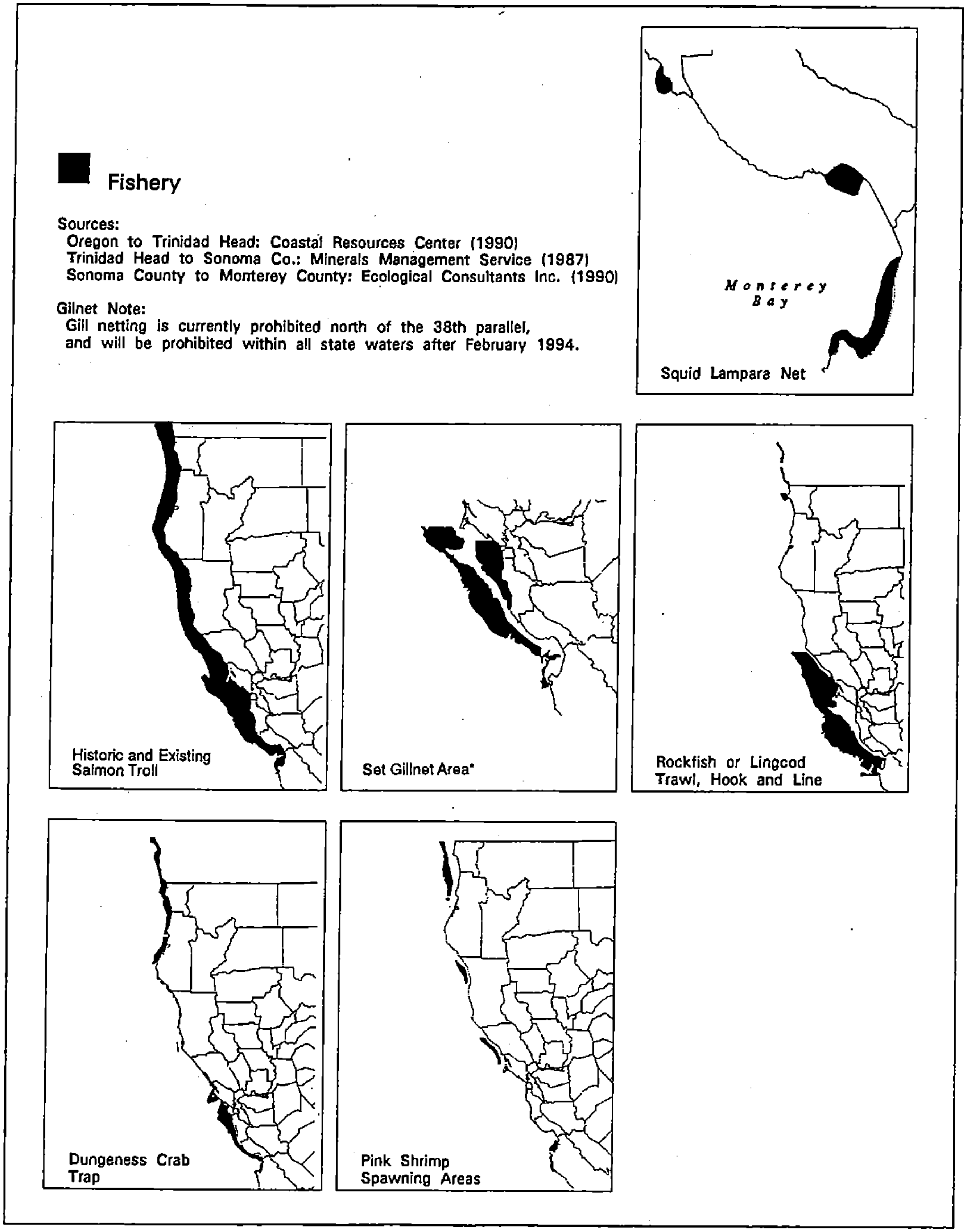

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OFFSHORE COMMERCIAL FISHERIES
Figure 3.4-7

fishery may reemerge, depending on regulations. Other purse seine fisheries should continue, although annual fluctuations in landings should be expected due to environmental conditions.

San Francisco Area Ports

According to CDFG commercial landings data, predominant species landed in San Francisco area ports include Pacific herring (Bay fishery), rockfishes, sole, sea urchin, salmon, sablefish, dungeness crab, northern anchovy, market squid, shrimp, lingcod, sanddab, albacore tuna, and others (CDFG 1992). Between 1980 and 1991, pounds landed by commercial fishermen were relatively stable with a mean catch of 46.6 million pounds per year.

For most fisheries, San Francisco port area trends would likely be similar to those described for Monterey area ports, above. Sea urchin landings peaked in 1989 and are on the decline. Landings may stabilize given management efforts to control the harvest at a level that will sustain the fishery. Dungeness crab landings are dependant on ever-changing environmental conditions, but similar harvest patterns are expected.

Eureka Area Ports

According to CDFG commercial landings data, the predominant species landed in Eureka area ports include sea urchin, sole, Pacific hake, rockfishes, shrimp, Dungeness crab, thornyhead, sablefish, salmon, lingcod, albacore tuna, smelt, and others (CDFG 1992). Between 1980 and 1991, the total pounds landed by commercial fishermen were variable with a mean catch of 71.5 million pounds per year. Fluctuations in salmon catches account for much of the variability.

Trends for Eureka area ports are expected to be the same as previously described, except that neither anchovy nor squid are caught in significant numbers off the north coast.

3.4.4.2 Aquaculture

In the region, at least 25 different aquaculture leases are scattered within the 3-mile limit (state waters). Most of the leases are in Tomales Bay; others are in Elkorn Slough, Monterey Bay, Santa Cruz, Drakes, Estero, Bodega Bay, Humboldt Bay, and off Crescent City. Major products include different species of oysters, mussels, clams, abalone, and scallops. Table 3.4-2 lists the aquaculture leases by county and by product in the north coast project area. In 1991 production totaled nearly 2.4 million pounds.

The aquaculture industry is at a crossroads; its future potential is dependent on markets and the price for California raised products (Malan, personal communication 1993). California's coast offers just a few protected locations for operations; therefore, most future sites are in bays, the San Francisco Delta, and at upland sites. Suitable aquatic sites also require clean water and must not impede access to public waters and lands. For these reasons, upland locations with adequate water sources are growing in popularity. On the coast, reseeding of abalone may expand. There is also interest in seabass and other finfish resource enhancement. Oyster and other shellfish cultivation in Tomales Bay and elsewhere is expected to hold steady.

3.4.4.3 Kelp Harvesting

Kelp grows in dense beds in waters up to 100 feet (30 m) deep, but most plants concentrate in depths of 60 feet (18.25 m) or less. A kelp bed may be harvested several times a year. Kelp is harvested for a variety of products derived from alginates, which are extracted from the kelp. The extract is currently used in inks, dyes, latex, rubber, and food stabilizers. Kelp has been harvested commercially in California since 1911.

Currently, there are six companies that harvest kelp along the coast in the regional project area. Kelp beds are spotty along much of the north coast and total 4,005 acres (see Figure 3.3-21). Acreage within the study area is less than 10 percent of total kelp bed acreage off California. Kelp canopies exist from Cape Vizcaino (Mendocino County) to Fort Ross (Sonoma County), and from Point Monterey (San Mateo County) to Capitola Beach (Monterey Bay). Within this area, larger canopies exist from Laguna Point to Bridgeport Landing Point Arena to Fort Ross and locations off Moss Landing, Santa Cruz, Davenport, Pigeon Point, and Halfmoon Bay (CDFG 1992). These beds represent the area available to commercial harvesters in the study area. Both leased and unleased kelp beds are harvested. If a bed is leased, the operator has an exclusive right to harvest from the

Table 3.4-2

NORTH COAST PROJECT AREA REGISTERED MARINE AQUACULTURE OPERATIONS

County	Growing		Size (Acres)
	Area	Products	
Monterey	Elkhorn Slough	Pacific Oysters, Native Oysters, Bay Mussels, Japanese Scallop, Quahog Clams, Native Littleneck Clams	7.42
	Monterey Bay	Red Abalone Res. & Developmt.	1
Santa Cruz	Santa Cruz	Abalone, Rock Scallop Res. & Developmt.	0
		Red Abalone	0
Marin	Tomales Bay	Commercial Prod. Pacific Oysters	178.8
		Commercial Prod. Bay Mussels, Pacific Oysters, European Oysters	10
		Commercial Prod. Pacific, European Eastern & Native Oysters, Littleneck Clams, Bay Mussels	5
		Pacific Oysters, European Oysters, MLA Clams, Bay Mussels,	131.9
		Commercial Prod. Pacific Oysters, Quahog Clams	5
		Commercial Prod. Pacific & European Oysters, MLA Clams, Bay Mussels	25
		Mussels, Oysters, Clams, Res. & Developmt.	23
		Pacific Oysters, Bay Mussels, MLA Clams	128.2
		Commercial Prod. Eastern, Pacific, & European Oysters, Mussels	1

Table 3.4-2 (Continued)

NORTH COAST PROJECT AREA REGISTERED MARINE AQUACULTURE OPERATIONS

County	Growing		Size (Acres)
	Area	Products	
Marin (Continued)	Tomales Bay (Continued)	Commercial Prod. Pacific & European Oysters	156
		Commercial Prod. Pacific, Eastern, & European Oysters, Mussels, Clams	5
		Commercial Prod. Pacific Oysters, Mussels, Scallops	10
	Drakes Estero	Commercial Prod. Fresh Shucked & Whole Pacific Oysters, Rock Scallop, Bay Mussels	1,059 1
Sonoma	Bodega Bay	Red Abalone	N/A
Humboldt	Humboldt Bay	Clams, Arcata Oysters, Shrimp, Cram & Marine Arcatia CA Fish, Res. & Developmt.	2
		Commercial Prod.- Fresh Shucked Oysters	1,744
	Humboldt Bay, Mad River Slough	Commercial Prod. of Seed for Manila Clam, Pacific European Oyster, Rock Scallop, Geoduck	0
	Sand Island, North Humboldt Bay	Commercial Prod. North Bay of Pacific Oysters, European Oysters, MLA Clams, Bay Mussels	349.2
Del Norte	Crescent	Red Abalone	N/A
	Crescent City Harbor District	Abalone	N/A
Totals	—	—	3,843+

Notes: 0 - Lease is less than 1 acre in size.
N/A - Not available.

Source: California Department of Fish and Game, 1 August 1991.

leased portion. Unleased beds may be harvested by any licensed harvester, consistent with CDFG regulations.

Kelp harvesting for alginates is expected to hold steady (Glantz, personal communication 1993). The main factor influencing the supply of kelp is ocean conditions, including weather (destructive storms) and El Nino. Kelp restoration may help restore damaged beds and, thus, limit adverse environmental and development-related effects in certain areas. Aquaculture, if the industry grows significantly, may increase demand for kelp.

3.4.4.4 Recreational Fisheries

Table 3.4-3 presents the estimated distribution of fish catches by species (excluding salmon) and fishing mode for 1989 for northern California (Point Conception to Oregon). These data are the best available that indicate recreational fishing effort by all modes for the regional project area. The northern California catch comprised about 27 percent of the total statewide recreational fishing catch of 31.5 million fish (U.S. Department of Commerce 1990).

As with commercial catches marine recreational fishing catches are on a steady decline. Along the northern California coast the most popular fish landed in 1989 (the latest year for which data is available) were rockfish, smelt, surfperch and other fishes. Salmon, also in decline, may rebound if habitat restoration is successful. Catches of halibut and rockfish may increase, because of the proposition 132 ban on gillnets in state waters (most recreational fishing occurs within three miles of shore). Catches of abalone, clams, and other shellfish will be dependant on environmental conditions.

Table 3.4-4 summarizes the number of access points by county along the project area coast. The names of access points by County are detailed in Appendix H (Land Use).

Charter Fishing

Between 1985 and 1990, the number of charter boats operating out of coastal harbors that recorded landings ranged from 154 to 196. Nearly 83 percent of landings were comprised of rockfish; salmon, lingcod, and mackerel. Charter boat fishing accounts for 22.6 percent of total northern California recreational fishing effort (Table 3.4-3). Outer coast charter boat landings are presented by species for years 1983 through 1991 in Appendix E.1, Table E.1-5.

Private Boat Fishing

Private fishing boats operate out of virtually every harbor and launch site along the north coast. Their fishing patterns are similar to charter boat patterns. However, private boat fishing accounts for 44.5 percent of total north coast recreational fishing effort. Private boat anglers concentrate on rockfish and catch most of the white croaker.

Shore Fishing

Shoreside anglers fish from public and private piers, and almost anywhere access can be made to the beach; beachgoers dig for clams and other mollusks, along sandy beaches as well. Table 3.4-3 indicates that smelt, surfperch, queenfish, herring, and other species are popular targets. Shore fishing accounts for 32.9 percent of total northern California recreational fishing effort.

Diving

SCUBA and skin diving take place from shore, piers (although this is generally illegal), private boats, and commercial dive boats. Diving usually occurs in habitats rich in marine life such as rocky areas or kelp beds. Abalone and crab are the primary species taken by northern California divers. Sea urchin recreational diving is limited.

Table 3.4-3

ESTIMATED TOTAL NUMBER OF FISH CAUGHT BY MARINE RECREATIONAL FISHERMEN BY SPECIES GROUP AND FISHING MODE: NORTH CALIFORNIA, JANUARY 1989 TO DECEMBER 1989

Species	Northern California (Numbers of fish in 1,000's)	Percent Charter Boat	Percent Private Boat	Percent Shore
Surf smelt	389	*	*	100
Jacksmelt	506	*	*	100
Kelp bass	-	47.5	44.8	7.7
White croaker	628	7	61.8	31.2
Walleye surfperch	114	*	9.4	90.6
Redtail surfperch	-	1.2	*	98.8
Barred surfperch	36	3.9	*	96.1
Pacific mackerel	-	21.8	40.8	37.4
Black rockfish	378	44.9	51.8	3.3
Blue rockfish	568	27.6	53.1	19.3
Boccacio	70	66.8	9.0	24.2
Olive rockfish	54	75.5	23.0	1.5
Rockfishes, other	2,201	48.3	49.0	2.7
Fish, unspecified	3,519	14.3	52.3	33.4
Totals	**8,494**	**22.6**	**44.5**	**32.9**

Note: A dash (-) denotes less than thirty thousand. However, the number is included in row and column totals. An asterisk (*) denotes none reported. Figures do not include salmon catches estimated by state recreational surveys. Percent ratio based on NMFS Tables: Estimated Number of Fish Caught by Marine Recreational Fishermen by Species Group and Fishing Mode: Pacific Coast, January 1989 - December 1989 and Estimated Total Number of Fish Caught by Marine Recreational Fishermen by Species Group and Subregion: Pacific Coast, January 1989 - December 1989

Source: U.S Department of Commerce 1990

Table 3.4-4

PUBLIC FISHING SHORELINE ACCESS

County	Shorefront Access	Pier	Marina
Monterey	11	4	0
Santa Cruz	15	2	1
San Mateo	15	2	1
San Francisco	3	1	1
Marin	4	1	0
Sonoma	26	2	4
Mendocino	16	1	1
Humboldt	18	0	2
Del Norte	15	0	1
Totals	125	13	11

Source: California Coastal Commission (1991).

3.5 AIR QUALITY

3.5.1 Environmental Setting

3.5.1.1 Local Climatology

The climate of the San Francisco Bay Area is characterized as maritime, where extreme variations in ambient temperatures are rare. The climate is strongly influenced by the nearness of the Pacific Ocean and the irregularities in the inland topography.

During the warmer months, the high pressure system over the Pacific Ocean off the California coast results in negligible precipitation and northwest wind flows over the Bay Area. These northwesterly flows across the Pacific result in ocean surface movement off the California coast and promote the upwelling of cold water near the San Francisco coastline. As cool moisture-laden air approaches the coast, further cooling occurs as it flows across this cold band. This cooling is often sufficient enough to result in condensation and the formation of fog and clouds in the region during the warmer months.

In winter, when the high pressure system in the Pacific weakens, high westerly winds aloft allow frequent weather systems to move inland across northern California. With the formation of a persistent high pressure system over the mountainous regions of northeast California, winter winds in the Bay Area are from the east and northeast.

The majority of the Bay Area's precipitation occurs from November to April. Average rainfall at the City of Richmond is 21.8 inches. During this period, inversions are either nonexistent or very weak; the frequent replacement of air masses with each storm make stagnant conditions rare.

Dispersion of pollutants is affected by weather patterns. Stagnant periods which inhibit the dispersion of pollutants in the lower atmosphere result from abnormally high temperatures and relatively stable conditions. On warmer days when the land-sea temperature differential is high, turbulence results from the passage of westerly winds over the irregular topography, thereby improving the dispersion of pollutants.

3.5.1.2 Topography

The topography at the site and surrounding area is characterized by steep hills that rise rapidly from sea level adjacent to San Pablo Bay and the south side of the Carquinez Strait. The hills are cut by numerous drainage channels and streams. Elevations in excess of 900 feet are reached in the rugged hills of the Franklin Ridge area, located approximately 2.5 miles to the southwest.

The Carquinez Strait, which drains the Sacramento and San Joaquin Rivers into San Pablo Bay, is located immediately north of the site. North of Carquinez Strait, the topography is also characterized by steep, hilly terrain with incised drainages. Sulphur Springs Mountain, located approximately 6 miles northeast of the site, reaches a maximum elevation of 957 feet. Farther to the east, elevations exceed 1,100 feet.

Regional topography to the west and southwest is dominated by the mountainous Marin Peninsula located approximately 15 miles to the west. Mount Diablo, located approximately 18 miles to the southeast, is also a major regional topographic feature with an elevation in excess of 3,800 feet.

3.5.2 Regulatory Setting

3.5.2.1 National and State Ambient Air Quality Standards

Ambient air quality standards are regulatory levels of ambient pollutant concentrations that, when exceeded, may adversely impact the health and welfare of the public. National Ambient Air Quality Standards (NAAQS) were established as a result of the provisions of the Federal Clean Air Act (FCAA) (42 U.S.C. Sec. 7401 et. seq.) of 1970. The NAAQS are divided into primary standards designed to protect public health, and into secondary standards intended to protect the public from any known or anticipated adverse effects of a pollutant. The national standards may be equalled continuously and exceeded once per year. NAAQSs have been established for ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, suspended particulate matter (PM_{10}), and lead.

California Ambient Air Quality Standards (CAAQS) were established starting in 1969 as a result of the Mulford-Carrell Act. In addition to the NAAQS pollutants, the state has established CAAQS for visibility reducing particles, sulfates, hydrogen sulfide, and vinyl chloride. CAAQS for ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and suspended particulate matter (PM_{10}) are not to be exceeded, while the remaining standards can not be equalled or exceeded.

The pollutants for which standards have been established and the corresponding national and state ambient air quality standards are shown in Table 3.5-1.

The five directly emitted primary pollutants are carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), precursor organic compounds (POC), and suspended particulate matter (PM_{10}). Ozone results from reactions involving NO_x and POC. Ozone, CO, NO_X, SO_x, PM_{10}, and POC are considered criteria pollutants. The following is a summary of the characteristics for each criteria pollutant.

- **Ozone** - Ozone is a pungent, colorless toxic gas. Ozone makes up 90 percent of the group of pollutants known as photochemical oxidants. Ozone and other photochemical oxidants are products of atmospheric reaction of NO_x and POC with ultraviolet light. High ozone levels can adversely affect plants and can cause respiratory irritation in humans.

- **Carbon Monoxide (CO)** - Carbon monoxide is an odorless, colorless toxic gas produced by incomplete combustion of carbon containing substances. Carbon monoxide interferes with the transfer of fresh oxygen from blood into body tissues.

- **Oxides of Nitrogen (NO_x)** - Nitric oxide is formed from nitrogen and oxygen at high combustion temperatures and further reacts to form other oxides of nitrogen such as nitrogen dioxide. Nitrogen dioxide reacts with ultraviolet light to initiate reactions producing photochemical smog and it reacts in air to form nitrate particulates. Nitrogen dioxide significantly affects visibility.

- **Sulfur Oxides (SO_x)** - Sulfur dioxide, the main component of sulfur oxides, is a colorless, pungent gas primarily formed by combustion of sulfur containing fossil fuels. High sulfur dioxide concentrations irritate the upper respiratory tract, while low concentrations of sulfur dioxide injure lung tissues. When sulfur oxides react they form sulfate, which significantly reduces visibility.

- **Particulates (PM_{10})** - Dust, aerosols, soot, mists, and fumes make up atmospheric particulates. Sources of particulates include industrial and agricultural operations, combustion, and photochemical reactions of pollutants in the atmosphere. Particulates substantially reduce visibility and adversely affect the respiratory tract. PM_{10} is made up of finely divided particulate matter less than 10 microns in diameter.

- **Precursor Organic Compounds (POC)** - Organic compounds are made up primarily of carbon and hydrogen. Motor vehicle emissions and evaporation of organic compounds produce hydrocarbon emissions. Hydrocarbon levels can affect plant growth. Many hydrocarbon species react in the atmosphere to form photochemical smog.

Air quality in the San Francisco Bay Area is directly regulated by the Bay Area Air Quality Management District (BAAQMD). The efforts of the BAAQMD are focused on reducing the quantity of pollutants emitted to the atmosphere so that attainment of the NAAQS and CAAQS can be obtained and/or maintained. At present, the San Francisco Bay Area's attainment classifications are as depicted in Table 3.5-2. Ozone, PM_{10}, and carbon monoxide are the three pollutants for which the air basin has been designated as nonattainment according to either the national or state ambient air quality standards.

3.5.2.2 Regional Standards

In the Bay Area, new or modified projects are subject to federal, state, and BAAQMD rules, regulations, laws, and plans.

In November 1990, the FCAA was amended requiring states to demonstrate the attainment of the NAAQS through the amendment of their State Implementation Plans (SIP). The FCAA requires the inclusion of specific rules and regulations which focus on the emissions from major stationary sources (i.e., offset ratios, retrofit controls) and the reduction of toxic air emissions (i.e., maximum achievable control technology).

Table 3.5-1

AMBIENT AIR QUALITY STANDARDS[1]

Pollutant	Averaging Time	California Standards[2]		Federal Standards[3]		
		Concentration	Method	Primary	Secondary	Method
Ozone	1 Hour	0.09 ppm (180 ug/m³)	Ultraviolet Photometry	0.12 ppm (235 ug/m³)	Same as Primary Std.	Ethylene Chemiluminescence
Carbon Monoxide	8 Hour	9.0 ppm (10 mg/m³)	Nondispersive Infrared Spectroscopy (NDIR)	9 ppm (10 mg/m³)	Same as Primary Stds.	Nondispersive Infrared Spectroscopy (NDIR)
	1 Hour	20 ppm (23 mg/m³)		35 ppm (40 mg/m³)		
Nitrogen Dioxide	Annual Average	—	Gas Phase Chemiluminescence	0.053 ppm (100 ug/m³)	Same as Primary Std.	Gas Phase Chemiluminescence
	1 Hour	0.25 ppm (470 ug/m³)		—		
Sulfur Dioxide	Annual Average	—	Ultraviolet Fluorescence	0.03 ppm (80 ug/m³)	—	Pararosaniline
	24 Hour	0.04 ppm (105 ug/m³)		0.14 ppm (365 ug/m³)	—	
	3 Hour	—		—	0.5 ppm (1.300 ug/m³	
	1 Hour	0.25 ppm (655 ug/m³)		—	—	
Suspended Particulate Matter (PM_{10})	Annual Geometric Mean	30 ug/m³	Size Selective Inlet High Volume Sampler and Gravimetric Analysis	—	—	—
	24 Hour	50 ug/m³		150 ug/m³	Same as Primary Stds.	Inertial Separation and Gravimetric Analysis
	Annual Arithmetic Mean	—	—	50 ug/m³		
Sulfates	24 Hour	25 ug/m³	Turbidimetric Barium Sulfate	—	—	—
Lead	30-Day Average	1.5 ug/m³	Atomic Absorption	—	—	Atomic Absorption
	Calendar Quarter	—		1.5 ug/m³	Same as Primary Std.	
Visibility Reducing Particles	1 Observation	In sufficient amount to reduce the prevailing visibility to less than 10 miles when the relative humidity is less than 70 percent		—	—	—

[1] Prepared in accordance with ARB Fact Sheet 39 (revised 11/91)
[2] California standards for ozone, carbon monoxide, sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, suspended particulate matter (PM_{10}), and visibility reducing particles, are values that are not to be exceeded.
[3] National standards, other than ozone and those based on annual averages or annual arithmetic means, are not to be exceeded more than once a year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is equal to or less than one.

Table 3.5-2

SAN FRANCISCO BAY AREA AIR BASIN DESIGNATIONS FOR NATIONAL AND STATE AMBIENT AIR QUALITY STANDARDS

Pollutant	Designation	
	National	State
Ozone	Nonattainment	Nonattainment
Nitrogen Oxide	Unclassified/Attainment	Attainment
PM10	Unclassified	Nonattainment
Sulfur Dioxide	Attainment	Attainment
Carbon Monoxide	Nonattainment (Urban) Unclassified/Attainment (Rural)	Nonattainment (Urban)[1]
Sulfates	No Standard	Attainment
Lead	No Standard	Attainment
Hydrogen Sulfide	No Standard	Unclassified
Visibility Reducing Particles	No Standard	Unclassified

[1] San Jose Urbanized Area - Nonattainment
Vallejo Urban Area - Nonattainment transitional
San Francisco County - Nonattainment transitional

Source: California Air Resources Board, Technical Support Division (July 1992)

The California Clean Air Act (CCAA) Health and Safety Code Division 26 of 1988 requires each local air pollution control district to achieve and maintain the CAAQS by the earliest practicable date. In October 1991, BAAQMD adopted the "Bay Area '91 Clean Air Plan" (CAP) that provides the attainment strategy for ozone and carbon monoxide through the continuous reduction in emissions from direct and indirect sources of air pollution.

The CAP contains potential stationary source control measures to be developed and proposed for adoption in the future. Control Measure ID No. B5 (Limitations on Marine Vessel Tank Purging) is proposed for adoption in 1993. The control measure proposes the control on ballasting and housekeeping emissions through either the installation of control equipment or the restriction of such activities to outside specific zones to ensure that the emissions would not have an impact on the district's air quality.

In 1987, the California Legislature passed AB 2588, "Air Toxics 'Hot Spots' Information and Assessment Act." This Act requires facilities to establish emission inventory plans and reports for the purpose of developing site-specific emission inventories of toxic substances. In addition, facilities designated as high priority by the local air district must perform health risk assessments based upon the air toxics emitted from the facility. The risk assessment is then used as the basis for public notification and education to nearby residences should it be determined that the excess cancer risk from the facility exceeds the air district's predetermined risk criteria.

In 1992, SB 1731 was signed into law. This bill requires facility operators designated as high priority under AB 2588 "Air Toxics 'Hot Spots' Information and Assessment Act" to conduct an airborne toxic risk reduction audit and develop a plan to implement airborne toxic risk reduction measures. Facility operators are then required to implement the measures set forth in the plan.

Within the jurisdiction of the BAAQMD, direct sources of emissions are subject to the rules and regulations of the district. New or modified projects are permitted under Regulation 2, Rule 2, the New Source Review (NSR) Rule under the BAAQMD rules and regulations that requires all increases in emissions in excess of 1 ton per year of ozone precursors (POC and NO_x) to be offset at a greater than 1.0 to 1.0 ratio.

3.5.2.3 Air Monitoring Data

Industrial facilities monitor their sources of emissions and/or calculate emissions for the purpose of tracking compliance with BAAQMD permits and to assist in achieving compliance with the local Clean Air Plan. Sources of emissions over which the facility has control are considered direct emissions, whereas emissions relating to vehicle traffic to and from the facility are considered indirect emissions. Vehicle traffic includes trucks, barges, tankers, tugboats, etc. Indirect emissions are most likely to be mobile source emissions.

3.5.2.4 Monitoring Stations

The BAAQMD maintains and operates a regional air monitoring network for determination of compliance with air quality standards. The network is made up of 30 monitoring stations, the locations of which are depicted on Figure 3.5-1. The air monitoring stations are used to measure the ambient concentrations of pollutants for which air quality standards have been established. The constituents monitored at each of these stations are listed in Table 3.5-3. Each station monitors a combination of gaseous and/or particulate pollutants either on a continuous or every- 6-day basis. The data are used to describe the quality of air within the surrounding community and to determine the attainment status of the air basin.

In addition to monitoring the constituents for which ambient air quality standards have been established, the BAAQMD also monitors for several constituents classified as toxic air pollutants. Toxic air pollutants are pollutants suspected of having the potential at very low concentrations, of causing a risk to human health. The toxic air pollutants monitored by the BAAQMD include benzene, carbon tetrachloride, chloroform, ethylene dichloride, ethylene dibromide (EDB), methylene chloride, perchloroethylene (perc), toluene, trichloroethylene (TCE), and vinyl chloride.

The air monitoring stations closest to the project site are those located in the City of Richmond (13th Street) and the City of Vallejo (Tuolumne). A 3-year summary of the ambient air quality data collected at these two stations as well as a summary of the entire San Francisco Bay Area air basin are provided in Tables 3.5-4 and 3.5-5, respectively.

The station located in Vallejo also monitors for the toxic air pollutants listed above. Toxic air pollutant monitoring data for the 1989 calendar year from this station is contained in Table 3.5-6.

3.5.2.5 Inventory Information

BAAQMD (CARB 1991) has estimated an emissions inventory for Unocal's Marine Terminal of 1,350 pounds per day of POCs. This inventory is based upon gasoline loading emissions only, and does not include other sources of direct or indirect source emissions (i.e., fugitives, other product loading, ballasting, vessels) associated with the Unocal Marine Terminal.

This inventory also does not reflect the installation of a vapor recovery system in September 1991. The vapor recovery system is designed to reduce POC emissions by 95 percent from loading and tank washing operations and will significantly reduce emissions for the life of the lease compared with previous historical emission levels.

An extensive direct and indirect source emissions inventory (including the use of the vapor recovery system) is presented in Section 3.5.4 of this document.

3.5.3 Odors

A source of odors from the Marine Terminal are emissions of fugitive POC that may be emitted to the atmosphere during loading and unloading operations. At the Marine Terminal, it is difficult to determine if odors are from the Terminal or the Refinery itself due to the proximity of the two facilities. No odor or nuisance complaints have been received concerning the Unocal Terminal (BAAQMD, personal communication 1992).

LEGEND:

- ● Gaseous pollutant or multipollutant monitoring site
- o Particulate sampling only
- ✧ ARB operated site
- * Discontinued during year
- † Site relocated

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Source: California Air Resources Board, California Air Quality Data, (1990)

SAN FRANCISCO BAY AREA AIR BASIN MONITORING STATIONS OPERATING DURING 199

Figure 3.5-1

Table 3.5-3

1990 CALIFORNIA AIR MONITORING NETWORK

Basin County Station	Basin and Station Number	Pollutants Monitored													Agency
		Gaseous							Particulate						
		O_3	CO	NO NO_2 NO_x	SO_2	H_2S	THC	CH_4 NMHC	TSP	Pb	SO_4	NO_3	PM_{10}	COH NEPH	
San Francisco Bay Area Air Basin	**02**														
Alameda County															
Fremont-Chapel Way	6000336	X	X	X			X	X	X	X	X	X	B	X	D
Hayward-La Mesa	6000337	X													D
Livermore-Old First Street	6000340	X	X	X			X	X	X	X	X	X	B	X	D
Oakland-Alicia	6000339	X	X												D
San Leandro-Hosp	6000343	X											B		D
Contra Costa															
Bethel Island	700442	X	X	X	X				X	X	X	X	B	X	D
Concord-2975 Treat Blvd.	700440	X	X	X	X		X	X	X	X	X	X	B	X	D
Crockett-Kendall Avenue	700437				X										D
Martinez-Jones Street	700434				X										D
Pittsburg	700430	X	X	X	X		X	X	X	X	X	X		X	D
Richmond-10675 7th Street	700441				X										D
Richmond-13th Street	700433	X	X	X	X		X	X	X	X	X	X	B	X	D
Marin County															
San Rafael	2800783	X	X	X			X	X	X	X	X	X	B	X	D
Napa County															
Napa-Jefferson Street	2800782	X	X	X			X	X	X	X	X	X	B	X	D
San Francisco County															
San Francisco-10 Arkansas	9000306	X	X	X	X		X	X	X	X	X	X	B	X	D
San Francisco-Ellis Street	9000303		X												D
San Mateo County															
Redwood City	4100541	X	X	X			X	X	X	X	X	X	B	X	D

Table 3.5-3
(Continued)

1990 CALIFORNIA AIR MONITORING NETWORK

Basin County Station	Basin and Station Number	Pollutants Monitored													Agency
		Gaseous							Particulate						
		O_3	CO	NO NO_2 NO_x	SO_2	H_2S	THC	CH_4 NMHC	TSP	Pb	SO_4	NO_3	PM_{10}	COH NEPH	
Santa Clara County															
Gilroy-9th Street	4300389	X	X												D
Los Gatos	4300380	X													D
Mountain View-Cuesta	4300387	X													D
San Jose-4th Street	4300382	X	X	X			X	X	X	X	X	X	B	X	D
San Jose-Moorpark	4300377								X	X	X	X	B		D
San Jose-Piedmont Road	4300386	X													D
San Jose-Tully Road	4300391												B		D
San Jose-West San Carlos	4300390	X	X	X					X	X	X	X	B	X	D
Solano County															
Benicia	4800876				X										D
Fairfield-Bay Area APCD	4800875	X													D
Vallejo-Tuolumne	4800879	X	X	X	X		X	X	X	X	X	X		X	D
Sonoma County															
Santa Rosa-837 Fifth Street	7900893	X	X	X			X	X	X	X	X	X		X	D
Sonoma-1st Street	4900887	X													D

Footnotes

Not all data reported from the air monitoring stations are published.

A = California Air Resources Board is the responsible agency.
B = NO_3-10, SO_4-10, C1-10, and NH_3-10 analyses included.
D = The Air Pollution Control District is the responsible party.
E = Episode monitoring.
F = A federal agency is responsible.
P = Private industry is the responsible agency.
S = Special studies.
* = Not all data from the air monitoring station has been received at this time.
( ) = Indicates pollutant monitoring was discontinued during the year.

Table 3.5-4

PROJECT LOCATION AIR QUALITY TRENDS

Pollutant	One Hour Standard (Unless Noted)		Vallejo-Tuolumne			Richmond (13th Street)		
	State	Federal	1989	1990	1991	1989	1990	1991
Ozone	0.09 ppm	0.12 ppm						
Days Exceeding Federal Standard			0	0	0	0	0	0
Days Exceeding State Standard			2	2	2	1	0	0
Carbon Monoxide	9.0 ppm[1]	9.0 ppm[1]						
Days Exceeding Federal Standard			2	0	0	0	0	0
Days Exceeding State Standard			2	0	0	0	0	0
Nitrogen Dioxide	0.25 ppm	0.53 ppm[2]						
Days Exceeding Federal Standard			0	0	0	0	0	0
Days Exceeding State Standard			0	0	0	0	0	0
Sulfur Dioxide	0.25 ppm	0.14 ppm [3]						
Days Exceeding Federal Standard			0	0	0	0	0	0
Days Exceeding State Standard			0	0	0	0	0	0
Suspended Particulate Matter (PM_{10})+	50 ug/m^3	150 ug/m^3						
Days Exceeding Federal Standard						0	0	0
Days Exceeding State Standard						5	5	9

[1] 8-hour average
[2] Annual average
[3] 24-hour standard
+PM_{10} Monitor installed at Vallejo (Tuolumne) station in 1991, no data available.

Table 3.5-5

SAN FRANCISCO BAY AREA BASIN AIR QUALITY TRENDS

Pollutant	One Hour Standard (Unless Noted)		Days		
	State	Federal	1989	1990	1991
Ozone	0.09 ppm	0.12 ppm			
Days Exceeding Federal Standard			4	2	2
Days Exceeding State Standard			22	14	23
Carbon Monoxide	9.0 ppm[1]	9.0 ppm[1]			
Days Exceeding Federal Standard			0	6	4
Days Exceeding State Standard			0	6	4
Nitrogen Dioxide	0.25 ppm	0.053 ppm[2]			
Days Exceeding Federal Standard			0	0	0
Days Exceeding State Standard			0	0	0
Sulfur Dioxide	0.25 ppm	0.14 ppm[3]			
Days Exceeding Federal Standard			0	0	0
Days Exceeding State Standard			0	0	0
Suspended Particulate (PM_{10})+	50 ug/m^3	150 ug/m^3			
Days Exceeding Federal Standard			0	2	2
Days Exceeding State Standard			51	34	18

[1] 8-hour average
[2] Annual average
[3] 24-hour standard
+PM_{10} Monitor installed at Vallejo (Tuolumne) station in 1991, no data available.

Table 3.5-6

TOXIC AIR CONTAMINANTS 1989 AIR MONITORING DATA VALLEJO MONITORING STATION

Pollutant	Max (ppb)[1]	Min (ppb)	Number of Obs[2]	OBS <LOD[3]	Mean[4] (ppb)	Concentration for Excess Cancer Risk of 1 in 1 Million[5]
Benzene	6.95	0.40	24	0	1.63	0.01
Carbon Tetrachloride	0.12	0.09	24	0	0.10	0.004
Chloroform	0.08	<0.02	24	12	0.02	0.04
Ethylene Dichloride	<0.10	<0.10	24	24	<0.10	0.011
Ethylene Dibromide (EDB)	<0.02	<0.02	24	24	<0.02	0.002
Methylene Chloride	1.30	<0.50	24	12	0.47	0.28
Methyl Chloroform	1.16	0.19	24	0	0.37	NC[6]
Perchloroethylene (Perc)	0.86	0.07	24	0	0.33	0.25
Toluene	12.25	0.70	24	0	3.16	NC[6]
Trichlorethylene (TCE)	0.09	<0.08	24	21	0.05	0.09
Vinyl Chloride	<0.30	<0.30	24	24	<0.30	0.005

1 ppb = parts per billion
2 Observations
3 Number of observations less than analytical limits of detection (LOD).
4 Includes observations that were less than LOD as 1/2 LOD.
5 Theses are concentrations at and above which there is a 1 in 1 million cancer risk. Unit risk factors used to calculate these values were obtained from the California Air Pollution Control Officers Association (CAPCOA) Risk Assessment Guidelines (1991).
6 NC = Not a carcinogen.

Source: Bay Area Air Quality Management District 1990.

Since September 1991, the quantity of fugitive POC emissions from the Marine Terminal has been significantly reduced with the installation of the previously discussed vapor recovery system which captures and destroys the POCs in a thermal oxidizer. The POCs are broken down to largely odorless compounds of water and carbon dioxide.

3.5.4 Existing Conditions

This section focuses on emissions associated with Marine Terminal operation. Refinery emissions are included in the ambient conditions presented in Table 3.5-3. A separate EIR is being prepared for a reformulated gasoline project.

The types of emissions associated with the current operation of the Marine Terminal are attributed to direct and indirect sources of emissions. The majority of the direct emissions, as summarized in Table 3.5-7, are organic compounds that are precursors to ozone formation or POCs. Note that because operations vary on a day-to-day basis, emissions are calculated on a ton-per-year basis and then averaged to a daily basis for comparison with the daily impact criteria.

There are four direct sources of emissions from the utilization of the Unocal Marine Terminal:

1. thermal oxidizer,
2. loading operations,
3. ballasting, and
4. fugitives (pumps, valves, and flanges).

The lightering of vessels is also a direct source of emissions; however, since this activity has not been practiced in association with the Unocal Marine Terminal since prior to 1988, it has been excluded from analysis.

Indirect sources of emissions are more likely to be mobile source emissions. The indirect emissions associated with the Unocal Marine Terminal include those emitted from trucks, barges, tankers, tugboats, etc., as they travel within the jurisdiction of the BAAQMD.

There are three indirect sources of emissions from the utilization of the Unocal Marine Terminal:

1. vessels,
2. truck transportation, and
3. rail transportation.

Descriptions of each of these direct and indirect sources and the identification of the emissions associated with each are provided below. The assumptions and methodologies utilized in quantifying the emissions are contained in Appendix F. These emissions are summarized in Table 3.5-8. Again, because operations vary on a day-to-day basis, emissions are calculated on a tons-per-year basis and then averaged to a daily basis.

3.5.4.1 Thermal Oxidizer

In September 1991, the quantity of POC emissions from the Marine Terminal was significantly reduced with the installation of the vapor recovery system that captures and destroys the POCs in a thermal oxidizer. The POCs are broken down to water and carbon dioxide. The destruction efficiency of the thermal oxidizer has been demonstrated to be greater than 95 percent as required by BAAQMD rules and regulations. The loading of petroleum liquids at the Terminal, according to BAAQMD permit conditions, may not be performed without the vapor recovery system and thermal oxidizer being in full operation.

The pollutants emitted from the thermal oxidizer that are associated with combustion consist of NO_x, SO_x, CO, and PM_{10}. The remaining 5 percent of the captured POC emissions that are not destroyed by the thermal oxidizer are also emitted and accounted for under "loading operations."

The unloading of crude and product is not controlled by the thermal oxidizer but is controlled through the use of an inert gas system (IGS). As material is removed from the hold it creates a vacuum. Exhaust emissions from the ship's engines are then drawn into the ship to fill the vacuum created as the petroleum is removed. Using this process, negligible amounts of vapors escape the ship.

Furthermore, the ballasting operations are not controlled by the thermal oxidizer. This is because only about 16 percent of the ships that call on the Marine Terminal are ballasted. Some of these ships use separate ballast tanks that do not purge petroleum vapors. Finally, most ballasted vessels offload crude,

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Table 3.5-7

AVERAGE ANNUAL EMISSIONS FOR DIRECT SOURCES
(tons per year)

Emission Source	PM_{10}	SO_X	NO_X	POC	CO
Vapor Recovery/Thermal Oxidizer	4.2	2.6	11.9	0.00	9.5
Loading Operations[1]	0.00	0.00	0.00	6.9	0.00
Ballasting	0.00	0.00	0.00	9.1	0.00
Pump, Valves, and Flanges	0.00	0.00	0.00	16.9	0.00
TOTAL	**4.2**	**2.6**	**11.9**	**32.9**	**9.5**
Total (pounds per day)	23.0	14.2	65.2	180.3	52.1

1 Unloading operations produce negligible POC emissions.

Table 3.5-8

AVERAGE ANNUAL EMISSIONS FOR INDIRECT SOURCES
(tons per year)

Emission Source	PM_{10}	SO_x	NO_x	POC	CO
Vessels	197.8	833.7	956.0	101.0	170.9
Trucks[1]	1.1	10.4	8.5	2.1	6.7
Railroad[1]	0.1	0.2	1.4	0.4	0.5
Total	199.0	844.3	965.9	103.5	178.1
Total (pounds per day)	1,090.4	4,626.3	5,292.6	567.1	975.9

1 See text for an explanation of the distances involved. Emissions based on emission factors presented by EPA in AP-42, A Compilation of Air Pollutant Emission Factors, 1985.

and this crude emits very little POC emissions (see Section 3.5.4.3).

3.5.4.2 Loading Operations

The primary source of POC emissions from Marine Terminal operations is from loading activities. Loading losses occur as POC vapors in "empty" cargo tanks are displaced to the atmosphere by the petroleum liquid being loaded in the tanks. The emissions are a composite of vapors generated from the evaporation of residual liquids and vapors formed in the tank as new liquids are being loaded. The quantity of vapors is dependent on the physical and chemical characteristics of both the previous cargo and the new cargo and the methods of loading.

As of September 1991, 95 percent of the POC emissions from the loading of all petroleum liquids are captured and destroyed in the vapor recovery system.

3.5.4.3 Crude Oil Ballasting

Ballasting is the practice of loading several cargo tank compartments with sea water after the cargo has been offloaded. The water, termed "ballast," provides improvement in the stability and drift of the ship under voyage. Typically, a ship is ballasted from 15 to 40 percent of capacity. In some vessels, ballast tanks are segregated from the cargo tanks and, therefore, no POC emissions are emitted from the ballasting operation. The four ships operated by West Coast Shipping Company that call on the Terminal to unload crude oil have segregated ballast tanks. These ships accounted for 84 percent of the crude oil unloading calls to the Terminal during 1985-1989 with "outside tankers" comprising the other 16 percent. This ratio is assumed to be consistent with Unocal's current crude oil offloading operations. Because the ballast configuration of these outside tankers is unknown, it is assumed that the ballast tanks are nonsegregated. Furthermore, as a worst-case scenario, these tankers are assumed to be ballasted to 40 percent of capacity.

Ballasting of cargo tanks reduces the quantity of emissions emitted during subsequent tanker loading. During the ballasting process, POC emissions are emitted to the atmosphere as the vapors from nonsegregated tanks are displaced with ballast. Currently, these emissions are not controlled by the vapor recovery system.

3.5.4.4 Fugitives (Pumps, Valves, and Flanges)

There are numerous pipelines associated with the Marine Terminal that transport petroleum liquids between the Refinery and the Terminal. The pumps, valves, and flanges associated with these pipelines are sources of fugitive emissions of POC. The leakage from these components is a function of the liquid being transported and the effects of variables, such as pressure, vibration, friction, heat, and corrosion.

The included analysis ensures that all pumps, valves, and flanges are either in operation or contain residual material at all times. Therefore, this analysis is based on emissions being produced 24 hours per day, 365 days per year. This probably overestimates the actual emissions as operations are not conducted daily and residual material within the pumps, valves, and flanges when not under pressure would generate fewer emissions.

3.5.4.5 Vessels

Vessels, (tankers and barges) which call at the Marine Terminal contribute indirect emissions to terminal operations. The indirect emissions consist of the combustion of fuel oil by the vessels' engines and generators while within the Golden Gate Bridge.

3.5.4.6 Truck and Rail Transportation

Indirect emissions result from the use of trucks and rail to export product from the Refinery operations.

Trucks are currently used to remove coke, lube oil, sulfur, and bulk and package wax from the Unocal facility. No import of raw product is performed by truck. Total trips for this export are averaged at 23,103 trips per year. Approximately 533,510 roundtrip miles are associated with these existing trucking operations. These miles are based on a 90-mile roundtrip, except for the export of coke that is transported only to the Unocal calciner located in Rodeo (i.e., 10 miles for a roundtrip).

As with truck traffic, no raw product is shipped into the Refinery by rail. However, butane, lube oil, and bulk wax are shipped out by rail. These shipments account for approximately 37 trips per year. This analysis assumes the use of two engines per train with each engine consuming 100 gallons per hour and 2 hours of operation within the BAAQMD.

3.5.4.7 Transit Losses

Transit losses typically result from the evaporation of petroleum liquids while the cargo is in transit. These losses are similar to breathing losses associated with petroleum storage tanks. POC emissions depend on the vapor tightness of the tank, the extent of venting during transit, the pressure relief settings, the pressure in the tank, the vapor pressure of the petroleum liquid, and the vapor/liquid saturation of the space above the liquid in the tank. All ships that call on the Terminal operate with an IGS. This system draws exhaust from the engines into the tanks during unloading operations and serves two purposes. First, as the space above the petroleum is filled with these exhaust emissions, it becomes deprived of oxygen. This oxygen would be necessary to support combustion. Therefore, this lack of oxygen ensures that the contained petroleum cannot burn. Second, this exhaust gas, along with vapor-tight seals, ensures that the tanks do not emit petroleum vapors to the atmosphere after the ship reloads and is underway. This then reduces transit losses to negligible (BAAQMD, personal communication 1993).

3.5.4.8 Future Conditions

The emissions associated with the operation of the Marine Terminal under future conditions should either remain unchanged or decrease through the implementation of compliance with rules, regulations, and plans of the BAAQMD.

Any increases in direct emissions that may result from future operational changes of the Marine Terminal will be required to be in compliance with the applicable rules and regulations of the BAAQMD. New or modified emission sources will be subject to the Best Available Control Technology (BACT) and offsetting provisions of Regulation 2 Rule 2 (New Source Review). Therefore, no net increase in Marine Terminal emissions will take place.

Future emissions from indirect sources should remain unchanged or decrease as BAAQMD implements transportation control measures contained in their "Bay Area '91 Clean Air Plan" and indirect source control programs as required in the CCAA. Further, as EPA vehicle emissions limitations become more stringent and the California Air Resources Board extends pollutant testing to diesel trucks, future vehicles will emit fewer pollutants further reducing indirect emission sources.

3.6 VEHICULAR AND RAIL TRANSPORTATION

The ground transportation system that could be affected by the various project alternatives includes existing and future local and regional rail and highway facilities within the Rodeo area that connect the Unocal site with major inland rail and truck terminals. Of concern are San Pablo Avenue, Willow Avenue, John Muir (SR-4) west of interchange I-80, and I-80.

3.6.1 Highway Transportation System

3.6.1.1 Existing Roadways

The Refinery does not receive any crude oil via truck or train. All crude is delivered to the Refinery via Unocal's Oleum Pipeline or by ship. Trucks are used to transport coke, lube oil, sulfur, bulk wax, and packaged wax from the facility.

The existing regional interstate and state highway systems within the Rodeo area are shown on Figure 3.6-1. Arterial highways and freeways are most critical for the removal of product from the Refinery. San Pablo Avenue, a four-lane arterial, provides site access, and I-80 serves as the major transportation corridor for the movement of product. Both experience considerable congestion according to the County General Plan.

From San Pablo, trucks proceeding to or emanating from the north utilize I-80. Access is at the interchange of San Pablo Avenue, Pomona Street, and I-80. Trucks proceeding to or emanating from the south also utilize I-80. Here, access is at the interchange of Willow Avenue (also a four-lane arterial) and I-80 or John Muir (SR-4, a two-lane arterial) and I-80.

San Pablo Avenue provides the access to the Unocal Refinery and, ultimately, the pier. Information on traffic along the road (as well as its extension) was obtained from the County of Contra Costa Department of Public Works (personal communication, Vendon Mcleod, August 11, 1992). Table 3.6-1 summarizes the obtained data.

Data for both I-80 and SR-4 were obtained from Caltrans (1990) and are summarized in Table 3.6-2. (Note that Caltrans neither presents individual values for each direction of the two-way traffic nor differentiates whether the a.m. or p.m. peak hour contains the greater volume of traffic).

Mr. Mcleod also provided data along Parker at 4th Street to determine the percentage of automobiles, medium trucks, and heavy trucks. Three hours' worth of data were presented (3:00 to 6:00 p.m.). Of the 3,584 vehicles passing this point during this 3-hour period, nine were medium trucks, while 26 were heavy trucks. Thus, 99 percent were automobiles, 0.3 percent were medium trucks, and 0.7 percent were heavy trucks.

These data were not borne out by field visits conducted by the Chambers Group on August 21, September 15, and October 19, 1992. The average vehicle ratio for these 3 days was 90.2 percent automobiles, 3.7 percent medium trucks, and 6.1 percent heavy trucks. Due to the industrial nature of the area, these data are more typical of the project area.

The percentages of each class of vehicles for I-80 and SR-4 were ascertained for data contained in "1989 Annual Average Daily Truck Traffic on the California State Highway System" (1990). Table 3.6-3 lists the percentages of automobiles, medium trucks, and heavy trucks along the I-80 and SR-4 in the project vicinity.

Based on the percentages present on the freeway and highway, the percentages provided by the County of Contra Costa of both medium and heavy trucks would appear to be low on the surface streets. However, one must consider the time at which the counts were obtained (i.e., 3:00 to 6:00 p.m.). Most heavy trucking is performed during the early hours of the day because trucks typically pick up and deliver materials to be used during the work day. Furthermore, most trucking is completed by 3:00 p.m. to avoid the evening rush. This is verified by the 3 hours of counts on Parker where 3:00 to 4:00 p.m. contained 18 trucks, 4:00 to 5:00 p.m. contained 14 trucks, and 5:00 to 6:00 p.m. only contained 3 trucks.

3.6.1.2 Project-Generated Road Traffic

Though no raw product is trucked into the Refinery, product is trucked away from the site. These products include coke, lube oil, sulfur, bulk wax, and packaged wax. Each is subsequently addressed.

Coke is transported from the facility to the Unocal calciner located in Rodeo on Highway 4. The trucks proceed from the Refinery through the town of Rodeo

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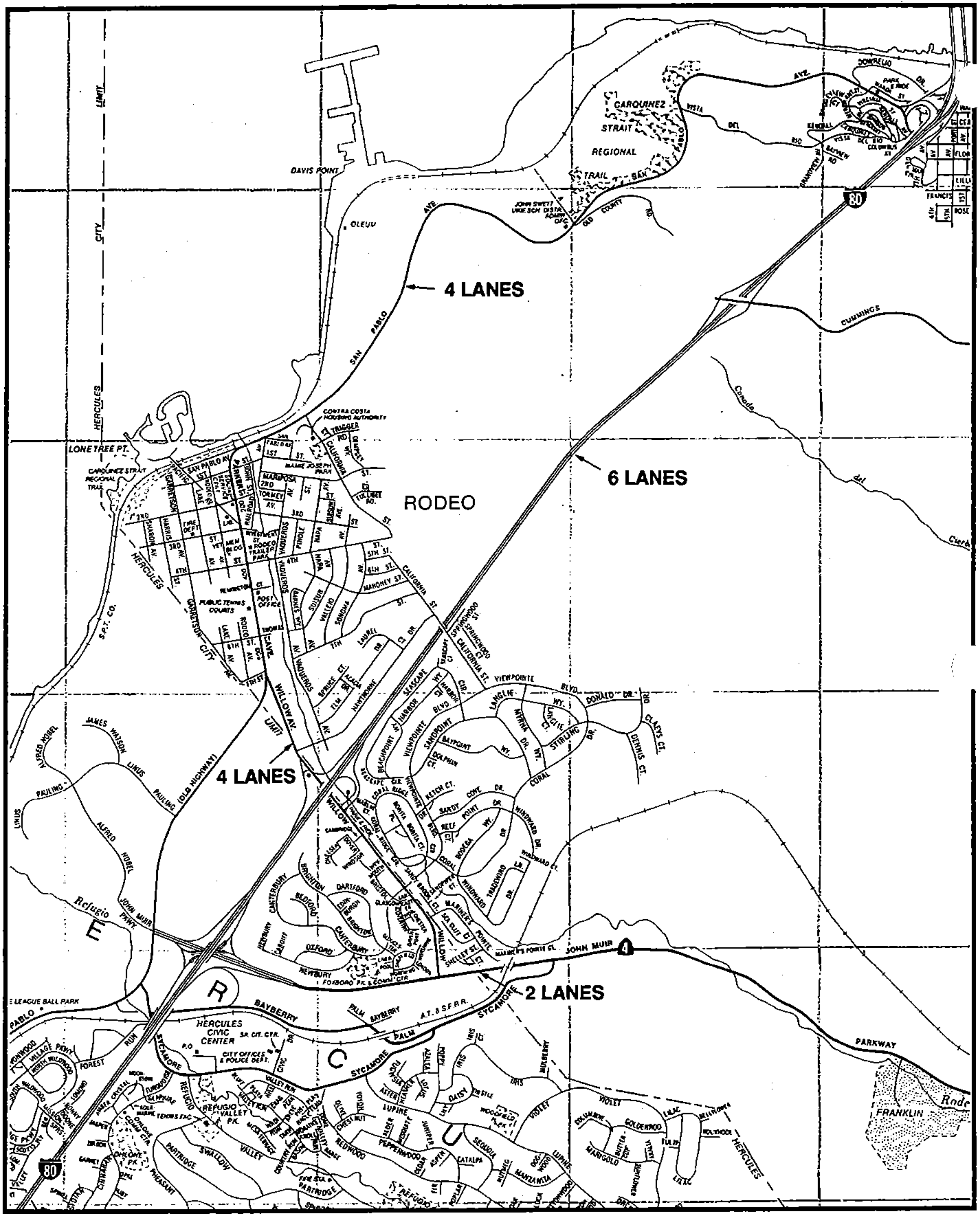

REGIONAL ROADWAY AND RAILWAY SYSTEM

Figure 3.6

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Source: California State Automobile Association
Benicia, Hercules, Rodeo, Crockett, Port Costa, CA

Table 3.6-1

TRAFFIC VOLUMES IN PROJECT AREA

Road Name	Location	Direction	ADT	A.M. Peak Hour (time)	A.M. Peak Hour (volume)	P.M. Peak Hour (time)	P.M. Peak Hour (volume)
San Pablo Avenue	West of Wanda	East-bound	1,636	7:45	66	5:30	256
San Pablo Avenue	West of Wanda	West-bound	1,906	6:00	387	2:15	142
San Pablo Avenue	North of California	North-bound	2,786	6:15	267	4:45	339
San Pablo Avenue	North of California	South-bound	2,203	10:45	159	3:00	292
San Pablo Avenue	South of Willow	North-bound	3,320	11:00	179	5:15	454
San Pablo Avenue	South of California	South-bound	3,206	6:30	412	3:30	206
Parker Avenue	North of 4th Street	North-bound	6,188	10:45	417	5:15	832
Parker Avenue	North of 4th Street	South-bound	6,178	11:00	403	3:15	436
Willow Avenue	South of San Pablo	North-bound	6,253	7:00	441	6:00	510
Willow Avenue	South of San Pablo	South-bound	5,586	11:45	322	4:00	434

Table 3.6-2

FREEWAY AND HIGHWAY VOLUMES IN PROJECT AREA

Route No.	Location	ADT	Peak Hour Traffic
I-80	Carquinez Bridge - Crockett Interchange	105,000	12,600
I-80	Crockett Interchange - Cumming Skyway Interchange	107,000	12,800
I-80	Cumming Skyway Interchange - Willow Avenue Interchange	100,000	12,000
I-80	Willow Avenue Interchange - SR-4 Interchange	99,000	11,300
SR-4	I-80 - Willow Avenue	30,000	3,300

Table 3.6-3

VEHICLE MIX ON FREEWAYS AND HIGHWAYS IN PROJECT AREA

Roadway Name	Location	Percent Autos	Percent Med. Trucks	Percent Heavy Trucks
I-80	Carquinez Bridge	93.3	1.8	4.9
I-80	SR-4	92.6	2.3	5.1
SR-4	I-80	90.7	3.6	5.7

via San Pablo Avenue then eastbound on Highway 4 to the calciner. This coke hauling is performed 24 hours per day, 7 days per week. A typical truckload of coke is approximately 22.5 tons. In 1990 and 1991, coke trucks made 18,583 and 20,062 trips to the calciner, respectively.

Lube oil is transported via truck to various locations too numerous to list. Within the project area the major route proceeds through the town of Rodeo and on to I-80. Lube oil is hauled in tank trucks with a typical capacity of 195 bbl. In 1990 and 1991, lube oil trucks made 472 and 342 trips from the Refinery, respectively.

Sulfur is also transported via truck to various locations too numerous to list. Again, the major route proceeds through the town of Rodeo and on to I-80. In general, each load weighs 27 tons. In 1990 and 1991, sulfur trucks made 1,976 and 2,056 trips from the Refinery, respectively.

Bulk wax is also transported via truck to various locations too numerous to list. Here again, the major route proceeds through the town of Rodeo and on to I-80. In general, bulk wax is shipped in 180 barrel tank trucks. In 1990 and 1991, bulk wax deliveries accounted for 861 and 1,134 trips from the Refinery, respectively.

Package wax is transported in slabs. Truckloads of slabbed wax can range in size from 1 to 24 tons with a typical truckload being 22 tons. In 1991, 360 truck trips were made for the delivery of package wax.

3.6.1.3 Future Roadway Improvements

The Contra Costa County General Plan, for up to the year 2005, identifies a proposed six-lane freeway bypass for SR-4 that would alleviate congestion on the present two-lane portion of SR-4 (John Muir Parkway). A six-lane Richmond Parkway is also proposed to tie into I-80 about 6 miles south of Davis Point. Future projections to the year 2005 estimate an overall increase in trip generation of 6.5 percent.

3.6.2 Rail Transportation

Regional rail access to and from the Unocal site is by existing Southern Pacific Transportation Company rail facilities that extend both north and south from the project area (Figure 3.6-1). Conversation with Richard McCloskey of Southern Pacific Transportation Co. (SPT) revealed tbat, within the project area, the railroad operates a single line track that uses welded rails. Approximately 12 trains use this track on a daily basis. Trains average 46 railcars and two engines. The average speed is 22.25 mph, and 36 percent of the operations are conducted between 10:00 p.m. and 7:00 a.m. However, operations are subject to occur at all hours with frequent changes in response to the needs of SPT's customers.

3.6.2.1 Project-Generated Rail Traffic

As with road-based transportation, no raw product is shipped into the Refinery by rail. However, product is shipped out via railroad. These products include butane, lube oil, and bulk wax. Each is addressed below.

Butane is transported from the facility in 750 bbl tank cars to the Unocal Refinery located at Wilmington, California, or to underground storage in Arizona. This material is typically loaded during regular business hours. In 1990 and 1991, there were 1,012 and 1,499 trips, respectively.

Lube oil is transported in 550-bbl tank cars typically loaded during regular business hours to various locations. In 1990 and 1991, 314 and 341 lube oil shipments were made via rail, respectively.

Bulk wax is also transported to various locations in 550-bbl tank cars typically loaded during regular business hours. In 1990 and 1991, 89 and 130 bulk wax shipments were made via rail, respectively.

3.6.3 Regulatory Setting/Compliance

Those portions of the affected ground transportation system available for public use are regulated by local, state, and federal agencies.

Interstate highways, state routes, and bridges are governed by the Federal Highway Administration (FHA) and Caltrans; county roads are governed by the County of Contra Costa; and other local streets and highways are governed by local cities. In all cases, specific standards apply with respect to the planning, design, and operation of roadways and intersections. It is important to note that not all governing agencies impose the same criteria (e.g., cross sections and rights-of-way for the same street may differ from jurisdiction to jurisdiction).

Rail facilities are regulated in the state by the Public Utilities Commission (PUC). The operation of trains is also subject to PUC guidelines; the design and operation of railroad grade crossings are subject to Federal Railroad Administration (FRA) guidelines. Numerous other federal agencies also have regulatory authority over rail transportation.

3.7 NOISE

3.7.1 Fundamental Concepts of Environmental Acoustics

For purposes of this evaluation, noise is defined as unwanted sound. Airborne sound is a rapid fluctuation of air pressure above and below atmospheric pressure. Sound levels are usually measured and expressed in decibels (dB) with 0 dB corresponding roughly to the threshold of hearing.

Most of the sounds we hear in the environment do not consist of a single frequency, but rather of a broad band of frequencies with each differing in sound level. The intensities of each frequency combine to generate a sound. The method commonly used to quantify environmental sounds consists of evaluating all of the frequencies that comprise a sound in accordance with a weighting that reflects the fact that human hearing is less sensitive at low frequencies and extremely high frequencies than in the frequency mid-range. This is called "A" weighting, and the decibel level so measured is called the A-weighted sound level (dBA). In practice, the level of a sound source is conveniently measured using a sound level meter that includes an electrical filter corresponding to the A-weighting curve.

Although the dBA level may adequately indicate the level of environmental noise at any instant, community noise levels (i.e., unwanted sound) vary continuously. Most environmental noise is a conglomeration of noise from distant sources creating a relatively steady background noise in which no particular source is identifiable. Time variation in noise exposure is typically expressed in terms of a steady-state energy level equal to the energy content of the time varying period (called Leq) or, alternately, as a statistical description of the sound level that is exceeded over some fraction of a given observation period. The statistical noise descriptors, L10, L50, and L90, are commonly used; they are the dBA levels equaled or exceeded during 10, 50, and 90 percent of a stated time period. Finally, because community receptors are more sensitive to unwanted noise intrusion during the evening and at night, state law requires that, for planning purposes, an artificial dB increment be added to quiet-time noise levels in a 24-hour noise descriptor called the Community Noise Equivalent Level (CNEL) or Day-Night Noise Level (Ldn). For the CNEL descriptor, a 5-dBA penalty is added to the noise produced between 7:00 and 10:00 p.m. and a 10-dBA penalty is added to noise produced between the hours of 10:00 p.m. and 7:00 a.m. The Ldn is calculated in the same manner but no penalty is added to the 7:00 to 10:00 p.m. noise. Both descriptors give roughly the same 24-hour average with the CNEL being slightly more restrictive.

The effects of noise on people can be listed in three general categories:

- Subjective effects of annoyance, nuisance, and dissatisfaction;
- Interference with activities such as speech, sleep, and learning; and
- Physiological effects such as startling and hearing loss.

The levels associated with environmental noise, in almost every case, produce effects only in the first two categories. Workers in facilities such as industrial plants can experience effects in the last category. Unfortunately, there is as yet no completely satisfactory way to measure the subjective effects of noise or of the corresponding reactions of annoyance and dissatisfaction. This is primarily because of the wide variation in individual thresholds for annoyance, and individual habituation to noise resulting from past experiences with noise.

Thus, an important way of determining a person's subjective reaction to a new noise is comparison with the existing environment to which one has adapted. In general, the more a new noise exceeds the previously existing ambient noise level, the less acceptable the new noise will be judged by the hearers.

With regard to increases in dBA levels, knowledge of the following relationships will be helpful in understanding this report:

- Except in carefully controlled laboratory experiments, a change of 1 dBA cannot be perceived.
- Outside of the laboratory, a 3-dBA change is considered a just-perceivable difference.
- A change in level of at least 5 dBA is required before any noticeable change in community response would be expected.

- A 10-dBA change is subjectively heard as approximately a doubling in loudness, and would almost certainly cause an adverse change in community response.

3.7.2 Region of Influence

The region of influence (ROI), in this case, is defined as the area surrounding the offshore and onshore elements of the project alternatives. The ROI also includes the corridors adjoining the ground transportation routes, including both vehicular and rail traffic, that would be used to access the Refinery. Any noise-sensitive receptors that could be affected by noise from project construction or operation, both onsite and offsite, are included in the ROI.

3.7.3 Existing Conditions

The noise in and around the Unocal Refinery results from a wide variety of sources at the Refinery, at the Wickland Terminal adjacent to the east, at the Pacific Refining Refinery about 1 mile to the south, the Pacific Refining Company Marine Terminal about 1,000 feet to the west, and the City of Rodeo to the southeast. Primary noise sources at the Refinery include loading facilities, extensive truck traffic, and occasional trains. In the residential neighborhoods of Rodeo, noise from the various terminals is heard as a steady sound in the background punctuated by separate identifiable sounds, such as from a horn honking, the running of a ship's engine, or a train.

In addition to sound generated by Terminal and Refinery activities, the noise environments in the surrounding communities are affected by vehicular traffic on the local streets, trains, aircraft flying overhead, and other typical neighborhood noises.

Traffic-generated noise is dependant on several factors: the volume and speed of traffic; and the ratio of cars, medium trucks, and heavy trucks (or vehicle mix). To determine the vehicle mix on the local roadways, Chambers Group conducted field monitoring along San Pablo Avenue on August 21, September 15, and October 19, 1992. The average vehicle mix for these monitored periods was 90.2 percent automobiles, 3.7 percent medium trucks, and 6.1 percent heavy trucks.

On and offsite noise monitoring was conducted using a Larson-Davis LDL Model 700 Dosimeter/Type 2 Integrating Sound Level Meter. The unit meets the American National Standards Institute Standard S1-4-1983, Type 2 and International Electrotechnical Commission Standard 651, Type 2.

The unit was calibrated prior to the first set of readings. The accuracy of the calibrator is maintained through a program established through the manufacturer and is traceable to the National Bureau of Standards. The unit meets the requirements of the American National Standards Institute Standard S 1.2-1971 and the International Electrotechnical Commission Publication 123-1961.

Leq noise readings were obtained at four locations, two situated on the Terminal and two along San Pablo Avenue. Noise level locations are shown on Figure 3.7-1.

The first reading was obtained on the pier during the loading of gasoline onto the <u>Coast Range</u>. At this time the <u>Sierra Madre</u> was also at berth, but was not undergoing loading or unloading activities. The reading was obtained at a distance of 50 feet south of the TO. The noise from the this unit is associated with its blowers used to evacuate vapors from the ship's hold. This oxidizer is used to burn off vapors emitted during the loading of gasoline and, with the exception of minor crane noise associated with the occasional movement of a hose, represents the only discernable noise source of all the activities on the pier.

A 16-minute Leq reading (NR-1) was obtained starting at 11:02 a.m. During this time, two cars passed by at slow speed. The wind averaged approximately 4 to 5 mph with gusts to 6 mph. The Leq was 74.3 dBA. The minimum and maximum values were 73.5 and 77.5 dBA, respectively.

The second reading (NR-2) was obtained at a distance of 200 feet to the south of the TO. This 15-minute reading began at 11:22 a.m. The wind averaged 5 to 6 mph with gusts to 8 mph. One aircraft distant overflight was noted during the reading. The Leq was 61.1 dBA with minimum and maximum values of 60.5 and 62.5 dBA, respectively.

To assess the noise contribution from traffic on the access roads, Leq sound level measurements were also

NOISE LEVEL MONITORING LOCATIONS
Figure 3.7-1

taken along San Pablo Avenue, both to the southwest and northeast of the Refinery.

The third reading (NR-3) was taken to the southwest of the Refinery. The meter was situated on a dirt lot approximately 53 feet northwest of the near southwest-bound lane, facing the road. The reading was taken from 12:49 to 12:59 p.m. An Leq of 65.9 dBA was obtained; minimum and maximum values were 47.0 and 85.2 dBA, respectively. During this period, 51 automobiles, 2 medium trucks, and 3 heavy trucks were observed. The average speed was approximately 45 mph. The meter was situated over dirt and gravel (soft site). The wind was steady at 3 mph with gusts from 4 to 6 mph.

The fourth reading (NR-4) was taken to the northeast. The meter was situated on a dirt lot approximately 130 feet west of the corner of Pomona Street on the south side of San Pablo Avenue facing the Carquinez Bridge. Here, the road proceeds up a grade to the west. The bridge was approximately 1/3 mile from the monitored areas. The reading was taken from 1:20 to 1:35 p.m. An Leq of 59.4 dBA was obtained. The minimum and maximum values were 48.5 and 74.0 dBA, respectively. During this period, 53 automobiles, no medium trucks, and 1 heavy truck were observed. The average speed was approximately 35 mph. The meter was situated over dirt and dried grasses (soft site). The wind was steady at 4 mph with gusts from 5 to 7 mph. Ambient noise was also produced by vehicles on the bridge in the background. Furthermore, one aircraft overflight and one train in the distance were noted during this time.

The background noise of the bridge was monitored for 2 minutes when no vehicles passed by. The Leq was 51.6 dBA with minimum and maximum values of 48.0 and 56.5 dBA, respectively.

When modeled using the FHWA Highway Noise Prediction Model and the parameters discussed above, site NR-3 has a predicted Leq of 65 dBA, while NR-4 has an Leq of 59 dBA. Thus, in this case the model appears to be quite accurate in its prediction of the measured vehicle-generated noise.

In addition to measured noise, existing noise levels were modeled for San Pablo Avenue, Parker Avenue, Willow Avenue, I-80, and SR-4. The model is based upon the Federal Highway Traffic Noise Model (FHWA-RD-77-108) as updated with the most recently available California truck noise emissions data (CALVENO-85) for current traffic levels. In calculating CNEL noise levels, hourly traffic volumes were based on the following Caltrans methodology:

- The morning rush hour lasts from 6:00 to 9:00 a.m., and the traffic volume for each hour of this rush hour is equal to 2 hours of standard, nonrush hour daytime traffic.
- The evening rush hour lasts from 4:00 to 7:00 p.m. and the traffic volume of this rush hour is also equal to 2 hours of standard, nonrush hour daytime traffic. This is typical, but exceptions exist where this rush hour may contain more or less than this value.
- Nighttime traffic is equal to 15 percent of the total average daily traffic (ADT) and is divided between the hours of 10:00 p.m. and 6:00 a.m.

In accordance with data obtained in the field, the typical traffic mix consists of 88.4 percent automobiles, 4.2 percent medium trucks, and 7.4 percent heavy trucks on surface streets. The average speed was approximately 40 mph. The vehicle mixes along I-80 and SR-4 were modeled in accordance with the data presented in "1989 Annual Average Daily Truck Traffic on the California State Highway System" (U.S. Department of Transportation, 1990) and were 92.6 percent automobiles, 3.1 percent medium trucks, and 4.3 percent heavy trucks on I-80 and 90.7 percent automobiles, 4.1 percent medium trucks, and 5.2 percent heavy trucks on SR-4. An average speed of 55 mph was assumed. Table 3.7-1 presents the results of the model.

Noise impacts are also possible along railroad lines in the project area. In accordance with data obtained from Southern Pacific Railroad, approximately 12 trains pass through the project area on a daily basis. The average number of engines and railcars are 2 and 46, respectively. The average speed is 22.25 mph and 36 percent of these operations are between the hours of 10:00 p.m. and 7:00 a.m. The rails are welded. Finally, horns are sounded at all grade crossings. Based on the methodology presented in "The Noise Guidebook" (U.S. Department of Urban Development 1985), the railroad would produce a noise level of 69 dBA Ldn at a distance of 100 feet from the rails. This value would be raise to 79 dBA Ldn in areas of grade crossing where the engineer is required to sound a horn or whistle. Table 3.7-2 presents the distances to various railroad noise levels for both scenarios.

Table 3.7-1

MODELED NOISE LEVELS ON LOCAL ROADS IN PROJECT AREA

Road Name	Location	ADT	Ldn (dBA)[1]
San Pablo Avenue	West of Wanda	3,542	67
San Pablo Avenue	North of California	4,989	69
San Pablo Avenue	South of Willow	6,526	70
Parker Avenue	North of 4th Street	12,366	73
Willow Avenue	South of San Pablo	11,839	72
I-80	SR-4 Interchange - Carquinez Bridge	99,000 - 107,000	83
SR-4	I-80 - Willow	30,000	78

[1] As measured at a distance of 50 feet from the centerline of the road.

Table 3.7-2

RAILROAD NOISE AT VARYING DISTANCES IN PROJECT AREA

Case	No Grade Crossing	With Grade Crossing
Ldn @ 100 feet (dBA)	69	79
Distance to 70 dBA Ldn (feet)	95	400
Distance to 65 dBA Ldn (feet)	180	850
Distance to 60 dBA Ldn (feet)	380	1,800

3.8 EARTH RESOURCES AND STRUCTURE STABILITY

3.8.1 Topography/Bathymetry

The Unocal Marine Terminal and filled state lands lie at the northwest tip of Davis Point, a slight promontory at the end of a northwest-trending ridge. The ridge is truncated rather abruptly at the edge of San Pablo Bay; the project site was completely submerged prior to development for Refinery use (Dames and Moore 1945). In the past, shoreline portions of the site were elevated above sea level by the placement of several feet of fill. The fill is largely loose to medium dense, poorly to moderately compacted, fine- to medium-grained sand. Fill thicknesses range from as little as 3.5 feet north of the spherical butane tank No. 302 to more than 16 feet north and west of the grease/wax complex. East of the Terminal connecting wharf (the area of ballast water tank No. 103), fill material is 12 to 13 feet deep (Woodward-Lundgren 1971). The location of these facilities in relation to the Terminal is shown on Figure 3.8-1.

This development of the shoreline properties occurred between 1886 and 1938: an 1886 topographic map of the site (Dames and Moore 1945) shows the area now occupied by shoreline properties of the site still submerged beneath San Pablo Bay. Aerial photographs of the site taken in 1938 show the shoreline properties fully developed. The area of the butane tank thus occupies filled land now elevated slightly above sea level. Elevations on the site are presently 10 to 13 feet above mean sea level (MSL) (Bechtel 1987).

The Marine Terminal extends on a pile foundation from a manmade shore 1,730 feet horizontally into the waters of San Pablo Bay. Bathymetry of the Bay beneath the wharf area is variable, in part due to ongoing dredging operations at the Terminal. Along the north side of the wharf, bathymetry relative to MSL is about 46 feet at the west end, 36 feet at mid-wharf, and 45 feet at the east end. On the shoreward side of the wharf (south side), bathymetry is 20 feet at the west end, 12 feet at mid-wharf, and 38 feet at the east end. Water shallows along the trestle, from 12 feet at the wharf to 0 feet at the shoreward end of the trestle.

3.8.2 Stratigraphy and Soils

3.8.2.1 Regional Characteristics

San Francisco Bay is a drowned river valley that developed within a northwest-trending structural trough formed in Franciscan bedrock. Approximately 2 million years ago, in the Late Pliocene, the San Francisco-Marin block tilted toward the east along the Hayward Fault. The uplifted western edge of the block formed the hills of Marin while the downdropped eastern edge created the elongated depression that is now the Bay. Following the downdropping of the bedrock block, material eroded from the Rodeo/Berkeley/Oakland Hills was deposited in alluvial fans which gradually coalesced to form the broad, gently sloping plain that borders the eastern shoreline of the Bay.

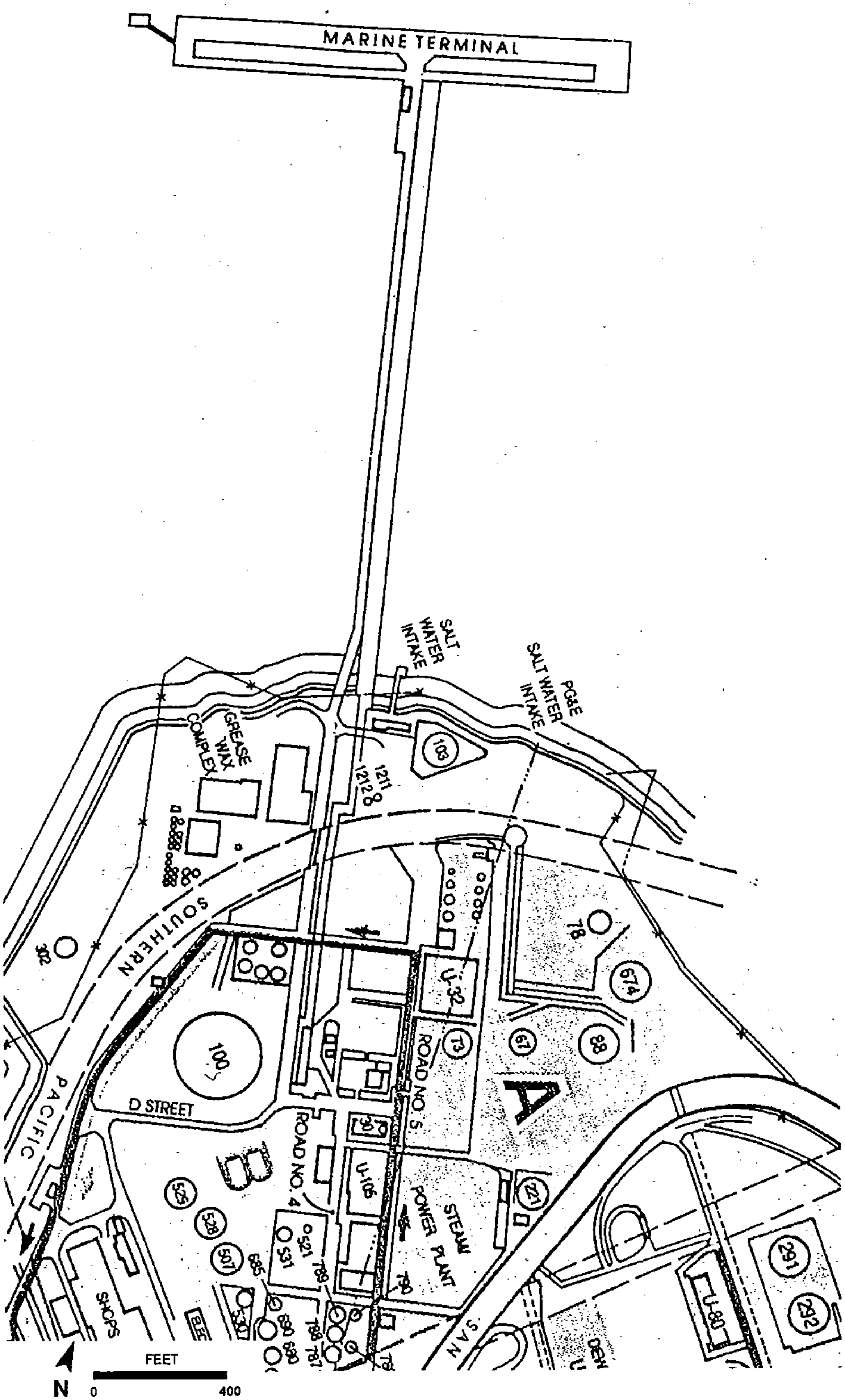
Carquinez Strait and the Golden Gate were formed during the mid-Pleistocene, by a river system that eroded deep channels. Flooding occurred as the sea level rose in response to Pleistocene continental glaciation melting cycles.

Bedrock in the East Bay is Jurassic-Cretaceous (132-62 millions of years of age) to Quaternary in age (less than 1 million years of age). West of the Hayward Fault bedrock is Franciscan Complex, a melange of deep marine sedimentary and volcanic rocks, metamorphic rocks of variable grade, limestones, and radiolarian cherts. East of the Hayward Fault lies a thick sequence of Jurassic-Cretaceous-age, Great Valley sequence sandstones and shales, overlain by a mixed Tertiary-age (60-4 millions of years of age) group of marine and nonmarine sedimentary and volcanic rocks.

Since the Cretaceous (65 Million years) age, the entire region has been subjected to recurrent and, since the mid-Tertiary, continuous folding and faulting. Many rock units, especially those near fault zones, are highly sheared and deeply weathered.

3.8.2.2 Site-Specific Characteristics

Soils investigations were performed for the dolphin structure (Woodward-Clyde 1970) and, more recently, geotechnical studies have been performed for the vapor recovery system on the Terminal (Geomatrix Consultants 1990) and for Phase I hydrocarbon investigations, onshore (Woodward-Clyde 1991). The results of these studies form the background for the



TANKS AND GREASE/WAX COMPLE LOCATIONS
Figure 3.8-1

site-specific characteristics near and under the Terminal.

The San Pablo Group, which forms the bedrock beneath the site, are mid-Tertiary (25 million years of age). Figure 3.8-2 shows geological characteristics surrounding the site.

Under the Terminal, there are submerged bedrock units of the Cierbo and Neroly Formations overlain by young bay deposits and fill. The bedrock units are marine sedimentary rocks of the San Pablo Group. The Neroly Formation is the younger of the two units, resting conformably on top of the Cierbo Formation. The crest of the ridge overlooking the site consists of massive sandstones and siltstones of the Cierbo Formation. The unit strikes northwest and dips to the southwest (Woodward-Clyde 1991). Depth to bedrock varies from a few feet on portions of the shoreline properties to more than 140 feet below the wharf at the Marine Terminal (Woodward-Clyde 1970, Geomatrix 1990).

During late Pleistocene and Holocene time (approximately the last 15,000 years), sea level fluctuations alternately submerged and subaerially exposed low ridges and valleys of a gently rolling landscape just offshore. These fluctuations were responsible for the deposition of three major flat-lying, unconsolidated lithologic units along the predevelopment bayshore (Woodward-Clyde 1991). These units are, in ascending stratigraphic order, the Lower Bay Mud, the Bay Sand, and the Bay Mud (Woodward-Clyde 1991). Deposition of these units has buried the ridge and valley topography that existed in the near offshore prior to sea-level rise.

Beneath the Marine Terminal, there is an additional lower sand unit beneath the Lower Bay Mud. It is described as dark gray, medium- to coarse-grained, with clay and silt layers, and as medium dense to dense. The sand is about 20 feet thick (Woodward-Clyde 1970; Geomatrix 1990).

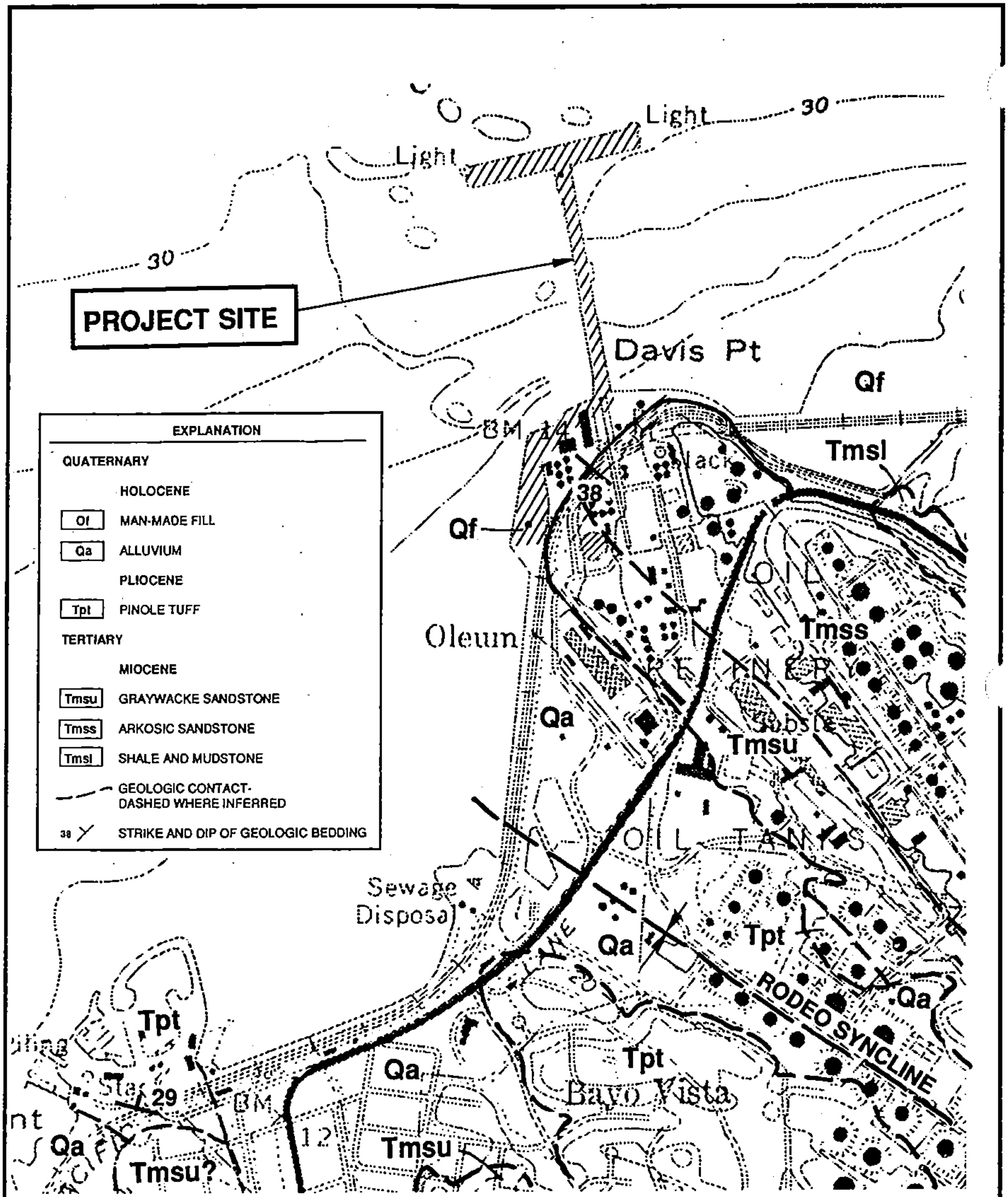
The Lower Bay Mud is a gray clay or silty clay, containing significant amounts of decayed vegetation and, locally, peat. Recent boring log descriptions indicate the unit is soft to medium stiff, although locally, near the base, it is described as stiff (Woodward-Clyde 1991). A hydrogen sulfide odor was noted in some of these borings during drilling. The Lower Bay Mud is thickest near the shore and along the axes of the old drowned valleys, typically exceeding 35 to 40 feet in depth. It is generally absent in the vicinity of the buried ridge tops (Woodward-Clyde 1991). Beneath the Marine Terminal, the Lower Bay Mud is about 65 feet thick, described as soft to stiff (Geomatrix 1990). Locally, there may be zones of loose to medium dense silty sand (Woodward-Clyde 1970).

The Bay Sand, near the Terminal, consists predominantly of fine- and very fine-grained sands and silt. The sand varies widely in thickness; like the Lower Bay Mud, the Bay Sand is somewhat thicker near the axes of the old buried valleys and thinner in the vicinity of the buried ridge tops (Woodward-Clyde 1991). The Bay Sand attains a maximum thickness of 25 to 30 feet along the current shoreline of San Pablo Bay. Beneath the Marine Terminal, however, the Bay Sand is not present.

The Bay Mud is a gray silty clay, containing significant amounts of organic matter. Under most of the Terminal and Refinery area the Bay Mud rests directly on either underlying bedrock or on the Lower Bay Mud. The Mud rests on Bay Sand only along the axis of one of the drowned valleys, corresponding to an area approximately 640 feet wide just onshore of the Marine Terminal between ballast water tank 103 and the grease wax complex and extending from the hillside outward under San Pablo Bay (see Figure 3.8-1). The Bay Mud is approximately 31 feet thick along this swath. It is absent in the subsurface from the grease wax complex westward to the edge of the site (Woodward-Clyde 1990). Beneath the Marine Terminal, where it rests directly on soils of the Lower Bay Mud, the Bay Mud has an approximate thickness of 30 feet.

Prior to Refinery development, the shoreline was several hundred feet to the south of its present location. The shoreline properties have been raised to their present elevations by the placement of varying thicknesses of fill. The fill is largely loose to medium dense, poorly to moderately compacted, fine- to medium-grained sand. The shoreward terminus of the Marine Terminal trestle is constructed on about 13 feet of engineered fill over Bay Mud. Elsewhere along the length of the Terminal, thicknesses range from 10 to 15 feet.

Subsurface conditions at the Marine Terminal were evaluated based on test boring WC-1 drilled by Woodward-Clyde and Associates in September 1970 and GM-1 drilled by Geomatrix Consultants in July 1990 (Woodward-Clyde 1970, Geomatrix 1990). The



REFERENCE : Preliminary Geologic Maps of the Benecia and Mare Island Quadrangles, T.W. Dibblee, 1980, U.S.G.S Open File Report 80-400

GEOLOGICAL CHARACTERISTICS NEAR DAVIS POINT

Figure 3.8-2

locations of the borings are presented on Figure 3.8-3. Boring logs are presented in Appendix G.

For both borings, depths were based on the distance from the top of the concrete deck of the wharf (elevation 17.2 feet). For WC-1, the mud line was encountered at a depth of about 42 feet (EL -25 feet) below the top of the wharf. The materials below the mud line consist mainly of loose, dark gray sand, and very soft, silty clay (Bay Mud), which extend to a depth of 90 feet (EL -73 feet). Beneath the Bay Mud are alternating layers of medium stiff to stiff silty clays, clayey silts, and sandy clays to a depth of about 134 feet (EL -117 feet). Dense sands and gravels were encountered below these depths to hard sandstone rock at a depth of about 152 feet (EL -135 feet).

For GM-1, the mud line was encountered at a depth of about 60 feet (EL -43 feet) below the top of the wharf. Below the mud line, the Bay Mud extends to a depth of 81 feet (EL -64 feet). Beneath the Bay Mud are alternating layers of medium stiff to stiff silty clays, clayey silts, and sandy clays to a depth of about 132 feet (EL -115 feet). Dense sands and gravels were encountered below these depths to hard sandstone rock at a depth of about 140 feet (EL -123 feet).

Prior to its original construction in the 1950s, eight timber test piles were driven at various locations at the Marine Terminal site. The test pile data are shown on the as-built pile plan prepared for the wharf and approach structure (Unocal Engineering Drawing No. 52M05-A01, dated July 17, 1953). Four of these piles were at the wharf and four were at the approach. The test piles were driven to depths varying from 117 feet (EL -100 feet) to 127 feet (EL -110 feet).

Specific subsurface conditions immediately beneath the butane tank are unknown because no specific geotechnical data were available. In order to make a preliminary evaluation of the subsurface conditions, data were interpolated by GeoResources Consultants from two borings drilled in 1948 by Dames and Moore (DM-1 and DM-2), located 300 to 400 feet away from the butane tank on state-filled lands. Figure 3.8-4 presents the drilling location. Drilling logs are presented in Appendix G.

Borings DM-1 and DM-2 were drilled from the ground surface at EL +10 feet. About 3 to 6 feet of surficial fill overlying relatively soft clayey soils extending to a depth of 24 feet (EL -14 feet) were encountered. A layer of firm sand was encountered below the soft clays. The firm sand layer was, in turn, underlain by decomposed shale bedrock. Accurate water level data could not obtained because of borehole caving.

In its Phase I hydrocarbon investigations, Woodward-Clyde bored two groundwater monitoring wells just onshore of the Terminal between the ballast water Tank 103 and the grease/wax complex. Groundwater depths across the shoreline acreage are generally shallow, about 9 feet below the surface, or 4 to 6 feet above MSL. A deeper, confined or semiconfined aquifer is interpreted to be present in the vicinity within the Bay Sand where it is overlain by Bay Mud (Woodward-Clyde 1991). Near-surface groundwater is probably affected by tidal influences; the effects of tidal influences on deeper, confined aquifers is unknown. Groundwater in the upper zone is probably brackish due to tidal influences; the quality of groundwater in deeper zones is unknown. No information regarding the existence and/or extent of hydrocarbon contamination in either zone was available.

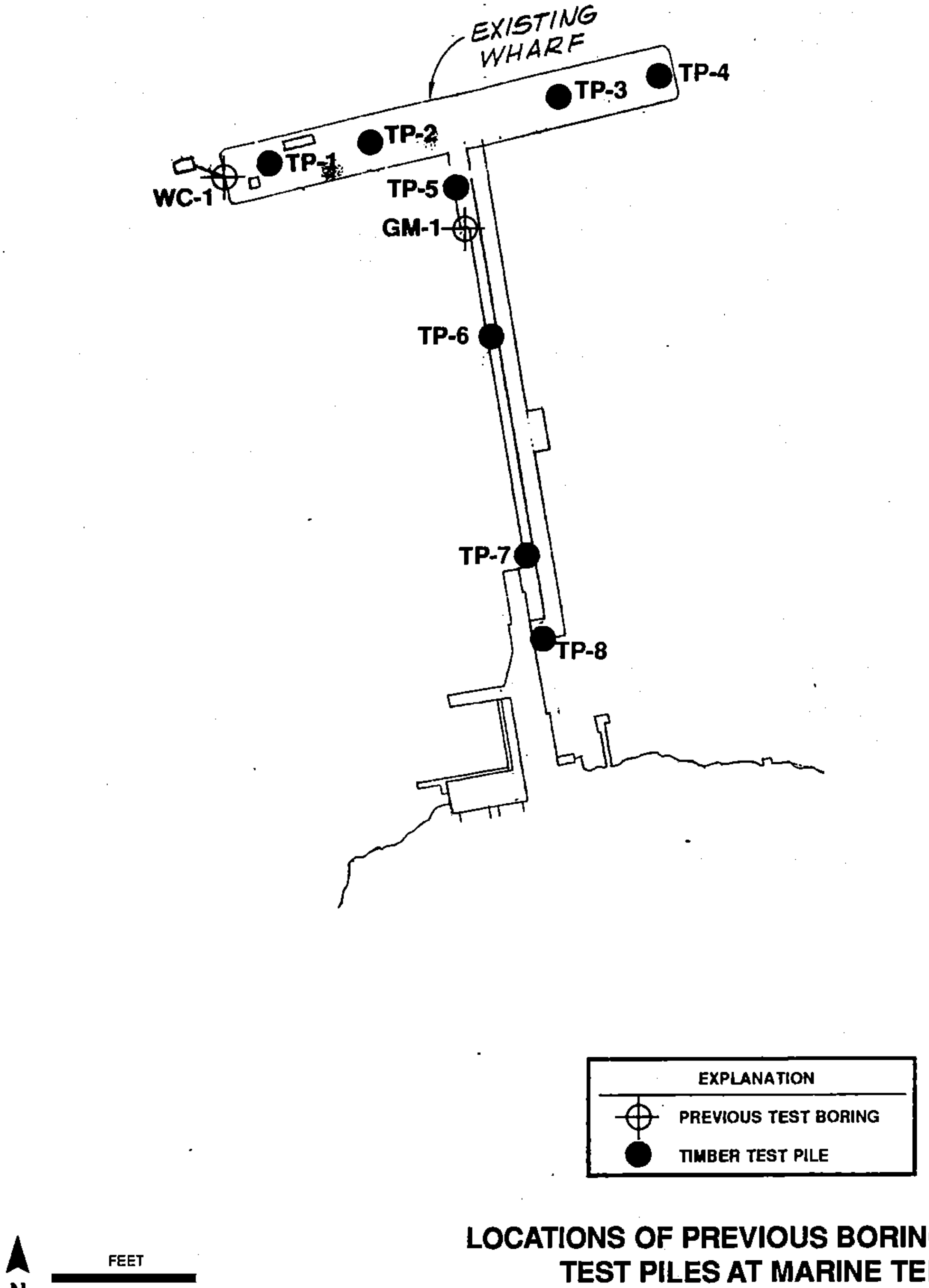
3.8.3 Seismicity

3.8.3.1 Regional Characteristics

The San Francisco Bay region is an area of high seismic activity. The San Andreas Fault system, forming the bounding surface between the obliquely convergent North America and Pacific plates, trends northwest through the area in a band 50 miles wide. The San Andreas Fault system has produced strong earthquakes in the past and may be expected to do so in the future.

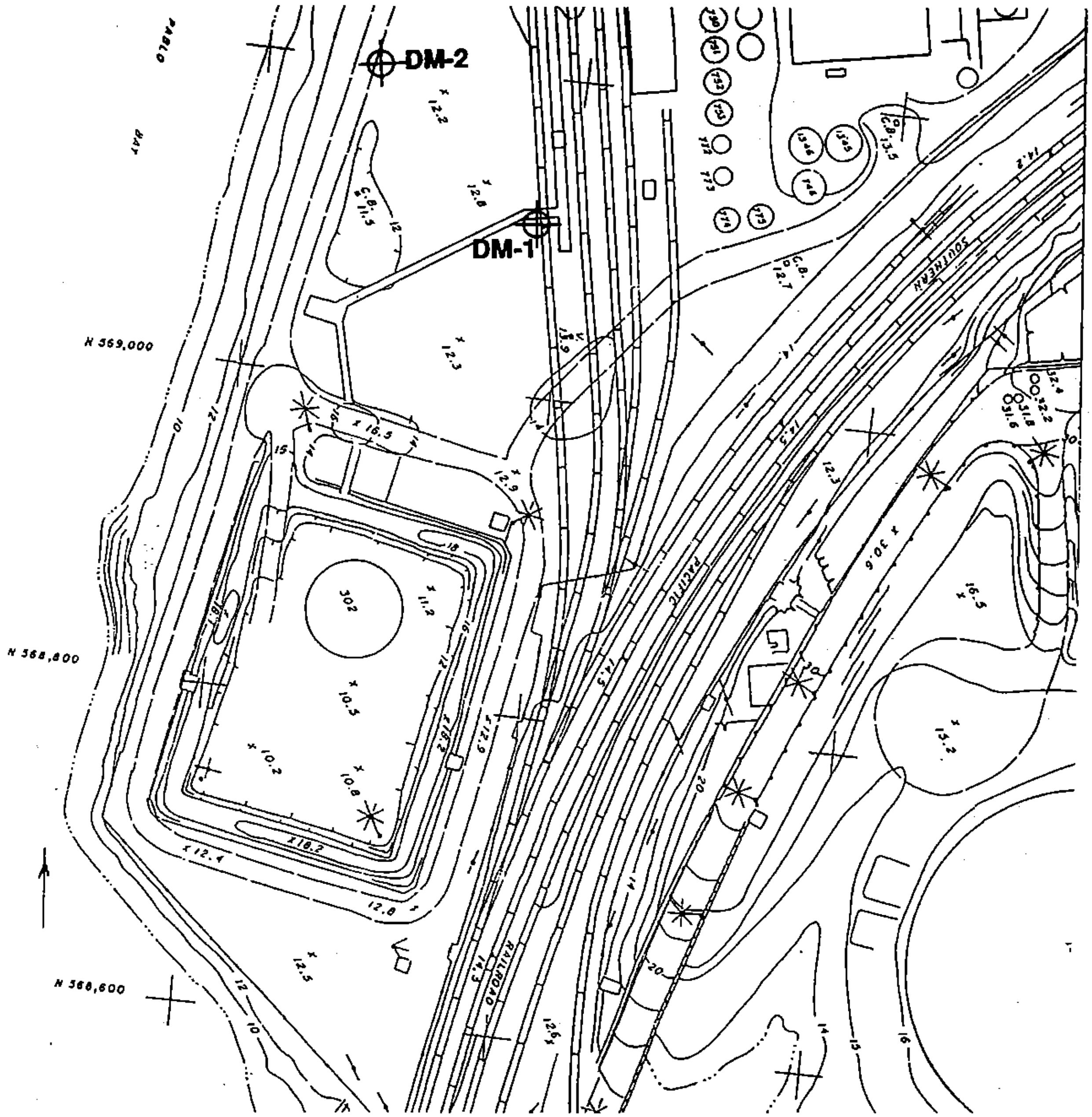
Among the prominent faults within the San Andreas Fault system are the Hayward, the Calaveras, the Rodgers Creek, the Green Valley, the Concord, and the Greenville. Figure 3.8-5 is a vicinity map showing major faults. Table 3.8-1 lists these major active faults within the region, their maximum credible earthquake, the average estimated peak bedrock acceleration that may be anticipated from an earthquake on the fault, and the distance from the site.

In the northeastern San Francisco Bay region, dominant members of the San Andreas Fault system include the Hayward, Rodgers Creek, and Green Valley Faults. The East Bay Hills, southwest of the site, are a geomorphic expression of the extensive vertical component of fault motion along the Hayward Fault. The Hayward Fault has generated two major earthquakes in the 200 years for which historic records



Source: Base from Bechtel, 1971

LOCATIONS OF PREVIOUS BORINGS AND TEST PILES AT MARINE TERMINA
Figure 3.8-3



EXPLANATION

PREVIOUS TEST BORINGS

N

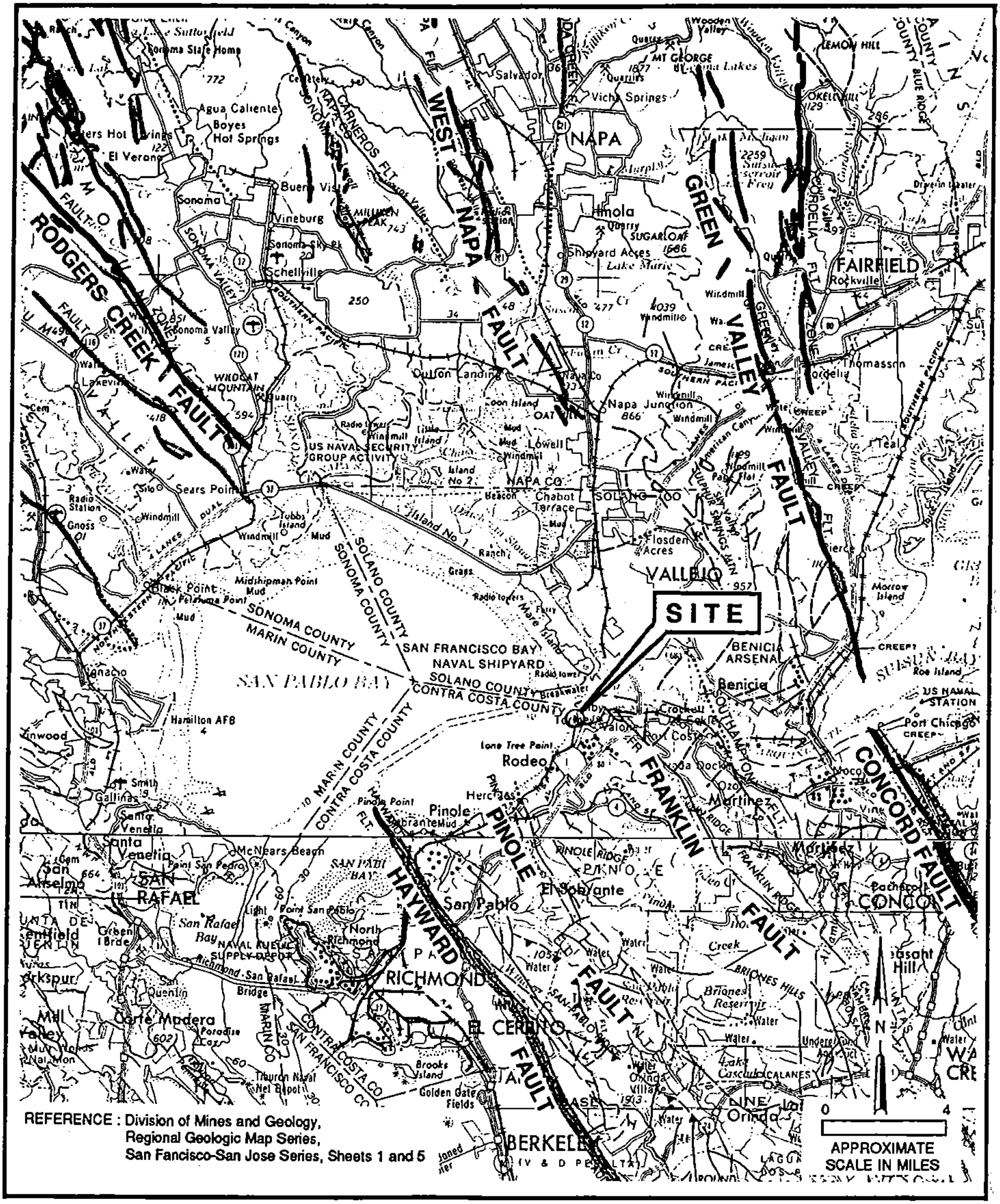
FEET

0 100

Source: Base from Bechtel, 1971

LOCATIONS OF PREVIOUS BORINGS AT BUTANE SPHERE
Figure 3.8-4

6276-1/93



REGIONAL FAULT MAP
Figure 3.8-5

Table 3.8-1

KNOWN ACTIVE AND POTENTIALLY ACTIVE FAULTS IN SITE VICINITY

Fault	Maximum Credible Earthquake [1]	Average Values of Maximum Estimated Bedrock Acceleration (g) [2]	Site Distance from Fault (miles)
San Andreas	8.3	0.27	27
Hayward	7.5	0.48	6.5
Rodgers Creek	7.0[3]	0.37	11
Green Valley	6.6	0.35	9
Calaveras	6.0	0.12	19
Concord	5.4	0.16	10
West Napa	6.5 [4]	0.38	7
Greenville	6.5 [5]	0.05	40

[1] Wesson et al., 1975
[2] Seed and Idriss, 1982
[3] Budding et al., 1991
[4] Wesnousky, 1986
[5] Wright et al., 1982
Source: Geo/Resources Consultants, Inc.

are available; one in 1836, the other in 1868 that had a magnitude of approximately 7.5. The Working Group on California Earthquake Probabilities (1990) estimates there is a 28-percent chance that a Richter magnitude 7.0, or greater, earthquake will occur on the northern segment of the Hayward Fault within the next 30 years.

Two major earthquakes also occurred on the San Andreas Fault in 1838 and 1906. The 1906 event had a magnitude of approximately 8.0. Both the 1906 San Andreas Fault event and the 1868 event on the Hayward Fault caused strong shaking and significant damage in the Bay Area. The previous earthquakes may have caused significant shaking, but did so with less damage because the area was less populated in earlier years.

An estimated Richter magnitude 6.6 earthquake also occurred in 1898, probably on the southern end of the Rogers Creek Fault (Toppozada 1992). The nearby (less than 2 miles from the Unocal Marine Terminal) Mare Island Navy yard was severely damaged in the quake, and Modified Mercalli intensities of VIII or greater were experienced from Vallejo and Mare Island to Sonoma and Petaluma (Toppozada 1992).

3.8.3.2 Site-Specific Characteristics

The site is located along the eastern shore of San Pablo Bay, a broad shallow trough developed in response to both ancient and recent fault activity in the Bay region. San Pablo Bay is interpreted to be a pull-apart basin formed by right-stepping transfer of strike-slip deformation from the Hayward Fault to the Rogers Creek and West Napa Faults (Williams and Anima 1992).

There are no known active (faults that have experienced surface displacement within the past 10,000 years) or potentially active (displacement within the past 1,600,000 years) faults crossing the site. Because of this, the site does not lie within an Alquist-Priolo Special Study Zone as defined by the California Division of Mines and Geology (Division 2, Chapter 7.5 of the State of California Public Resources Code).

A local, inactive fault (neither active or potentially active) has been mapped offsetting Tertiary-age rocks about ½ mile away within the Refinery (Woodward-Clyde 1991). The trace of the potentially active Franklin Fault trends northwest about 1 mile east of the site; the trace of the potentially active Pinole Fault is 3 miles to the southwest. The nearest known active faults include the Hayward Fault, 6.5 miles to the southwest of the site; the San Andreas Fault, 24 miles southwest of the site; and the Calaveras Fault, 26 miles southeast of the site.

The Franklin Fault is interpreted to be the northern extension of the active Calaveras Fault. Recent work (Williams and Anima 1992) suggests there may be a fault connection between the Pinole Fault and the active Rodgers Creek Fault.

Deep soil deposits, typical of those underlying the shoreline portions of the site, also underlie the Marina District of San Francisco and the collapsed Cypress Street viaduct in Oakland; areas of concentrated damage from the 1989 Loma Prieta earthquake. During that event, the soil deposits amplified the relatively moderate levels of bedrock shaking experienced at these sites. Significantly stronger levels of ground shaking occurred in Bayshore soil deposits at Treasure Island, Alameda, and Emeryville, as well as other locations. Peak bedrock accelerations were amplified by factors of 2 to 3, producing peak ground surface accelerations at deep alluvial sites on the order of 0.16 to 0.33 g (Seed et al. 1990). In addition, the deep, cohesive soils tended to cause especially pronounced amplification of long period (low frequency) components of bedrock shaking. Such low frequency waves are most damaging to long period major structures, e.g., the Cypress Street viaduct (Seed et al. 1990).

3.8.4 Liquefaction, Differential Settlement, Lateral Spreading, and Lurching

Loose, sandy fill materials extend below the relatively shallow (4 to 6 feet below surface) groundwater level. These soils may be subject to liquefaction and loss of strength during severe ground shaking due to a moderate or large earthquake. Liquefaction occurs when saturated, loose to medium dense, relatively clay-free sand and silts are subjected to earthquake ground motion. The tendency of these soils is to densify due to the ground vibrations exerting an increased water pressure on the soils, forcing the grains apart, and generating a "quick" or liquefied condition. Differential settlement, ground boiling, racking, and tilting are common structural responses to liquefaction.

Liquefaction is a common phenomenon associated with earthquakes in coastal and flood plain areas because of high water tables. The widespread damage of structures and utilities in the Marina District of San Francisco during the 1989 Loma Prieta earthquake was caused by the liquefaction of the hydraulically placed fill material.

The Marine Terminal structure is supported by driven piles founded on dense sands and bedrock. Liquefaction potential for the Terminal is considered to be low.

Conditions beneath the butane tank are unknown. Contract drawings for the supporting pile mat indicate that the ground was compacted; this information with the depth and large number of piles strongly suggests that the liquefaction potential for this area is low.

The settlement of structures founded on weak soils, particularly Bay Mud and artificial fill materials, is exacerbated by seismic shaking. Breakage of pavement surfaces is a result of settlement. Perimeter dikes and levees at Metropolitan Oakland International Airport suffered from settlement and lateral spreading displacements on the order of 2 to 3 feet during the Loma Prieta earthquake (Seed et al. 1990). The shoreline acreage at the Unocal Refinery has the potential for a similar response in the event of severe ground shaking.

The phenomenon of lateral spreading involves the horizontal movement of loose, unconfined soils during seismic events. Because fill areas within the project area are generally confined behind manmade barriers and embankments, the potential for lateral spreading is low.

Lurching is similar to lateral spreading, but occurs in soils on relatively steep slopes as a result of seismic activity. The most susceptible area on the project site is the riprap lining the shoreline acreage. The riprap piled on the bayward face of the shoreline acreage consists of boulders of concrete rubble and rock up to 24 inches in diameter.

3.8.5 Tsunamis

Tsunamis (seismic sea waves) are long-period waves generated by underwater seismic disturbances, volcanic eruptions, or landslides. Tsunamis affecting the site would most likely originate west of the Golden Gate, within the Pacific Rim. During the period between 1854 to 1964, approximately 21 tsunamis were recorded at the Fort Point tide gauge in San Francisco. The largest wave height recorded was 7.4 feet resulting from the 1964 Alaska earthquake (Tri-Cities Seismic Safety Study 1973). It is estimated that a tsunami with a wave height or runup of 20 feet could pass through the Golden Gate every 200 years. A 10-foot wave is estimated to occur every 90 years (Ritter and Dupre 1972).

A tsunami originating in the Pacific Ocean would be significantly attenuated as it passed through San Francisco Bay. The estimated 100-year runup (the rush of water up on a structure on the breaking of a wave) value of 8.2 feet (near the Golden Gate) decreases to 4.9 feet near San Quentin, and further decreases to 3.3 feet near the Unocal San Francisco Refinery area (Dames and Moore 1988).

3.8.6 Structural Conditions of Terminal and Butane Facility

3.8.6.1 Marine Terminal

Designs and Upgrades

The present Marine Terminal consisting of a wharf and approach structure was constructed in 1955 with modifications designed in 1970 by Earl and Wright Consulting Engineers, San Francisco. This wharf completely replaced a previous structure that was destroyed by a fire. The existing Terminal was constructed of precast concrete piles that were driven below the mud line to depths ranging from 83 to 89 feet, which would place these piles into the medium stiff to stiff silty clays, clayey silts, and sandy clays beneath the wharf. The vertical piles were designed to withstand deck live loads in addition to the dead load of the deck. The deck is supported between bents (rows of piles) on reinforced cast-in-place concrete cross members that in turn support the precast deck panels. The finish elevation of the panels is 17.0 feet above MLLW. The design deck, berthing, and marine loads (Earl and Wright Consulting Engineers 1992) are as follows:

- main wharf - 300 psf or H20-316-44 truck;
- approach bent No. 209 to main wharf - 300 psf or H20-316-44 truck;
- approach bent No. 209 to shore - H20-316-44 truck;
- pipeway - 75 psf for pipes and contents;
- wind load - 15 psf;
- current - 3.5 knots;
- seismic - 13.3 percent gravity with one-third increases in stresses;
- wave loading - none specified;
- design vessel - T-2 tanker, 16,500 DWT;
- approach velocity - none specified; and
- fendering - steel coil springs spaced at 3 feet on center with an energy absorption of 4.5 kip-ft (1.5 kip-ft/ft of fendering) and a spring base retention of 9.0 kips (3.0 kips/ft of fendering).

Concrete pipeway beams support pipe runs longitudinally along the wharf and the approach structure. The lowered top elevation (11.36 feet above MLLW) of the pipeway beams results in the top of the piping below the deck.

To stabilize the wharf and the Terminal from sidesway movement caused by lateral loads, batter piles were installed and tied into the concrete beams connecting the bent cross members. These consist of concrete piles with a 2.5:12 batter and steel piles with 5:12 batter. The 115-foot-long steel batter piles were constructed of 14BP73 steel covered with 2 inches of gunnite reinforced with 2- by 2-inch No. 12 wire mesh. To protect against mooring action, wood and steel (not gunnited) fender piles were installed on the north side of the wharf.

In 1971, a mooring dolphin was built off of the west end of the wharf with a walkway connecting the two structures. The dolphin accommodates larger vessels mooring to the wharf. The contract documents produced by Santa Fe Pomeroy, Inc., indicate that the following design criteria were used:

- uniform live load
  - 100 psf on dolphin
  - 50 psf on walkway

- berthing load
  - 80,000 DWT tanker with an approach velocity of 0.3 ft/sec
- seismic
  - 10 percent of dead load
- mooring load at dolphin
  - maximum load = 100 tons with maximum angle of line pull vertical = 0 to 30 degrees above horizontal combined with horizontal = 0 to 30 degrees with face of dolphin
  - maximum load = 50 tons with maximum angle of line pull vertical = 0 to 30 degrees above horizontal combined with horizontal = 30 to 90 degrees with face of dolphin
- mooring at new quick release hooks at existing wharf
  - maximum load = 50 tons with maximum angle of line pull vertical = 0 to 30 degrees above horizontal combined with horizontal = 25 to 90 degrees with face of dolphin

The dolphin is constructed of prestressed concrete vertical and batter piles about 123 feet long, which extend 84 feet into the mud line. The 1,326-square-foot cast-in-place concrete deck is level with the existing wharf and its fender line is parallel. Vertical bearing piles with timber facing provide mooring protection for the structure. Mooring equipment includes two 100-ton quick release hooks, fairleader, and winch.

The as-built pile plan indicates that the Marine Terminal is, for the most part, supported on 18-inch-square precast reinforced concrete piles. A portion toward the north side (water side) of the structure (bents 210-215) is supported on 20-inch-square precast reinforced concrete piles. Both the 18- and 20-inch concrete piles were planned to be driven to a depth of 109 feet (EL -92 feet) below the top of the wharf. The lengths of the piles were either 100 or 106 feet to offset the variation in cutoff at different areas.

Current Condition

On July 22, 1992, a California registered civil engineer from the Chambers Group and a California certified engineering geologist from Geo/Resources Consultants made a cursory inspection of the Terminal facility. The inspection included the approach structure, wharf, and dolphin. The facility also was inspected on December 14, 1992, by staff of the SLC Vallejo Marine Facilities and Inspection Division (MFID) office, staff of the Long Beach MFID, and a representative of Unocal. In addition, a visual, above-water inspection of the undersides and piles was conducted on Wednesday, December 16, 1992. The inspection was roughly the equivalent of an API RP 2A "Level I Survey," and was performed as part of the annual MFID facility inspection program.

The deck of the Terminal did not show signs of distress (i.e., cracking, settling, and spalling) and, overall, appeared to be in very good condition.

Steel batter piles viewed in the pipe run of the wharf were spalled in a few locations above the water line exposing corroded steel and others had longitudinal cracks in the gunnite that were stained with rust. The concrete pipeway beams had long longitudinal cracks in portions of the lower third (tension side) with rust stains and spalling. The sacrificial wood piles are not protected on their top caps; most are in fair condition, and some have damage.

The majority of vertical piles throughout the wharf showed no signs of distress, corrosion, or erosion. However, some areas of probable vessel impact show severe damage, and have no lateral load carrying capacity. At the valve control station the approach structure was viewed from underneath on a companionway below the pipes. The concrete pipeway beams showed signs of corrosion of the reinforcing steel, but not as severe as mentioned for a few locations on the wharf. The edge bumpering system is a structurally independent portion of the wharf, and both the east and west ones have damage.

The detached dolphin with the steel and concrete piles is showing some rust/corrosion of the steel piles. It is not clear if these steel piles are filled with concrete.

The available data indicate that the original design capacity of the concrete piles was 40 tons. The 18-inch-square concrete piles were estimated to have capacities higher than 40 tons, except for the wharf area. The existing wharf deck appeared to be in very good condition without any obvious distress except for the vapor recovery system (VRS). The VRS is mounted on the outrigger concrete bents, supporting various pipelines running from the Terminal to the shore. Damage was apparent directly under the VRS and, also, one bent closer to shore. Unocal has plans to repair this damage by December, 1993.

The remainder of concrete piles in the wharf area appear to be adequate for the present loading condition. The apparently adequate performance of the wharf area piles relative to the calculated capacities may be due to one or several of the following reasons:

- The loads on the concrete piles at the wharf area have never exceeded 33 tons.
- The concrete piles at the wharf area are providing support of the existing wharf deck with a factor of design less than 2. For "actual load" up to 40 tons, the factor of safety would have been lowered to 1.65.
- Based on laboratory tests performed on soil samples recovered from the borings, the estimated capacity of the existing piles may be too conservative. However, these are the only data available for pile assessment at the present time.

3.8.6.2 Butane Tank

Designs and Upgrades

Southeast of the landside bulkhead of the wharf is a bermed area that contains a 20,000-bbl (840,000-gallon) spherical butane tank that is supported on a tower on state-filled lands. The bermed area is approximately 200 by 140 feet with the longer side parallel to a paved road that runs along San Pablo Bay. The containment area beneath the tank drains into two catchbasins in the southeast and southwest corners. These basins are capable of being drained through underground pipes that connect to an emergency sump pump located approximately 110 feet west of the containment area. These details are provided on Bechtel's engineering drawing 40E-A-25 Revision 5, dated 10/26/70.

The as-built foundation and pile plan for the butane tank (Bechtel's drawing No. 20E-A-4, dated March 1970) shows that the supporting piers connect to a 3 feet thick ring-shaped footing at the ground surface. The bottom of the footing is at EL +6.25 feet. The ring-shaped footing is, in turn, supported by 240 cast-in-place reinforced concrete piles. The as-built foundation and pile plan shows that the cast-in-place reinforced concrete pile capacity is 30 tons. The piles taper from 18 inches in diameter at the top to 8 inches at the lower tip. The reinforcement for the piles consists of four No. 6 rebars extending to a depth of 20 feet (EL -14 feet) below the bottom of the footing. The tip of the piles would be deeper than this depth. The 10-legged tank tower bears on top of 10 concrete pedestals, which are 54 inches square with two anchor bolts. None of the drawings provided design criteria for static, seismic, or wind loading for the tank or its tower.

Current Condition

On the same site visit, the Chambers Group and Geo/Resource Consultants representatives also made a cursory inspection of the butane tank/tower from outside of its bermed containment area. The tank and its supporting tower appeared to be plumb, without any outward appearances of structural over-stressing or deflection.

3.8.7 Cumulative Environment

Most shoreline areas of San Francisco Bay are underlain by Bay Mud and unconsolidated alluvial and marine sediments. Bedrock may be quite shallow, as at the Unocal Refinery, or it may lie at depths greater than 1,000 feet, as at Oakland International Airport. In most of the San Francisco Bay Area, Bay Mud is between 0 and 20 feet thick immediately offshore. However, the Port of San Francisco has recorded thicknesses greater than 100 feet. Nearly all marine facilities and most shoreline industrial facilities are constructed on land reclaimed from the Bay by placement of fill material over Bay Mud, or on piles driven through Bay Mud to deeper, more cohesive sediments or bedrock.

The entire region is seismically active. Major fault zones bound the San Francisco Bay Area (see Figure 3.8-5, Regional Seismicity Map) in a series of northwest-trending bands. None of the facilities within the cumulative environment, except for Sacramento and Stockton, are more than 10 or 12 miles from one of the active faults listed in Table 3.8-1, and most sites are considerably closer.

3.9 AESTHETICS

3.9.1 General Visual Characteristics of Bay Area

San Francisco and San Pablo Bays' shoreline characteristics include a range of visual stimulations comprised mainly of urbanized and industrial areas, with occasional rural and open space areas, and coastal wetlands and areas of salt evaporation ponds. The landform throughout most of the area includes hilly terrain. Where there is no development, this open area is generally covered with low vegetation.

The greatest portion of urbanization is within the central and southcentral portion of San Francisco Bay. From San Francisco south to Palo Alto, urban development is prevalent on the western shoreline. On the eastern shoreline urban development is continuous from Pinole Point to San Leandro.

San Francisco and San Pablo Bays contain about 90 percent of California's remaining coastal wetlands. Major preserves and shoreline parks include Suisun Bay Marsh, with many duck hunting preserves; San Pablo Bay National Wildlife Refuge off of Tubbs Island, which is accessible by boat; and Point Pinole Regional Shoreline. China Camp State Park, along the southwest shore of San Pablo Bay, preserves a historic Chinese shrimp fishing village. Coyote Hills Regional Park and San Francisco Bay National Wildlife Refuge protect important wetland acreage in the South Bay for wintering waterfowl. Many other small parks, piers, and recreational marinas also provide access to the shoreline.

The southern portion of the Bay Area contains several large areas of salt evaporation ponds. One is located north of the San Francisco Bay National Wildlife Refuge on the eastern shoreline, and another across the Bay on the western shoreline. Several others are also located along the far southern end.

Within the Bay Area, there are 8 ports, 26 marine terminals, and a number of naval terminals located throughout the Bay. The major port areas are San Francisco, Redwood City, Oakland/Alameda, Richmond, San Pablo Bay, and Carquinez Strait. A map of these facilities and a description were presented in Section 2.4.2.1. Marine vessel traffic is a common sight through the Bay Area.

3.9.2 Visual Characteristics of Marine Terminal and Vicinity

The project site is located in the western portion of Contra Costa County on the San Pablo Bay at Davis Point. The entire Unocal facility, including the Terminal, Refinery, and tank farm, is located in the district known as Oleum, from Davis Point to the area southeast of Interstate 80. Davis Point is a light promontory at the end of a northwest-trending ridge that truncates abruptly at the edge of San Pablo Bay. The general area of the landform in the immediate vicinity of the Terminal is characterized by gently rolling hills with open spaces and flatter areas where development occurs. The rolling hills generally have only spotty areas of vegetation coverings.

Visually, the area is a mix of land uses, including the Unocal Refinery (Figure 3.9-1a) and other industrial refinery uses including the nearby C&H Sugar Refinery, the Wickland Terminal located about 1 mile east of the Unocal Wharf, and the Pacific Refining Company's Marine Terminal located about 1,000 feet to the west (Figure 3.9-1b). The Pacific Refining Refinery is located further down the coast with the community of Rodeo located between the Unocal and Pacific Refining Refineries. Small portions of the nearshore property remain undeveloped as do portions of the background hills. An aerial photo of this area is presented in the project description as Figure 2.2-1.

Other shoreline uses in the northern end of San Pablo Bay are also industrial in nature. Mare Island U.S. Naval Shipyard is located on the north side of San Pablo Bay, across from Davis Point.

The Unocal Marine Terminal consists of a tee-head ship and barge berthing structure, a mooring breasting dolphin, and a shore-connecting trestle pipelineway. The structure is shown on Figure 3.9-2a. The ship berthing structure is 1,250 feet long and 136 feet wide. The mooring breasting dolphin is 51 by 32 feet in dimension and is located about 74 feet from the west of the end of the tee. The trestle pipelineway connecting the Terminal to the shore is 1,730 feet long and 77 feet wide. The pier is constructed of precast concrete piles, and the deck is precast concrete panels. Even through the pier structure protrudes into the water from the shoreline, it visually blends into the existing conditions of the surrounding industrial uses of the area.

The 3.6 acres of filled lands contain a 20,000-bbl butane storage sphere as shown on Figure 3.9-2b. The sphere is a 60-foot-diameter aboveground steel structure supported on ten 4.5-foot square piers attached to the equator of the sphere. There is associated piping and containment diking as seen in the figure. The sphere visually blends in with the Refinery facilities.

The Pacific Refining Company Marine Terminal consists of an offshore structure. The wharf is a concrete pile and concrete-decked surface with two breasting and four mooring dolphins in line with the face connected by catwalks, and two breasting dolphins in line with the rear of the face. The face tanker berth is 1,228 feet long while the rear of the face barge is 258 feet. The Wickland Oil Terminal is a small structure which extends less than 400 feet offshore, also comprised of catwalks along its mooring structure.

3.9.3 North Coast

Offshore visual features are somewhat more spectacular than those within the Bay. From the Golden Gate north the shoreline consists of dramatic coastline features including rolling hilly coastal landforms dropping to sandy beaches, jagged rock outcropings forming hazards to marine vessels in the nearshore, cliffs that drop to the sea, and large, flat beach areas with dunes. Small shoreline communities and picturesque harbor areas also dot the shoreline in some areas. In addition to beaches, numerous recreational access points are along the coastline as presented in Section 3.10. Also, there are a large number of rivers and creeks that cut the coastline adding visual interest, as well as established preserve areas. Vegetation is diverse, ranging from salt marsh vegetation to forest areas.

When compared to the shoreline of southern California, much of northern California remains representative of the shoreline of years past. Little development has occurred and areas remain in pristine form.

A few of the more unique visual areas along the outer coast are briefly presented below.

The Farallon Islands, located 27 nautical miles west of Point Bonita in Marin County, rise from the edge of the continental shelf forming jagged, rocky outcropings. The islands are the most important seabird nesting site on the coast.

Mount Tamalpais State Park in Marin County includes peaks that reach an elevation of over 2,600 feet. The west and south sides of the mountain extend to the sea between Muir Beach and Stinson Beach. A range of forest habitats are in this area.

In Marin County, Tomales Bay is 13 miles long, 1 mile wide, and very shallow with wide expanses of mudflat. The Bay is part of an area important ecologically for the Pacific herring and other fish and birds. The Tomales Bay Ecological Reserve and the Point Reyes National Seashore are features of the area.

Bodega Bay in Sonoma County originated as a small fishing port in the 1870s. The town contains examples of 1910-era craftsman bungalows. Nearby, the Bodega Dunes consist of a 900-acre sand dune area reaching elevations of 150 feet, some of the highest in the state.

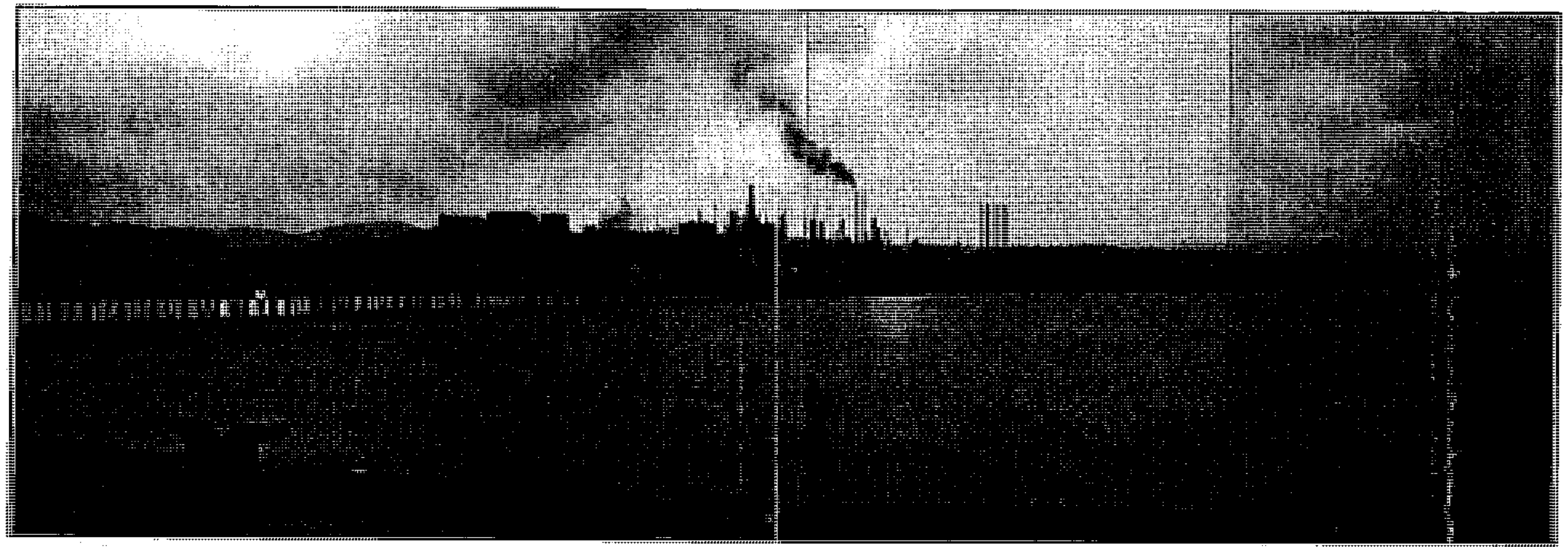
In Sonoma County, a 13-mile stretch of coastline forms the Sonoma Coast State Beaches characterized by short stretches of sandy beach separated by rocky headlands. Goat Rock and other offshore rocky areas provide wildlife habitat. Endangered peregrine falcons occasionally winter in the area.

In Mendocino County, Sinkyone Wilderness State Park is a mix of steep gorges and narrow ridges blanketed by a vast forestland dropping to the sea. In addition to crashing surf and offshore rocks, wildlife, particularly birds, are abundant.

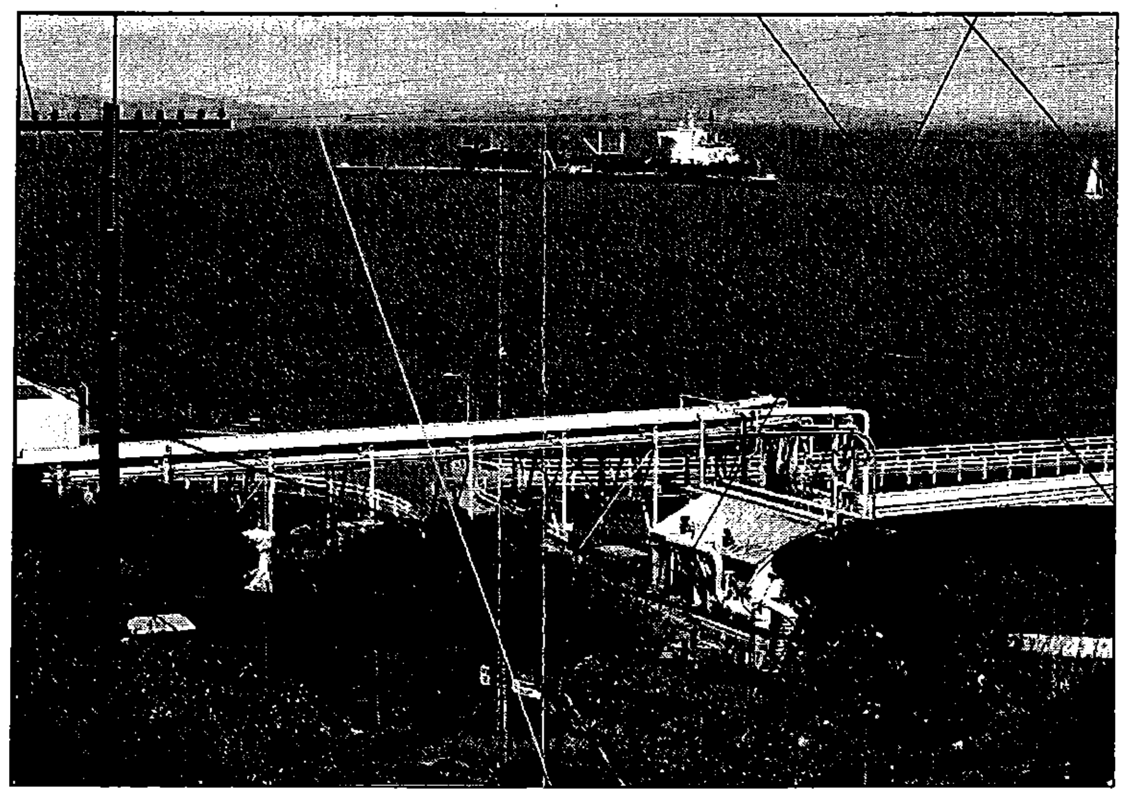
The town of Mendocino, overlooks Mendocino Bay, and is a major tourist destination. A very picturesque setting, Mendocino is known as a flourising artist's colony, and as a popular area for a variety of bed and breakfast inns.

The King Range National Conservation Area in Humbolt County is part of the "Lost Coast" and rises abruptly from sea level to a height of 4,000 feet in less than 3 miles. The area, administered by the Bureau of Land Management, contains 60,000 acres of rugged mountains and shoreline.

In Humbolt County, Trinidad Bay Harbor offers spectacular coastal views. Features include the 362-foot-high Trinidad Head which juts out onto the west side of the harbor, Prisoner Rock and other rock formations. Other features include Indian Beach and

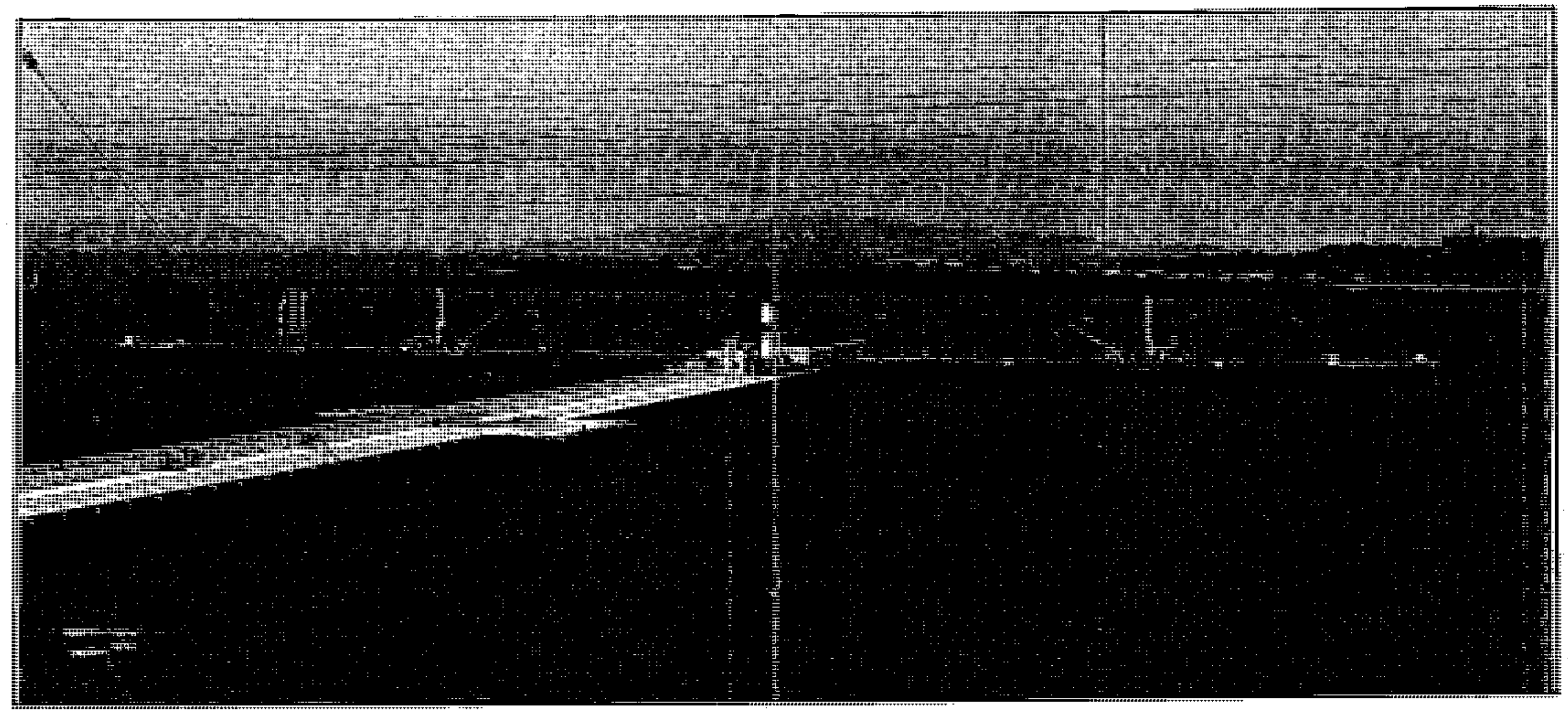


a) Unocal Refinery from Unocal Marine Terminal trestle pipelineway.

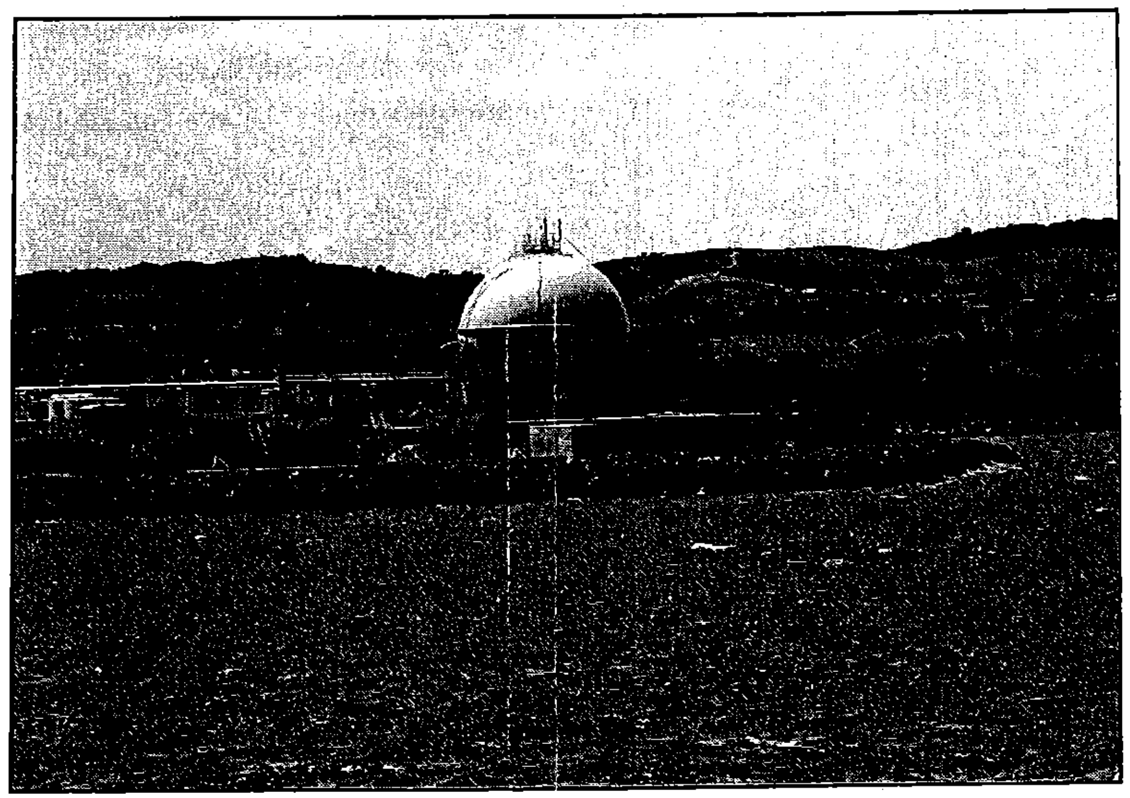


b) Pacific Refining Company's Marine Terminal from Unocal Refinery.

UNOCAL REFINERY AND PACIFIC AND WICKLAND MARINE TERMINALS
Figure 3.9-1



a) Unocal Marine Terminal



b) Butane Storage Sphere

UNOCAL MARINE TERMINAL AND BUTANE SPHERE ON STATE FILLED LANDS
Figure 3.9-2

nearby tidepools, as well as the pier and marina that make the harbor a popular attraction.

The City of Eureka, located in Humbolt Bay, is known for its variety of styles of historic structures which still stand today. Nearby, both Indian and Woodley Islands offer visual pleasure through the variety of birds that can be seen in reserve areas. A large marina is also located in Woodley Island.

On the west side of Arcata Bay, Samoa Dunes extends the length of a 10-mile-long spit that separates Arcata Bay from the ocean. A variety vegetation occurs through the area and provides for a unique setting.

Humbolt Lagoons State Park is another, very picturesque area within Humbolt County. The 1,036-acre park includes a freshwater marsh as well as saltwater lagoons and a variety of vegetation and wildlife.

Redwood National Park, located in Del Norte County, is a 106,000-acre national park established in 1968 to preserve virgin forests of coast redwood. The park includes several coastal areas.

3.10 LAND USE/RECREATION

3.10.1 Land Use/Recreational Policy Issues

3.10.1.1 Introduction

This section summarizes land use planning and recreational resource management policies primarily as they relate to general growth of the Bay Area, Bay conservation and development (including shoreline development) policies, and policies related to park and recreational uses and public access.

3.10.1.2 Land Use Policies

County Land Use Policies

The Contra Costa County General Plan (January 1991) uses the population, housing, and employment projections for the years 1990 to 2005. The Plan also reflects the influence of two recent initiative measures that will impact the long-term physical development of the County through the horizon of the General Plan. The two measures include "the Revised Contra Costa Transportation Improvement and Growth Management Program" (Measure C, August 1988), and "The 65/35 Contra Costa County Land Preservation Plan" (Measure C, November 1990). The provisions of these two measures are integrated into the elements of the General Plan in such areas as land use, growth management, transportation and circulation, housing, public facilities and services, and conservation and open space issues. In addition, Measure C 1990 established an Urban Limit Line as part of a 65/35 land preservation standard that limits urban development in the County to a maximum of 35 percent of the land, with the other 65 percent designated for nonurban uses and preservation.

Within the Conservation Element of the General Plan is a section on harbors. In addition to discussion of expansion of the Port of Richmond, goals are directed to: (1) promote safe, convenient and appropriate water transportation for the County; and (2) encourage continued operation, expansion and economic viability of harbor facilities.

Regional Planning Policies

San Francisco Bay Conservation and Development Commission

Coastal issues including land use policies around San Francisco Bay are within the jurisdiction of the BCDC, established in 1965 (pursuant to the McAteer-Petris Act) to prepare an enforceable plan to guide the future protection and use of San Francisco Bay and its shoreline. The Commission consists of 27 members who represent interests in the Bay, including federal, state, regional, and local governments, and public representatives of the Bay Area. The San Francisco Bay Plan (1968) as amended in 1988 provides the basis for regulating development in the Bay and tidal wetlands in the Bay Area and to ensure maximum feasible public access to the Bay. Nontidal wetlands are regulated by the U.S. Army Corps of Engineers (CCC 1987).

The original McAteer-Petris Act gave the BCDC authority to issue or deny permit applications for placing fill, extracting materials, or changing the use of any land, water, or structure within the area of its jurisdiction. The BCDC is thus directed to perform its regulatory process in conformity with the provisions and policies of the Act, the San Francisco Bay Plan, and Bay Plan maps, which guide the future protection and development of the Bay and its shoreline. The BCDC's jurisdiction in shoreline areas, as defined in the Act includes San Francisco Bay, a shoreline band 100 feet deep landward (excluding subdivisions), saltponds, managed wetlands, and certain waterways.

Based on its extensive studies of San Francisco Bay and preparation of the Bay Plan, the BCDC has determined the following major conclusions and policies, relative to land use and recreational uses. The Bay is considered a single body of water that can be effectively managed only on a regional basis. The most important uses of the Bay are those that provide substantial public benefits as a body of water. Desirable, high-priority uses of the shoreline can also be accommodated without substantial loss of natural resource areas. Shoreline areas that are suitable for priority uses, including ports, water-related industry, airports, wildlife refuges, and water-related recreation, are limited and should be reserved for these purposes. In some cases, filling in the Bay may be allowed if it provides substantial public benefits.

The Bay Plan also limits bay filling to the purposes previously listed because of the harmful effects that can result to the Bay, including destruction of habitats, water and air pollution, and diminished scenic quality. Other issues addressed in the Bay Plan include water quality and fill design and safety.

The following is a list of the major proposals in the Bay Plan:

1. Develop maritime ports, expansion and development (includes ports at Richmond and Selby)

2. Deepen shipping channels to improve access to industries

3. Develop future land and preserve existing land uses for water-related industries

4. Develop waterfront parks and recreation facilities (beaches, marinas, fishing piers, scenic drives, and trails)

5. Expand airport facilities on land

6. Maintain wildlife areas in diked historic baylands

7. Encourage private shoreline development while protecting public access

Sensitive and Protected Lands

As previously discussed, development of the Bay and tidal wetlands in the Bay Area is regulated by the San Francisco Bay Plan (1968) as amended. The U.S. Army Corps of Engineers regulates nontidal wetlands (California Coastal Commission 1987). However, approximately 16,000 acres of diked wetlands along the perimeters of the Bay and estuary lie outside the BCDC's jurisdiction and are open to development (California Coastal Commission 1991).

Table 3.3-5 provides a list of the major tidal marshes of San Francisco/San Pablo and Suisun Bays. A discussion of preserves and shoreline parks is also included in Section 3.10.2.3.

Association of Bay Area Governments

The Association of Bay Area Governments (ABAG) is a council of governments for the Bay Area, composed of elected city and county officials. They provide a forum for addressing regional problems in the Bay Area and for formulating and implementing regional development policies. Their regional growth projections provide the basis of federal- and state-mandated regional plans (such as the County General Plan), and review of federally funded programs in the region. In 1967, ABAG produced a regional plan for the San Francisco Bay Area. The most recent amendment occurred in 1991. Specifically, the Plan provides long-term regional goals, objectives, and policies on the topics of (1) housing, (2) economic development, (3) environmental quality, (4) safety, (5) recreation, (6) transportation, and (7) health.

In addition, the Plan provides policies for subregions, which determine what short-range actions are necessary to implement the regional policies. Contra Costa County is divided into three subareas: West, Central, and East County. The project site is located in West County which, presently, does not have subregional policies.

3.10.1.3 Recreational Policies

<u>Regional Parkland and Recreational Policies</u>

Regional parklands in Alameda and Contra Costa County, including the project area, are within the planning area of the East Bay Regional Parks District (EBRPD). The district includes nearly 65,000 acres of land comprised of 15 regional trails and 49 separate park units. Parklands are classified into regional categories, including regional parks, preserves, open space, shoreline areas, wilderness, recreation areas, trails, and land banks. The purpose of the District is to acquire, preserve, protect, develop, and operate parklands in the two counties in perpetuity for public use. The 1989 Master Plan for the EBRPD was developed to achieve this purpose and contains appropriate policies, goals, and programs for current operations and long-range growth of EBRPD parklands.

Throughout the planning process, EBRPD coordinates with other agencies that provide facilities serving regional parkland needs. The District also takes a role in the preservation of nonpark open space through participation and cooperation with the development of open space plans at the federal, state, regional, county, and city level. The EBRPD will assist these agencies in implementing open space land acquisition plans and regulations. Long-range growth and direction of the

EBRPD are shown on the Master Plan Regional Parkland and Trail Map (East Bay Regional Park District Master Plan 1988). The map includes the existing EBRPD parklands and indicates future or potential parkland and trail acquisition.

County Recreational Use Policy

The Open Space Element of the County General Plan addresses issues of parks and recreation land. The County recognizes the EBRPD efforts. The two agencies work in a cooperative effort for maintenance of existing and acquisition of new park and recreational facilities. County goals include development of park and recreational facilities to serve the needs of the County population including the development of a system of interconnected hiking, riding and bicycling trails and paths suitable for both active recreational use and for the purpose of transportation/circulation.

The County and EBRPD are studying the feasibility for a trail connecting two EBRPD facilities: Lone Tree Point Regional Park in Rodeo and Carquinez Strait Regional Shoreline east of Crockett. A multi-use concept accommodating pedestrian/hiking, bicycle, and equestrian uses where feasible, have been examined (The Planning Collaborative 1992). The preferred alignment would route the bicycling trail along San Pablo Avenue through the Unocal Refinery.

This trail is part of a much larger plan, the Bay Trail Plan which proposes development of a regional 400-mile hiking and bicycling trail around the perimeter of San Francisco and San Pablo Bays (Association of Bay Area Governments 1989). In 1987, Senate Bill 100 (known as Ring around the Bay) became law and directed the Association of Bay Area Governments to adopt a plan and implementation program for what has become known as the Bay Trail Plan. More than 100 local, regional, state, and federal agencies as well as recreation organizations and environmental interests throughout the Bay Area have been involved.

Public Access Policies

San Francisco Bay

Public access required by the BCDC consists of pedestrian access to and along the shorelines and beaches of the Bay. These accessways may be improved by paving, landscaping, and street furniture such as benches. Related recreational activities, such as bicycling, fishing, picnicking, and nature education, may also be allowed. Visual access to the Bay is also considered a part of public access. Although public access to the approximately 1,000-mile Bay shoreline has substantially increased since the adoption of the Bay Plan in 1968, only a limited amount of shoreline is open to the public. Similarly, there are still several shoreline areas with little or no visual access to the Bay.

The Bay Plan policies state that, in addition to the access provided by recreational areas and facilities, maximum feasible access to and along the waterfront should be provided through new development in the Bay or on the shoreline. Development can include residential, industrial, port, public, or other uses as long as there are no safety or significant use conflicts. When public access is provided as a condition of development, the access should be permanently guaranteed by appropriate means, such as dedication of title or easements. Because there are various federal, state, regional, and local jurisdictions involved in the Bay Area, the BCDC is directed to cooperate with these agencies and special districts to provide new public access and eventually link the series of parks and access areas as much as possible such as that proposed by the Bay Trail Plan discussed above. Proposed projects should include provisions for public access consistent with the BCDC's requirements and guidelines.

Outer Coast

Proposition 20 (1972), the California Coastal Act (1976), and the state Coastal Conservancy Act (1976) were the major legislative acts that established strong access policies and programs. The California Coastal Commission implements these policies through its requirement of providing public shoreline access as a condition of certain coastal development permits. Local governments are required to include provisions in their Local Coastal Programs (LCPs) for acquiring, improving, and managing access areas. In addition, the Coastal Conservancy provides funding and technical assistance to local governments and citizens groups to acquire, develop, operate and manage new accessways (California Coastal Commission 1991). In 1979, additional legislation was enacted that directed the California Coastal Commission and State Coastal Conservancy to establish a comprehensive program to maximize public coastal access and coordinate all local, state, and federal efforts to implement the program. As part of the program, the California Coastal Commission was mandated to prepare a Coastal Access Guide for the public.

Article 10, Section 4 of the state constitution guarantees the public's right to access to the state's navigable waters along the California coast. Approximately 42 percent of the state's shoreline is publicly owned and accessible, with the remaining 58 percent either privately owned or held by federal, state, and local governments, and not open to the public. The public's right of access to or along the state's tidelands can be obtained by (1) purchase of shoreline lands for public use by federal, state, or local governments or private organizations, (2) deed restrictions or dedications by the landowner that grant the public the right to cross private property, or (3) through legal doctrines of "implied dedication" and "prescriptive rights."

"Dedicated" lands become open to the public only after an agency or private party has accepted responsibility for liability and maintenance. The California Coastal Commission and many local governments require the provision of access as a condition of approval for development permits to mitigate impacts of new coastal developments on public access. Most of the dedicated strips of land remain undeveloped and unmanaged by government agencies and, as yet, do not form a continuous system of access to and along the shore (California Coastal Commission 1991).

The determination of the existence of "implied dedication" and "prescriptive rights" is controversial because these rights are acquired through use of property without the owner's permission and it relies on proof of historic use. The Coastal Act requires the California Coastal Commission to make determinations as to the existence of these rights where there has been historic use of the area. Other agencies responsible for protecting these rights include local governments, the California Department of Parks and Recreation, the Wildlife Conservation Board, the SLC, and the Attorney General.

3.10.1.4 State and Federal Policies

The state of California owns tide and submerged lands waterward of the ordinary high watermark. State law gives primary responsibility for determination of the precise boundary between these public tidelands and private lands, and administrative responsibility over state tidelands to the SLC. Access and use of state shoreline areas can be obtained through purchase or lease agreements. The project site is currently operated under an interim lease agreement from the SLC. The preparation of this EIR is in partial fulfillment of the state's consideration for a new or continued long-term lease.

Other state agencies having control over land use in Contra Costa County include the California Department of Parks and Recreation, the CDFG, Caltrans, and the BAAQMD.

Federal agencies having regulatory authority that affect county land use and growth issues include the EPA, the Army Corps of Engineers, and the Department of Fish and Wildlife.

3.10.2 <u>Land Uses - Marine Terminal and Surrounding Area</u>

3.10.2.1 Project Site

The Unocal project site is located on the east side of San Pablo Bay in Contra Costa County, Northern California (Figure 1.2-1, Project Vicinity). Adjacent counties include Solano (north), Sonoma (northwest), Marin (northwest, west), San Francisco (southwest), Alameda (southwest), San Joaquin (southeast, east), and Sacramento (northeast). Contra Costa County is generally comprised of three distinct subareas West, Central, and East County. The project site is located in the West County subarea, which includes the urbanized shoreline of the San Francisco and San Pablo Bays and is separated from the rest of the County by the Briones Hills and open space watershed lands of the East Bay Municipal Utility District. The incorporated cities within the western subarea include El Cerrito, Richmond, San Pablo, Pinole, and Hercules. The unincorporated communities of this subarea include Kensington, El Sobrante, Oleum/Rodeo, Crockett/Valona, and Port Costa.

The Unocal Marine Terminal extends from Davis Point into the entrance of Carquinez Strait, which connects San Pablo Bay and Suisun Bay. San Pablo Bay forms the western boundary to the Unocal site. The entire Unocal facility, including the Terminal, Refinery, and tank farm, is located in the district known as Oleum from Davis Point to the area southeast of Interstate 80 (Eastshore Freeway). A Pacific Gas and Electric

(PG&E) facility is actually located within the boundaries of the Unocal property. C&H Sugar also operates a sugar refinery in the vicinity. The unincorporated communities immediately adjacent to the site include Crockett to the northeast and Rodeo to the southwest. Adjacent land to the east of the project site is vacant.

Land use designations for the project site and the surrounding area are shown on Figure 3.10-1. These designations are from the current County Land Use Map and are discussed in detail in the Contra Costa County General Plan. It is important to note the interrelationship between the ULL, the 65/35 standard and the land use designations identified in the Land Use Element of the General Plan. The project site is located within the urban limit line that encompasses the area from Richmond to Crockett. This line limits urban development to a maximum of 35 percent of land within the County.

The submerged lands under the Terminal and a small strip of filled tidelands immediately southwest of the Terminal are owned by the SLC and leased to Unocal. Currently, a butane storage tank is the only structure located on the filled tidelands. The designation for the tidelands and the existing Unocal facility is heavy industry. Land uses surrounding the Unocal facility include a mix of both light and heavy industry, public and semipublic (private land dedicated to pubic use or public land restricted for public use), commercial/residential, and open space.

Access to the project area is via I-80, the principal transcontinental route in northern California and Old Highway 40. Interstate-80 intersects State Highway 4 (John Muir Parkway) at Hercules, runs northeast through Rodeo and east of the project site, then runs north across the Carquinez Strait to Vallejo. Several names have been given to Old Highway 40 as shown on various maps. This highway is known as San Pablo Avenue as it winds its way from Richmond to Hercules, as Parker Avenue through Rodeo, then as Old Highway 40 as it traverses across the existing Unocal Refinery site to its intersection with I-80 in Crockett.

A mainline of the Southern Pacific Railroad also traverses the project site along the westside. The 100-foot-wide railroad right-of-way follows the eastern shoreline of San Pablo Bay, through Crockett and along the southern shoreline of Carquinez Strait and Suisun Bay. The right-of-way contains the Concord and Brisbane product pipelines owned and operated by Santa Fe Pacific and a third product pipeline that runs to Richmond.

3.10.2.2 Adjacent Land Uses

Section 2.4 provides a description of the cumulative environment that includes the main facilities, terminals, and other industrial land uses in the vicinity of the project. Marine terminals located in the project vicinity are shown on Figure 2.4-1. The following section discusses land uses of the area immediately adjacent to the Unocal facility.

The Wickland Oil Selby Terminal is located immediately north of the Unocal Refinery. The Terminal also extends from the shoreline into the Carquinez Strait, but is smaller, has a limited pipeline capacity, and is primarily used as a product terminal. The majority of the shoreline area is vacant, disturbed land with a few existing structures. The land use designation for this area is heavy industrial.

The area to the east and northeast of the Unocal property is mostly undeveloped open space consisting of low rolling hills. In the area north of Old Highway 40, there is a cluster of residential units and a school located in the community of Tormey. The mostly-vacant lands between Tormey and Selby are designated for open space and parks and recreational uses, and include the Carquinez Strait Trail. A bicycle and recreational trail is also designated along San Pablo Avenue in this area, including adjacent to the Unocal Refinery. The land use designation for the area between Old Highway 40 and I-80 is for agricultural and public/semipublic uses. A large vacant parcel, located adjacent to I-80 northeast of the Wickland Oil Company tank farm is owned by the county and designated as public and semipublic land. This parcel is reserved for a planned industrial arterial road between I-80 and San Pablo Avenue (Policy 3-156, Land Use Element).

The unincorporated community of Crockett/Valona is comprised of single and multiple residential, commercial, and industrial uses. The shoreline area west of the Carquinez Bridge is designated commercial recreational and provides public access to the Bay. The shoreline east of the bridge is designated for heavy industrial uses including oil terminals facilities. Areas of open space, parks and recreational, public/semipublic, and agricultural uses surround the Crockett/Valona area.

The lands on the inland side of I-80, adjacent to the Unocal facility are designated for heavy industrial uses. One parcel in this area is now owned and managed by the SLC. Several oil tanks are located on the hillside in this area. The undeveloped lands surrounding these tanks include open space and a buffer of agricultural lands that have been designated in the County Land Use Element to separate the Viewpoint residential area from future industrial development of the Unocal property. Within the policies for the Rodeo area, these open space lands are intended to remain essentially undeveloped. Further east and to the south are the lands within the Briones Hills Agricultural Preservation Area. This rural area includes large properties owned by either the East Bay Municipal Utility District or the EBRPD. These properties are designated for watershed, parks and recreation, and agricultural land uses through the term of the county's planning period (Contra Costa County 1991).

The unincorporated community of Rodeo is located immediately adjacent to the Unocal site to the southwest. The original section of the community of Rodeo was settled in the early 1900s. Most of the residential and commercial area west of I-80 was developed by the mid-1960s Redevelopment Plan. County land use policies and standards for the Rodeo Area emphasize waterfront development, recreational areas, and revitalization and redevelopment within and around the Old Rodeo portion of the community. Upgrading of the waterfront area, in particular, Bennett's Marina and Joseph's Fishing Resort, is planned for commercial recreational uses, which would provide more public access and capitalize upon the proximity of the Bay (The Planning Collaborative, Inc. 1992).

The City of Hercules is also located along the I-80 corridor, southwest of Rodeo. The city encompasses approximately 7 square miles with 524 acres of undeveloped land within the city limits. The Sphere of Influence, which could be annexed to the city in the future, contains about 1,365 acres. Predominant land uses include residential uses with planned business parks and undeveloped parcels of commercial land. The residential areas were developed beginning in the late 1970s. Since then, population growth has been rapid, and it is anticipated that almost all of the available residential land within the current limits will be built out. The projected population in 1993 is approximately 19,000. Currently, over 700 acres in the city are zoned for industrial, industrial/commercial, highway and services commercial, neighborhood commercial, and town center. The Pacific Refining Company is located at the city's northernmost limit next to Rodeo in an industrial district.

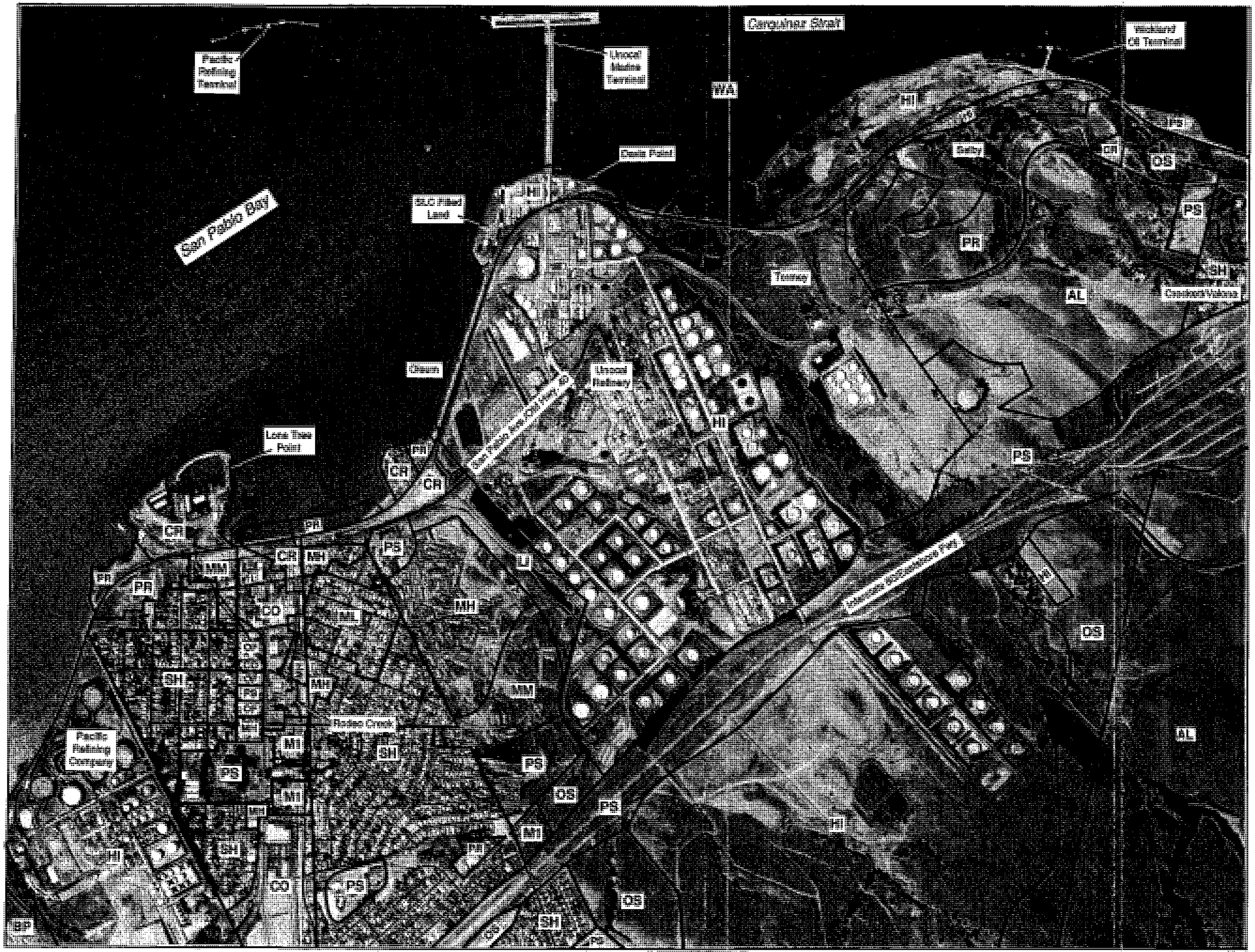
South of the project site in North Richmond, hundreds of acres of vacant industrial land are expected to be developed or redeveloped during and after the planning period of the general plan. Completion of a major flood control and freeway project is expected to improve the area in order to attract businesses and investors.

3.10.2.3 Land Uses in San Francisco and San Pablo Bays and Adjacent Areas

San Francisco and San Pablo Bays' shoreline characteristics include a range of land uses comprised mainly of urbanized and industrial areas, with occasional rural and open space areas, and coastal wetlands and areas of salt evaporation ponds. The landform throughout most of the area includes hilly terrain. Where there is no development, this open area is generally covered with low vegetation.

Most of the coastline within San Francisco Bay is urbanized with the exception of the northern and southern ends. This includes the western shoreline from Palo Alto on the south to San Mateo and San Francisco on the north. From San Francisco north, there are the communities of Sausalito, the Tiburon Peninsula, and San Rafael. Park and marsh areas then begin to form along the western shoreline portion of San Pablo Bay. This area also includes Hamilton Air Force Base, Petaluma Point, and the San Pablo National Wildlife Refuge. Most of this area is not highly developed.

Mare Island Naval Shipyard is along the northeast San Pablo Bay shoreline near Vallejo and the mouth of Carquinez Strait. Continuing south along the eastern shoreline of San Pablo Bay is Davis Point and the Unocal Marine Terminal and the communities of Rodeo and Pinole before Pinole Point. From Pinole Point south, San Francisco Bay's eastern shoreline is also highly urbanized with the cities of Richmond, Berkeley, Alameda/Oakland, and San Leandro as far south as the central part of the Bay, with marshes and salt evaporation ponds shoreward of the cities of Hayward and Fremont. The San Francisco Bay National Wildlife Refuge is located to the southern portion of this shoreline along with more salt evaporation ponds.



LEGEND

SINGLE FAMILY RESIDENTIAL
(Units per net acre)
- SH High (5.0 to 7.2)

MULTIPLE FAMILY RESIDENTIAL
(Units per net acre)
- ML Low (7.3 to 11.9)
- MM Medium (12.0 to 20.9)
- MH High (21.0 to 29.9)

COMMERCIAL AND INDUSTRIAL
- CO Commercial
- OF Office
- BP Business Park
- LI Light Industry
- HI Heavy Industry
- CR Commercial Recreation

MIXED USE AREAS
- M1 Downtown Rodeo

OPEN SPACE AND OTHER USES
- PS Public/Semi-Public
- PR Parks and Recreation
- OS Open Space
- AL Agricultural Lands

N

FEET
0 1000

Source: General Plan Land Use Element, Contra Costa County, January 1991.

LAND USE
Figure 3.10-1

The shoreline area along Carquinez Strait is a mix of industrial and urban uses, interspersed with hilly undeveloped terrain, similar to that around Davis Point. Further east, within Suisun Bay and Grizzly Bay, the shoreline is dominated by wetland areas especially along the northern landform. The southern shoreline is comprised of wetlands as well as several small communities.

Within this area, there are 8 ports, 26 marine terminals, and a number of naval terminals located throughout the Bay. The major port areas are San Francisco, Redwood City, Oakland/Alameda, Richmond, San Pablo Bay, and Carquinez Strait, and east. A map of these facilities and a description is presented in Section 2.4.2.1.

Major preserves and shoreline parks of San Francisco Bay include Suisun Bay Marsh with duck hunting preserves; San Pablo Bay National Wildlife Refuge with mudflats, salt marsh and open water that serve as a Pacific Flyway stop for birds; Tubbs Island, accessible by boat; and the Point Pinole Regional Shoreline. China Camp State Park, along the southwest shore of San Pablo Bay, preserves a historic fishing site; Coyote Hills Regional Park and San Francisco Bay National Wildlife Refuge protect important wetland acreage in the South Bay for wintering waterfowl. Other sensitive natural areas of the Bay include Grizzly Island Wildlife Area, Lower Sherman Island Wildlife Area, Petaluma River and Marsh, Napa River and Marsh, and Bay Model. Bay ecology displays and educational programs are offered at the Audubon Wildlife Sanctuary in Richardson Bay, San Mateo County Coyote Point Park and Museum, the Palo Alto Baylands Interpretive Center, and the Environmental Education Center in Alviso.

3.10.3 Recreation

3.10.3.1 Recreation Near the Marine Terminal

The entire project site is within the EBRPD jurisdiction. Currently, there are three existing Regional Shorelines in the vicinity of the Unocal site. The Point Pinole and San Pablo Bay Regional Shorelines lie to the south, and the Carquinez Strait Regional Shoreline is located to the north near Crockett. The shoreline and hills along the Carquinez Strait between Crockett and Martinez constitutes one of the few undeveloped coastal areas in the East Bay. Land use policies of the County General Plan encourage preservation of the natural scenic and historical resources in this area. The San Pablo Regional Shoreline is also designated as containing potential sites for future acquisition.

A portion of Old Highway 40, approximately from Tourmey to Selby, is designated in the Master Trail Map as an Existing Regional Trail and has been indicated on other maps as the Carquinez Strait Trail. An irregularly shaped area between the trail and the shoreline is designated as existing EBRPD lands.

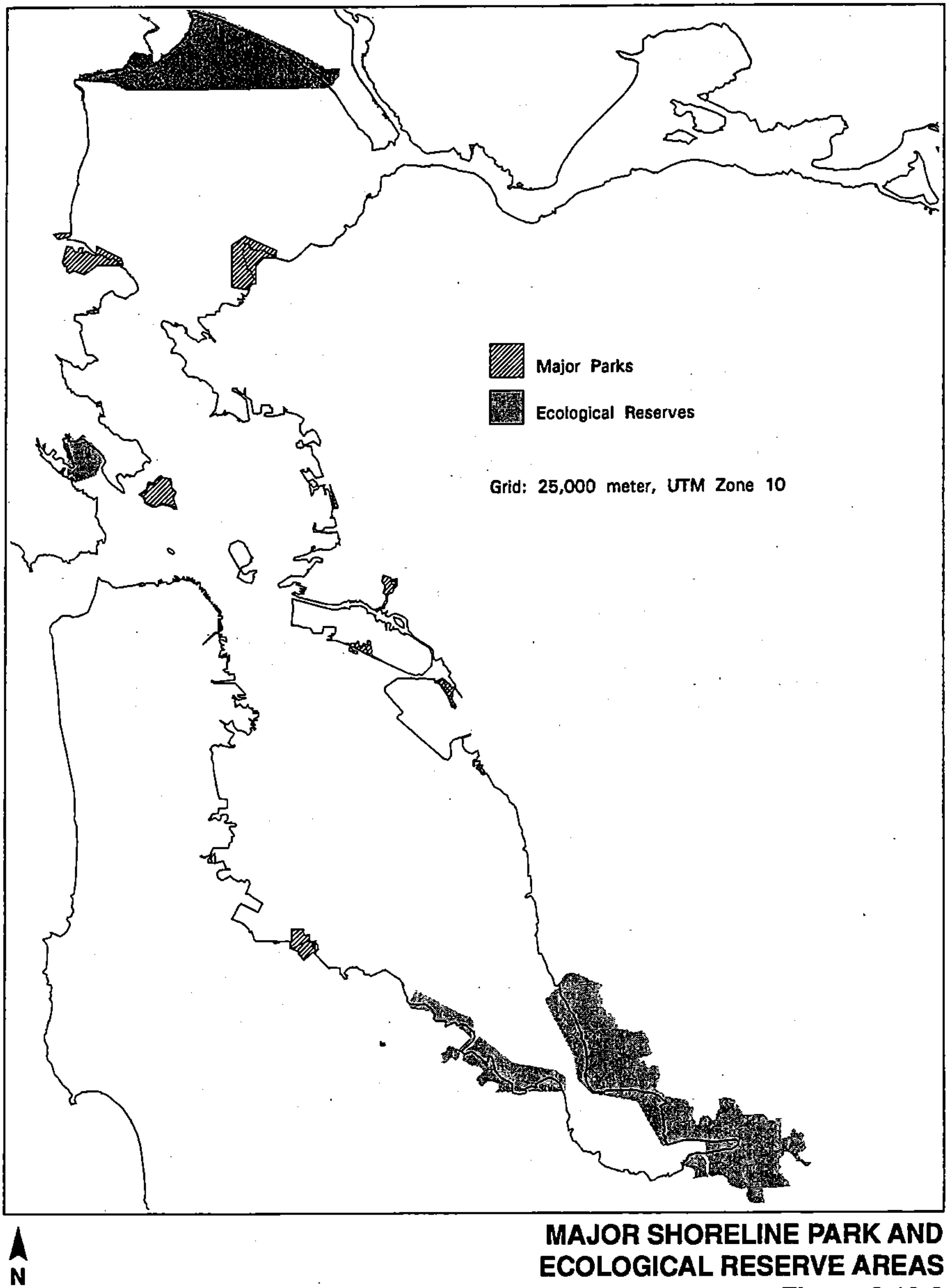
Lone Tree Point is located southwest of the Unocal facility near the boundary of Rodeo and the city limits of Hercules. The point was recently acquired by the EBRPD to provide access to San Pablo Bay and for eventual development as a day-use park. Since its acquisition, the EBRPD has kept the property closed to the public because unsafe physical conditions preclude public use (Woodward-Clyde 1992).

Ultimately, the district and county, city, and park agencies of the San Francisco Bay Area plan to join the region and communities on a grand scale with a proposed Bay Trail and a Ridge Trail. The Bay Trail would follow the shoreline around the entire San Francisco Bay, and the Ridge Trail would wind through the hilltops above the Bay. Together, the 1,000 miles of interconnecting trails would increase inland and shoreline access and maintain natural habitats (EBRPD as amended 1989). The path of the proposed trial along the eastern shore of San Pablo Bay will traverse the Unocal site. Acquisition of trailways through private property is considered as these lands come up for permitting or through an environmental review process.

Public marinas are located on both sides of the Unocal site in Rodeo and Crockett. The Rodeo Marina (Bennett's Marina) is located at Lone Tree Point. Joseph's Fishing Resort is also in this area at Rodeo, while Crockett Marine Service and Glen Cove Marina are located about 3 and 6 miles northeast of the Terminal, respectively. The Point Pinole Fishing Pier is located at Pinole Point, south of the project site.

3.10.3.2 Recreational Uses in the San Francisco and San Pablo Bay Area

The San Francisco and San Pablo Bays contain a variety of shoreline-related recreational opportunities. Major recreational park areas and sensitive land uses (including wildlife reserves/refuges) in the San Francisco and San Pablo Bays area are listed in Table 3.10-1 and shown on Figure 3.10-2.



MAJOR SHORELINE PARK AND ECOLOGICAL RESERVE AREAS
Figure 3.10-2

Table 3.10-1

MAJOR SHORELINE RECREATIONAL AREAS
SAN FRANCISCO AND SAN PABLO BAY

Bay Parks	
San Leandro Bay Park John F. McInnis County Park China Camp State Park Frank's Tract State Recreation Area Oakland - Lake Side Park Oakland - Estuary Park Angel Island State Park Berkeley Aquatic Park	Point Pinole Regional Shoreline Robert Crown Memorial State Beach Coyote Point County Park Marine World Marina Green Park Brannan Island State Reservation Area Benicia State Park
Refuges/Reserves	
Lake Merrit Waterfowl Refuge Lake Merrit Natural Science Center San Pablo Bay National Wildlife Refuge San Francisco Bay National Wildlife Refuge	Sherman Island Waterfowl Management Area (Lower Sherman Island Wildlife Area) Mount Tamalpais Game Refuge at Richardson Bay Grizzly Island Wildlife Area

Developed parks and recreational and sightseeing areas that provide access to the shoreline are found along the urbanized sections of San Francisco Bay, particularly along the waterfront areas of the San Francisco peninsula. In addition, there are approximately 140 boat-launching ramps/marinas and associated facilities (including fishing piers) throughout the Bay (see Appendix H for listing). Extensive private boating (both sail and power) occurs throughout the Bay and Delta.

Undeveloped marsh areas are located to the south. The San Francisco Bay National Wildlife Refuge and Coyote Hills Regional Park at the southern end of the Bay provide opportunities for hiking and biking in selected areas and near the shore.

The northern end of San Pablo Bay is not as urbanized. Most of the shoreline along north San Pablo Bay and across the Bay from the project site consists of the San Pablo National Wildlife Refuge where hiking and hunting activities are allowed. There are only a few boat ramps and fishing piers in this area.

Recreational uses along the Carquinez Strait shoreline include the Benicia State Recreation Area and a scenic drive along the southern shore between Crockett and Martinez. Boat ramps and fishing piers are found along the urbanized areas in Benicia and Martinez.

The shoreline around the Suisun Bay and Grizzly Bay are dominated by wetland areas, especially in the northern sections. These marshland and wildlife areas are mostly traversed by unimproved roads and trails and provide opportunities for hiking, boating, restricted hunting, and fishing. Some boat ramps and fishing piers are available along the southern shoreline near Pittsburgh and in the Sacramento Delta area at the far eastern end.

3.10.3.3 Recreational Uses on the Outer Coast

The outer coast from the Oregon border south to Santa Cruz includes the counties of Del Norte, Humboldt, Mendocino, Sonoma, Marin, San Francisco, San Mateo, and Santa Cruz. Uses along the coast consist of undeveloped open coastal areas, areas of concentrated development and urban uses, wetlands, unique shoreline and coastal resource areas, and recreational uses. Appendix J includes a list of recreational parks and coastal access points from Del Norte County south to Santa Cruz County.

Opportunities for recreational fishing are also available along California's 1,100 miles of shoreline. Along the outer coast there are numerous locations with fishing piers and berthing and launching facilities for recreational boats. There are 13 piers and 11 major marina facilities providing fishing access as presented in Table 3.4-5 of Section 3.4. Recreational fishing areas and access points along the north coast are shown on Figure 3.10-3.

Current information about recreation areas and public access points along the California coastline was taken from California Coastal Access Guide (California Coastal Commission 1981, revised Spring 1991); California Coastal Resource Guide (California Coastal Commission 1987), a companion to the California Coastal Access Guide; and the Northern California Atlas & Gazetteer (DeLorme Mapping Company 1988). The following is a discussion of land uses and recreational uses along the outer coast by county and summarizes information from the above references.

Del Norte County

Del Norte County lies in the extreme northwest corner of California. This area is known primarily for its extensive redwood forests and anadromous fish rivers that provide the resources for the county's two principal industries, timber and commercial fishing, as well as recreational opportunities. The county's 42-mile-long coastline is characterized in the north by narrow sandy beaches and low-lying terraces. Much of the coastline consists of northwest-trending dunes that extend south to Point George. The county's south coast is dominated by redwood forests and characterized by high, eroded cliffs that stretch to the mouth of the Klamath River. The towns of Smith River, Crescent City, and Klamath are popular tourist areas. Redwood National Park has beaches and parks that provide access to the shore and coastal recreational areas. The Park extends through Del Norte and Humboldt Counties and encompasses a total of 106,000 acres. State beaches, parks, harbors, and fishing accessways also provide public access points along the coast.

Humboldt County

The coastal area of Humboldt can be divided generally into three areas. In the north, sandy beaches backed by steep cliffs and bluffs, rocky coves and tidepools, three large lagoons, the forests of Redwood National Park, and commercial timberland dominate the landscape. From south of Trinidad to the Eel River, the central coastal area consists of low-lying fertile river deltas and bays. The more populated areas around the Mad River, Humboldt Bay, and the Eel River are centers for dairy, fishing, and timber industries. The cities of Arcata and Eureka are in Humboldt Bay, one of California's major shipping and commercial fishing ports. The southern coast is characterized by steep ridges and high coastal mountains that drop abruptly to narrow, exposed beaches. In addition to timber and fishing, tourism and recreation-related activities are the most important industries within the county.

Along the north coast south to Humboldt Bay, the various beaches, parks, lagoons, and campgrounds can be accessed from hiking trails and scenic roads off of Highway 101; the numerous bays and rivers provide opportunities for public fishing. Humboldt Bay has a marina, several boat-launch areas, parks, recreational vehicle parks, and two marshlands for hiking and passive recreational activities such as birdwatching. Sand dunes line the western boundary of the Bay along the Samoa Peninsula and the north and south spits that form the entrance to the Bay. In the southern portion of the county, beaches are accessed from roads and trails/paths that stretch from pullouts to the shore. Many of these trails lie adjacent to private land. The King Range National Conservation Area includes over 62,000 acres (of which 6,700 acres are still privately owned) of steep coastal mountains and shoreline administered by the BLM. The BLM operates camping areas, and there are numerous hiking trails that cross the range. This primitive area, which constitutes part of the "Lost Coast," has very few roads.

Mendocino County

Over 130 miles long, Mendocino County's coast is noted for its eroded sea cliffs and numerous small pocket beaches. Undeveloped terraces extend for miles along the coast between Highway 1 and the ocean and are occasionally interrupted by small towns and villages, and the deep ravines of creek, stream, and river inlets. Access to the shoreline is often steep and difficult. Sandy beaches are generally secluded and protected by the cliffs. Diving along the rocky shores is a popular activity, especially during abalone season. An offshore underwater park for divers and the Point Arena Underwater State Reserves are located

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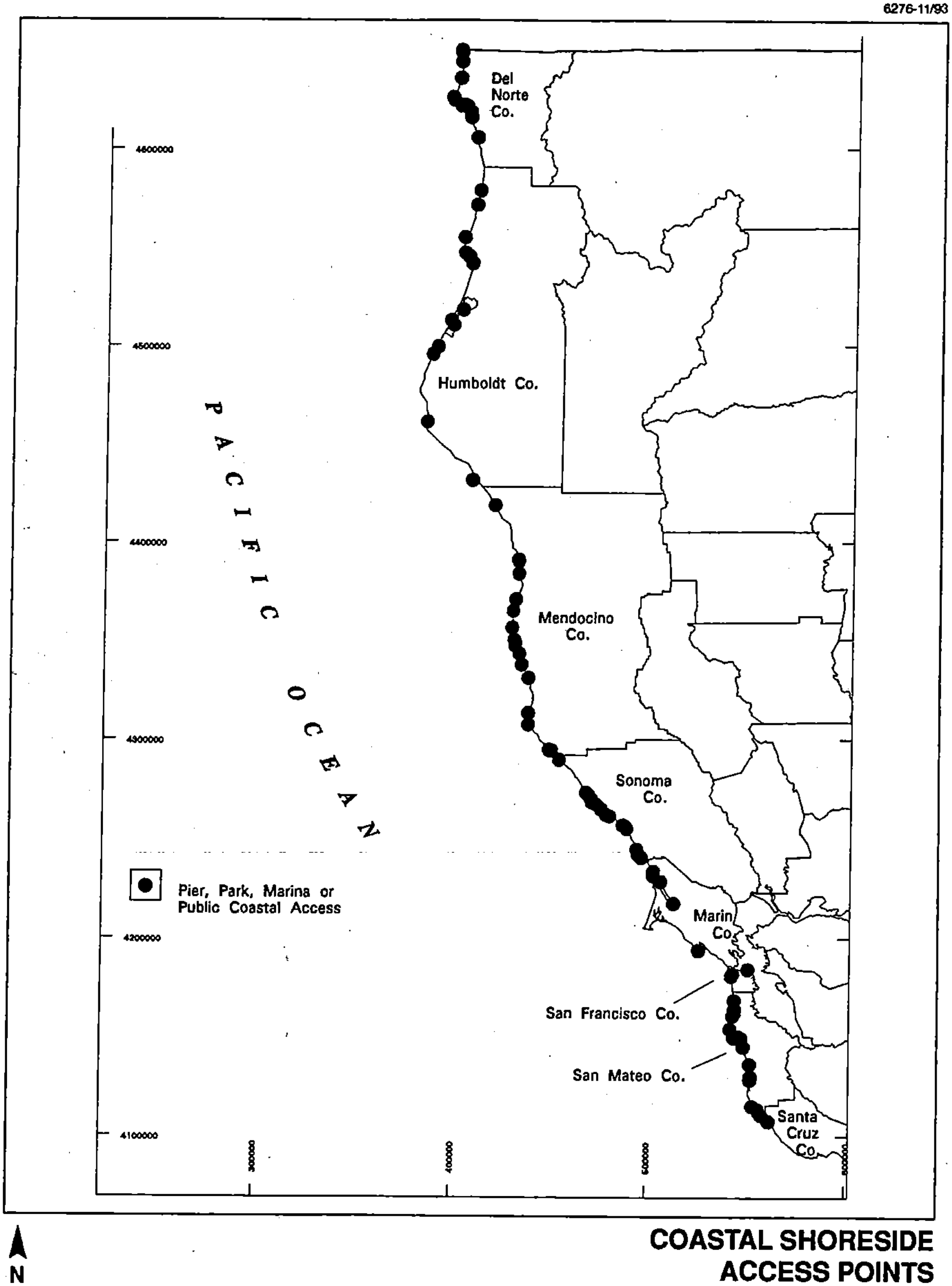

COASTAL SHORESIDE ACCESS POINTS
Figure 3.10-3

at Manchester State Beach. Boat-launch facilities are limited to Noyo Harbor, Albion Flat, and Arena Cove, although car-top and inflatable boats can be launched from some beaches.

The center of the county's tourist industry is the town of Mendocino. Unique to this portion of the coastline is the northern Mendocino County area known as the "Lost Coast," where Highway 1 heads inland through the Sinkyone Wilderness State Park and the King Range National Conservation Area in the north, through mostly private land toward the south. Access to the beaches, dunes, and tidepools is primarily by hiking trails.

Sonoma County

The Sonoma County coast is also characterized by steep cliffs, terraces, and occasional small towns. The northern one-third of the coast is mostly private land with limited public access, including the 10-mile-long Sea Ranch development, with certain other private lands accessible for a fee. Salt Point State Park (400 acres) is located 20 miles north of Jenner and is a popular area for camping, hiking, and whale watching. The southern one-third of the coast is almost exclusively State Beach. The Sonoma Coast State Beaches comprise over a dozen sandy coves and pocket beaches between the Russian River at Goat Rock and Bodega Bay. This part of the coast is also popular for fishing. South of these beaches along Highway 1 is Bodega Bay, the county's southernmost coastal town. Bodega Harbor is a center for commercial fishing, recreation, and sportfishing. Parks, campsites, and boating facilities are also available in the harbor.

Marin County

The geology of this section of coast reflects its location along the San Andreas rift zone. Steep headlands with grassy ridges and forested ravines dividing numerous coastal bluffs form the Marin County coast. The 16-mile-long Tomales Bay is part of the rift zone and separates the Point Reyes Peninsula from the rest of the county. The Bay supports a significant commercial shellfish industry that began in the late 1800s. The southern end (Tomales Bay Ecological Reserve) is a wildlife refuge for migrating waterfowl. The western shore of the Bay on the peninsula has two beaches, a state part, and saltmarsh study area. Overall, access for boating and fishing activities are limited to the north near the entrance to Tomales Bay. The Bay also outlines the eastern boundary of the 64,000-acre Point Reyes National Seashore which is part of the federally owned Golden Gate National Recreation Area (GGNRA). The Point Reyes National Seashore is one of only seven national seashores in the United States and is comprised of several beaches, lagoons, hiking trails, preserves, and wilderness areas.

At Bolinas Lagoon to the south, the coastline arcs northwestward to form the crescent-shaped Drakes Bay along the southern shore of the peninsula. This section of the peninsula has a beach, nature preserve, and a marine preserve at Duxbury Reef where public fishing is restricted. Beaches and parks located south from Stinson Beach to Kirby Cove near the Golden Gate are mostly within the GGNRA, which is administered by the National Park Service. Trail systems throughout this area connect the GGNRA, the Muir Woods National Monument, and the Mount Tamalpais State Park. In the southern portion of the county, the Marin headlands across the Golden Gate from San Francisco have mostly remained undeveloped.

Southwest of the Point Reyes Peninsula are the Farallon Islands that are part of the 100-acre Farallon Islands National Wildlife Refuge (established in 1972) and managed by the U.S. Fish and Wildlife Service and the Point Reyes Bird Observatory. In 1982, the gulf of the Farallons National Marine Sanctuary was established to protect the waters adjacent to the coast between Bodega Head in Sonoma County, Rocky Point in Marin County, and the Farallon Islands extending offshore for 6 nautical miles and including the waters within 12 nautical miles of the Farallons. Also included within the sanctuary are Bodega Bay, Tomales Bay, Drakes Bay, Bolinas Bay, Bolinas Lagoon, Estero Americano, and Estero de San Antonio on the mainland.

San Francisco County

San Francisco lies at the northern tip of a 50-mile-long peninsula separating the Pacific Ocean from the waters of San Francisco Bay. The ocean coastline of San Francisco County, from the Golden Gate Bridge to Burton Beach at the San Mateo County line, is almost all public land. The GGNRA encompasses this 8-mile-long section of coast and includes sandy blufftops, coves and cliffs, and sandy beaches adjacent to the city of San Francisco. Only one ocean beach in San

Francisco (China Beach) is safe for swimming. Other activities available to the coast include hiking trails and overlooks. A coastal trail extends from the Golden Gate Bridge to the Cliff House (a historical seaside resort) and connects portions of the GGNRA. The 4-mile-long Ocean Beach stretches from the Cliff House to Fort Funston. Stairs lead to the beach where surfing and fishing are allowed. Golden Gate Park encompasses over 1,000 landscaped acres near the beach, and features museums, gardens, and the Steinhardt Aquarium. At the southern end of the county, a trail leads from Fort Funston to the beach and sand dunes.

The city of San Francisco is the urban core of a nine-county metropolitan area clustered along the shoreline of San Francisco Bay. As previously discussed, access to the shore within San Francisco Bay is under the jurisdiction of the San Francisco BCDC.

<u>San Mateo County</u>

San Mateo County has 55 miles of Pacific coastline and is often referred to as the Coastside. The populated urban areas within the county include Daly City and Pacifica to the north. With the exception of Half Moon Bay, the area south of Montara Mountain just below Pacifica is sparsely populated and largely undeveloped. The coastal towns of Moss Beach, San Gregorio, and Pescadero retain the character of small coastside farming and fishing communities. The coastline is characterized by steep sea cliffs in the Daly City and Devil's Slide areas. South of Devil's Slide, the marine terraces above the sea cliffs support coastal agriculture. While too cold and hazardous for swimming activities, the beaches in San Mateo County provide opportunities for tidepooling, picnicking, marine mammal watching, and pier and shore fishing. Beaches are accessed from the cliffs via trails and stairs. There are numerous state beaches, public beaches, and natural areas including the James Fitzgerald Marine Reserve, Pescadero Marsh Natural Preserve, and the Año Nuevo State Reserve where marine mammals can be observed. Pillar Point Harbor (Johnson Pier) is the only small boat harbor between San Francisco and Santa Cruz. It also contains a popular municipal fishing pier.

<u>Santa Cruz County</u>

South of Año Nuevo Point, the varied coastline of Santa Cruz County extends for 42 miles from the coastal terraces beneath the Santa Cruz Mountain in the north to the farmlands of the Pajaro Valley in the south. North of the city of Santa Cruz, the coast is characterized by narrow, sandy beaches backed by steep bluffs. To the south, along the north shore of Monterey Bay the coastline consists of wide and sheltered swimming beaches and sand dunes.

Miles of sandy beaches, extensive parklands, hiking and biking trails, and a bike route that extends the length of the county make this county a popular tourist and recreation area. The City of Santa Cruz is a popular tourist town that offers beaches for swimming, surfing, fishing, and a boardwalk amusement park, the last of its kind open on the California coast. A mile-long protected sandy beach stretches in front of the boardwalk. Recreational facilities, including campgrounds, picnic areas, play facilities, and access for fishing, are available at numerous beaches. Boating and fishing facilities are available in Santa Cruz and Capitola.

3.11 CULTURAL RESOURCES

3.11.1 Historic Characteristics of Area

The major component of the cultural resource evaluation of Unocal's San Francisco Marine Terminal facility included an extensive examination of all published archaeological data, survey reports, site records, historic archives, and ethnographic information pertaining to the general Contra Costa County shoreline between the towns of Hercules on the northwest and Crockett on the northeast. In particular, all records pertaining to officially recognized cultural resources were examined to determine if any sites have been identified within either Unocal's Marine Terminal or Refinery properties:

1. A check of the information on file with the Regional Office of the California Archaeological Site Survey to determine the presence or absence of previously recorded historic or prehistoric cultural resources within the Marine Terminal or adjacent Refinery facility,

2. A check of appropriate historic references to determine whether historic era archaeological deposits are located within the Marine Terminal and could possibly, be adversely impacted by planned expansion, consolidation, or removal of the facility.

Appendix I presents the complete details of the Cultural Resources evaluation prepared for this project.

3.11.1.1 Results of Literature Check

On June 9, 1992, the records maintained by the Northwest Information Center, California Archaeological Inventory, stored at the Department of Anthropology, Sonoma State University in Rohnert Park, were examined (File No. 60800-92-217). This review indicated that the specific project area consisting of Unocal's San Francisco Marine Terminal, as well as the adjacent San Francisco Refinery, have not been the subject of any specific cultural resource investigation until the present evaluation. The research indicates there are no National Register of Historic Places properties located or listed within the study area; the State of California Department of Parks and Recreation (1976, 1979, 1982) list also indicates that no historic landmarks, places, or other officially recorded sites are officially known to be located within the study area.

The absence of the San Francisco Marine Terminal and Refinery, dating from the 1890s, from federal and state listings does not reflect the properties' inherent ineligibility, just the lack of sufficient historic research to document how significant the growth and success of the petroleum processing and transportation industry has been to the growth of Contra Costa County in the latter portions of the nineteenth and early twentieth century. The present Marine Terminal was constructed in 1955, after a 1952 fire destroyed the previous Terminal. The existing Terminal does not constitute a recordable historic property under current federal guidelines.

3.11.1.2 History of Archaeological Evaluations in the Immediate Project Vicinity

Although research indicates that Unocal's facilities have not been previously examined by modern archaeologists conducting field surveys as part of environmental impact studies, portions of the Union Oil Company (now Unocal) land holdings may have been examined early in this century.

As plotted on the Information Center's base maps, a prehistoric shellmound site recorded by Nels C. Nelson in 1907, now known as CA-CCo-257, is shown on the eastern promontory known as Davis Point. This area lies to the south and east of the southern edge of the Marine Terminal property, near a series of oil tanks that have been built into Davis Point. As plotted on the Information Center at Sonoma State University, CCo-257 is located south and east of the southern end of the Marine Terminal, near a grouping of seven or eight oil tanks. According to site records, the shellmound was to have been of considerable size. Disturbance of the mound had occurred with the last of the material removed around 1907 to give place for some oil tanks. Reports agree that many skeletons and artifacts continually were uncovered through the years of the site's existence.

3.11.1.3 Other Investigations of Nearby Properties

The closest previously evaluated property to Unocal's Marine Terminal facility is the Pacific Refining Company Refinery facility in Hercules to the southwest, a property possessing highly similar physical and environmental settings to the study area. The Pacific Refining Refinery property has been examined by archaeologists on several occasions, partly due to a previous proposal to expand the facility as well as more recent plans to build residential subdivisions in the former location of the Hercules Powder Factory, also encompassed within the Pacific Refining Refinery property. The Hercules Powder Works is recognized as one of the most significant cultural resources of the Rodeo/Hercules area. While this facility has not been officially nominated to the National Register of Historic Places, county and local sources do provide pertinent data on its importance to the growth of the town of Hercules.

The archaeological surveys of the Pacific Refining Refinery facility and adjacent properties during recent years have resulted in the discovery of several scientifically significant, but highly disturbed, remnants of both prehistoric and historic cultural resources, including physical deposits from aboriginal occupation (CA-CCo-258 and CCo-474/H) as well as structural and other remains from the Hercules Powder Company, which apparently operated on this parcel up into the 1960s (Maniery and Maniery, 1983; Holman & Associates, 1978, 1982).

3.11.1.4 Archaeological Investigations along the Contra Costa Shoreline

Information on prior archaeological studies that have been conducted by researchers associated with the University of California early in this century, as well as by other institutions and individual consulting firms that have worked in this area after the late 1940s when new highways and later residential subdivision projects were being contemplated and built near the communities of Hercules and Crockett along the coast in the Carquinez Strait, were reviewed.

Portions of the then-unfilled shoreline and upland areas within the narrow canyons of the Contra Costa County coast of the San Francisco and San Pablo Bays were examined by Nels C. Nelson during his circumnavigation of the bayshore in the summer of 1907. This research project was performed by Nelson while he was a graduate student in the Anthropology Department of the University of California, Berkeley. The project was conducted under the direction of Dr. John C. Merriam, an invertebrate paleontologist and acting head of the Anthropology Department in the late 1890s and first decade of the 1900s, prior to the assumption of position of department head by anthropologist, Dr. Alfred Kroeber, in 1909.

Nelson's research was published in 1909 as "Shellmounds of the San Francisco Bay Region." Details on Nelson's sites Nos. 262 to 253, which stretch along the Contra Costa shoreline from west of Pinole to Crockett on the east, are presented in Appendix I to this EIR. With the exception of CCo-257, no sites are located in the immediate project area.

Pursell (1940) mentions that in several places in the San Pablo Bayshore area, such as Crockett and in the "neighborhood" of Oleum, Indian shell mounds had been observed by residents as well as other commentators. These observations apparently were made during what probably were major landscape alteration for roads, industrial developments, railroad construction, or similar activities. Nelson's CCo-257 may be the observed site at Oleum, but it seems that few of these disturbed sites have been described at length in the documents reviewed as part of the current Unocal study. Recent surveys for highway improvements characteristically refute the possible survival of Nelson sites Nos. 256 and 248, but seem quick to designate identified prehistoric shell deposits and artifacts found in the road rights-of-way as new sites.

Because the Information Center plots CCo-257 extremely close to the Marine Terminal, there is a possibility that buried site constituents may still exist in the project area. Aboveground remnants of this site will not be found, because the entire landform upon which the site was reported has been removed for the placement of oil tanks and similar facilities. However, future activities could uncover buried cultural deposits.

3.11.2 Existing Conditions

Based on the highly similar physical and environmental settings of Unocal's Marine Terminal and Refinery to the adjacent Pacific Refining Refinery property in Hercules to the west, as described by Nelson and later researchers, there is a high probability that both prehistoric and historic cultural resources are present in some form within the Unocal Refinery property adjacent to the Terminal. Underground portions of CCo-257 could survive beneath the ground upon which oil tanks have been built, located to the south and east of the Marine Terminal at the end of Davis Point.

In addition, previously unrecorded prehistoric shell deposits might be present in either remaining shoreline areas (that have not been completely eroded away) or in the very narrow canyons into which the Refinery facilities currently have been built. The likelihood of unrecognized shell deposits surviving in the interior canyons is greater, because these areas often have not been as heavily modified for the construction of oil refinery facilities, roads, and railroad routes. The more inland localities also might be less covered by pavements and other materials that would hamper a standard archaeological surface examination.

In addition, there is a possibility that buried or submerged cultural resources, dating from either the aboriginal Native American occupation or, later historic EuroAmerican settlement with commercial or industrial development could be present within both the landward and shoreward parts of the facility.

Prehistoric shell deposits might be buried beneath landslide debris, cut-and-fill necessary for refinery facilities or roadways, or pavements associated with oil tanks and similar industrial facilities (where bare, open ground usually is avoided).

Foundations of former historic buildings and structures also might survive in either the Marine Terminal or Refinery areas. Remnants of the older wharf and Marine Terminal destroyed by the fire also could survive, now encapsulated beneath or within the new Terminal wharf built of concrete in 1955.

3.12 ENERGY

This section describes the regional energy perspective for importing, refining, and shipping crude oil and petroleum products. It should be noted that the analysis primarily focuses on capacities rather than actual shipments because the current productions will be expected to vary, depending on economic and other factors in the state. These other factors include individual refiner's marketing strategies and relative costs of various crude oil sources.

3.12.1 Refining Capacity

The Unocal Refinery capacity is estimated at approximately 73,100 barrels per calendar day (BPCD) or approximately 27 million barrels per year (BPY) of refined products (note: 1 barrel [bbl] equals 42 gallons). Total San Francisco Bay Area refining capacity is estimated at 278 million BPY (Petroleum Supply Annual 1991). Total state refinery output is estimated at 776 million bbl (California Energy Commission 1991). The Bay Area refineries make up the majority of total refinery output in the area, which is estimated by the Energy Commission as 320 million bbl for all of northern California.

Table 3.12-1 illustrates the projected capacity of San Francisco area refineries. The Unocal Refinery represents 9.6 percent of refinery capacity in the region. The Chevron USA Refinery in Richmond is nearly four times larger than the Unocal Refinery, with the Exxon USA facility in Benicia, the Shell Oil Company, and the Tosco Refinery in Martinez also substantially larger. Two independent refineries, the nearby Pacific Refining Company Refinery in Hercules, and the Huntway Refinery Company in Benicia, are smaller than the Unocal Refinery.

3.12.2 Crude Oil/Product Shipment and Marine Terminal Capacities

In 1991, crude oil receipts at the San Francisco Bay Area refineries were 280 million barrels, with the vast majority of the crude coming from Alaska and foreign sources (California Energy Commission 1991). The Unocal Marine Terminal received approximately 8.9 million bbl (or roughly 6.3 percent) of the crude oil shipped into the Bay Area.

Table 3.12-1

SUMMARY OF SAN FRANCISCO BAY AREA REFINING CAPACITIES ATMOSPHERIC CRUDE OIL DISTILLATION CAPACITY

Owner/Location	Barrels/Day
Chevron USA, Richmond	220,000
Exxon Co. USA, Benicia	128,000
Huntway Refinery Co., Benicia	8,600
Pacific Refinery Co., Hercules	55,000
Shell Oil Co., Martinez	144,100
Tosco Corp, Martinez	131,900
Unocal Corp, Rodeo	73,100
TOTAL	760,600

Source: Petroleum Supply Annual (1991) Volume 1.

Table 3.12-2 summarizes the total capacities of the San Francisco Bay marine terminals, and Table 3.12-3 summarizes the overall transport of crude oil in and out of the area. The vast majority of oil and product capacities are from the Carquinez Strait and Port of Richmond because the major oil refineries and oil storage/distribution facilities are located within these areas. Tables 3.12-4 and 3.12-5 specifically define the characteristics of the terminals within the Carquinez Strait and Port of Richmond. Figure 2.4-1 in Section 2 delineates their general locations. The marine terminals within other regions of the Bay are associated with the intake and distribution of petroleum products, as well as facilities for storing and distributing bunkering fuels.

Table 3.12-2

TOTAL CAPACITY OF SAN FRANCISCO BAY MARINE TERMINALS

General Terminal Locations	Barrels/Day
Carquinez Strait	28,395,000
Port of Richmond	19,402,985
Ports of Oakland/Alameda	54,700
Port of San Francisco	524,000
Port of Redwood City	357,000
TOTAL BAY AREA	48,733,685

Table 3.12-3

1987 TANKER AND BARGE TOTAL TRAFFIC (IN AND OUT) IN SAN FRANCISCO BAY AREA (crude and petroleum products)

Terminal	Crude (tons)	Petroleum Products (tons)
Oakland	105,888	788,258
San Francisco	0	685,236
Redwood City	17,488	26,569
Richmond	8,808,867	19,947,277
Humboldt Bay	0	111,647
Totals	8,932,243	21,558,987

1 barrel = 42 gallons = 311 pounds (crude) = 0.155 tons (crude)
1 ton = 2,000 pounds
1 gallon of crude = 7.4 pounds (average

Reference: Offshore Oil Terminals, Potential Role in US Petroleum Distribution - OCS Report MMS 90-0014

Table 3.12-4

CRUDE OIL/PETROLEUM PRODUCTS MARINE TERMINALS IN CARQUINEZ STRAIT

Operator	Berthing Space (feet)	Depth Alongside (feet)	Storage Tanks	
			Number	Capacity (bbls)
Exxon Co., U.S.A.	1,100	38	15 6	1,500,000 2,280,000[2]
Huntway Refining Co. of Northern California	2,404	38	5 2	300,000[2] 48,000
Wickland, Martinez	1,000	35	11 4	800,000 2,000,000[2]
Pacific Refining Co.	1,228+258	35-21	4 13	1,000,000[2] 1,000,000
Shell Oil Co.	1,858+442+750	45-20	66	5,316,000[3]
Pennzoil	880	40	12	1,000,000
Tosco Corp.	978, total	35-38	6 13	460,000[2] 579,000
do.	1,320-850	38-18	110	7,700,000[3]
Unocal Refining and Marketing Corp., a division of Unocal Corp.	1,375+622+520	35-20	45	1,000,000[3] 2,867,000
Wickland Oil Terminals, a subsidiary of Wickland Oil Co.	650	40	6	490,000
TOTALS	–	–	319	28,395,000

[1] Fuel oil for plant consumption.
[2] Crude oil.
[3] Includes crude oil.

Table 3.12-5

CRUDE OIL/PETROLEUM PRODUCTS MARINE TERMINALS IN THE PORT OF RICHMOND

Operator	Berthing Space (feet)	Depth Alongside (feet)	Storage Tanks	
			Number	Capacity (bbls)
Time Oil Co.	720	36	25	6118,000[1]
Texaco Refining & Marketing Inc.	635	32	41	601,200
Castrol, Inc.	700	32	13	85,000
Unocal Refining and Marketing Division, Unocal Corp.	736+736	35	72[2]	237,300
Arco Products Co.	710+710	35	46	737,000[1]
Chevron U.S.A., Inc.	3,065	50/40	1,200	16,000,000
Paktank Corp.	1,047	32	79	504,485[1]

[1] Includes Other Bulk Liquids
[2] Tanks are connected by pipeline with company-owned refinery at Oleum, California.

It is estimated that the Unocal Marine Terminal has a capacity of 3.9 million bbl, which represents approximately 8 percent of total marine terminal capacity in the Bay Area.

3.12.3 Pipeline Capacities

3.12.3.1 Crude Oil Pipelines

Approximately 60 percent of the crude oil for the Unocal Refinery is delivered by pipeline with the remaining 40 percent from Alaska crude via the Marine Terminal. One pipeline, the 16-inch-diameter Oleum Pipeline owned by Unocal, carries a combination of SJVH crude, Coalinga Nose crude, and Santa Maria gas/oil from the Unocal Santa Maria Refinery. This pipeline generally parallels Interstate 5 and, based on estimates by Unocal, carries approximately 94 percent of its design capacity.

Two other existing crude oil pipelines carry crude oil from the San Joaquin Valley to Bay Area refineries. These include Chevron's 18-inch Belridge to Richmond pipeline and Texaco's 20-inch Coalinga to San Francisco pipeline that serves the Shell and Tosco Refineries. Both are proprietary pipelines that are near capacity.

Shell Oil Company also has a 16-inch pipeline that was permitted to be constructed in the Bay Area, but has never been constructed. Its overall purpose was to provide crude oil to the Shell facility.

3.12.3.2 Product Pipeline

Approximately 20 different products that comprise 45 percent of the Unocal Refinery's output are shipped through the Marine Terminal. This includes all product to the Pacific Northwest because no pipelines service that area from the Bay Area.

Refined products are shipped from the Unocal Refinery via three pipelines, including the Unocal Richmond Pipeline, and the Concord and Brisbane Pipelines owned by the Santa Fe-Southern Pacific Pipeline Company.

The Unocal Richmond Pipeline is a 6-inch line that transports product from the Unocal Refinery to Unocal's Richmond Terminal. This is a proprietary line that is operating near capacity and is used exclusively for shipment of products.

The 12-inch Brisbane and 8-inch Concord lines are used on a time-share basis with other users in the Bay Area. These pipelines allow shipment throughout the Bay Area, as well as the Sacramento and Reno areas via interconnection with other pipelines. The Brisbane and Concord lines also connect the Unocal Refinery with many other marine terminals. These pipelines are for product only and are of a limited capacity.

The Unocal Refinery has a direct product line to the Wickland Oil Selby Storage Terminal located nearby. It has been used by Unocal on several occasions to store product at the Wickland Facility. The capacity of this interconnection is quite limited.

3.12.4 Long-Term Energy Perspective

The long-term refinery requirements and the shipment of crude oil and products are dependent on a wide variety of worldwide, national, and regional factors, including the following:

- general economy, which is directly related to consumption of fossil fuels;
- availability, characteristics, and price of various crude sources;
- environmental concerns relative to the type of crude to be refined, and the fact that reformulation of fuels using such oxidizers as MTBE, may give small refiners a competitive disadvantage; and
- individual marketers may change marketing areas or locations for refineries because of market pressure.

Because of the many variables, it is not possible to predict with certainty the energy picture within the Bay Area. Assumptions have been made that are considered to be in line with a reasonable worst-case analysis for CEQA purposes:

- The demand for petroleum products will increase by 1.1 percent per year as predicted by the California Energy Commission (1991 Fuel Report Working Paper: California Energy Statistics) for the next 20 years and then level off.
- The sources of San Joaquin Valley heavy crude and other domestic crude including Alaskan crude will be reduced substantially. The Bay Area will rely more on tankering of crude from foreign sources. For this analysis, it is estimated that crude oil tanker deliveries will increase by 50 percent regionally. The Unocal facility will increase its crude oil tanker deliveries by 60 percent (from 9.2 to 14.7 million bpy).
- Shipment of product will occur as it currently does with an approximately 30-percent increase in quantities shipped in the next 20 years (from 14 to 18.2 million bpy).
- At least one small refinery in the Bay Area will close.
- Other refineries in the area will also increase proportionately in capacity in relation to demand for crude import.

SECTION 4 - IMPACTS AND MITIGATIONS

4.1 INTRODUCTION

4.1.1 General Description of Section

This section presents the impacts and mitigation measures associated with the Proposed Project, its cumulative impacts, and the No Project and Consolidation Alternatives. Because the Proposed Project is the consideration of a new lease for continued operations (for up to a 40-year period), the project is, in actuality, the continuation of existing conditions as they are at present. Therefore, the discussion in resource sections, as appropriate, has been organized to focus on the continuation of existing conditions as a discussion separate from future conditions. Future conditions assume an increase in Unocal tankering of crude by 60 percent and an increase in product tankering by 30 percent, based on assumptions presented in Section 2.1.2.

Within the discussions of continuation of existing operations, normal operating conditions have been presented as discussion separate from accident conditions where oil or product is spilled. This delineation has been made to focus on mitigation appropriate for those impacts to resources resulting from spills. Spill modeling as presented in Section 1.5.2 has been applied, combined with application of GIS overlays as presented in Section 1.5.4, to determine potential impacts to resources.

Significance criteria are provided for each resource discipline. These criteria were established early in this EIR process and remained unchanged throughout the impact evaluation. In addition to adherence to these set criteria, significance to impacts is also classified according to the following definitions:

- Class I - A significant adverse impact that cannot be mitigated to nonsignificant.
- Class II - A significant adverse impact that can be mitigated to nonsignificant.
- Class III - An impact that is adverse, but nonsignificant.
- Class IV - A beneficial impact.

4.1.2 Application of Modeling and GIS Overlays

Three levels of oil spill modeling were used as tools to project (1) the likelihood of spills, (2) the extent of oiling from "typical" spills, and (3) the greatest risk to 20 critical shoreline locations. Details on modeling are presented in Section 4.2.

Probabilistic/conditional modeling (also referred to as trajectory analysis) was used to determine the likelihood or relative risk of a spill contacting regions of the Bay and outer coast. Modeling has taken into consideration accidents at the Marine Terminal, as well as along tankering routes, and is applied to the Proposed Project (Unocal specific tankering), as well as to the cumulative discussions (Unocal's contribution within the cumulative environment). Water-based impact sections (water quality, marine biology, and fisheries) used the probabilistic model to identify those sensitive resources most vulnerable to oil spills.

The second level of modeling (scenario modeling) used 12 individual spill scenarios representing spills of crude and product in the Bay and two scenarios of crude oil spills along the outer coast. Spill sizes vary from 500 bbl of product at the Terminal to 100,000 bbl of crude oil in the Precautionary Zone in the Bay and along the outer coast. These models were run as representations of the range of spills that could occur. In addition to their use in water-based impacts sections, scenario modeling was applied to land use/ recreation impacts.

The third level of modeling (receptor mode modeling) was conducted to determine potential spill receptor locations represented the greatest risk to sensitive shoreline resources. Twenty receptor sites were identified and used in conjunction with the probabilistic modeling results in the analysis of marine biological and fisheries impacts.

The modeling was integrated into the GIS to combine oil spill scenario and resource mapping to produce numerical and/or graphical data sets that depict resource areas contacted by representative spills. Generally, tables were produced, instead of maps, giving acreage and/or percentages of resources in the Bay and outer coast that would be impacted by various spills.

The analysis focused on the risk that oil would contact those crucial areas (the trajectory and receptor mode analyses) and identified the percentage of those crucial areas that would be oiled from each oil spill scenario (scenario analysis). For the scenario analysis, it should be recognized that areas identified as most crucial for each resource are not the only areas where that resource may be found. Therefore, if an identified area is not contacted by oil, it does not mean that there will be no impacts to that particular resource, as the scenario modeling is representational of specific spills. In such cases, trajectory analysis is referred to. If an area identified as most important for a particular resource is not contacted, it means that the relative risk to that resource would be low and that impacts of the scenario being analyzed would probably not be significant.

It should be noted that GIS results were not the sole determinant as to whether or not a resource would be impacted by oil. In determining impacts to marine biological and fisheries resources, assumptions were made about the areas where each resource would be most vulnerable to oil, such as preferred habitats or the most productive areas. Historic data from impacts of past oil spills were also applied.

Detailed discussion of modeling application is presented in Sections 4.2.1.1 and 4.2.1.2.

4.2 OPERATIONAL SAFETY/RISK OF ACCIDENTS

4.2.1 Introduction

This section assesses the potential system/public safety impacts from the continued operation of the Terminal. This includes the potential impacts from the tankers and barges calling at the Terminal and the butane storage tank located on the onshore segment of the SLC lease. The potential impacts from tankers and barges have been analyzed along normal vessel routes within San Francisco Bay and outside the Bay to the Precautionary Area and north to the Oregon border. Vessel traffic south from the Precautionary Area was previously addressed in the GTC Gaviota Marine Terminal Final Supplemental EIR/EIS (Aspen 1992).

This analysis addresses the potential impacts from continuation of current operational actions and from accidents including fires, explosions, and spills; the potential size of the accidents (type and amount of material involved in the accident or release); and the potential consequences of the accident. For oil or product spills, spill trajectory modeling was conducted to determine where the spill may go and how large an area may be impacted. This section also evaluates the adequacy of current emergency response capabilities and the anticipated adequacy of future capabilities to respond to various accidents and spills, such as fires, explosions, and spills of both crude oil and product.

This section also includes an explanation of the methodology used in the analysis, the results of the analysis, and identification of mitigation measures. Wherever possible, data and methodology consistent with that used in the GTC Gaviota Marine Terminal EIR/EIS have also been used. More detailed information of the modeling is contained in Appendix B.

4.2.1.1 Spill Trajectory Analysis

The computer-based oil spill model OSRISK was used to perform the spill trajectory analysis for both San Francisco Bay and the northern California coastline. A detailed description of the how the model works is presented in Appendix B. Briefly, OSRISK is driven by hydrodynamic model outputs. OSRISK accepts wind and surface current information from external sources and combines them with geographic data and data describing oil spill behavior. The model simulates an oil spill occurring under a specific set of conditions, taking into account the time of year, wind conditions, tidal state, spill volume, chemical composition, the extent of tidally inundated substrates, and other factors. The spill is represented as a cluster of independently moving points (called Lagrangian elements), each one representing a fraction of the entire spill volume. The basic model output for a given oil spill scenario is a listing of the position of the Lagrangian elements at 30-minute (San Francisco Bay) or 3-hour (outer coast) intervals.

The hydrodynamic component of the model for San Francisco Bay was prepared using the RMA-2V model originally developed for the Corps of Engineers (Norton et al. 1973; King 1977; Norton 1980). This model was used to prepare three hydrologic data sets for use by OSRISK, each one representing a different level of inflow from the bay delta. Each data set consisted of 30-day tidal cycles including both spring and neap tides. Details of the hydrodynamic modeling are presented in Appendix B.

Hydrologic data for the northern California coast were derived from the Minerals Management Service's curvilinear surface current grid for the Pacific coast, prepared by Dynalysis of Princeton. Data used by OSRISK are seasonally averaged surface current vectors integrated into a grid representing the outer coast.

Wind data for San Francisco Bay were based on measured wind speeds and directions that were provided by the BAAQMD. Wind speeds and directions from eight representative sites around the Bay were recorded at 1-hour intervals during 1990 and 1991, and adjusted to correct for altitudinal variation in wind speed. Wind speeds and directions recorded by four NOAA automated offshore weather buoys during 1900-1991 are used to characterize winds off the outer coast. Model results closely reflect real-time wind events.

For both San Francisco Bay and the outer coast, the shoreline was digitized using USGS 1:24,000 topographic maps. The USGS shoreline map was merged with the USFWS National Wetlands Inventory (NWI) coverage using GIS to resolve coastal habitats and intertidal substrates. Three relevant themes were extracted from the NWI data set: (1) irregularly exposed mud and sand, (2) regularly exposed mud and sand, and (3) emergent marsh. Because the NWI provides a much more detailed description of the nature of the shoreline, the NWI coverage was used wherever one of these three themes were present.

Where the shoreline was not defined by these coverages and where there were manmade structures, the USGS-based coverage was used. Lagrangian elements floating over mud or sand substrates or through a marsh are assumed to be stranded if the tidal elevation estimated from the output of the RMA-2V model is less than the corresponding bottom depth. Oil is assumed to move through marshy areas until it contacts the landward side of the marsh boundary.

Because both crude and refined petroleum products typically contain a substantial portion of volatile compounds, the volume of a spilled product that remains in the environment will decrease with time. OSRISK uses the modeling technique developed by the NOAA Hazardous Materials Modeling Group to describe this process. Spilled volumes are divided into component fractions, each component having an estimated half-life. At the time when a Lagrangian element is released, the model assigns it to one of these fractions. Movement and spread were modeled for nonpersistent and persistent oils.

Although a wide range of crude oils and refined products are shipped into and out of the Bay and the Unocal Terminal, the crude oils and products were divided into two general classes: light products and crude oil. Simulations of light product spills are based on the characteristics of kerosene, a typical light refined product. This type of product volatizes relatively rapidly, and little remains within 24 to 48 hours after a spill occurs. Light products were modeled as consisting of three fractions, each with different half-lives of persistence on the water. Half lives were 5.3, 14, and 69 hours for the three fractions.

Crude oils also vary widely in their composition but typically contain a substantial amount of highly persistent tar-like compounds. While the lighter fractions of a crude oil spill may disappear over a period of several days, the remaining heavier fractions may last from several weeks to several months, floating at or near the water surface. Initially, these heavier fractions may emulsify with sea water to form a substance called mousse. In this state, the effective volume of oil can actually increase in spite of the evaporation of the more volatile components. The remaining oil may eventually form into highly persistent tarballs or mats. All of these processes depend not only on the composition of the spilled crude oil, but also on weather conditions and sea state. Therefore, crude oil is modeled as persistent, and each Lagrangian element is tracked until it is beached or moves outside of the model domain. Because spills within the Bay are deposited on land within a few days, they were tracked by the model for up to 2 weeks. Because spills along the tanker routes outside the Bay can take several weeks to make landfall, they were tracked for up to 30 days.

The area affected by an oil spill varies with the volume of the spill, the age of the spill, and the wind and current conditions that prevail during the course of the spill. OSRISK simulates the process of spreading by adding a random diffusive component to the advection induced by winds and currents at each model time step.

4.2.1.2 Modeling Approach

<u>Probabilistic Analysis</u>

Approach

Probability of contact from spills resulting from Unocal Terminal activity, cumulative terminal activity in the Bay, Unocal tanker transport, and cumulative tanker transport was determined using modeling of oil movement. Modeled spills were released from marine terminals and segments of the tanker transport lanes used in the Bay and the tanker route along the outer coast north to Oregon.

The probabilistic analysis was designed to provide an estimate of the likelihood that oil would contact any specific region or resource given that a spill has occurred. Thus, the results of this analysis are called "conditional probabilities"; they are conditioned on the premise that a spill has occurred. While this analysis does not present the probability of a spill occurring, it does present information on the areas likely to be oiled if a spill does occur. Because the results are conditional probabilities, the results from the various cases modeled cannot be compared.

Twelve separate cases were modeled, each representing one factor of the Proposed Project or the cumulative case. One thousand randomized scenarios were run for each of the following cases of potential spills (a total of 12,000 runs):

- Unocal tankering of crude oil within San Francisco Bay,
- Unocal tankering of products within San Francisco Bay,
- cumulative tankering of crude oil within San Francisco Bay,
- cumulative tankering of products within San Francisco Bay,
- Unocal tankering of crude oil along the outer coast,
- Unocal tankering of products along the outer coast,
- cumulative tankering of crude oil along the outer coast,
- cumulative tankering of products along the outer coast,
- accident at the Unocal Terminal involving crude oil,
- accident at the Unocal Terminal involving refined products,
- accident at all Bay Area terminals involving crude oil, and
- accident at all Bay Area terminals involving refined products.

The following factors were randomized for each scenario:

- wind sequence (based on a randomized starting date),
- position in the 30-day tidal cycle when the spill started,
- level of fresh water inflow from the delta,
- spill location, and
- spill volume.

Selection of the date and tidal state was based on the assumption that a spill was equally likely at any time of year or state of the tide. Selection of inflow conditions was based on the estimated frequency of the three possible states in the future (below normal, dry, and critical). Selection of the spill location assumed that the likelihood of an accident was proportional either to the amount of vessel (tanker and tank barge) traffic along a particular segment of a transport route (for tankering) or the number of oil/product transfers (for terminals). Tankering accidents were assumed to occur anywhere along the transport routes, and terminal accidents were assumed to occur at the facilities. Selection of spill volumes were based on the spill distributions presented in Section 4.2.3.1 and Appendix C. Results of these runs were saved as the positions of the Lagrangian elements at 2-hour intervals within the Bay or at 8-hour intervals along the outer coast. These data were used to generate surfaces of the probability of contact to shoreline and open water areas.

Results of the trajectory model were expressed as probability of contact with each cell of a 1-km grid within the Bay and a 5-km grid off the outer coast. Differing probabilities were mapped in shades of gray to show the distribution of risk. Probability of contact with portions of the shore was assumed to be the same as the probability of contact with adjacent waters. Although a reasonable approximation, probabilities may be greater or lesser due to the influence of offshore/onshore winds and longshore currents.

Probabilities of contact were generated for three degrees of oiling: light (any contact at all), moderate (100 to 1,000 bbl per square km), and heavy (> 1,000 bbl per square km). Light oiling, as used in the model, is a film of oil on the water up to thickness of 0.016 mm (100 bbls per square km). The film would range in appearance from a silvery sheen to iridescent or dull colors (International Tanker Owners Pollution Federation, Ltd. 1983). As larger amounts of oil are spilled, gravity causes oil to spread until it reaches an equilibrium thickness of about 0.1 mm (dependent on type of oil and temperature). In the model, oil slicks of this thickness are classified as moderate and have a black or dark brown appearance. When the quantity of spilled oil is very great, or spread is limited by the shoreline or other barriers, thicker oil slicks can occur. In the model, thickness greater than 0.16 mm (1,000 bbl per square km) is classified as heavy; these slicks are black or, if subjected to wave action, form a brown or orange oil-water "mousse." In analysis of the impacts of oil spills on resources, it is presumed that heavy oiling would do more damage and persist for a longer time than moderate oiling, and moderate oiling would do more damage and persist longer than light oiling.

Heavy oiling occurs near the tanker routes or near terminals because the oil has not yet had time to disperse. Similarly, the greatest likelihood of any level of oiling is near the source, decreasing with distance from possible spill sites. Channels with high-flow rates tend to have a high likelihood of oiling due to the tendency of oil to remain in the channel and oscillate with the tides.

Figure 4.2-1 presents the conditional probability of moderate oiling from a persistent oil spill at the Unocal Marine Terminal. The figure shows that there is a 0.2- to 21-percent probability that moderate oil could impact Carquinez Strait and the southern and eastern portions of San Pablo Bay, given there is a spill of persistent oil at the Unocal Terminal. The figure also shows that the most likely areas to be oiled are in the immediate vicinity of the Terminal and the western half of the Carquinez Strait.

The actual annual probability of any square in the figure actually being oiled from a spill of persistent oil at the Unocal Marine Terminal can be estimated by multiplying the annual probability of a spill at the Terminal (0.037 - see Appendix C) by the probability that the spill involves a persistent oil (0.79 - see Appendix C), and then by the probability that the square will be oiled given there is a spill (the probability range given in the legend). Thus, the annual probability of moderate oiling in the dark areas on Figure 4.2-1 from a persistent oil spill at the Terminal would be between 0.003 and 0.006. The annual probability of moderate oiling along the southern and western shoreline of San Pablo Bay and the eastern half of Carquinez Strait would be between 5.8×10^{-5} and 5.8×10^{-4}.

The conditional probability figures for spills at the Terminal and for the other cases are contained in Appendix B. These conditional probabilities have been used by the various resource disciplines in their impact evaluation.

Summary of Probabilistic Analysis

The following section discusses the potential trajectories of the oil given there is a spill. Risk of oil contact with waters and shoreline is defined in three levels: (1) less than 10 percent, called low; (2) 10 to 50 percent, called medium; and (3) greater than 50 percent, called high. These are conditional probabilities; the probabilities across the various cases cannot be compared because the underlying conditions or assumptions of each is different. The probability levels can only be used within each case to determine the areas most likely or least likely to be impacted by oil, given there is a spill for that case. It should be noted that spreading of oil according to the model takes into consideration first washup of the spill; thus, further washups would increase the duration of impacts beyond the modeled time frames, and actual spills may travel farther up sloughs than indicated by the model.

<u>Spill at Unocal Terminal</u> - Should oil or product spills occur at the Unocal Marine Terminal, waters and shoreline within about 6 to 8 km of the Terminal are subject to the greatest risk of contact, including all of Carquinez Strait and waters west of Davis Point in the deeper waters of the ship channel. Any of these waters and shoreline have a medium to high risk of contact. Shallow waters of west and north San Pablo Bay are subject to a low risk of contact, including the mouths and adjacent shore of both Sonoma Creek and Petaluma River. Risk of contact with waters and shoreline in the northern part of San Francisco Bay ranges from low to medium, with a low risk south of Tiburon. Waters and shoreline subject to moderate oiling are found only within eastern San Pablo Bay and Carquinez Strait. Most of this area is subject to a low risk of moderate oiling; within 2 km of the Unocal Terminal and in Carquinez Strait, the risk of moderate oiling increases to medium. Heavy oiling from spills is also limited to the immediate vicinity of the Terminal, western Carquinez Strait, and the ship channel to a distance of 8 km west of the Terminal. The risk of heavy oiling to any part of these waters is low. The distribution of risk of contact of product spills is similar to that of crude oil spills. However, more rapid evaporation of petroleum products, relative to crude oil, results in a lower risk of contact with waters and shoreline at greater distances from the point of release.

<u>Spills from Unocal Tankers</u> - Unocal tankers, as used in this analysis, include tankers supplying crude oil to the Unocal Refinery and tankers carrying Unocal products from the Unocal Marine Terminal to other ports. Oil spills along the route used by Unocal tankers through the Bay predominantly affect waters of the ship channel, where they are moved back and forth with tidal currents. This effect is greatest in the northern part of San Francisco Bay and in San Pablo

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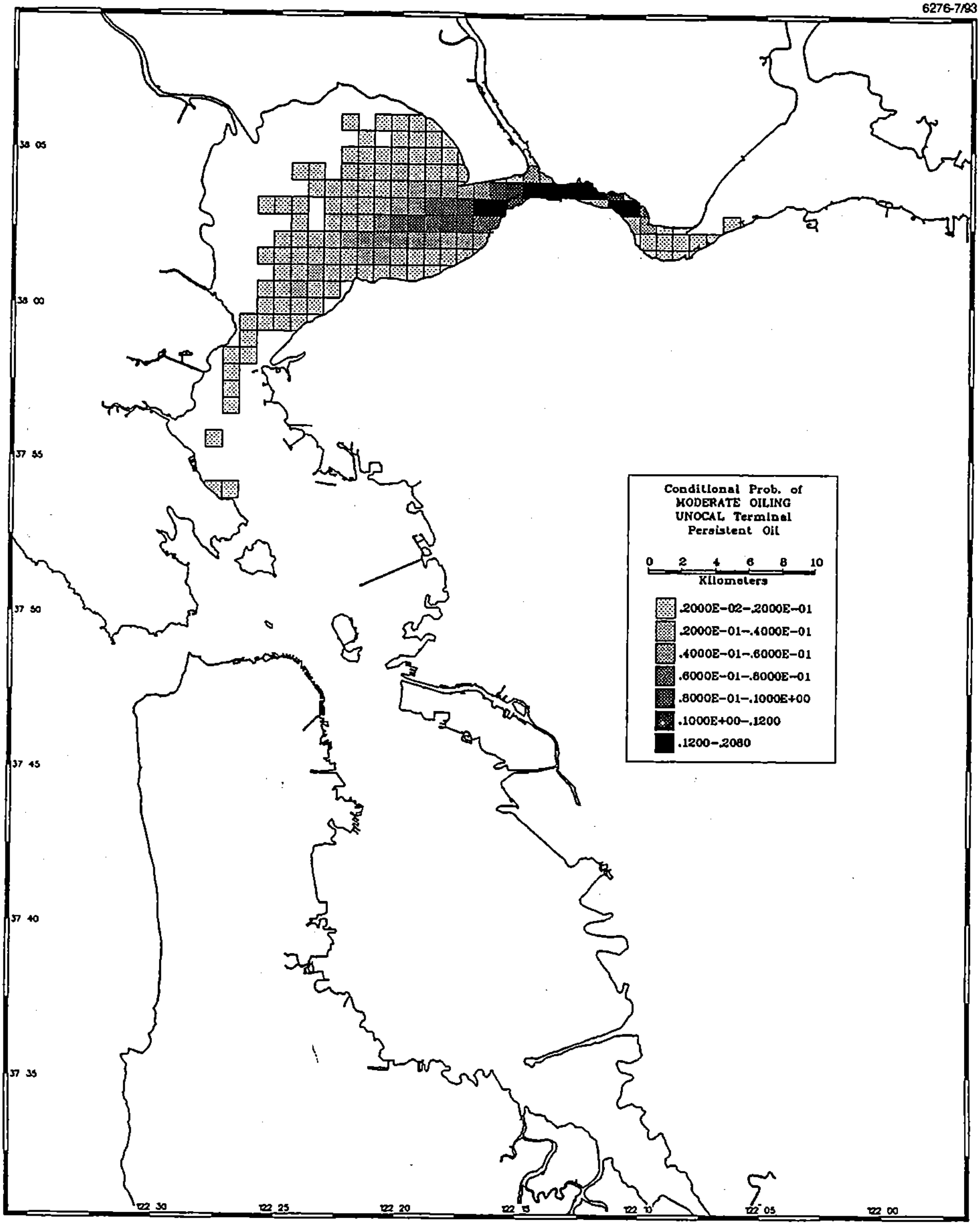

EXAMPLE OF PROBABILISTIC MODEL RUN
Figure 4.2-1

Bay. Closer to the Golden Gate, spills tend to be flushed from the Bay on ebb tides. Most waters within about 2 km of the ship channel are subject to a medium risk of contact from crude oil spills (slightly less for product spills). The likelihood of contact declines with distance from the ship channel, especially over broad expanses of shallow water and mudflats. Land subject to the greatest chance of contact is in Carquinez Strait, Mare Island, along the southern shore of San Pablo Bay, from Point San Pablo to Point Richmond, the eastern shore of the Tiburon Peninsula, and Angel Island. The likelihood of moderate or heavy oiling follows the same pattern, with the greatest chance found in deeper waters of the ship channel. Point San Pablo and Angel Island are each subject to a medium risk of moderate oiling from a crude oil spill, and a low risk of heavy oiling.

Spills from Unocal tankers in the Gulf of the Farallones and off northern California can contact any part of the outer coast and all waters within a distance offshore of 70 to 80 km. Slicks of petroleum products do not travel as far from the point of release as crude oil does due to evaporation, but have the same general pattern of drift with winds and currents. Across open water, risk of contact by crude oil declines from moderate to low within about 30 km of the transport route. Risk of shoreline contact is generally greatest where the tanker transport route is closest to shore. North of Point Reyes, risk of contact with portions of the shoreline or waters within about 20 km is low. Most waters within the Gulf of the Farallones and south to Monterey Bay are subject to a low to medium risk of contact from crude oil spills. Areas having the greatest risk of moderate oiling from spills of crude oil include Cape St. George, Trinidad Head, and Cape Mendocino, Point Reyes and adjacent shore to the north, the Gulf of the Farallones, and shelf and slope waters to Monterey Bay. Risks of heavy oiling from crude oil spills are greatest, but still low, in the Gulf of the Farallones, from Bolinas Point to Point San Pedro, and over the shelf break about 10 km west of the Farallon Islands.

Spill Probabilities South of Santa Cruz - The GTC Gaviota Marine Terminal Final Supplemental EIR/EIS (Aspen 1992) shows conditional probabilistic model distributions based on oil spill contact with endangered species for spill trajectories lasting 3, 10, and 30 days. The model results show the conditional probability, in percent, of contacting shoreline targets at any location along the coast. From the model results, contours were plotted that represent 1 and 5 percent conditional probabilities of shoreline target contact within 30 days on an annual average basis. The resulting probability distributions show that the 1 percent and 5 percent probability of contact contours would be located furthest offshore of coastline from Santa Cruz south to Point Conception during winter and spring (approximately 25 nautical miles (nm) to the 5 percent line). With the onset of summer, the 1 percent and 5 percent zones approach the coast between Point Conception and Monterey Bay as a result of nearshore current and associated offshore flows near Point Sur, and persistent winds out of the north-northwest. This modeling shows that the chance of an oil spill contact with sensitive species increases for routes north of Monterey Bay. Off the entrance to San Francisco the 1 percent and 5 percent contours lie 70 to 80 nm from the coastline.

Development of Design Basis Accidents and Scenario Selection

Approach

The purpose of the scenario analysis is to analyze how a particular spill could behave over a period of time. The analysis is representative for a specific set of conditions, depicting the movement of oil over time and how large an area is impacted. Response effectiveness can then be evaluated against the output from the scenario analysis. It should be noted that this modeling neither covers every type of spill nor accommodates all potential movements of a particular spill. The modeling effort is intended to identify the range of potential impacts associated with various sizes of oil spills, emphasizing the potential impacts under the more prevailing conditions.

Oil or product spills were defined by identification of design basis accidents. Design basis accidents are scenarios of potential accidents ranging from fairly minor incidents to catastrophic spills that could be reasonably assumed to occur at the Marine Terminal or would be associated with tankers whose destinations or departures would be from the Terminal.

San Francisco Bay and outer coast were examined with respect to the types and potential for tanker accidents. The history of spills and accidents that have occurred in the Bay Area was examined (refer to Section 3.1.6). This included releases that have occurred at the Unocal Terminal and other marine terminals within the Bay Area, and casualties that have occurred involving tankers and tank barges. Consideration was also given to the types of accidents and consequences of such accidents that could occur including terminal pipeline leakage, vessel collisions with terminal structures, groundings, vessel collisions, and hull failure.

Spill sizes vary from 500 to 100,000 bbl. For the 500- and 1,000-bbl spills, the outflow was assumed to occur within 30 minutes. Larger spills were assumed to occur at a constant release rate over 24 hours. Tides were chosen to be either maximum ebb or flood near the spill site at the beginning of the outflow. The two seasonal variations for each scenario consisted of one wind sequence from the summer and one from the winter/spring. Summer winds tend to blow consistently from the west, while winter/spring winds are characterized by strong but variable winds frequently associated with the passage of storms.

For each of the scenarios, model output consists of the positions of each Lagrangian element shown at 30-minute intervals until the final extent of oiling is reached. This output was exported to a GIS so spills could be overlayed with resources for analyzing and displaying the potential effects on the resources. These results are presented in various resource sections of this EIR.

Potential accidents from the Proposed Project include spills at the Terminal from transfer operations and spills from tankers/barges. Spills at terminals are generally smaller and result from tank overfillings, hose or pipeline rupture, or possibly a crack in a vessel tank. A release of 1,000 bbl of oil and 500 bbl of product were chosen to represent worst case spills from the Terminal. Each of these scenarios was modeled for two environmental conditions with the results summarized below (see Bay Scenarios 1, 2, 7, and 8).

Two size spills were chosen to represent worst-case tanker/barge spills in the Bay. A 20,000-bbl spill was chosen as a release of oil from one to two tanks, while a 100,000-bbl spill was chosen as a spill from a total tanker casualty. The 20,000-bbl spill was assumed to occur in the channel just off the Unocal Marine Terminal (Bay Scenarios 3 and 4), while the 100,000-bbl spill was assumed to occur in the tanker lane near Alcatraz Island where the tanker lanes come together (Bay Scenarios 9 and 10). The Outer Coast Scenarios 1 and 2 were also chosen with 100,000-bbl spills to represent worst-case releases. Outer Coast Scenario 1 was chosen to be in traffic lanes just outside the Bay, while Outer Coast Scenario 2 was chosen to be along the northern coast of California.

Bay Scenarios 5 and 6 were chosen to represent spills that could occur in tanker lanes near the eastern end of the Carquinez Strait, while Bay Scenarios 11 and 12 were chosen to represent spills that could occur during lightering at Anchorage 9 in San Francisco Bay.

Scenario Models

Fourteen reasonable worst-case scenarios were modeled, representing hypothetical accidents covering a wide range of possible spill sizes, locations, and seasonality. A brief description of the extent of movement of oil from these spills is described below. A summary of the models is presented in Table 4.2-1. The description does not take into consideration the effects spill response actions might have on the spread of the oil but presents the maximum extent of oil spread.

Bay Scenario No. 1 - Scenario No. 1 was a 1,000-bbl spill of crude oil released at the Marine Terminal (Figure 4.2-2). The modeled spill was moved by a sequence of winds beginning March 21, 1991, and an ebb tide; all spill elements had beached after 45 hours. During the first 6 hours, oil drifted west in a relatively compact slick 1 to 1.5 nautical miles (nm) in diameter. Oil then drifted north, becoming diffuse over an area approximately 2 by 3 nm, and reaching intertidal mudflats in the San Pablo Bay National Wildlife Refuge off Sonoma Creek. All oil was beached after 45 hours in Sonoma Creek to about Napa Slough, along the shore of Tubbs Island to the west, and along the eastern shore of San Pablo Bay to a distance of about 2 miles.

Bay Scenario No. 2 - Scenario No. 2 was a 1,000-bbl spill of crude oil released at the Marine Terminal (Figure 4.2-3). The modeled spill was moved by a sequence of winds beginning July 5, 1991, and a flood tide; all spill elements had beached after 18 hours. Oil from this release moved east into Carquinez Strait carried by a flood tide. After 3 hours, most oil was on or near shore between Davis Point and Carquinez Point, and by 6 hours had contacted Semple Point on the north side of the Strait and the town of Crockett on the south side. Nine to 12 hours after release, oil had been carried deep into the Strait and contacted the shore between about Glen Cove and Dillon Point to Benicia Point in Solano County. Fifteen to 18 hours after release, remaining oil had beached from Martinez

Table 4.2-1

SUMMARY OF SCENARIO MODEL RUNS

Scenario	Location	Spill Size (bbl)	Outflow	Spill Type	Wind/Current	Duration
Bay 1	At Terminal	1,000	Instantaneous	Crude	03-21-91/Ebb	1 day, 21 hours
Bay 2	At Terminal	1,000	Instantaneous	Crude	07-05-91/Flood	18 hours
Bay 3	Near Terminal	20,000	24 hours	Crude	01-19-91/Ebb	12 days, 6 hours
Bay 4	Near Terminal	20,000	24 hours	Crude	06-26-90/Flood	2 days, 15 hours
Bay 5	East End, Carquinez Strait	1,000	Instantaneous	Crude	02-14-90/Flood	1 day, 3 hours
Bay 6	East End, Carquinez Strait	1,000	Instantaneous	Crude	07-20-90/Flood	12 hours
Bay 7	At Terminal	500	Instantaneous	Product	02-11-90/Ebb	9 hours
Bay 8	At Terminal	500	Instantaneous	Product	08-13-90/Flood	6 hours
Bay 9	Near Alcatraz	100,000	24 hours	Crude	03-01-90/Flood	3 days, 9 hours
Bay 10	Near Alcatraz	100,000	24 hours	Crude	09-11-91/Flood	4 days, 9 hours
Bay 11	Anchorage 9	1,000	Instantaneous	Crude	11-26-91/Flood	2 days, 12 hours
Bay 12	Anchorage 9	1,000	Instantaneous	Crude	08-16-90/Flood	2 days, 15 hours
Outer Coast 1	Southeast of Farallon Islands	100,000	24 hours	Crude	03-90	8 days, 22 hours
Outer Coast 2	Southwest of Punta Gorda	100,000	24 hours	Crude	10-91	18 days, 10 hours

to Pacheco Creek in Contra Costa County, with extensive contamination of Pacheco Creek and the surrounding estuaries.

Bay Scenario No. 3 - Scenario No. 3 was a 20,000-bbl spill of crude oil released over a 24-hour period along the tanker route just off the Marine Terminal (Figure 4.2-4). The modeled spill was moved by a sequence of winds beginning January 19, 1991, and an ebb tide; all spill elements had beached or moved out of the model domain after 12 days, 6 hours. Oil spread extensively over the eastern and southern waters of San Pablo Bay and into the Carquinez Strait, and was also carried southward on ebb tides to contact most of north San Francisco Bay. Near-continuous fouling of the shore occurred along the south side of the Carquinez Strait and San Pablo Bay from the town of Crockett to Pinole Point, and along the north side of the Strait from Dillon Point west to the Mare Island breakwater. In Contra Costa County, patches of oil also contacted shore from Pinole Point southward to Point Richmond. On the Marin County (northern) side of San Francisco Bay, parts of the shoreline were contacted on Point San Pedro, Paradise Cove, Tiburon, and Angel Island.

Bay Scenario No. 4 - Scenario No. 4 was a 20,000-bbl spill of crude oil released over a 24-hour period along the tanker route about 2 kilometers (km) northwest of the Marine Terminal near the Mare Island breakwater (Figure 4.2-4). The modeled spill was moved by a sequence of winds beginning June 26, 1990, and a flood tide; all spill elements had beached after 63 hours. Initially, oil was carried on flood tide through the Carquinez Strait and deep into Suisun Bay, and then carried on ebb tide into central San Pablo Bay. Contact with the shoreline was continuous from Mare Island along the north side of Carquinez Strait to Army Point (at the northern terminus of the Benicia-Martinez Bridge), and along the south side from Davis Point to the town of Crockett. Patches of oil also beached from Martinez to Port Chicago and in Suisun Bay on Simmons Island (part of Grizzly Island).

Bay Scenario No. 5 - Scenario No. 5 was a 1,000-bbl spill of crude oil released in the tanker lane at the east

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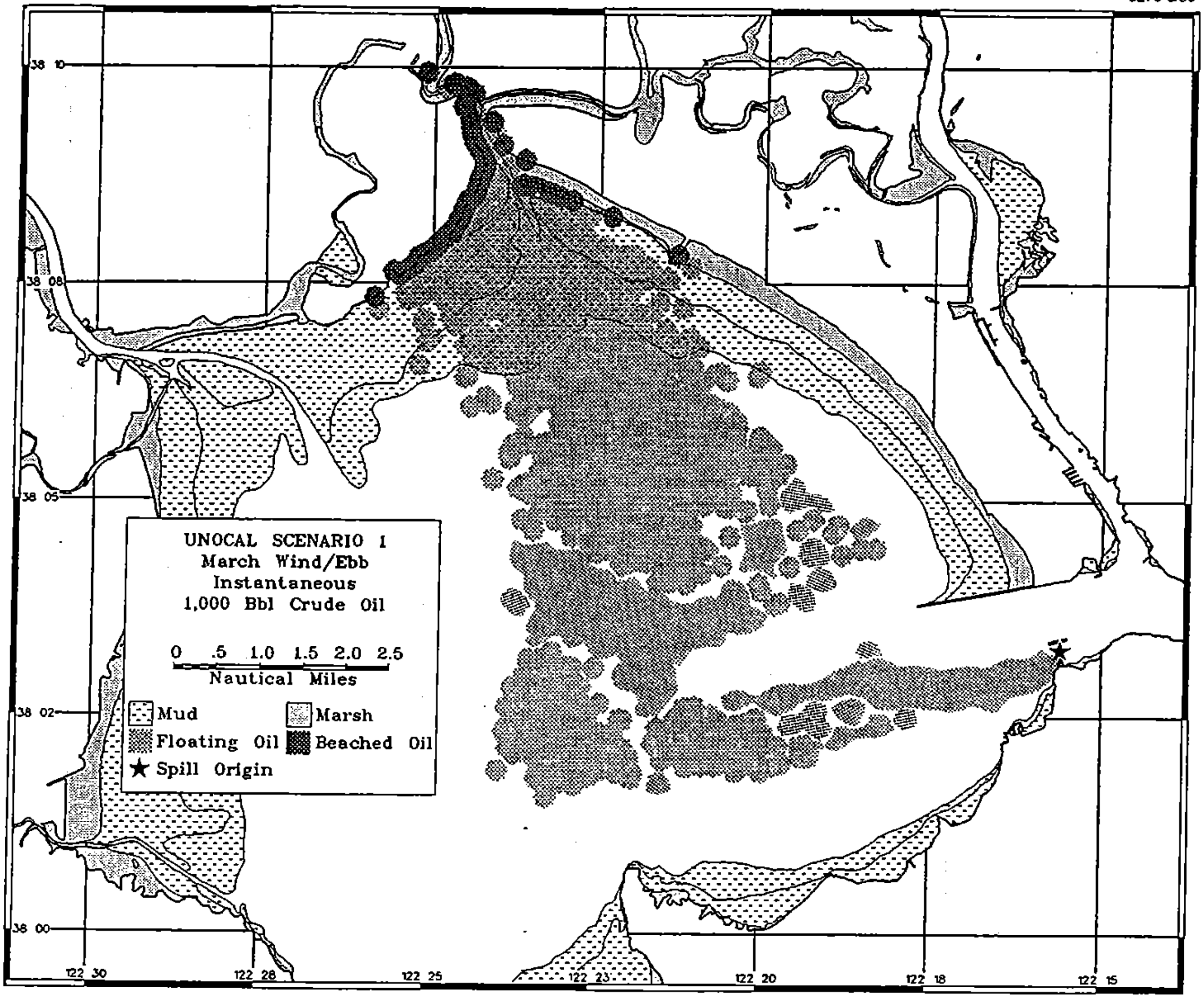

Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.

BAY SCENARIO NO. 1
1,000 BBL CRUDE SPILL FROM MARINE TERMINAL, MARCH WIND/EBB TIDE
Figure 4.2-2

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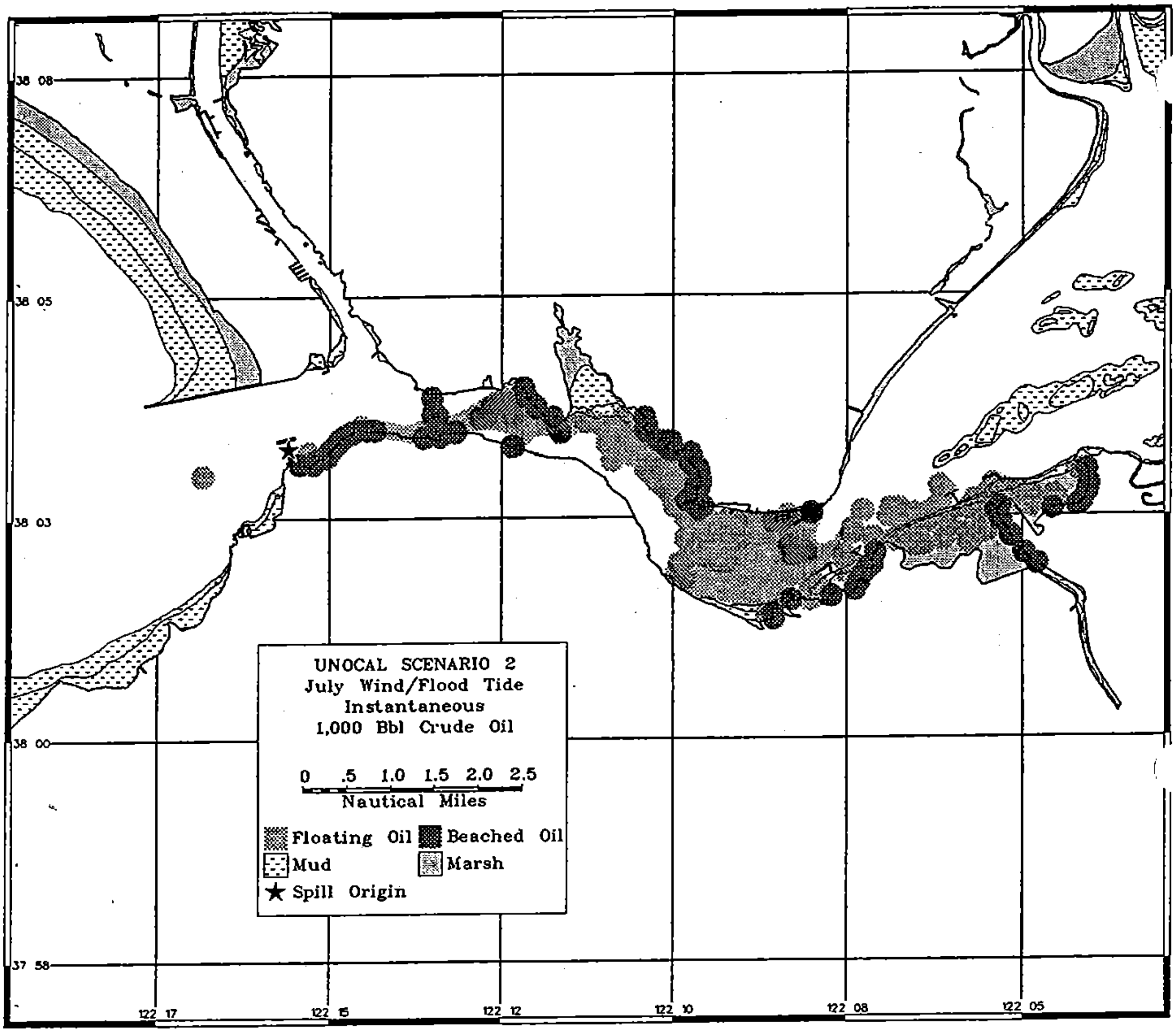

Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.

BAY SCENARIO NO. 2
1,000 BBL CRUDE SPILL FROM MARINE TERMINAL, JULY WIND/FLOOD TIDE
Figure 4.2-3

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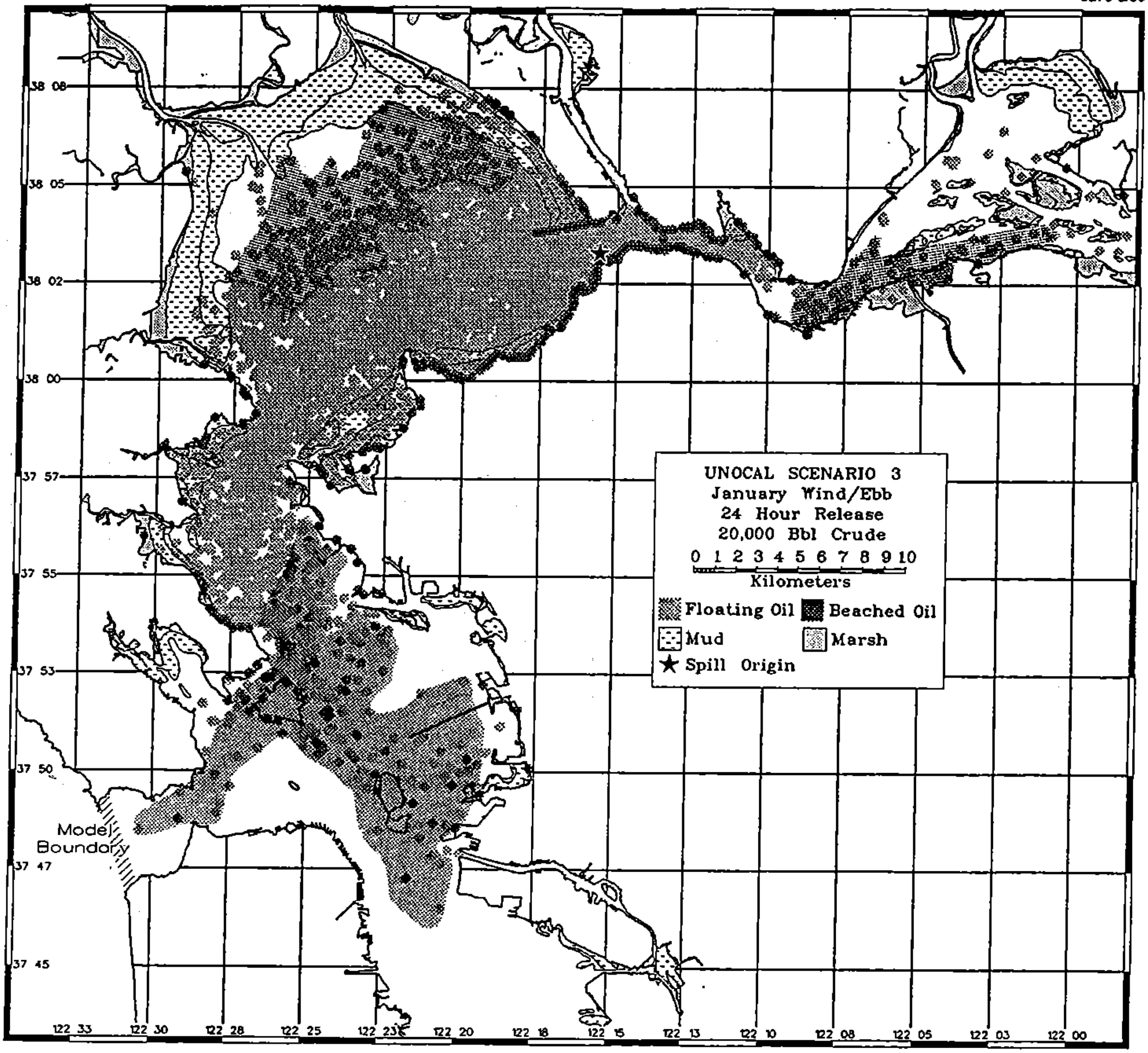

BAY SCENARIO NO. 3
20,000 BBL CRUDE SPILL FROM
TANKER ROUTE, JANUARY WIND/EBB TIDE
Figure 4.2-4

Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.
Darker dots not along shoreline result from Lagrangian elements crossing many times over spill duration period.

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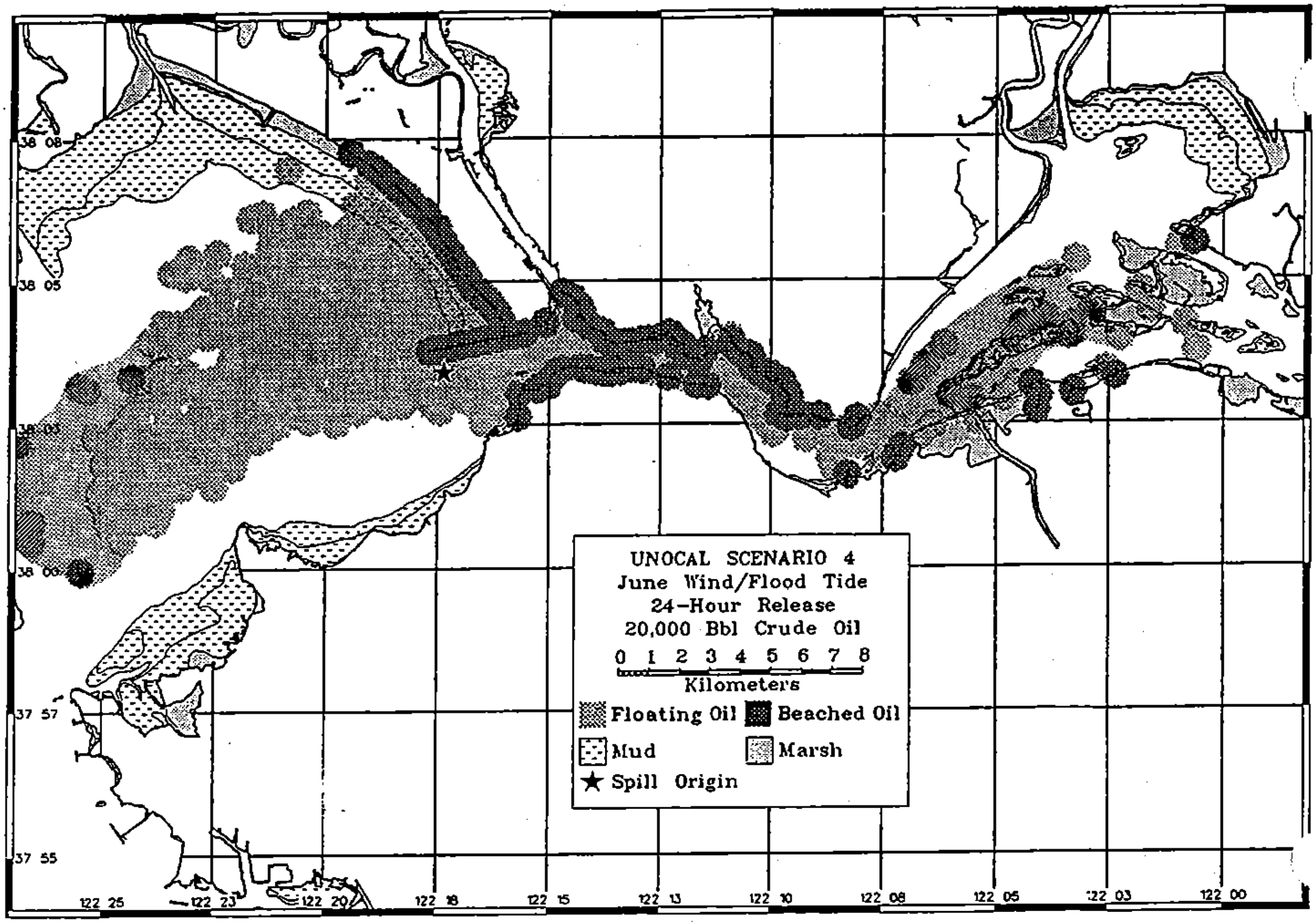

BAY SCENARIO NO. 4
20,000 BBL CRUDE SPILL FROM
TANKER ROUTE, JUNE WIND/FLOOD TIDE
Figure 4.2-5

Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.

end of Carquinez Strait (Figure 4.2-6). The modeled spill was moved by a sequence of winds beginning February 14, 1990, and a flood tide; all spill elements had beached after 27 hours. Within the first 3 hours, winds and currents carried oil out of the Strait and into Suisun Bay. Over the next 24 hours, oil spread extensively to contact intertidal mudflats in Grizzly Bay, and around Roe, Ryer and Simmons Islands in Suisun Bay. Shoreline contact occurred predominantly along eastern Grizzly Bay and the south side of Simmons and Dutton Islands.

Bay Scenario No. 6 - Scenario No. 6 was a 1,000-bbl spill of crude oil released in the tanker lane at the east end of Carquinez Strait (Figure 4.2-7). The modeled spill was moved by a sequence of winds beginning July 20, 1990, and a flood tide; all spill elements had beached after 12 hours. Most oil from this scenario spill beached within a few hours of release along the south shore of Suisun Bay from about Pacheco Creek to Middle Point, including the Avon-Port Chicago Marsh.

Bay Scenario No. 7 - Scenario No. 7 was a 500-bbl product spill released at the Marine Terminal (Figure 4.2-8). The modeled spill was moved by a sequence of winds beginning February 11, 1990, and an ebb tide; all spill elements had beached after 9 hours. Within the first 3 hours, most of the petroleum products had moved west and south, and had spread into a slick about 3.0 by 0.5 km near the south side of San Pablo Bay. The slick beached midway between Davis Point and Pinole Point contaminating about 4 to 5 km of shore.

Bay Scenario No. 8 - Scenario No. 8 was a 500-bbl product spill released at the Marine Terminal (Figure 4.2-9). The modeled spill was moved by a sequence of winds beginning August 13, 1990, and a flood tide; all spill elements had beached after 6 hours. Initial beaching of spilled petroleum products occurred from Davis Point to Carquinez Point; currents rapidly carried products into Carquinez Strait where it contaminated the northern shore from Jones Point (at the Mare Island Strait) to Point Benicia.

Bay Scenario No. 9 - Scenario No. 9 was a 100,000-bbl spill of crude oil released over a 24-hour period in the tanker lane near Alcatraz Island (Figure 4.2-10). The modeled spill was moved by a sequence of winds beginning March 1, 1990, and a flood tide; all spill elements had beached or moved out of the model domain after 3 days, 9 hours. Moved by winds and currents, oil spread extensively throughout central and northern San Francisco Bays, then was carried northward in scattered small slicks into central San Pablo Bay. Near-continuous contact with the shoreline occurred from Point Bonita, at the entrance to San Francisco Bay, along the Marin County shore of Richardson Bay, Tiburon, and Angel Island. In San Francisco, oil contacted the shoreline from the Presidio and Golden Gate Bridge to India Basin. In Contra Costa County, the shore from Richmond and Marina Bay to Point San Pablo was extensively contacted with oil. Most oil carried into San Pablo Bay eventually beached along the northern-eastern shore from Sonoma Creek to the Mare Island breakwater.

Bay Scenario No. 10 - Scenario No. 10 was a 100,000-bbl spill of crude oil released over a 24-hour period in the tanker lane near Alcatraz Island (Figure 4.2-11). The modeled spill was moved by a sequence of winds beginning September 11, 1991, and a flood tide; all spill elements had beached or moved out of the model domain after 4 days, 9 hours. Most oil from this spill remained in the central San Francisco Bay where virtually all waters were heavily or repeatedly contacted. Extensive oiling occurred in San Francisco from Seal Rocks at the entrance to the Bay, along the shore to the San Francisco-Oakland Bay Bridge and China Basin, and Alcatraz and Yerba Buena Islands. Across the Bay, oiling was continuous from Oakland International Airport northward to Red Rock and Castro Rocks near the Richmond-San Rafael Bridge.

Bay Scenario No. 11 - Scenario No. 11 was a 1,000-bbl spill of crude oil released at Anchorage 9 about 5 km southwest of Hunters Point (Figure 4.2-12). The modeled spill was moved by a sequence of winds beginning November 26, 1991, and a flood tide; all spill elements had beached after 60 hours. Within 3 hours, a compact slick moved into the south Bay, 4 to 5 km off the San Francisco International Airport. The slick then spread and dispersed widely to contact waters, mudflats, shore and marshes of San Mateo County south of the Dumbarton Bridge and Santa Clara County to about Guadalupe Slough.

Bay Scenario No. 12 - Scenario No. 12 was a 1,000-bbl spill of crude oil released at Anchorage 9 about 5 km southwest of Hunters Point (Figure 4.2-13). The modeled spill was moved by a sequence of winds beginning August 16, 1990, and a flood tide; all spill elements had beached after 63 hours. Within 3 hours, a compact slick moved into

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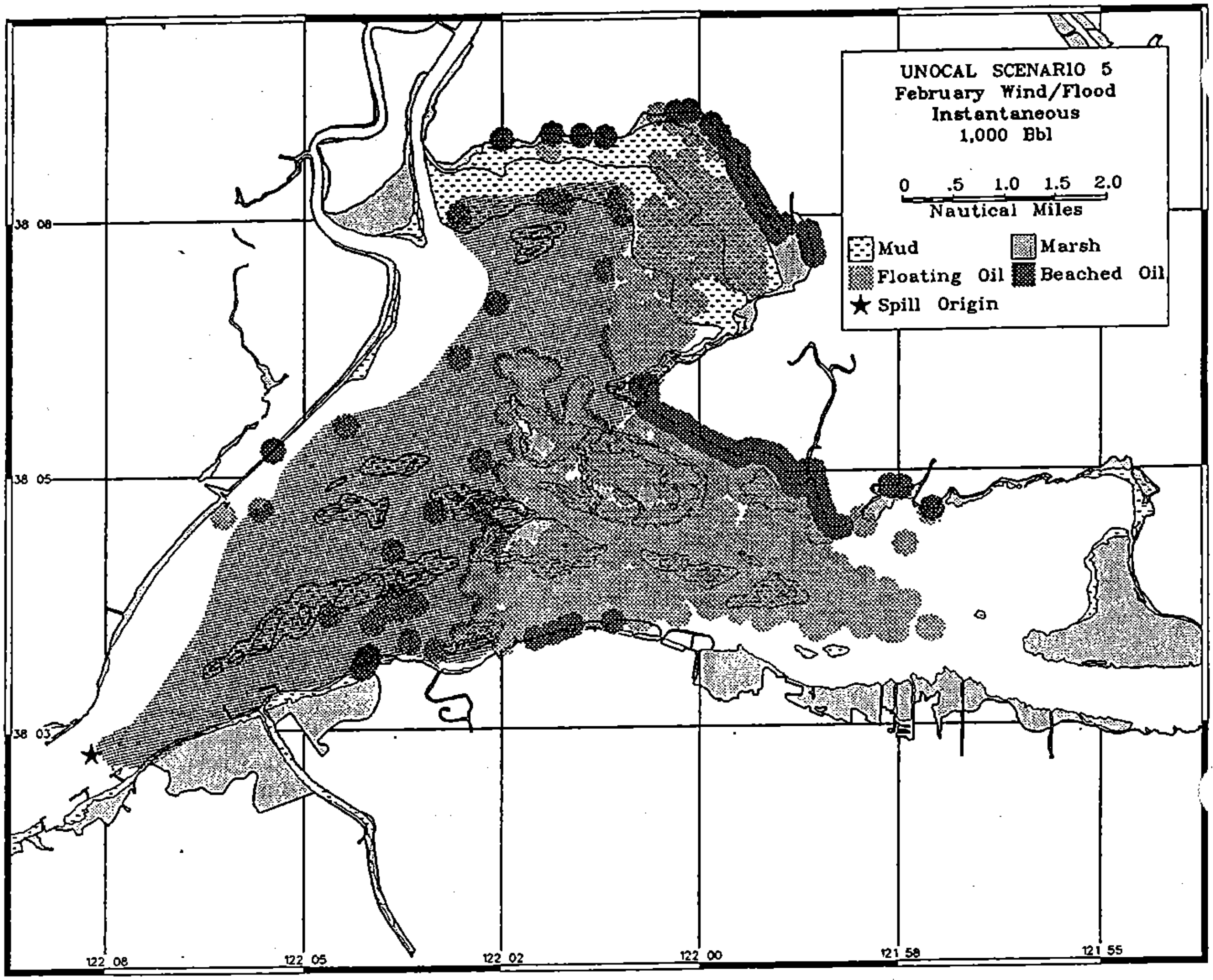

BAY SCENARIO NO. 5
1,000 BBL CRUDE SPILL IN TANKER LINE-EAST END OF CARQUINEZ STRAIT FEBRUARY WIND/FLOOD TIDE
Figure 4.2-6

Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.
Darker dots not along shoreline result from Lagrangian elements crossing many times over spill duration period.

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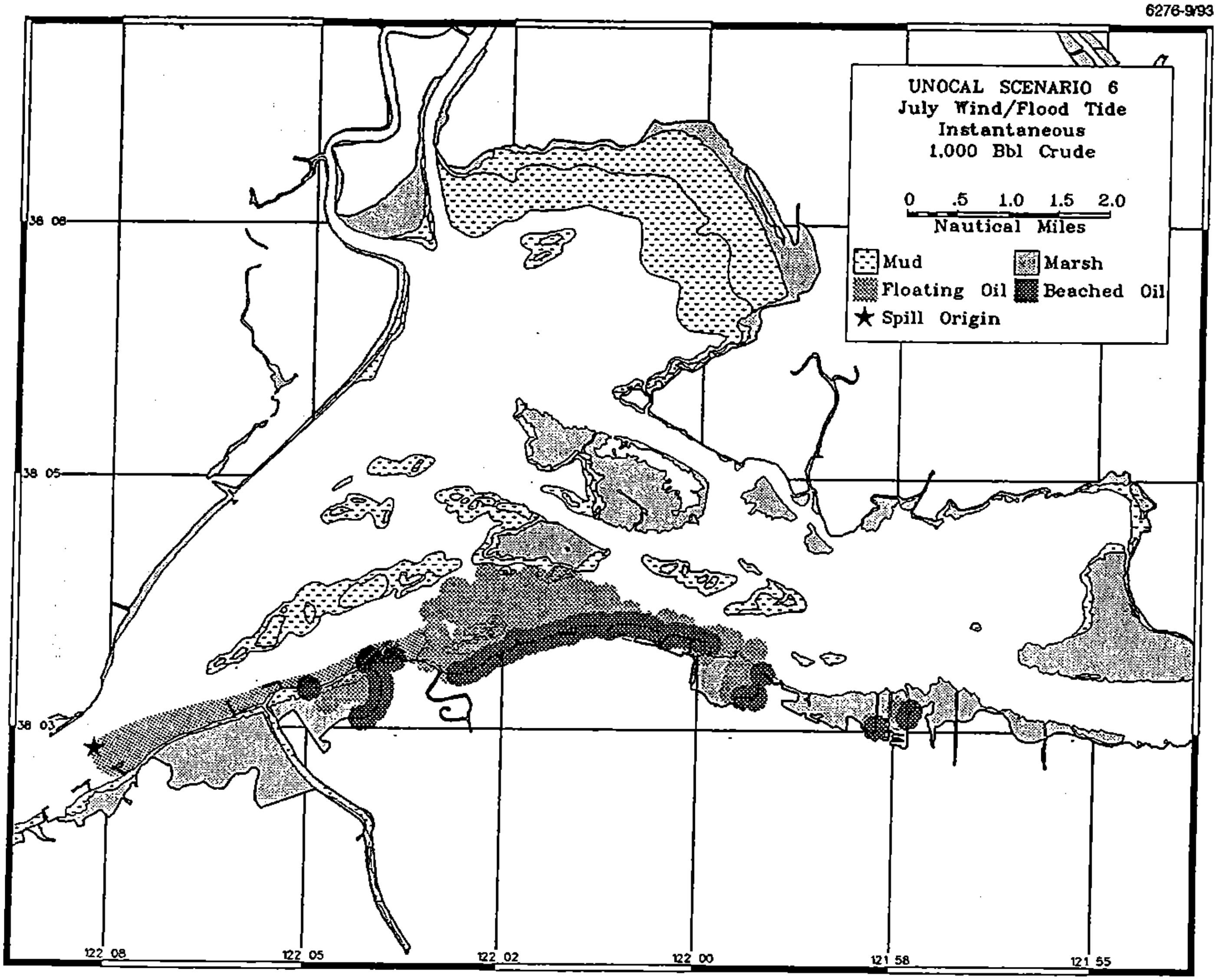
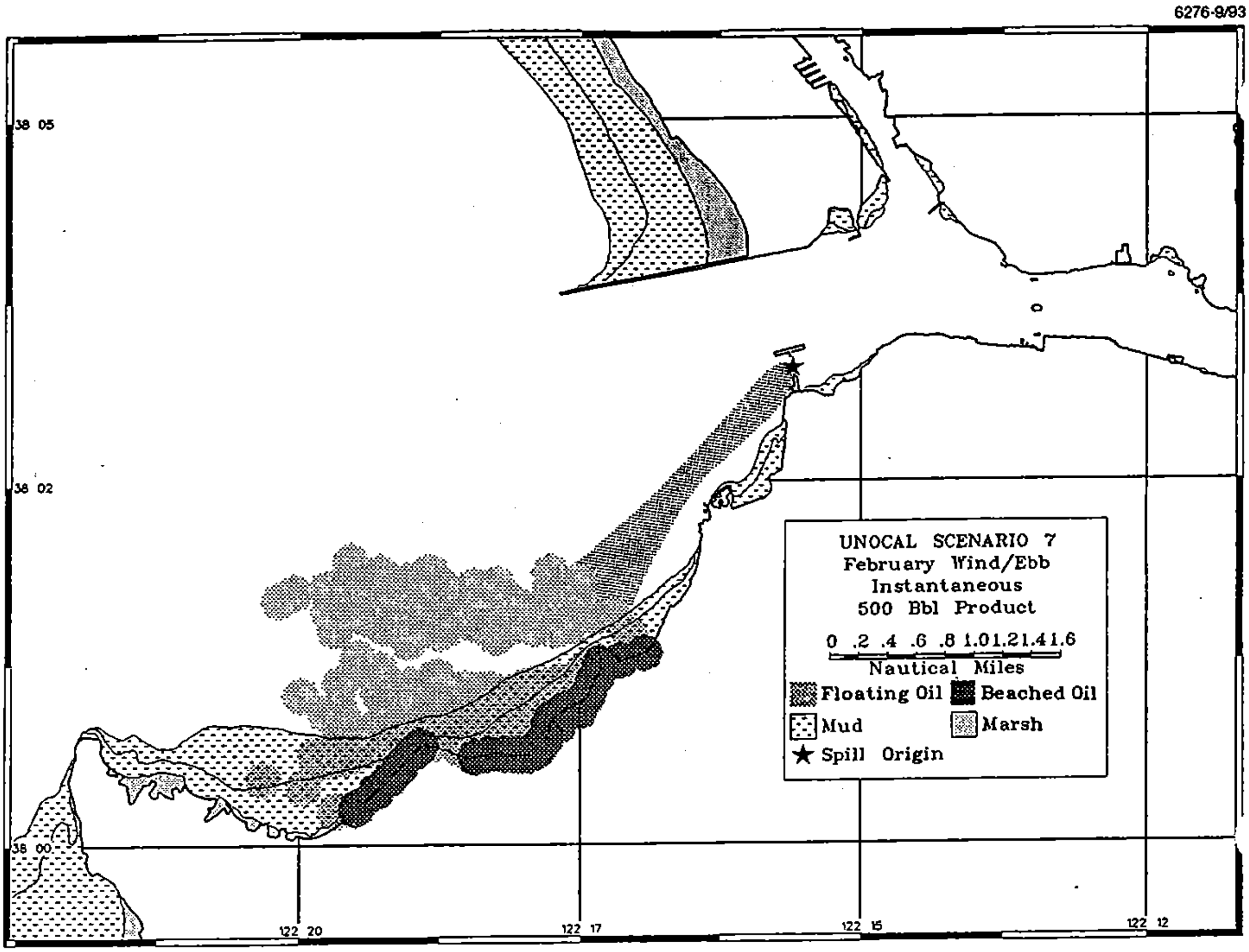


Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.

BAY SCENARIO NO. 6
1,000 BBL CRUDE SPILL IN
TANKER LANE-EAST END OF CARQUINEZ STRAIT
JULY WIND/FLOOD TIDE
Figure 4.2-7



BAY SCENARIO NO. 7
500 BBL PRODUCT SPILL FROM
MARINE TERMINAL, FEBRUARY WIND/EBB TIDE
Figure 4.2-8

Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.

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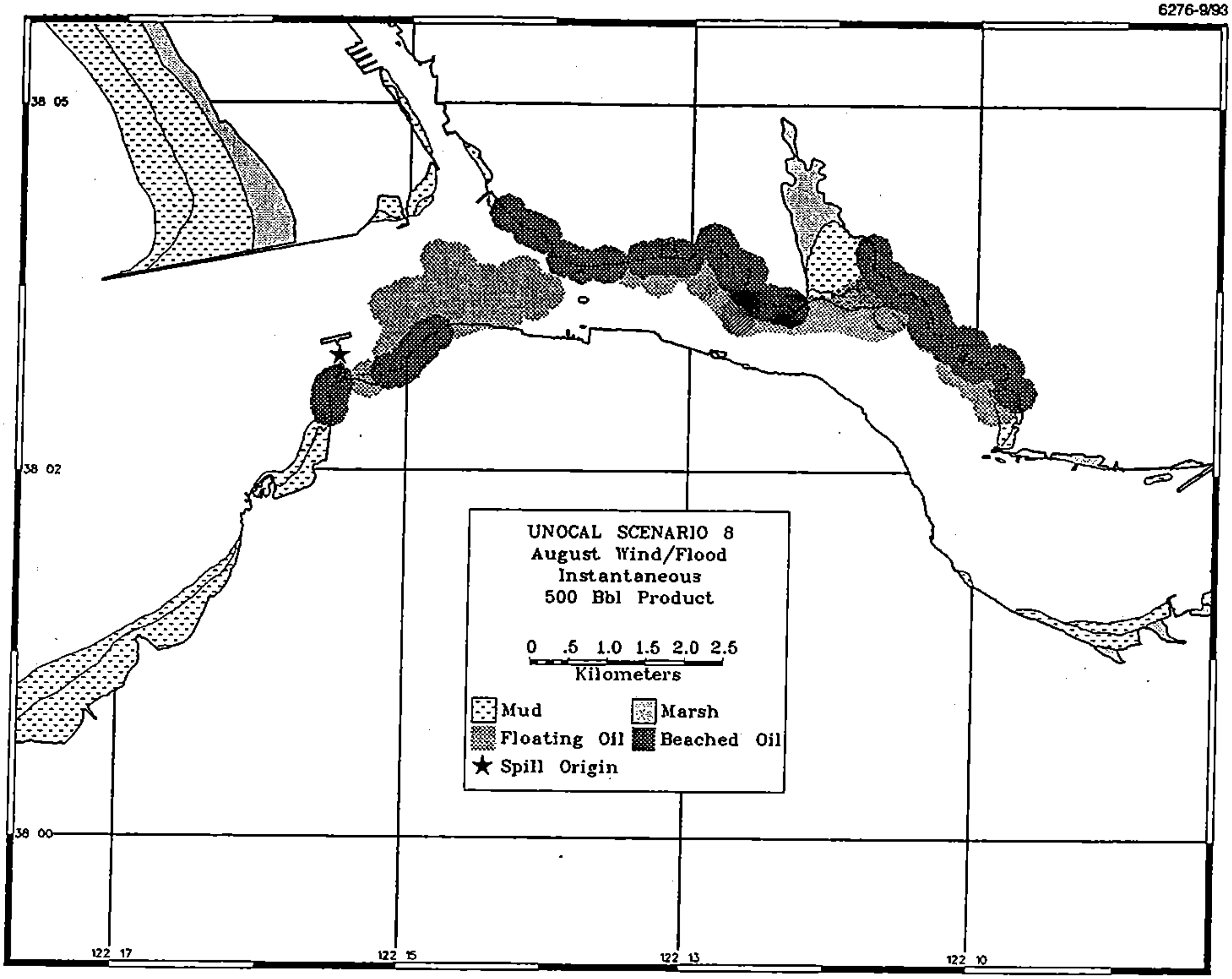
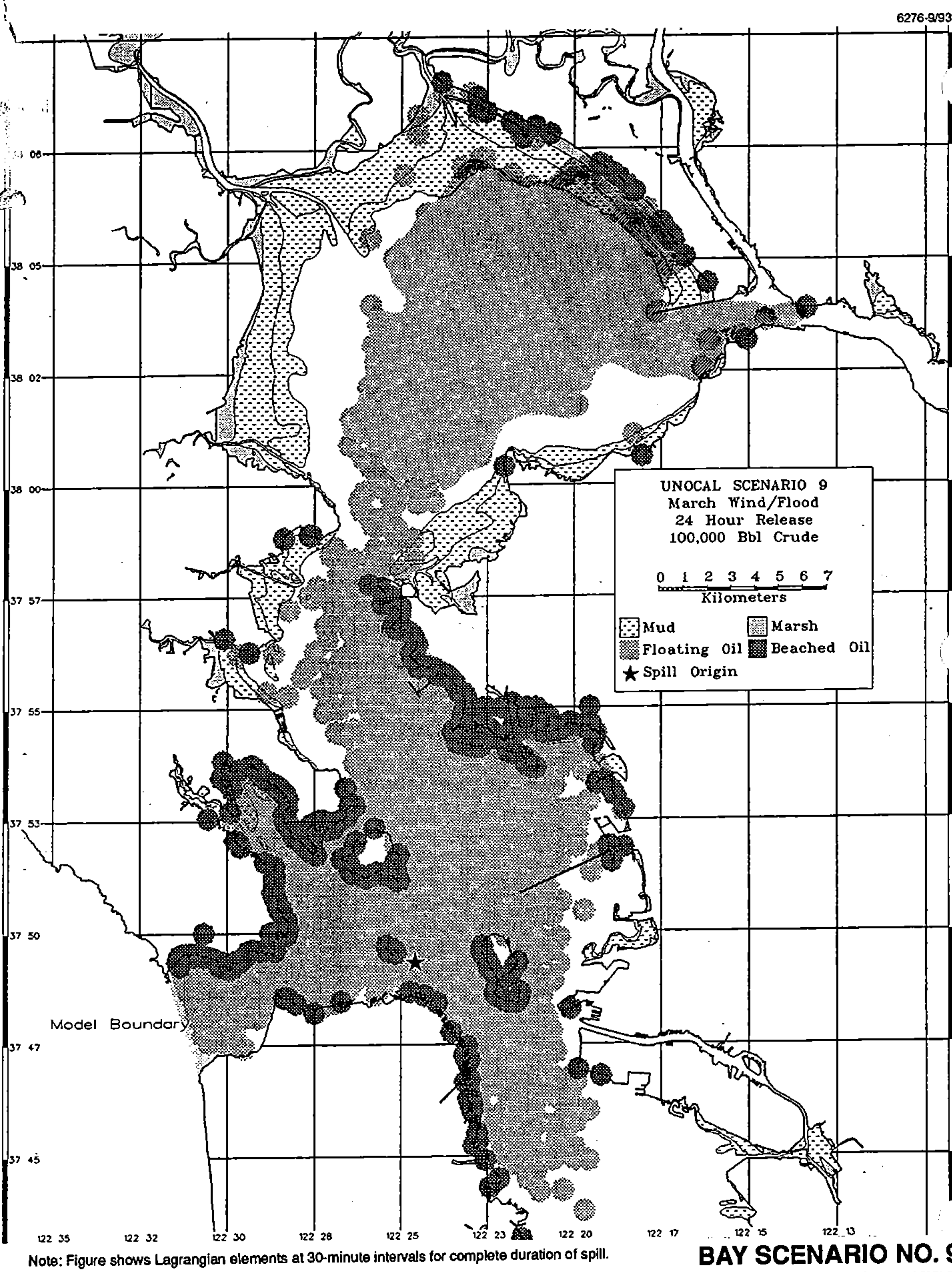


Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.

BAY SCENARIO NO. 8
500 BBL PRODUCT SPILL FROM MARINE TERMINAL, AUGUST WIND/FLOOD TIDE
Figure 4.2-9

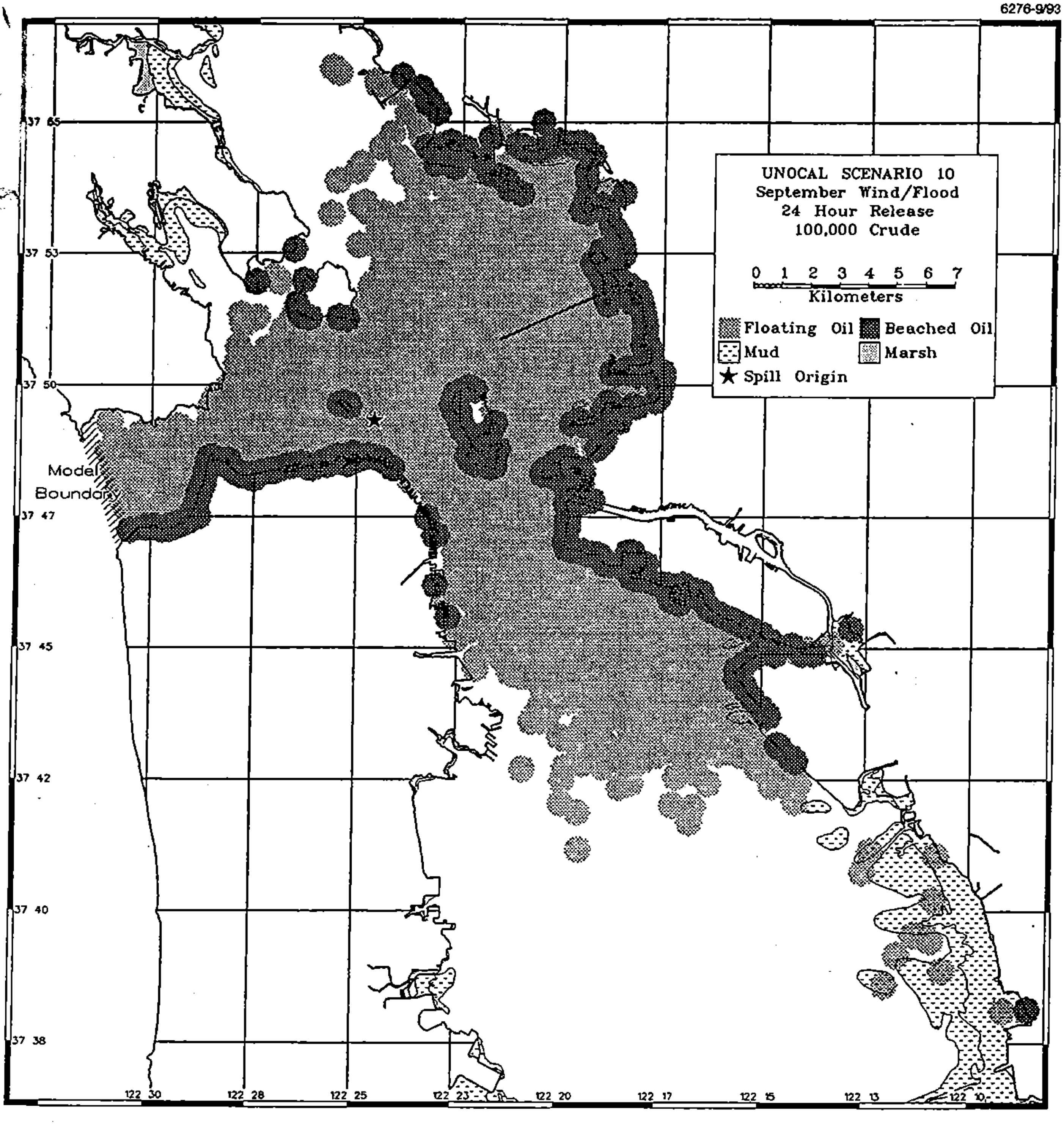


Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.

BAY SCENARIO NO. 9

100,000 BBL CRUDE SPILL NEAR ALCATRAZ ISLAND, MARCH WIND/FLOOD TIDE

Figure 4.2-10



BAY SCENARIO NO. 10
100,000 BBL CRUDE SPILL NEAR
ALCATRAZ ISLAND, SEPTEMBER WIND/FLOOD TIDE
Figure 4.2-11

Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.

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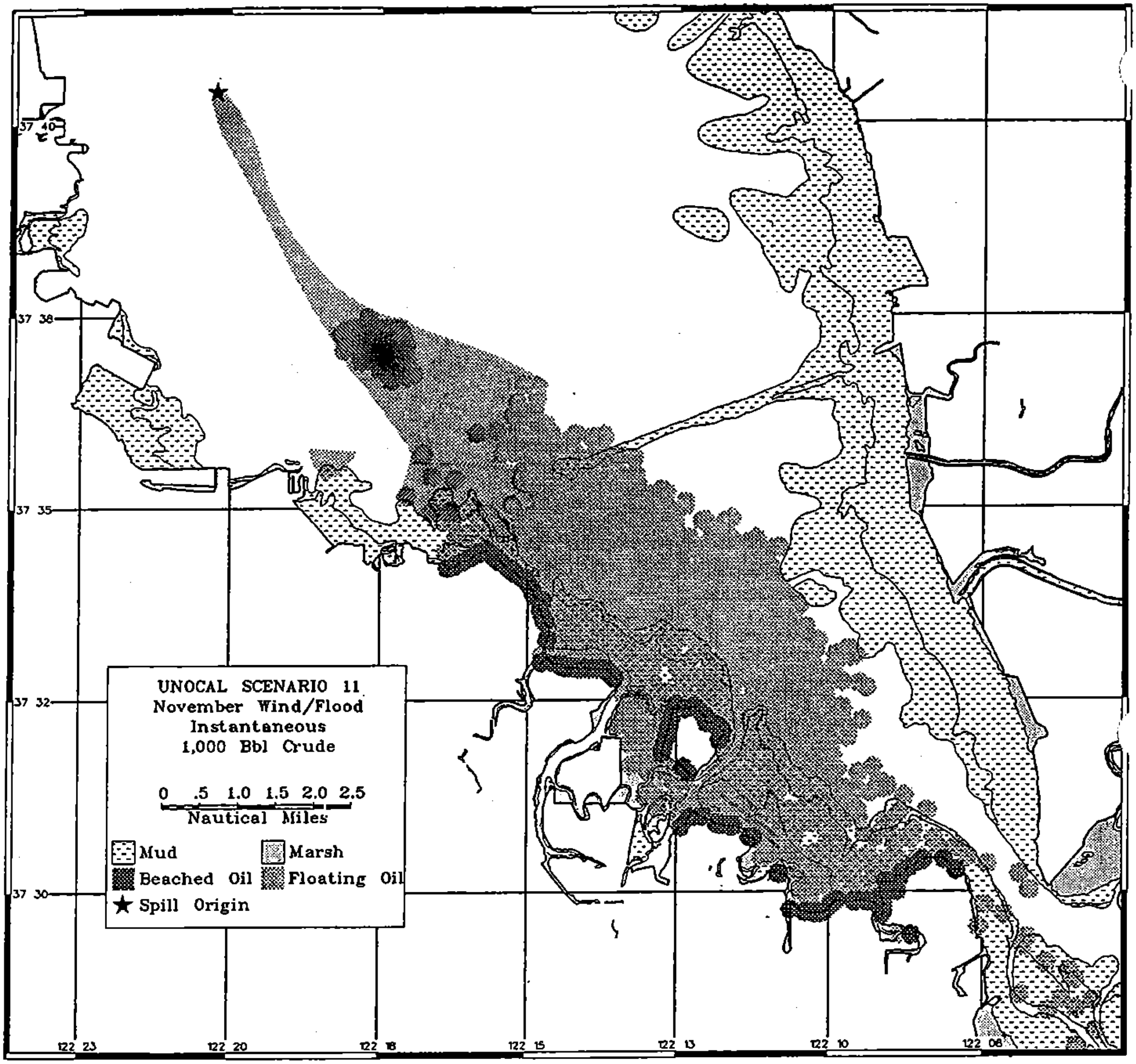

Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.

BAY SCENARIO NO. 11
1,000 BBL CRUDE SPILL AT
ANCHORAGE NO. 9, NOVEMBER WIND/FLOOD TIDE
Figure 4.2-12

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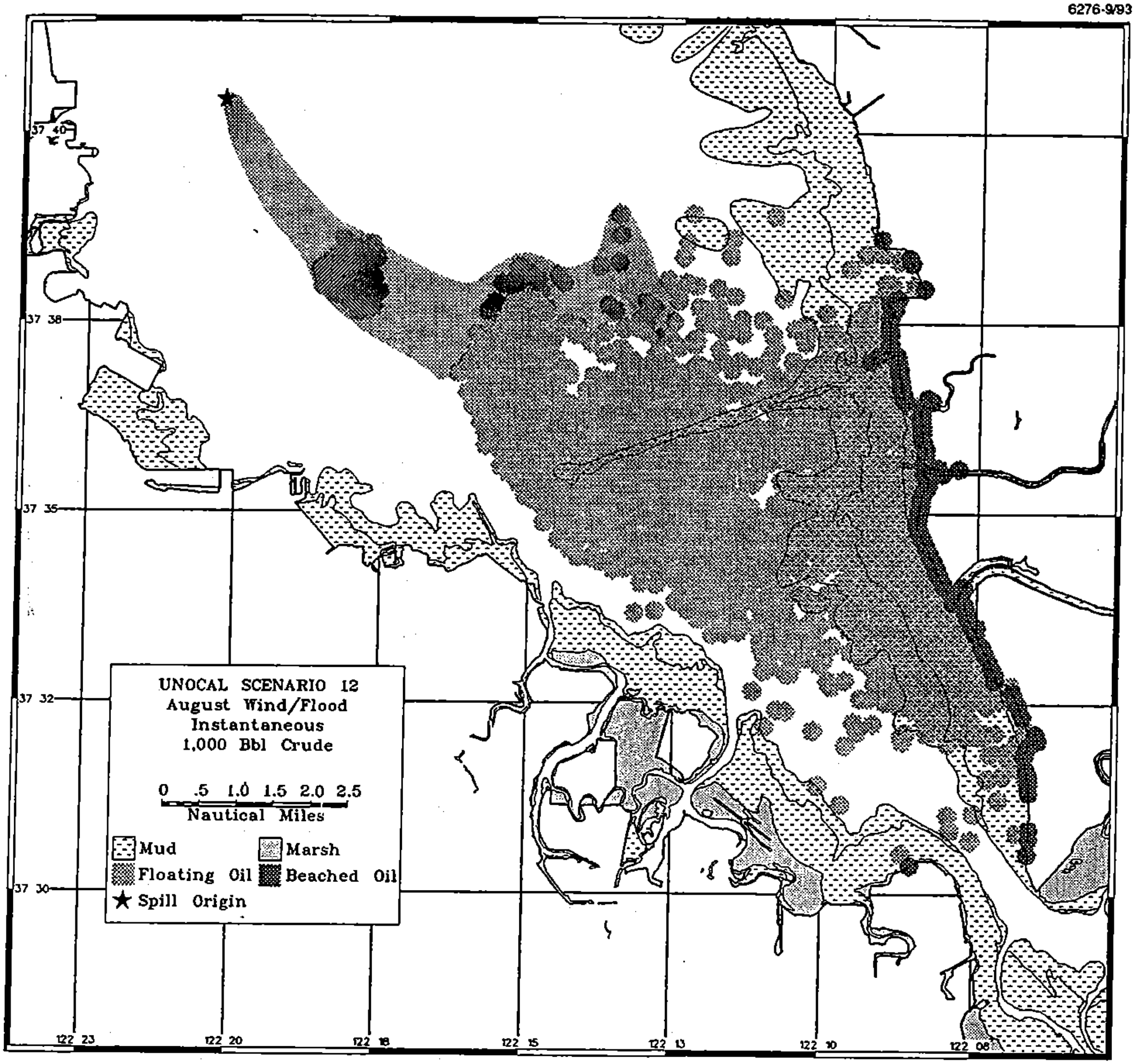


BAY SCENARIO NO. 12
1,000 BBL CRUDE SPILL AT
ANCHORAGE NO. 9, AUGUST WIND/FLOOD TIDE
Figure 4.2-13

Note: Figure shows Lagrangian elements at 30-minute intervals for complete duration of spill.

the south Bay, 4 to 5 km off the San Francisco International Airport. The slick then spread and dispersed widely to contact waters, mudflats, marshes and shore of Alameda County from Coyote Hills Slough to Calaveras Point.

Outer Coast Scenario No. 1 - Outer Coast Scenario No. 1 was a 100,000-bbl spill of crude oil released over 24 hours from the westbound traffic lane about 5 km southeast of the Farallon Islands (Figure 4.2-14). The modeled spill was moved by a sequence of winds taken from March 1990. All oil beached or moved out of the model domain within 8 days, 22 hours. Oil moved northward with passage of storm cells and southeast winds, contacting the Farallon Islands and driving oil nearly to Point Reyes. When prevailing northwest winds resumed, oil moved to the southeast, again beaching on the Farallon Islands, and then contacting the mainland shore from about Point Montara to Point Ano Nuevo. Oil that did not beach along this 65-km (36 nm) stretch of coast drifted southward into Monterey Bay.

Outer Coast Scenario No. 2 - Outer Coast Scenario No. 2 was a 100,000-bbl spill of crude oil released over 24 hours from a location along the tanker route about 30 km (16.5 nm) southwest of Punta Gorda (Figure 4.2-15). The modeled spill was moved by a sequence of winds taken from October 1991. All oil beached or moved out of the model domain within 18 days, 10 hours. Oil from this spill moved southward, remaining over the shelf break to about the latitude of Cape Vizcaino, then continued over the shelf (waters less than 200 m in depth) until contacting the shore. Oil beached along a 50-km (27.5-nm) stretch of rocky shore extending from Bruhel Point south to the Albion River and Navarro Head, including the towns of Fort Bragg and Mendocino.

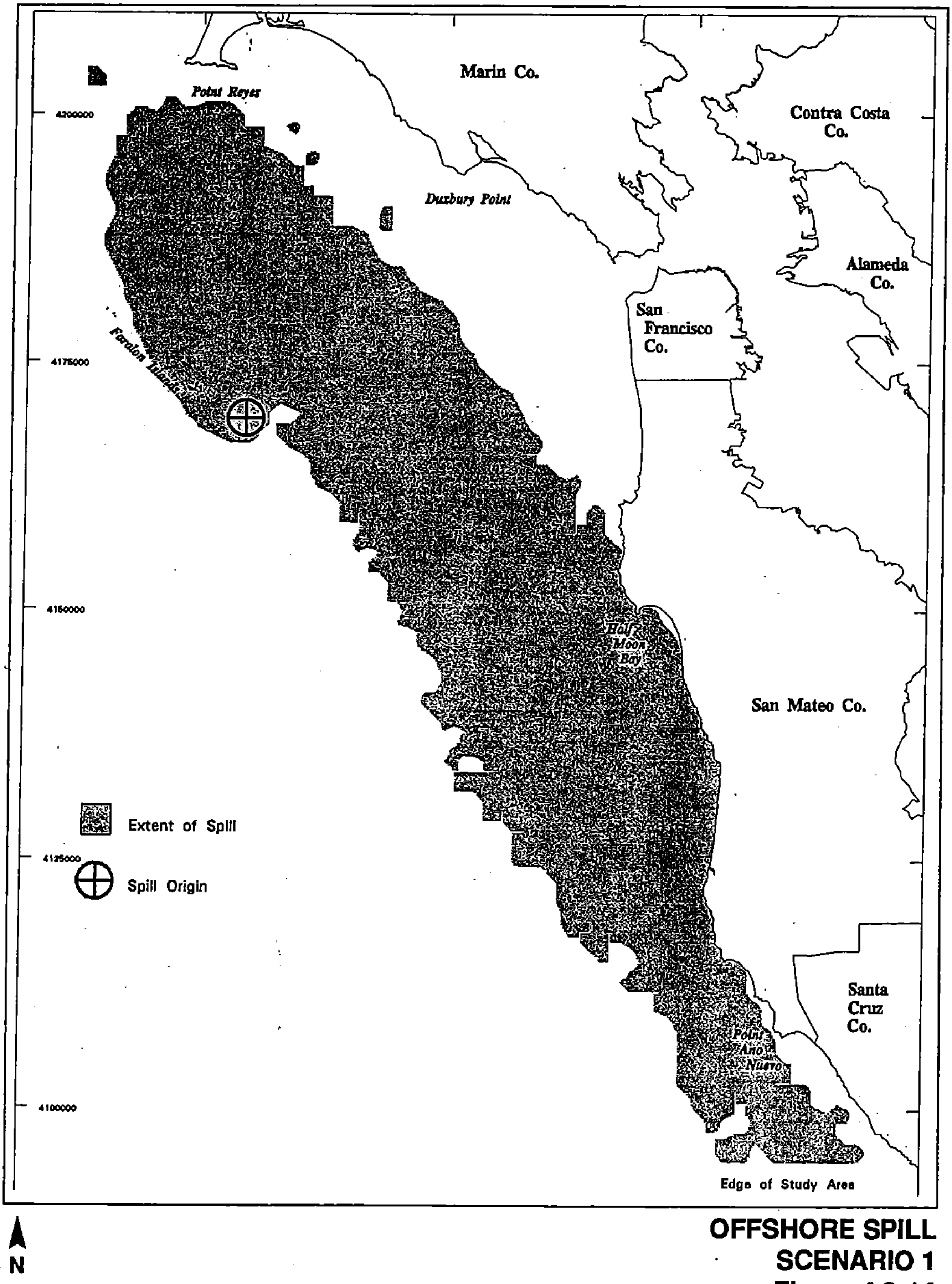
Outer Coast Scenario Modeling for San Francisco South - The motion and fate of spilled crude oil were also modeled along the California coast from San Diego north to Point Arena, north of San Francisco in the GTC Gaviota Marine Terminal Final Supplemental EIR/EIS (Aspen 1992). Modeling was accomplished using SPILLSIM, a generalized spill model developed by Seaconsult Marine Research Ltd. of Vancouver, Canada, which combines high-resolution surface currents with a spill motion and fate module that yields the volume distribution as a function of time. An offshore spill scenario of 100,000 bbls was modeled. The spill location was off of the Golden Gate. Modeling was performed assuming that 50 percent of the oil was released instantaneously, with the remaining 50 percent spilled uniformly over the succeeding 5 hours. The annual probability of a spill was determined to be 0.000371 for vessels in transit from Point Conception to the Golden Gate. The average number of years between spills over a long-term exposure was determined to be 2,697 years. Results of this GTC modeled scenario are presented below. Figures showing the GTC scenario modeling results are presented in Appendix B, page B.2-50.

The GTC 100,000-bbl spill scenario examined the approaches to San Francisco coming from the south. During the winter, the Davidson current strengthens along the coast between Point Arguello and Point Sur. This flow tends to deflect oil moving downwind from a spill near the entrance to San Francisco offshore south of Point Sur. Consequently, during the winter, Davidson season, the dominant pathways for spilled oil tend to produce heavy shoreline oiling between the spill area and Monterey Bay (Figure B.2-38) or an offshore trajectory yielding little or no shoreline contact (Figure B.2-39). However, under sustained, strong northwest winds, the oil may contact the Channel Islands, as well as produce a light oiling of the shoreline between Monterey Bay and Point Conception (Figure B.2-40).

In the summer upwelling season, the wind and current regimes tend to bring oil onshore north of Monterey Bay and into the Bay itself. There is less tendency for the currents to deflect the oil offshore than during winter months. Figure B.2-41 illustrates one case where the spill did move south of Point Sur, producing shoreline oiling near Point Arguello, consistent with seasonal current patterns.

During the fall transition period (oceanic regime), the currents tend to deflect the oil offshore compared with the other seasons for the area north of Monterey Bay. As a result, the dispersion patterns contrast those of summer with a lower chance of spills reaching Monterey Bay. Typically, however, oil will contact the area around Point Sur on the coast and Point Arguello (Figures B.2-42 and B.2-43).

The discrete probability distribution is shown on Figure B.2-44. For the prevailing winds and currents in this area, the zone of highest frequency lies southeastward, roughly parallel to the coast. Shoreline contact is indicated with frequencies ranging from 30 to 60 percent, with the highest percentage at the entrance to Monterey Bay. Contact frequencies



OFFSHORE SPILL SCENARIO 1
Figure 4.2-14

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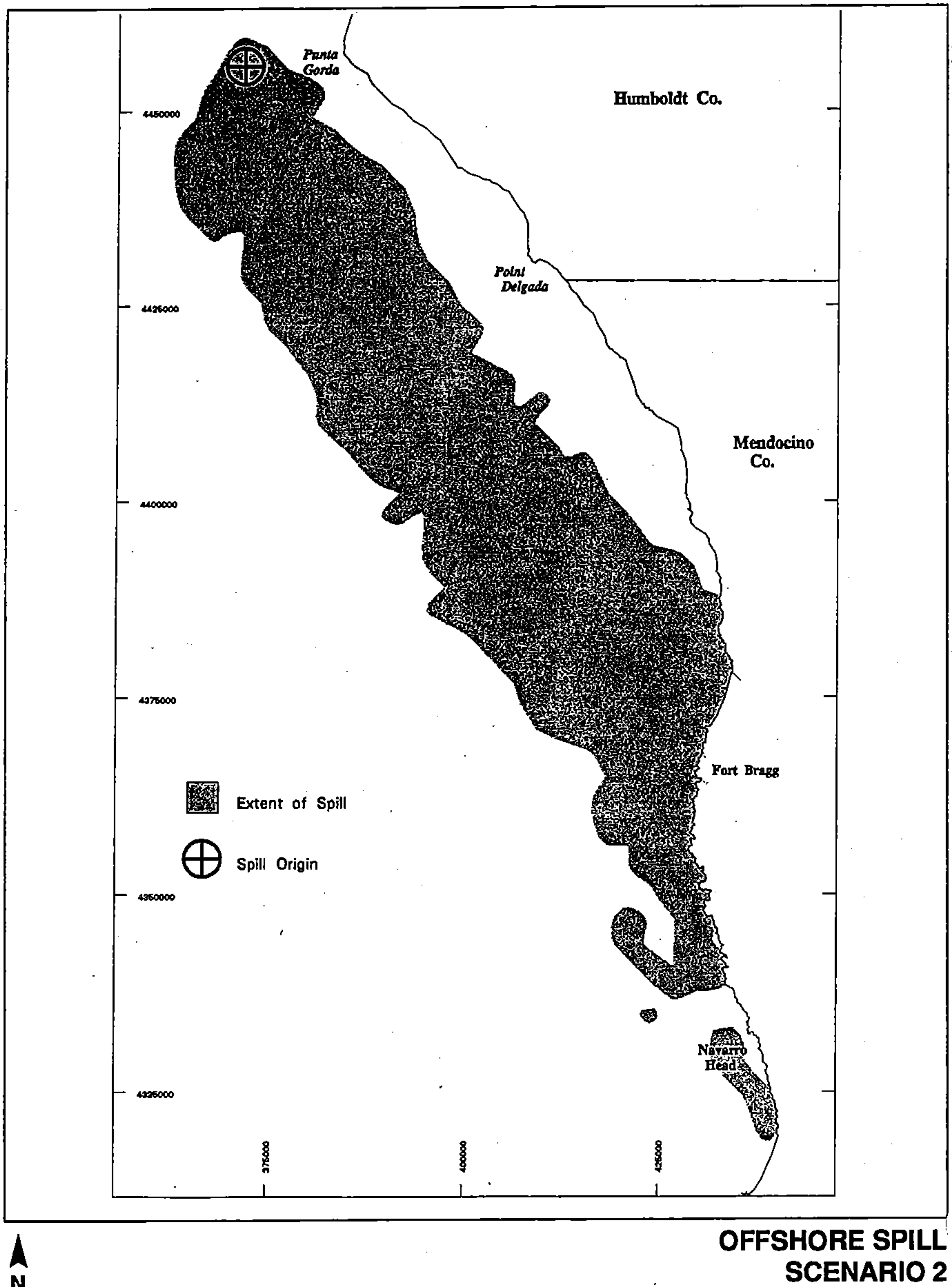

OFFSHORE SPILL SCENARIO 2
Figure 4.2-15

exceeding 20 percent extend southward as far as Point Conception. Contact frequencies of less than 15 percent extend 300 km from the location of the spill.

Receptor Mode Analysis

Receptor mode runs were conducted in order to determine which potential spill sites represented the greatest risk to 20 critical shoreline resources which were selected as representative of the entire Bay. Runs were performed both for (1) the probability that a spill released from a particular tanker route segment (Figure B.2-2 in see Appendix B) will contact each receptor, as well as, (2) the probability that a spill released from a particular terminal will contact each receptor. Terminal locations were shown on Figure 2.4-1. The 20 receptors examined in these runs are shown on Figure 4.2-16.

Individual Lagrangian elements with a dispersive factor corresponding to a 10,000-bbl spill were launched at 8-hour intervals over a 2-year period to reflect a wide range of wind and current conditions. (Wind data were used for 1990-1991, as discussed in Section 4.2.1.1, Spill Trajectory Analysis.) If a Lagrangian element was beached at the shoreline, this was considered a contact. This distance was defined as corresponding to one-half the expected length of coastline (Ford and Casey 1985) that would be impacted by a 10,000-bbl spill released from a given transport segment or terminal. The number of contacts were divided by the number of elements released in order to estimate the likelihood (percent chance) that a spill from a particular source will contact a receptor site.

Results of receptor mode runs are presented in Tables 4.2-2 and 4.2-3. These results are used as an additional analysis tool in conjunction with the probabilistic modeling results in the analyses of fisheries and marine biological impacts.

4.2.2 Impact Significance Criteria

A public safety impact is considered significant if there would be potential for fires, explosions, releases of flammable or toxic materials, or other accidents from the Terminal or from vessels calling at the Terminal that could cause injury or death to members of the public. Injury to Refinery or Marine Terminal personnel are not included.

Impacts are also considered significant if the existing facility does not conform to its oil spill contingency plans or other plans that are in effect. Additionally, impacts are considered significant if current or future operations are not consistent with federal, state or local regulations. However, conformance with regulations does not necessarily mean that there are not significant impacts.

Significance of impacts associated with oil spills was assessed within the specific resource areas such as water quality, marine biology, fisheries and recreation. This section describes the extent and potential for spills.

4.2.3 Proposed Project

4.2.3.1 Analysis of Continuation of Existing Operations

Marine Terminal Routine Operations

The various components of the Marine Terminal and Marine Terminal operations were analyzed from a system safety perspective. Each component is discussed below.

Structural Integrity of Wharf

The structural integrity of the wharf was evaluated by reviewing drawings supplied by Unocal, by visiting the facility, by reviewing results of piping inspection records, and by conducting discussions with Unocal and SLC personnel. A detailed discussion of the wharf design and the present condition of the wharf is contained in Sections 3.8.6.1 and 4.9. A recent SLC annual inspection of the Terminal discovered potential deficiencies in the structural integrity of the wharf. These deficiencies could lead to other problems resulting in various types of accidents, including hydrocarbon releases. This significant (Class II) impact would be mitigated by a variety of measures detailed in Section 4.2.5, including development and implementation of a Marine Terminal Audit Program and a planned maintenance program, and installation of a vessel approach rate monitoring system for the vessel master.

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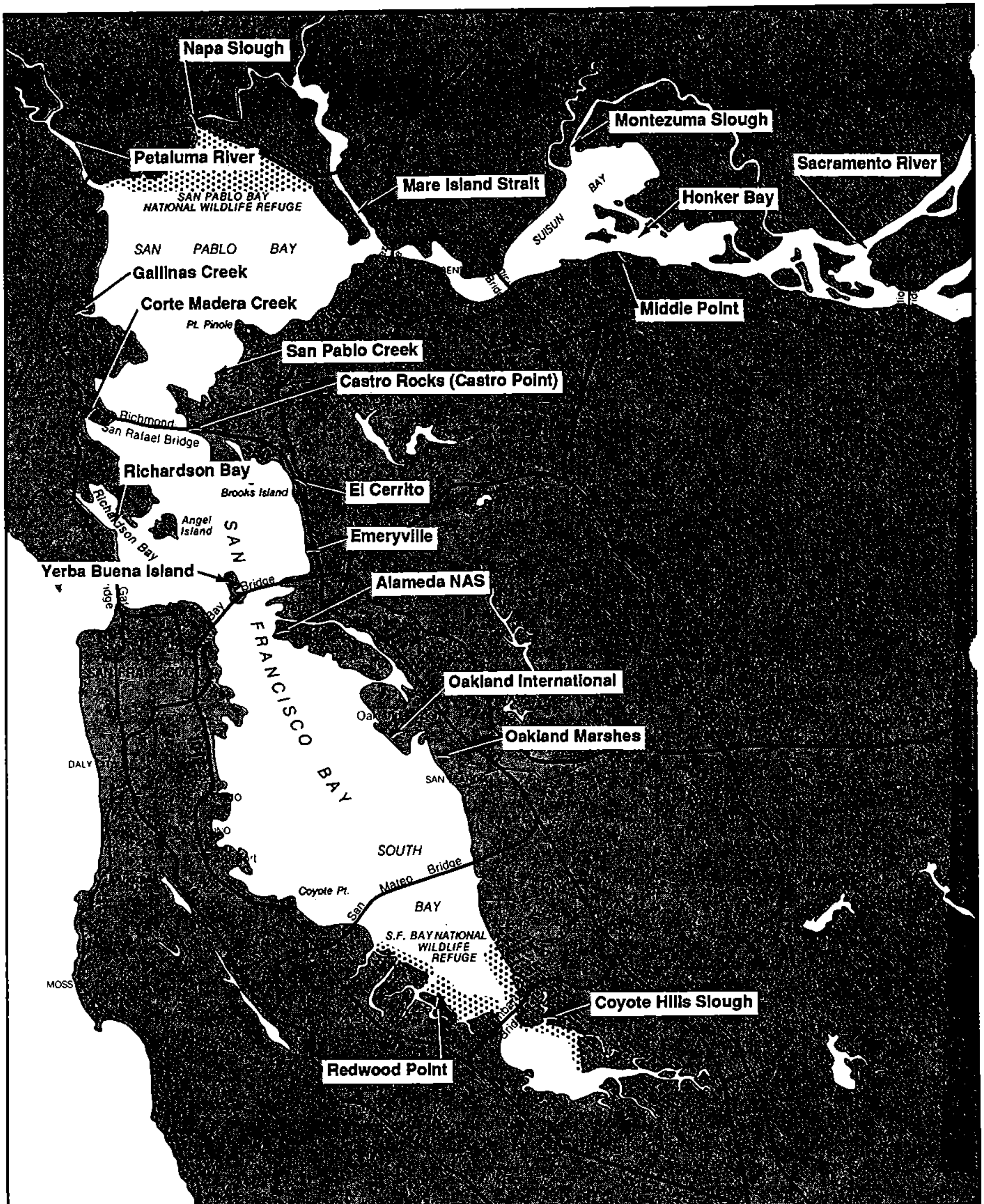

Source: California Coastal Resource Guide
California Coastal Commission, 1987

RECEPTOR MODE LOCATIONS
Figure 4.2-10

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Table 4.2-2

RECEPTOR MODE RUN RESULTS - TRANSPORT SEGMENTS
(probability [percent chance] that a 10,000-bbl spill from a particular transport segment will contact the specified receptors)

Receptor	Transport Segment (by percent)																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Corte Madera Creek	.10	.05	.10	2.05	5.06	5.76	3.81	1.25	.80	.65	.30	.10	.00	.00	.00	.00	.10	.20	.05
San Pablo Creek	.25	.35	1.00	20.51	24.09	18.37	6.91	1.40	.50	.60	.05	.00	.00	.00	.00	.00	.75	.40	.05
Emeryville	7.65	9.41	32.50	16.81	7.41	2.35	.35	.05	.20	.00	.00	.05	.00	.00	.00	.00	15.03	5.81	.25
El Cerrito	5.50	4.16	19.28	19.26	11.07	2.70	.35	.05	.10	.00	.10	.00	.00	.00	.00	.00	6.31	1.55	.05
Coyote Hills Slough	.05	.50	.30	.15	.05	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.80	8.77	39.87
Castro Rocks	1.05	1.20	2.75	27.41	28.54	17.02	4.81	.95	.30	.40	.10	.05	.00	.00	.00	.00	1.35	.70	.05
Yerba Buena Island	17.10	24.09	25.69	9.05	4.01	2.15	.65	.10	.15	.15	.00	.00	.00	.00	.00	.00	29.56	19.04	.65
Mare Island Strait	.00	.00	.05	3.65	15.22	29.93	50.20	63.58	61.59	60.79	43.24	8.75	.15	.00	.00	.00	.00	.00	.00
Redwood Point	.10	.05	.25	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.30	1.70	8.38
Montezuma Slough	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.10	.40	.90	1.80	1.10	.00	.00	.00	.00
Napa Slough	.00	.05	.00	.20	1.05	1.80	2.51	2.15	1.25	.75	.55	.00	.00	.00	.00	.00	.00	.00	.00
Petaluma River	.00	.00	.00	.20	.60	1.00	1.00	1.25	.70	.55	.10	.00	.00	.00	.00	.00	.00	.00	.00
Gallinas Creek	.00	.00	.15	.35	.65	1.15	1.70	2.00	1.20	.75	.55	.05	.00	.00	.00	.00	.10	.05	.00
Richardson Bay	.80	.75	1.60	8.65	10.27	8.56	4.61	1.80	1.10	.35	.15	.05	.00	.00	.00	.00	.80	.25	.15
Oakland Marshes	.25	2.45	1.40	.40	.20	.20	.00	.05	.00	.00	.00	.00	.00	.00	.00	.00	9.57	24.65	2.11
Oakland International	.35	2.35	1.35	.30	.15	.10	.00	.05	.00	.00	.00	.00	.00	.00	.00	.00	7.97	25.85	3.11
Alameda NAS	7.70	16.78	15.62	6.15	2.15	1.35	.40	.10	.15	.05	.00	.00	.00	.00	.00	.00	24.55	20.54	1.00
Honker Bay	.00	.00	.00	.00	.00	.00	.05	.10	.30	.30	1.20	6.75	20.96	60.90	91.60	100.00	.00	.00	.00
Middle Point	.00	.00	.00	.00	.00	.00	.05	.25	.35	.75	1.75	10.76	26.11	52.05	26.61	.00	.00	.00	.00
Sacramento River Mouth	.00	.00	.00	.00	.00	.00	.05	.10	.30	.15	.90	5.15	15.81	53.60	88.79	100.00	.00	.00	.00

Table 4.2-3

RECEPTOR MODE RUN RESULTS - TERMINALS
(probability [percent chance] that a 10,000-bbl spill from a particular terminal will contact the specified receptors)

Receptor	Terminal (by percent)																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Corte Madera Creek	.00	2.30	3.36	4.01	.55	.80	.45	.00	.00	.00	.05	.00	.00	.00	.00	.05	.00
San Pablo Creek	.00	42.61	45.82	31.85	.75	.50	.40	.00	.00	.00	.00	.00	.00	.00	.00	.85	.00
Emeryville	.00	7.71	3.71	4.31	.05	.05	.15	.00	.00	.00	.00	.00	.00	.00	.00	14.68	.00
El Cerrito	.00	14.82	7.11	7.01	.00	.10	.05	.00	.00	.00	.00	.00	.00	.00	.00	4.71	.00
Coyote Hills Slough	.00	.05	.05	.05	.00	.00	.05	.00	.00	.00	.00	.00	.00	.00	.10	2.30	.00
Castro Rocks	.00	53.68	50.43	34.75	.55	.35	.20	.00	.00	.00	.00	.00	.00	.00	.00	1.65	.00
Yerba Buena Island	.00	6.26	3.76	2.05	.15	.00	.05	.00	.00	.00	.00	.00	.00	.00	.00	32.62	.05
Mare Island Strait	.00	3.91	10.92	17.98	62.86	57.79	57.87	.65	.20	.75	1.45	.25	.20	.00	.00	.00	.00
Redwood Point	.00	.00	.10	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	99.50	.35	.00
Montezuma Slough	.00	.00	.00	.00	.00	.00	.05	.60	1.30	1.35	1.00	.80	1.25	.00	.00	.00	.00
Napa Slough	.00	.30	.65	1.20	1.10	1.00	.85	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Petaluma River	.00	.25	.45	.90	.35	.50	.45	.00	.00	.00	.00	.00	.00	.00	.00	.05	.00
Gallinas Creek	.00	.25	.85	.85	1.40	.85	.90	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Richardson Bay	.00	5.36	7.91	7.66	.70	.70	.45	.00	.00	.00	.00	.00	.00	.00	.00	.45	.00
Oakland Marshes	.00	.35	.20	.10	.10	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	12.22	.00
Oakland International	.00	.40	.25	.10	.10	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	11.82	.00
Alameda NAS	.00	4.06	2.25	1.45	.10	.00	.05	.00	.00	.00	.00	.00	.00	.00	.05	21.49	99.65
Honker Bay	.00	.00	.00	.00	.15	.30	.70	12.96	11.96	16.66	14.00	17.90	19.02	100.00	.00	.00	.00
Middle Point	.00	.00	.00	.00	.30	.50	.90	17.36	17.06	22.01	18.45	25.15	26.83	.00	.00	.00	.00
Sacramento River Mouth	.00	.00	.00	.00	.10	.25	.20	9.15	8.60	12.51	10.65	13.45	14.41	100.00	.00	.00	.00

Piping and Loading/Unloading System

Piping and instrumentation diagrams (P&IDs) and flow and instrument diagrams of the terminal piping and instrumentation system supplied by Unocal were reviewed as well as the Marine Terminal Dispatcher Training Manual, Marine Terminal Complex Operating and Training Manual, and Marine Terminal Operations Manual. The P&IDs and flow diagrams supplied appeared to be old and not totally reflective of the current configuration at the terminal. The lack of up-to-date P&IDs can create safety problems during maintenance activities, facility upgrade, and upset conditions. The training and operations manuals are current and reflect the current state of the Terminal. It is noted here that a recent SLC regulation requires that the Terminal Operations Manual must be updated by December 1993 to meet additional requirements of SLC over and above those presently required by the U.S. Coast Guard. In addition, a current set of P&IDs is required by OSPR in their recent regulations regarding oil spill contingency plans for marine facilities. The absence of updated P&IDs is a significant (Class II) impact that can be mitigated to nonsignificant levels by updating the plans.

As shown in Section 3.1.6.1, there have been 15 spills at the Terminal since 1986. Six of the spills (40 percent) were caused by corrosion or erosion in the pipelines. The pipelines on the trestle are mounted directly above the water with no barrier or containment system to prevent released product from falling directly into the water. The OSPR regulations require that a risk and hazard analysis be conducted on marine facilities to identify hazards that could cause a release. This significant (Class II) impact can be mitigated by the development and implementation of a plan that, at a minimum, addresses assessing the current conditions of the pipelines, methods to correct all deficiencies and problems, ongoing inspections and maintenance, installation of an effective leak detection system, and methods to prevent released oil from reaching the water (e.g., catchment tray or trough).

Vapor Control System (VCS)

The VCS can be dangerous if not designed and operated properly because it is located on the pier near the wharf, close to where transfer operations take place and because of the volatile vapors. A major part of the VCS design is fire and explosion protection. In Unocal's VCS, oxygen is replaced in the vapor pipeline by inert exhaust gases generated by the ship. Nitrogen is admitted to the vapor pipeline if the oxygen content exceeds 5 percent. A detonation arrester is installed in the Berth M-2 vapor pipeline to prevent flame fronts from passing from the Marine Terminal to the ship. A water seal pot and detonation arrester in the line prevents flames from spreading from the thermal oxidizer equipment to the vapor pipeline. Flame arresters are installed in each burner stage pipeline of the thermal oxidizer.

Unocal has undertaken several measures to ensure that the design of the system is safe and that it is operated properly. Prima Tech, Inc. was hired by Unocal to conduct a HAZOP study on the VCS to ensure a safe design. Westinghouse Electric was also hired to conduct a quantitative hazards evaluation of the VCS (Westinghouse 1991). Westinghouse concluded that the use of the VCS as originally designed and installed may reduce the risk of fire or explosion at a tanker or barge during the loading process when compared with no vapor recovery.

Unocal submitted information on the VCS as originally designed and installed to the USCG in compliance with the requirements of 33 CFR 154. The USCG approved the system as originally installed with an Amendment to Letter of Adequacy for Unocal's Marine Terminal Operating Manual on January 7, 1992.

A SLC annual inspection of the Terminal in December, 1992, found that a detonation arrestor near the Berth M-1 vapor connection had been removed from its location and installed between the water seal and thermal oxidizer. SLC staff believes this may present a safety hazard. This issue needs to be resolved to the satisfaction of SLC and the USCG. This is considered a significant (Class II) impact that can be mitigated to nonsignificant levels through the development and implementation of a Marine Terminal Audit Program that addresses the location of the detonation arresters.

Marine Terminal Accident Conditions

Potential for Spills from Terminal

Based on review of the components of the Marine Terminal discussed above, it is appropriate to use spill statistics for marine terminals worldwide to estimate the potential for a spill from the Unocal Terminal. While the probability of a spill is presented in terms of spills per vessel transfer, the database includes spills that occur even when a vessel is not present. Thus, the probability actually reflects the probability of spills at the Terminal from all causes and not just those associated with transfer operations.

The GTC EIR (Aspen 1992) estimated that the "at pier" spill rate for spills greater than 1,000 bbl is 0.95 spills per 10,000 port calls for tankers worldwide. Because of the safety record of the San Francisco Bay Area, Aspen (1992) applied a 0.4 historical modifier to the worldwide spill rate, resulting in a spill rate estimate of 0.38 spills greater than 1,000 bbl per 10,000 port calls (3.8×10^{-5} spills per port call). The spill rate for tankers involved in Alaskan crude trade is 0.38 spills greater than 1,000 bbl per 10,000 port calls, similar to the modified Bay Area estimate.

In order to estimate the probability of smaller size spills, information on spills of 10,000 gal (238 bbl) occurring between 1978 and 1988 (Cutter Information Corp. 1989) was analyzed. Based on this data, the probability of spills greater than 238 bbl at marine terminals in the Bay Area is estimated to be 2.7×10^{-4} per port call. The database also showed that the spill rates were essentially the same for tankers and tank barges.

The Cutter database was also used to develop a spill size distribution for terminals within the Bay. Figure 4.2-17 presents the curve for the combined distribution, together with individual data points for tankers and tank barges. As can be seen by the figure, the spill distributions are essentially the same for tankers and tank barges. Thus, the combined distribution was assumed to represent a realistic spill distribution for all vessels at berth.

Based on the above, the expected mean time between spills greater than 238 bbl and greater than 1,000 bbl from the Unocal Marine Terminal would be approximately 27 and 187 years, respectively. Over a 40-year lease, there would be a 78 percent probability that a spill greater than 238 bbl would occur, and a 20 percent probability that a spill over 1,000 bbl would occur.

Even though the probability of a spill is low, and the probability of a large spill even lower, a large spill can occur and result in significant (Class I) impacts to water quality, biological resources, fisheries, and recreation (see Sections 4.3, 4.4, 4.5, and 4.11). Recommended measures to mitigate the potential for hydrocarbon transfer spills at the Terminal are presented in Section 4.2.5; they involve a variety of measures similar to those for pipeline and valving leaks and spills.

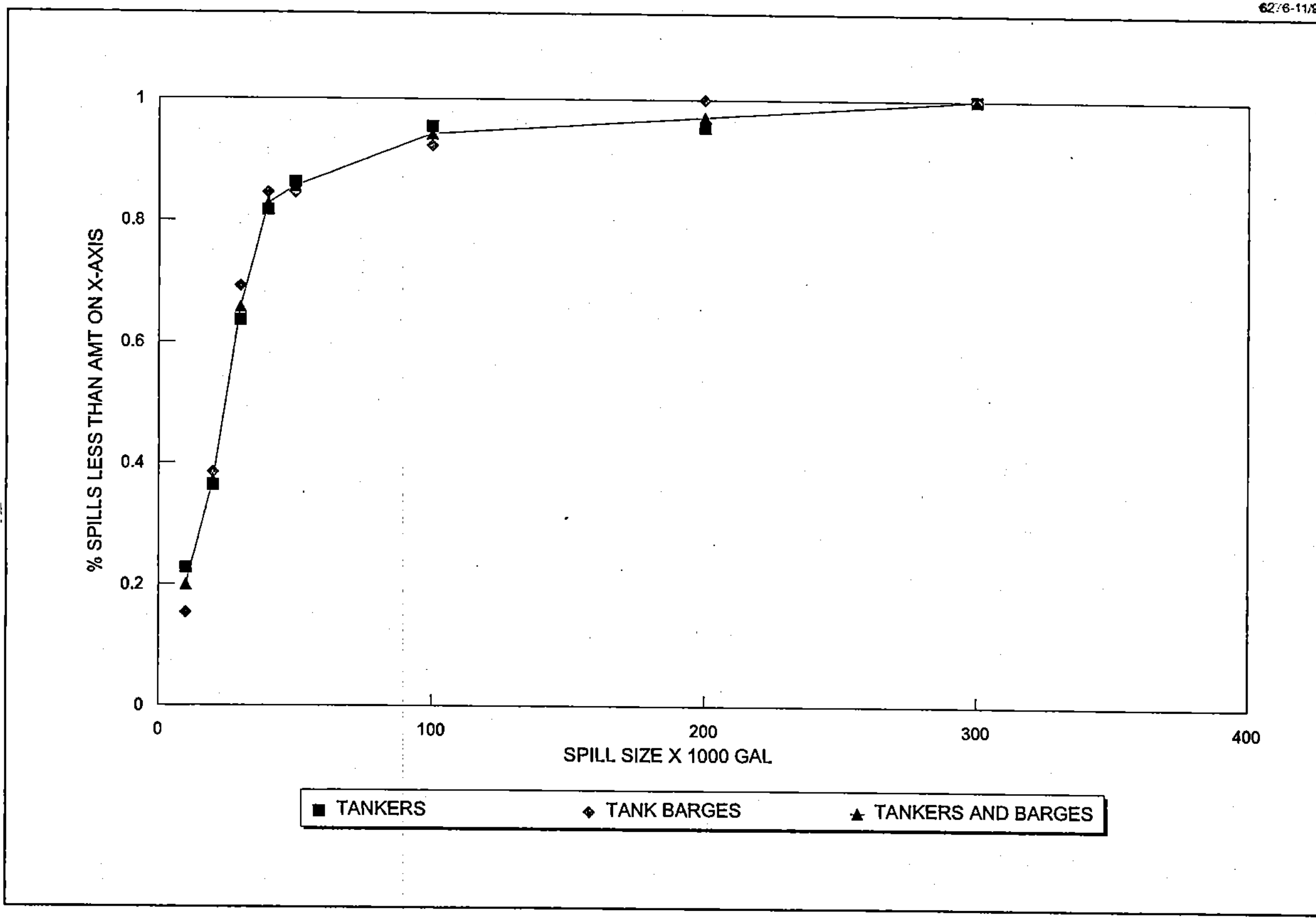
Potential for Fires and Explosions

Fires and explosions at the Terminal involving vessels and/or the Terminal itself are possible. Unocal has instituted several measures to minimize the potential for fires and explosions. First, vessels loading or unloading low flash cargoes (cargoes having a flash point of less than 150°F) are required to have properly operating inert gas systems (IGS). An IGS generates an inert gas which is injected into the cargo tanks to displace the oxygen to a level (below 10 percent) which will not support ignition. The Vessel Person-In-Charge (VPIC) is required to verify that the tanks are inerted and that the IGS is working properly before transfer operations can commence. Products with flash points greater than 150°F do not generate enough vapors to support ignition unless the product is heated to a temperature above 150°F.

A second potential area for a fire or explosion is the VCS. As discussed earlier, this system is equipped with numerous safety features and a risk analysis was conducted on the system (Westinghouse 1991). The risk analysis states that the use of the VCS may reduce the risk of fire or explosion at a tankship or barge during the loading process by a factor of 14 when compared with no vapor recovery. Based on the MMS Tanker Spill Database (Aspen 1992) it has been shown that 21.6 percent of spills greater than 1,000 bbl at a pier were due to fires or explosions. Applying the 21.6 percent to the spill rate estimate previously presented (2.7×10^{-4} spills greater than 238 bbl per vessel call) results in a spill rate estimate of 5.8×10^{-5} per vessel call caused by fire or explosion.

Based on the safety features in place at the Terminal and historical data, a risk estimate of 1×10^{-6} fires or explosions per vessel calling was used for the Unocal Terminal. This estimate results in an expected mean time between fires or explosions at the Unocal Terminal of 7,100 years. Note that the probability of spills already included those caused by fires and explosions.

A fire could generate radiant heat, and an explosion could create flying debris and blast overpressure and is considered to be a significant (Class II) impact. The Ports of Los Angeles and Long Beach have Risk



Source: Cutter Database

SPILL DISTRIBUTION AT TERMINALS
Figure 4.2-17

Management Plans (Port of Long Beach 1981, and Port of Los Angeles 1983) as an addendum to their respective Port Master Plans which specify a methodology to be utilized for calculating "hazard footprints" from marine terminals and tankers and barges. These Risk Management Plans do not require hazard footprints to be calculated for vessels equipped with IGSs because the risk of fire and explosion is considered to be so small. Nevertheless, this methodology has been utilized here to calculate the "hazard footprint" or area at risk from fires and explosions. The radiant heat footprint capable of causing second-degree burns to exposed skin after 30 seconds of exposure (1,600 Btu/sq. ft./hr) was calculated to be 300 feet around the ships. An explosion involving one of the tanks could send flying debris up to 1,500 feet from the ship.

Neither the radiant heat nor the flying debris hazard footprint would be expected to present a hazard to the public, because there are no areas where the public would be within 1,500 feet of the wharf area, resulting in a nonsignificant (Class III) impact. It is noted however, that workers at the Unocal and Pacific Refinery terminals could be injured. In addition, the flying debris hazard footprint would not present a hazard to any of Unocal's storage tanks also resulting in a nonsignificant (Class III) impact.

As stated in Section 3.1.2.6, fire response equipment is located at the Terminal. Unocal also maintains its own fire/emergency response department with full-time trained personnel at the Refinery. These personnel are trained in fighting petroleum fires and fires at the Terminal.

The first line of defense for a fire onboard a tanker or tank barge would be the onboard fire protection systems. Tankers are required by 46 CFR Part 34 to have sophisticated firefighting systems which include fire pumps, piping, hydrants, and foam systems. Tank barges are only required to have portable fire extinguishers while some are equipped with built-in systems. The tank vessel crews are trained in the use of firefighting equipment. The onboard firefighting equipment is sufficient to extinguish most fires.

The risk for fires and explosions can be mitigated by instituting the measures listed in Section 4.2.5 including inspections, the ability for vessels to quickly leave the wharf, operational requirements, maintenance programs, limitations on vessel calls, emergency response procedures, and other requirements.

<u>Butane Tank Routine Operations</u>

No operational or public safety impacts are expected from routine operation of the butane tank.

<u>Butane Tank Accident Conditions</u>

The probability of a major incident involving a butane pressure vessel is extremely low. It is estimated (ADL 1984 and 1985) that the probability of a catastrophic pressure vessel release is 2×10^{-5} per year or once every 50,000 years. Potential consequences of an accident involving a butane tank include a flammable vapor cloud, fire, or explosion. The extent of the area that could be impacted by these potential consequences was estimated using the WHAZAN model developed by Technica (Technica 1988).

A catastrophic butane sphere rupture may produce two outcomes: a cloud of vapor and a pool of spilled liquid, from which flammable gas will evaporate. Both the vapor cloud and the evaporating gas plume may have flammable regions. Both will drift and disperse with the wind, producing a spatially and temporally varying hazard footprint. If ignited, a pool fire, boiling liquid evaporating vapor explosion, or unconfined vapor cloud explosion may result. If members of the public are caught within the hazard radii of any of these events during the hazard exposure window, injuries or death may result. The size of the flammable cloud produced by the released butane would be a function of many factors including atmospheric stability, and wind. Numerous conditions were analyzed and the largest flammable gas hazard footprint was calculated to extend approximately 4,900 feet downwind.

If the butane pool is ignited, the size of its radiant heat hazard footprint (distance to 1,600 Btu/sq.ft./hr) was calculated to be approximately 1,000 feet.

An unconfined vapor cloud explosion (UVCE) is probably the worst event that could occur involving the butane tank, resulting in broken windows several miles away. Heavy damage could also occur to other structures in the area. UVCEs are only possible when large amounts of vapor are released and are extremely rare. It is estimated (Agbabian 1991) that the probability of an UVCE from a storage facility with several 2,500 bbl butane vessels was of the order 10^{-7} per year. While the potential consequences of a catastrophic accident involving the butane tank are severe, and is considered to be a significant (Class I) impact, the tank has been designed and constructed in such a manner that the potential for an accident occurring that could cause injury or death to members of the public is so remote that no mitigation measures are recommended.

Vessel Traffic Routine Operations

Routine vessel traffic operations consist of traveling to the Marine Terminal, loading or unloading operations, and then traveling from the Marine Terminal. No releases, fires, or explosions are expected from routine operations.

Routine operations have the potential to create impacts on recreational and other boating activities within and outside the Bay. However, because of the presence of designated vessel traffic channels and the VTS in-place both inside the Bay and just outside the Bay, the vessel traffic associated with the Unocal Marine Terminal does not create a significant impact (Class III) on other vessel traffic or boaters during routine operations.

Vessel Traffic Accident Conditions

The probability estimates for tanker and barge spills within the Bay are based primarily on data contained in the GTC EIR (Aspen 1992) and the Port Needs Study (USCG 1991). Application of the data and methodology from the GTC EIR (Aspen 1992) to the Unocal Proposed Project results in a spill estimate of 1.1×10^{-6} spills greater than 1,000 bbl per vessel transit for double hull tankers, and 1.6×10^{-6} for single hull tankers. This compared favorably to the USCG 1991 spill rate of 1.61×10^{-6} per transit for all tankers (USCG 1991). The probability of a spill per transit from tank barges was estimated to be 7.0×10^{-6} (USCG 1991). Based on Cutter Information Corp., 1989 spill data and on the average distance traveled by tankers and barges calling at the Unocal Marine Terminal, the estimates in Table 4.2-4 were developed for probability of spills over 238 bbl per nm traveled.

The distribution of size of a spill for tankers and tank barges given a spill in the Bay was also derived from Cutter Information Corp., data (1989). This distribution for tankers and tank barges is similar for smaller spills; however, the probability of a larger spill is higher for tankers because they can carry more oil.

Table 4.2-4

PROBABILITY OF VESSEL SPILLS OVER 238 BARRELS

Vessel	Spills per nm
Double bottom tankers - (tankers equipped with watertight protective spaces that do not carry any oil and which separate the bottom of the tanks that hold any oil within the cargo tank length from the outer skin of the vessel)	1.11×10^{-7}
Single bottom tanker - (tankers in which the bottoms of the cargo tanks are also the bottom of the tanker)	1.61×10^{-7}
Tank barges	8.29×10^{-7}

The expected mean time between spills greater than three specified sizes associated with tanker and barge transit within the Bay has been calculated using the spill probabilities in Table 4.2-4, the spill distribution derived from Cutter Information Corp. data, and the expected number of tanker and barge trips to the Unocal Marine Terminal. These are presented in Table 4.2-5. The expected mean time between spills is the reciprocal of the annual probability of a spill. The details of the calculations are presented in Appendix B.

Table 4.2-5

EXPECTED MEAN TIME BETWEEN UNOCAL-RELATED VESSEL SPILLS

Spill Size (bbl) Greater Than	Expected Mean Time Between Spills (Years)
238	1,100
1,000	1,450
10,000	7,100

The expected mean times between spills in the Bay associated with the Unocal Marine Terminal

(Table 4.2-5) have been combined with the expected mean times between spills at the Unocal Marine Terminal calculated previously (27 years for a spill over 238 bbl and 187 years for a spill over 1,000 bbl) to derive the expected mean time between Unocal Terminal and vessel related spills presented in Table 4.2-6. As can be seen from the data, the most likely source of a spill greater than 238 bbl is from the Terminal (expected mean time between spills of 27 years versus 1,100 years from tankers), while the most likely source for spills over 10,000 bbls is tankers (expected mean time between spills of 7,000 years).

Table 4.2-6

EXPECTED MEAN TIME BETWEEN UNOCAL TERMINAL (VESSELS AND TERMINAL SPILLS)

Spill Size (bbl) Greater Than	Expected Mean Time Between Spills (Years)
238	26
1,000	160
10,000	7,100

Tankers calling at the Unocal Terminal normally operate between the Unocal Terminal and terminals in California, Oregon, Washington, Alaska, and Hawaii. It was decided to limit analysis of vessel traffic outside the Bay to the precautionary area and out 50 nm from the coast and north to the Oregon border. Spills more than 50 nm from the coast are not expected to impact the shoreline. Vessel traffic to the south has been previously addressed in the GTC EIR (Aspen 1992). GTC modeling results (see Appendix B) and spill probability have been used in this analysis.

The probability of a spill greater than or equal to 1,000 bbl outside the Bay has been estimated based on the GTC EIR (Aspen 1992). The probability of a spill within the vessel traffic lanes is estimated to be 1.08×10^{-7} per nm, while the probability of spill outside the vessel traffic lanes is estimated to be 1.98×10^{-7} per nm. The spill size distribution, given a spill, was also based on the GTC EIR (Aspen 1992).

Based on the above data, the expected mean times between Unocal related tanker spills outside the Bay have been calculated and are presented in Table 4.2-7.

Table 4.2-7

EXPECTED MEAN TIME BETWEEN UNOCAL-RELATED TANKER SPILLS OUTSIDE THE BAY

Spill Size (bbl) Greater Than	Expected Mean Time Between Spills (Years)
1,000	530
10,000	1,330

Even though the probability of a spill is low, and the probability of a large spill is even lower, a large spill from a tanker or a barge can result in significant (Class I) impacts to water quality, biological resources, fisheries and recreation (see Sections 4.3, 4.4, 4.5, and 4.11). Measures to help reduce the potential for spills are presented in Section 4.2.5.

Accident conditions have the potential to create impacts on emergency response services. Because Unocal provides its own fire response services at the Terminal and is a member of both Clean Bay and MSRC, there is no significant (Class III) impact on the demand for public emergency response services.

4.2.3.2 Analysis of Future Operations

Marine Terminal

Over a 20-year projection period, it has been estimated that there will be a 60 percent increase in crude tankering and a 30 percent increase in product export tankering. This would result in an increase from 87 tanker and 54 barge trips per year (currently) to 139 tanker and 86 barge trips per year.

In the past, accidents at marine terminals have been shown to be approximately directly proportional to the number of vessel callings. However, because of the recent emphasis on safety and spill prevention and the implementation of recently enacted federal and state regulations, the probability of spills from vessels and marine terminals should actually be decreasing. Thus, when the number of tankers and barges calling at the Terminal increases, the probability of a spill would also probably increase; however, the increase would be less than a linear relationship. In this case, an increase of 52 tanker trips and 32 barge trips (an overall 60-percent increase in vessel trips) could be expected to result in a maximum increase in the probability of a spill of 60 percent. Since the production of Central Valley crude oil is expected to decrease, it is reasonable to assume that Marine Terminal use will increase substantially over the years since the Refinery operation would be dependent upon crude from other sources. Therefore, the probability of an oil spill from the Terminal will increase over the years.

<u>Vessel Traffic</u>

Accidents involving tankers and barges have been assumed to be a function of the number of nautical miles traveled by loaded vessels. However, the probability of an accident increases more than linearly if the area becomes overly congested. Because of the extensive VTS, an increase of vessel traffic in and around the Bay due to vessels calling at the Unocal Marine Terminal would most likely not cause the area to become congested. It is possible, however, the Unocal traffic combined with increased traffic from other terminals could result in congestion if the VTS were not upgraded to handle the additional traffic. This is considered to be an adverse but nonsignificant (Class III) impact.

4.2.3.3 Oil Spill Response Capability Analysis

Oil spill contingency planning and response capability is constantly being improved in response to recent federal and state regulations. In response to OPA 90, Unocal submitted an updated spill response manual to the USCG, EPA, and OSPR that, among other things, included calculations to establish a worst-case discharge from the Terminal and to show how and with what assets Unocal would respond to a worst-case spill. The size of the worst-case accident is based on the amount of oil or product that could be released from the loading/unloading lines, taking into consideration the length of time it would take to detect the release and shut down pumps and/or close valves.

Under recently codified SLC regulations, all onshore marine terminals except those "subject to high velocity currents" are required to deploy boom, prior to transferring oil, in a specified manner to enclose the water surface surrounding the vessel. An "onshore marine terminal subject to high velocity currents" is defined as an onshore terminal at which the maximum current velocities are 1.5 kts or greater for the majority of the days in the calendar year. The Unocal Terminal fits into this category. Onshore marine terminals subject to high velocity currents must provide sufficient boom appropriate to the conditions at the terminal, trained personnel, and equipment maintained in a standby condition at the berth for the duration of the entire transfer operation, so that a length of at least 600 feet of boom can be deployed within 30 minutes of a spill. At the present time, Unocal is contracting with Crowley to supply a crewboat capable of deploying boom within 30 minutes to stand by the Terminal during transfer operations.

The USCG, in response to OPA 90, requires that marine terminals must be able to respond to a small (50 bbl) spill with the following equipment:

- 1,000 feet of containment boom and a means of deploying it within 1 hour,
- oil recovery devices within 2 hours, and
- oil storage capacity for recovered oily material.

Based on Unocal's Oil Spill Contingency/Response Plan, the following paragraphs described the steps Unocal is expected to take in the event of a spill. In addition, the expected effectiveness of the response procedures are discussed. It is noted that the responses described below are for releases of crude oils or persistent products. Response to releases of flammable products (i.e., those with flash points below 100°F such as gasoline) would consist primarily of ignition control. No booming or skimming would be attempted because these products are highly volatile and evaporate rapidly. Also, releases of these products present the potential for fire, which present a safety hazard to responders.

Section 3.1.2.6 discusses the spill response equipment available at the Terminal. Following discovery of a spill, Unocal's first step would be to attempt to stop the release. The next step would be to deploy the boom located on the wharf if the spill were crude oil or a persistent product. There are two 1,000-foot reels of 11- by 16-inch Kepner Sea Curtain boom located on the wharf. The boom can be deployed using the standby vessel. In addition, the boom can be deployed from the reel by leading a nylon rope from the boom either to or around the vessel, and then using either the ship's winch or a winch on the wharf to pull the boom into position. This deployment is aided by the tidal currents which help to carry the boom out from the end of the wharf. Unocal can deploy the first 1,000 feet of boom within 30 minutes using the standby vessel. The additional 1,000 feet can be deployed within an additional 30 minutes. Because Unocal presently meets regulatory requirements for booming small spills, there is no significant (Class III) impact.

A 1.5-kt current would carry the oil 4,500 feet in 30 minutes and 9,000 feet in 60 minutes. The standby vessel could deploy the boom ahead of the oil; however, it would not be possible to deploy the boom ahead of the oil using winches on the wharf. Depending on the amount of oil released, one method of deploying the boom would be to encircle all or some of the oil with the boom and then let the boom and encircled oil drift. The boat could then deploy additional boom as needed.

Unocal relies on Clean Bay and MSRC to provide equipment and personnel over and above that located at the Terminal. Clean Bay can provide skimmers (oil recovery devices) within 2 hours. In addition, Clean Bay can provide a large response vessel, one spill spoiler, one mini spoiler, six workboats, and 5,000 feet of boom within 3 hours. Clean Bay can provide recovery and temporary storage in the time periods specified in Table 4.2-8. This meets USCG and EPA requirements.

Table 4.2-8

CLEAN BAY RESPONSE CAPABILITY

Time Period (Hours)	Temporary Storage
6	16,500 bpd derated skimming capacity; 3,500 bbls storage
12	23,500 bpd derated skimming capacity; 13,500 bbls storage
24	27,000 bpd derated skimming capacity
36	40,000 bpd derated skimming capacity (includes 10,000 bpd from Clean Seas)

Derated skimming capacity is defined as 20 percent of the name plate capacity of the skimmer. This lesser capacity was chosen to account for the fact that skimmers cannot always operate at maximum efficiency and cannot usually be operated after dark. Unocal, with the aid of Clean Bay, can meet the recently enacted OSPR regulations and no significant impacts would result (Class III).

According to the Unocal San Francisco Refinery Oil Spill Contingency/Response Plan (Unocal 1993), the worst-case spill that can reach the water is 297,112 bbl from tank 100. This tank is located within the Refinery (not associated with the Marine Terminal) and is separated from San Pablo Bay by a containment berm, Refinery roadway and railway right-of-way. The worst-case release attributed to the Terminal (not including a tanker or tank release) is below the threshold planning requirements established by the USCG and the State and, therefore, additional response assets need not be identified. Nevertheless, Unocal is a member of MSRC and has access to their equipment and services. MSRC's capability is discussed in Section 3.1.5.4. The worst-case tank spill is above the threshold planning requirements. A response to a spill of this size would require not only the assets of Clean Bay and MSRC, but those of organizations outside the Bay Area.

Unocal must notify the Federal On-Scene Coordinator (OSC) if they propose to use dispersants on an oil spill. The OSC then notifies the EPA and CDFG and provides them with information required to make a decision whether or not to authorize use of dispersants. It is unlikely that the use of dispersants would be approved on spills inside the Bay. Unocal has stated in their Oil Spill Plan that the procedures outlined in the Clean Bay Oil Spill Contingency Plan would be followed in the event that dispersants are used.

The following assesses the capability of Unocal to respond to various size releases.

Small Spills (<50 bbl) at the Terminal - With the aid of the standby vessel, Unocal should be able to deploy the onsite boom within 30 minutes. Depending on the amount of oil released and the current conditions, the deployment of this boom may or may not be sufficient to encircle the oil. If it is not, then additional boom would be deployed. Clean Bay would be notified immediately to send their response vessels, recovery capability, and storage.

Once some sort of containment has been achieved, recovery can begin. Recovery includes storage capacity and skimming capability. While recovery should start as quickly as possible, initial efforts should concentrate on containment.

If the oil cannot be contained locally, then an attempt would be made to contain as much as possible as it drifts from the site. Booming to protect sensitive resources might also be required.

Unocal, together with Clean Bay, should be able to contain and recover the majority of spilled oil. However, some oil would evaporate and some would mix with the water. A small spill of this size is considered adverse but nonsignificant (Class III).

1,000-bbl Spill at the Terminal - A 1,000-bbl spill at the Terminal was modeled for two environmental conditions (see Bay Scenarios 1 and 2 in Section 4.2.1.2). The modeling shows where the oil would go under these two environmental conditions if not contained. A spill of this size most likely could not be contained at the Terminal, especially if there were substantial currents over 1 kt which occur regularly at the Terminal. The response strategy would be to contain and recover as much oil as possible and to try to protect sensitive resources (see Sections 4.4 and 4.5). Clean Bay has sufficient booms, skimmers, and storage capacity to respond to a spill of this size. However, depending on the environmental conditions, it is likely that the oil would reach areas of the shoreline. It is unlikely that additional spill response equipment at the Terminal would increase containment and recovery capability in the general vicinity of the Terminal because of the high currents. Section 4.2.1.1 discusses the potential trajectories of spills at the Terminal as a function of environmental condition.

A 1,000-bbl spill from the Terminal is considered to be significant (Class I and II) as it could have significant impacts on marine biology, fisheries, and recreational facilities. No discussion of diversionary or protective booming could be found in Unocal's or Clean Bay's Oil Spill Contingency Plans. Specific impacts and mitigation measures to protect sensitive resources are discussed in Sections 4.4, 4.5, and 4.11.

Product Spills at the Terminal - Response efforts for product spills would depend on the characteristics of the product. As stated previously, response to a spill of a product with a flash point below 100°F would be limited to ignition control. Response to persistent products would be similar to that for crude oil except that many of these products are lighter and would evaporate more quickly, leaving less to contain and recover. Some limited success has been achieved in containing and recovering diesel.

Methyl Tertiary Butyl Ether (MTBE) - MTBE is expected to be delivered via tanker and used as an additive to reduce pollutants in gasoline. MTBE is partially soluble in water. Some of the material may sink while some may float. The flash point is -22°F and thus MTBE will evaporate rather rapidly. Because of these characteristics, response efforts to an MTBE spill would most likely be limited to ignition control. Spills of this material may contaminate water quality as discussed in Section 4.3 and may be toxic to marine life as is discussed in Section 4.4.

Tank Vessel Spills Within the Bay - Response to a spill from a tank vessel is the responsibility of the owner/operator. As a result of OPA 90, each vessel is required to have an oil spill response plan that identifies the worst case spill (defined as the entire contents of the vessel) and the assets that will be used to respond to the spill. WCSC, which owns the majority of tankers that call at the Terminal, has developed their plans in response to OPA 90. WCSC is a member of both Clean Bay and MSRC which can supply the resources required by the USCG/OPA 90. The response capability of other tanker companies and barge companies is less known; however, they must have spill response plans per 33 CFR 155, Subpart D. Most of the major tanker companies are members of Clean Bay and MSRC and therefore can demonstrate the required response capability. Since the OPA 90 plans have just recently been submitted, it is not known what assets some of the vessel companies will use to demonstrate their response capability.

Response to a vessel spill would consist of containment (deploying booms), recovery (deploying skimmers), and the protection of sensitive resources. If the oil were to reach the shore, and/or foul wildlife, the required response would include cleaning the shoreline and wildlife. Both Clean Bay and MSRC would make their local equipment and manpower available. If required, additional equipment and manpower would be made available from local contractors, other spill cooperatives (Clean Seas, Clean Coastal Waters), MSRC at other locations, and the USCG National Strike Team based at Hamilton Air Force Base in Marin County.

While Clean Bay and MSRC can provide the equipment and manpower required by OPA 90 and OSPR, it is unlikely that they could prevent a large spill from causing significant contamination of the shoreline. None of the plans examined discussed booming or other measures to protect sensitive resources. Thus, a spill from a tanker is classified as a significant (Class I) impact. Mitigation includes measures to reduce the probability of a spill and its impacts as presented in Section 4.2.5.

Tanker Spills Outside the Bay - Again, the vessel owner/operator is responsible for cleaning up spills and must be able to identify what assets will be used. It is unlikely that any vessel can identify this capability without belonging to Clean Bay and MSRC. Clean Bay together with MSRC can provide the required response resources outside the San Francisco Bay and north along the coast to Fort Bragg where Clean Bay's area of responsibility ends. The Humboldt Bay Oil Spill Cooperative covers the Humboldt Bay area; however, their capability is extremely limited outside of that area. MSRC maintains some response equipment in Humboldt Bay (see Section 3.1.5.4).

The Clean Bay Oil Spill Contingency Plan identifies sensitive resources along the outer coast however, it does not discuss how the resources would be protected in the event of a spill.

Response to spills outside the San Francisco Bay would be somewhat different from those inside the Bay. First, the environment outside the Bay may be more difficult to work in because of sea conditions. Booms lose their effectiveness rapidly once waves exceed 6 feet. There may be conditions that would make it impossible to provide any response actions. However, when waves are such that it is impossible to deploy response equipment, the wave energy causes the oil to be dispersed more rapidly. In addition, Unocal may request the usage of dispersants on the spill.

It may not be necessary to try to contain and clean up a spill if it does not immediately threaten the shoreline or a sensitive area. In such case, the trajectory of the spill would be monitored. If the spill has the potential to impact the shoreline and/or a sensitive area, then response efforts would consist of trying to contain, recover, and clean up as much oil possible and to protect the sensitive areas.

The Clean Bay and MSRC large response vessels are located inside San Francisco Bay. It would take the vessels a minimum of 2 hours to get underway and exit the Bay and 24 hours to reach the Fort Bragg area. Additional resources would be available from other response cooperatives and other MSRC sites. While the response capability meets the minimum requirements of OPA 90 and OSPR, a large spill could still result in significant (Class I or II) impacts to sensitive resources along the north coast (see Sections 4.4 and 4.5).

Tanker Steering or Propulsion Casualties - The recently enacted tug escort interim regulations should provide mitigation in the event of a vessel steering or propulsion failure within the San Francisco Bay. The interim regulations were developed by OSPR with input from the Harbor Safety Committee of the San Francisco Bay Region. While there is still some discussion on the bollard pull requirements of the tug escorts as a function of vessel size and whether the tug escorts should be tethered to the tank vessels, it is felt that these issues are better handled by the process now in place and thus no additional mitigation measures are required.

Tanker Fires Away from the Terminal - Tank vessel fires at the Terminal were addressed in Section 4.2.3.1. The primary response to a tank vessel fire away from the Terminal is the onboard fire response system. If the onboard fire response system is not able to contain the fire situation, then outside help must be called in. This would include the local fire departments and other specialty firms that provide services such as salvage lightering. It is extremely difficult to extinguish a major tanker fire. There is a potential significant (Class I) impact to public safety depending upon the location of a vessel fire. Mitigations are the same as those presented for fires and explosions at the Terminal and are presented in Section 4.2.5.

4.2.4 Cumulative Impacts

4.2.4.1 Introduction

This section describes the impact of the Unocal and all other marine terminals in the San Francisco Bay Area, as well as existing and future shipping within the region. The Unocal Marine Terminal is one of approximately 24 marine terminals operating in the Bay Area. All of these terminals transfer crude oil and/or petroleum products and thus present the potential for a hydrocarbon spill at the Terminal. In addition, the vessels (tankers and tank barges) calling at the terminals have the potential for a spill inside or outside the Bay or both. All of the terminal operators are members of Clean Bay.

4.2.4.2 Overall Probability of Accidents

Spills from a Marine Terminal

Data from the Marine Exchange (Marine Exchange 1992) and SLC (SLC 1992) were utilized to estimate the number of annual vessel callings at each of the terminals. Terminals near each other, such as those at the Port of Richmond, were combined for analysis purposes.

The same probability estimates were used to estimate the probability of spills at each of the terminal complexes as were used to estimate the probability of spills at the Unocal Terminal. This resulted in estimated expected mean times between spills greater than 238 and 1,000 bbl from a marine terminal of 1.8 years and 9.3 years respectively. The Unocal Marine Terminal contributes approximately 4 to 7 percent of the overall cumulative probability of a spill from a marine terminal inside the Bay.

A probabilistic spill trajectory analysis was prepared for all marine terminals using the methodology described in Section 4.2.1.2. The analysis showed that any area in the Bay could be impacted by light oiling depending on environmental parameters; however, the greatest potential for heavy oiling lies nearest marine terminals. Except for very small spills (50 bbl) considered as significant (Class II) impacts, all spills are considered as significant (Class I) impacts.

Spills from Tankering Inside the Bay

Data from numerous sources (Marine Exchange 1992, SLC 1992, Corps 1990, USCG 1991) and nautical charts were used to estimate tanker and barge traffic within the Bay. The probability of spills from a vessel is discussed in Section 4.2.3.1. Based on the amount of tanker and tank barge traffic along the routes within the Bay, cumulative spill probabilities were developed for each section of the Bay. These probabilities were then used to conduct the probabilistic oil spill modeling for cumulative tanker and tank barge traffic within the Bay.

The expected mean time between spills for all tanker and tank barge traffic inside the Bay greater than three sizes is presented in Table 4.2-9. Vessel traffic associated with the Unocal Terminal makes up approximately 3 percent of all tanker and tank barge traffic in the Bay.

Table 4.2-9

EXPECTED MEAN TIME BETWEEN VESSEL SPILLS INSIDE THE BAY

Spill Size (bbl) Greater Than	Expected Mean Time Between Spills (Years)
238	36
1,000	48
10,000	238

There are two major factors which could affect the expected mean time between spills in the future. First, an increase in tank vessel traffic would tend to decrease the expected mean time between spills. The USCG Port Needs study estimates an 18-percent increase in tanker and tank barge traffic over the next 20 years. Second, the implementation of new and more rigorous regulations, including the use of tug escorts and the phasing out of single hull tankers, should increase the expected mean time between spills. Thus, it is believed that Table 4.2-9 provides a realistic estimate of spills for future years also.

The probabilistic oil spill modeling shows that the most likely area of light oiling is in the middle of the Bay around the Precautionary Area, while the greatest potential for moderate and heavy oiling is along the vessel traffic routes from the Bay entrance to the Carquinez Strait. Oil spills are considered to result in significant (Class I) impacts.

Spills from Tankering Outside the Bay

Data from the Marine Exchange, which listed the last and next port of call for all tankers calling at marine terminals in the San Francisco Bay Area, was utilized to estimate the number of annual tanker trips along various routes outside the Bay. The Unocal-related tanker probability estimates and spill size distribution for tanker spills greater than 1,000 and 10,000 bbl were used for modeling cumulative tankering.

The expected mean time between spills outside the Bay is shown in Table 4.2-10. Unocal-related tankering makes up about 8 percent of the annual spill risk offshore northern California.

Table 4.2-10

EXPECTED MEAN TIME BETWEEN VESSEL SPILLS OUTSIDE THE BAY

Spill Size (bbl) Greater Than	Expected Mean Time Between Spills (Years)
1,000	42
10,000	123

The probabilistic oil spill modeling offshore northern California shows that, given a spill, the probability of heavy oiling reaching the coast is less than 0.1 percent except in the region around the Bay entrance, Point Reyes, and Humboldt Bay. The conditional probability of light to moderate oiling reaching the shore is between 0.1 and 16 percent with the highest probabilities occurring south of the Bay entrance. Oiling has the potential to result in significant (Class I) impacts to sensitive resources as presented in Sections 4.4.4.5 and 4.11.

Spill Response Capability

All terminals and most tanker and tank barge operators belong to Clean Bay and MSRC. Clean Bay and MSRC can provide all the necessary equipment and manpower to meet the requirements of existing regulations, however, oil spills can result in significant (Class I or II) impacts to the environment. Tankers and tank barges operating in U.S. and California waters must certify that they have the required capability under contract, however, it is not clear at this time how this capability can be demonstrated.

An impact on spill response capability could exist if there were two or more spills at the same time; however, the probability of this occurring is extremely small. Having many marine terminals and extensive vessel traffic in the Bay increases the total amount of spill response equipment and services available.

4.2.5 Significant Impacts, Mitigation Measures, and Residual Impacts

4.2.5.1 Unocal Responsibilities

Impact - Potential deficiencies in the structural integrity of the wharf were discovered during an inspection of the Terminal. These deficiencies could cause secondary impacts that could result in hydrocarbon releases resulting in a significant (Class II) impact.

Mitigation and Residual Impact - This potential impact can be mitigated to a level of nonsignificance by the application of the following measures by Unocal:

- Within 180 days of lease renewal, Unocal shall conduct a structural and safety system audit of the Terminal in concert with the SLC and a third party consultant as described in the Commission's "Marine Terminal Audit Program" document. The purpose of the audit is to

  - identify safety system, mechanical, electrical, and fire detection and suppression deficiencies;
  - identify structural damage or weaknesses that might affect the continued fitness-for-purpose of the facility;
  - advise whether these deficiencies have been properly assessed; and
  - advise what safety improvements would be taken to correct, prevent, or minimize these potential hazards.

  The audit will be conducted with teams composed of SLC, Unocal, and consultant personnel. Upon completion of the audit, Unocal shall implement the safety improvements in accordance with a scheduled plan.

- Develop, subject to review and approval of the SLC, and implement a preventative maintenance program within 180 days of lease renewal that includes periodic inspection of the wharf components.

- To prevent or minimize damage to the wharf and vessel, Unocal should install an Allision

Avoidance System (AAS) that provides information to the vessel master regarding the approach rate to the wharf.

- The lease for the facility should contain a clause which would allow the SLC to add or modify mitigation measures in the event of improved safety technologies or a spill greater than 2,100 gallons (50 bbl).

Impact - The potential release of hydrocarbons from pipelines on the trestle/wharf is considered a significant (Class II) impact.

Mitigation and Residual Impact - This potential impact can be mitigated to a level of nonsignificance by the application of the following measures by Unocal:

- Develop and implement a program to minimize the potential for pipeline leaks. This program shall, at a minimum, consist of the following:
  - assess the current condition of all the pipelines using the criteria prescribed in ASME B31G - 1991 and repair or replace problem pipe,
  - improve the existing pipeline inspection and maintenance programs, and
  - install an effective leak detection system (e.g., pressure point analysis).
- The lease for the facility should contain a clause which would allow the SLC to add or modify mitigation measures in the event of improved safety technologies or a pipeline spill greater than 2,100 gallons (50 bbl).

Impact - Accidental spills greater than 50 bbl, from hydrocarbon transfers at the Terminal, are considered a significant (Class I) impact.

Mitigation and Residual Impact - Unocal shall institute the following measures to reduce the probability of a spill and to reduce the impacts of a spill, should one occur. However, even with the implementation of these measures, the potential impact from spills during transfer operations remain significant.

- Cargo transfer will be stopped if the SLC inspector is not satisfied that the VPIC or TPIC is sufficiently fluent in the English language.
- No tank vessel shall load more than 98 percent capacity in any tank and no barge shall load more than 95 percent capacity in any tank to prevent the possibility of overfilling cargo tanks.
- To prevent or minimize the potential for operational errors, any barge handling cargo at the Terminal shall be manned by a minimum of one tankerman and one deckhand. Barges which are moored at the Terminal, but are not handling cargo, shall be manned by at least one person, who shall be either a deckhand or tankerman.
- Prior to arrival of any foreign flag vessel at the Terminal, Unocal shall obtain proof that such vessel has successfully completed an inspection in compliance with Regulation 13G of MARPOL 73/78. Such proof shall be made available to the Commission's Marine Facilities Inspection and Management Division's inspectors.
- Each vessel conducting an oil transfer at the Terminal shall be served by an exclusive TPIC.
- All loading arms shall be equipped with the USCG approved quick-release couplings within 180 days of lease renewal. A product flow control system will be interlocked at the coupling so that flow automatically stops prior to disconnection, providing an anti-spill safety feature.
- Develop and implement a preventative maintenance program within 180 days of lease renewal that includes periodic inspection of all components related to transfer operation at the Terminal.
- Within 180 days of lease renewal, Unocal shall conduct a structural and safety system audit of the Terminal in concert with the SLC and a third party consultant as described in the Commission's "Marine Terminal Audit Program" document. The purpose of the audit is to:
  - identify safety system, mechanical, electrical, and fire detection and suppression deficiencies;
  - identify structural damage or weaknesses that might affect the continued fitness-for-purpose of the facility;

- advise whether these deficiencies have been properly assessed; and

- advise what safety improvements should be taken to correct, prevent, or minimize these potential hazards.

The audit will be conducted with teams composed of SLC, Unocal, and consultant personnel. Upon completion of the audit, Unocal shall implement the safety improvements in accordance with a scheduled plan.

- The number of vessels that are allowed to call at the Terminal annually to transfer hydrocarbons shall be limited to 139 tankers and 86 barges.

- The lease for the facility should contain a clause that would allow the SLC to add or modify mitigation measures in the event of improved safety technologies or a spill greater than 2,100 gallons (50 bbl).

- Unocal shall pre-boom all transfers of persistent oil using booms which are effective in currents expected at the Terminal. For vessel loading operations, the boom shall enclose the water surface surrounding the vessel to provide containment for the entire vessel at the waterline and portions of the dock where the oil may spill into the water. The boom shall be deployed so that it provides a stand-off of not less than 4 feet from the outboard side of the vessel. For vessel offloading operations, the boom shall be deployed to provide containment for the vessel's entire inboard length at the waterline and portions of the dock where oil may spill into the water. SLC and Unocal shall review the effectiveness of the booming after 1 year. Based on this review, SLC will make a determination as to the continuation of this requirement.

<u>Impact</u> - Fires and explosions at the Terminal or onboard vessels are considered to be significant (Class II) impacts.

<u>Mitigation and Residual Impact</u> - These impacts can be mitigated by having Unocal institute measures to reduce the probability of an event and to reduce the impacts should one occur. The recommended mitigation measures are presented below.

- Cargo operations will be stopped if the SLC inspector is not satisfied that the TPIC or the VPIC is sufficiently fluent in the English language.

- To physically prevent simultaneous vapor connections to tank ships at both berths, either reinstall a detonation arrester (DA) in the cargo vapor pipeline at berth M-1, or cut out a section of berth M-1 cargo vapor pipeline immediately upstream of the condensate boot and install a blind flange with gasket on the condensate boot at the M-1 vapor pipeline connection point and a blind flange on the cargo vapor arm end.

- Prior to arrival of any foreign flag vessel at the Terminal, Unocal shall obtain proof that such vessel has successfully completed an inspection in compliance with Regulation 13G of MARPOL 73/78. Such proof shall be made available to the Commission's Marine Facilities Inspection and Management Division's inspectors.

- Within 180 days of lease renewal, develop a set of emergency response procedures subject to review and approval by the SLC to follow in the event of a tank vessel fire, and describe the roles of the fire departments in responding to such fires. The procedures shall also identify other response assets (e.g., fire response contractors, source of foam) that can be obtained in the event of a major incident.

- To prevent an event from spreading from/to the wharf/vessel (1) all vessels, including barges shall maintain the ability to get underway within 30 minutes; (2) mooring points shall be equipped with quick release devices (e.g., pelican hooks); and (3) dock mooring points shall be equipped with strain gauges with shipboard and/or wharf control room monitors, so that the moorings will have tension balanced at all times.

- The lease for the facility should contain a clause that would allow the SLC to add or modify mitigation measures in the event of improved safety technologies or a spill greater than 2,100 gallons (50 bbl).

- To prevent or minimize the potential for operational errors, each vessel conducting an oil transfer at the Terminal shall be served by an exclusive TPIC. There shall be one TPIC for each vessel.

- All loading arms shall be equipped with the USCG approved quick-release couplings within 180 days of lease renewal. A product flow control system will be interlocked at the coupling so flow automatically stops prior to disconnection to provide an anti-spill safety system.

Impact - The potential release of hydrocarbons from a tanker or a barge is considered a significant (Class I) impact.

Mitigation and Residual Impact - This potential impact can be partially mitigated by having Unocal institute measures to reduce the probability of a spill and measures to reduce the impacts a spill should one occur. However, even with the implementation of these mitigation measures, the potential remains for significant (Class I) impact from vessel spills. The recommended mitigation measures are presented below.

- All tank vessels bound for the Terminal or leaving the Terminal shall use the San Francisco Vessel Traffic Service.

- All vessels calling at the Terminal shall adhere to the recommended guidelines for safe movement of vessels found in the San Francisco, San Pablo, and Suisun Bay's Harbor Safety Plan.

- Prior to arrival of any foreign flag vessel at the Terminal, Unocal shall obtain proof that the vessel has successfully completed an inspection in compliance with Regulation 13G of MARPOL 73/78. Such proof must be made available to the Commission's Marine Facilities Inspection and Management Division's inspectors.

- A tug or combination of tugs with bollard pull in pounds equal to or greater than the tank vessel's deadweight tonnage shall be present during vessel mooring and unmooring.

- Unocal shall ensure that tugs of best available technology design (e.g., tractor tugs) escort all tank vessels bound for or leaving the Terminal.

- All loaded or partly loaded vessels bound for or coming from destinations other than those in California shall utilize the Main Traffic Lanes from/to the Precautionary Area and stay at least 50 miles offshore the California coast during transit.

- The lease for the facility should contain a clause that would allow the SLC to add or modify mitigation measures in the event of improved safety technologies or a spill greater than 2,100 gallons (50 bbl).

- Unocal shall ensure that adequate underkeel clearance is maintained at all times. At a minimum, Unocal shall conduct an annual bathymetric survey in the vicinity of the wharf.

- The number of vessels that are allowed to call at the Terminal annually to transfer hydrocarbons shall be limited to 139 tankers and 86 barges.

- Unocal shall ensure that all vessels calling at the Terminal have an oil spill response plan that meets USCG and OSPR requirements. In addition, Unocal shall provide initial response to spills from vessels calling at the Terminal while they are at or near the Terminal.

4.2.5.2 Cumulative Actions

Impact - Oil spills are considered to be a significant impact. Small spills can be mitigated and are classified as Class II impacts while large spills cannot be completely mitigated and are therefore classified as Class I.

Mitigation and Residual Impact - As discussed in Section 3.1.3, there are a great number of state, federal, and international regulations governing marine terminals and the transportation of hydrocarbons by vessel. The most effective measure that can be instituted to increase the safety of marine terminals and associated vessel traffic is the strict observance and enforcement of these regulations.

Vessel traffic in the Bay Area should continue to be monitored and if situations arise where safety may be jeopardized, then the VTS should be improved to alleviate these situations. This could involve measures such as adding additional radar coverage in the Bay Area. In addition, the practice of keeping tankers carrying crude oil 50 miles offshore should be continued where feasible.

State Lands should continue to review operations of marine terminals and institute measures to increase safety on a case-by-case basis based on an analysis of the facility.

Through these measures, the risk of accidents can be reduced, and small spills (Class II) can be rapidly cleaned up. Large spills, however, have the potential to remain as significant impacts.

4.2.6 Alternatives Analysis

4.2.6.1 No Project Alternative

If the lease were not renewed and Unocal no longer used the Marine Terminal, then the risk of a spill or accident at the Terminal would not exist. However, the overall risk of spills and accidents from tankering may not decrease if the crude oil and product shipment were transferred to another marine terminal. Impacts would be as described for the Proposed Project. The Class I risk of an accident from the butane tank would remain; however, this tank is designed and constructed to rigorous standards and the potential for an accident that could impact members of the public is extremely low (see Section 4.2.3.1). A discussion of possible material transportation alternatives follows in the section below.

Pier Structure Scenarios

Abandonment In-Place of Pier Terminal

Assuming that the pipelines from the pier would be removed, there would be a potential for a small spill (Class II impact) from the pipelines during the pipeline abandonment and removal process.

Mitigation and Residual Impact - The potential Class II impact of pipeline spills during pipeline removal could be reduced to nonsignificant levels by careful planning and the development of a comprehensive abandonment plan. This plan should address spill prevention and response measures that would be in place during the abandonment process.

The pier structure itself presents adverse, but not significant (Class III) risk to vessel traffic passing through the area.

Abandonment and Removal of Pier

The risk from this alternative would be the same as for the alternative where the pier is abandoned in-place except that the removal of the pier would eliminate the adverse, but not significant (Class III), risk to passing vessel traffic from the pier structure.

Refinery Scenarios - Continued Operation at Current Capacity

Under this alternative the crude and product presently shipped in and out of the Terminal would be replaced by another means of transportation. The potential impacts from alternative modes of transportation are discussed below.

Replacement of Crude From Central Valley Via Pipeline

There is a general consensus that pipeline transportation of crude oil presents less of an impact on the environment from spills than tanker transportation. This is due to two factors: (1) the maximum amount of oil that can be released from a pipeline is generally less than that which can be released from a tanker, and (2) oil spilled on the land generally causes less overall environmental impacts than oil spilled on water.

Failure rates for pipelines are generally described in terms of spills per unit length per year. Pipeline characteristics that can affect potential failure rates include age, size, design, depth of burial, corrosion protection, wall thickness, and operating temperature. A range of 0.012 to 0.5 releases per year per 100 miles of pipeline has been cited in recent reports (ADL 1986; PPC 1991; SDA 1991; Aspen 1992).

The following spill estimates for pipelines with diameters greater than 16 inches are presented (Aspen 1992):

- Leaks --
  - 0.08 per 100 miles per year for pipelines 40 or more years old
  - 0.03 per 100 miles per year for "existing" pipelines (approximately 20 years old)
  - 0.012 per 100 miles per year for "new" pipelines (in first 10 years)

- Ruptures --
  - 0.04 per 100 miles per year for "old" pipelines
  - 0.016 per 100 miles per year for "existing" pipelines
  - 0.006 per 100 miles per year for "new" pipelines

A leak is defined as a relatively small rate of release from a pipeline. A typical cause would be a small hole that results from corrosion pitting or a leaking flange or valve. A rupture represents a relatively high rate of release as might occur if the pipeline were breached by an external force.

The maximum spill volume is a combination of drainage potential and the pumping rate for the period of time before the breached segment can be isolated. Worst case calculations of spill volumes are normally based upon the assumption of complete drainage by gravity of the section of pipe between high ground and the point of rupture (called drainage volume). Additional spillage depends on the flow rate and response time to shut down the pipeline. Analysis of drainage volume assumes that the drainage will be complete. This will not necessarily be the case: first, the breach may be less than a full rupture; or a block valve within the affected pipe section may be successfully closed before complete evacuation occurs; or a check valve in an uphill stretch can prevent backflow of oil between high ground and the valve. The gradient of the terrain determines the hydrostatic force available to evacuate the pipe after the pumps are turned off. Evacuation will take much longer in nearly flat terrain. The average spill size from 16-inch-diameter crude oil pipelines, as reported to the Office of Pipeline Safety between 1980 and 1990, was 2,680 bbl (USDA 1991). This is the volume contained in two miles of 16-inch pipe.

Based on the probability estimates presented above, the expected mean time between leaks and ruptures of a new pipeline constructed from the Bakersfield area to the Unocal Refinery (approximately 350 miles) would be 24 and 48 years, respectively. In addition, during construction, there would be a potential for damage to other pipelines. The use of existing pipelines would not require construction activities, but existing pipelines may be significantly older and have a higher probability of leaks or ruptures. In the event of an accident, the amount of crude spilled from a pipeline would generally be less than a tanker. However, depending on the resources present, significant (Class I or II) impacts could still occur to sensitive resources on land.

Any modifications to the Refinery could increase the potential for accidents during the construction process. While the probability of such accidents is low, the use of equipment and the activities of workers increase the probability of accidents. Since the Refinery is isolated from the general public, and the probability of accidents is low, under a carefully planned and executed construction program, the modifications would not create significant public safety impacts (Class III).

All pipeline capacity from the San Joaquin Valley is already committed; therefore, a new pipeline would be required. As the production of San Joaquin Valley crude is expected to decrease, however, it is not likely that an investment in another pipeline would take place. In the long term, there may be additional capacity with the existing pipelines, but that will occur when the fields are in final decline.

<u>Mitigation and Residual Impact</u> - Mitigation for significant (Class II) impacts from spills on land include adherence to spill prevention and response planning. Impacts would be reduced to nonsignificant.

Replacement of Crude via Pipeline from Other Marine Terminals

This alternative would shift the risk associated with crude intake at the Unocal Terminal to other terminals in the Bay. This alternative could either slightly increase or decrease the risk depending on the characteristics and locations of the terminals utilized. Characteristics that could alter the risk would include

- The tanker may have to travel further to reach the other terminals. This would be true if the other terminals were in the Carquinez Strait such as Shell Martinez, Tosco, and Exxon Benicia. On the other hand, using terminals in the Richmond area may require tankers to travel a shorter distance.

- The added tanker traffic at the other terminals may create congestion and increase the risk for a collision or other incident.

- The other terminals may have a different (better or worse) level of spill response.
- Use of other marine terminals may not allow the addition of mitigation measures as a result of the lease renewal process.

As present, the Unocal facility does not have adequate pipeline capacity to connect with other marine terminals. The most likely alternative would be to construct a pipeline to the existing marine terminal at Selby. From this site many other terminals and other pipelines can be accessed. Construction of such a pipeline may create significant (Class II) impacts through the potential of hitting and rupturing other pipelines. Additionally, there would be a potential for the pipeline to be ruptured. This rupture would most likely come from future construction activities for other facilities.

Mitigation and Residual Impact - Mitigation for pipeline rupture during construction would be to have a carefully planned program that involves the careful planning and checking of pipeline locations prior to construction, and to have in place a response plan in the event of a rupture.

Product Export via Pipeline to Other Marine Terminals

As with crude oil discussed above, using other marine terminals to export products would shift the potential risk to the other terminals with the same advantages and disadvantages discussed above for crude transport. The fact that there are many different products to be exported complicates the process and may slightly increase the risk. Unocal would either have to build multiple pipelines to handle all of the various products or ship the products in batches through a single line. Construction could result in significant (Class II) impacts to pipeline rupture. Batching the products may require additional tanks to be built at the other terminals to temporarily store the products which would increase the handling and potential for spill.

Mitigation and Residual Impact - Mitigation remains the same as that for crude transport above.

Truck and Rail Product Transport

Table 4.2-11, taken from the Cajon Pipeline Draft EIR (EIP 1992), compares both the spill rate and deaths per billion-ton miles of petroleum transported.

Table 4.2-11

PETROLEUM TRANSPORTATION ACCIDENT RATES

Mode	Spill/Billion-Ton Miles	Deaths/Billion Ton Miles
Pipeline	0.5	0.01
Tanker	9.4	0.31
Rail Tanker	7.8	2.5
Truck	44.6	10.9

As can be seen from Table 4.2-11, the spill rate for rail tankers and trucks is considerably higher than for pipelines, while truck transportation has the highest spill rate. The rail tanker spill rate is similar but less than that for marine tankers. The death rate is considerably higher for both rail and truck with truck being the highest. The reason that the death rate is higher for rail and truck transportation is twofold: first, these modes of transportation are often commingled with public transportation, especially road traffic; and second, a spill often involves a high energy impact (collision, overturning, derailment) which can lead to a fire or explosion. Thus, both marine and pipeline transportation is preferable over rail and truck transportation from a risk prospective. Replacing the crude and product presently transported through the Unocal Marine Terminal by truck and rail transport would result in a significant (Class I or II) public safety impact.

Mitigation and Residual Impact - Mitigation for increased truck and rail transport includes those measures presented for traffic (Section 4.7). However, even with these measures, the potential remains for a significant safety impact.

Refinery Would Operate at Reduced Levels

Reduced Refinery operations would most likely have little impact on the demand for petroleum products in the area. The demand would be made up by other sources. While risk at the Unocal Refinery would be reduced, resulting in a beneficial (Class IV) impact, the risk from transporting crude oil and products to and from the Terminal would be shifted to some other location. The overall change in risk would be a function of many factors including the following:

- The risk from transporting the crude and products to/from the other refineries. The risk could be greater or less than the existing risk depending on the distance the vessels must travel and the hazards along the route.
- The location of the other terminals relative to sensitive resources.
- The accident and spill response measures in place at the other terminals.
- The potential risk from the other refineries. Other refineries may present a greater or lesser risk due to their locations relative to populated areas or due to their design or age.

Shutdown of the Refinery

With no Refinery, there would be no public safety impacts from the Unocal facility, resulting in a beneficial (Class IV) impact. However, the risk associated with the transportation of crude oil and products would most likely be shifted to another location in the Bay. There may also be a shift in the overall risks in that there may be a net import in product to the Bay Area to make up for any short- or long-term shortfall in refining capacities.

4.2.6.2 Consolidation Alternative

From a safety and risk perspective consolidation of the two terminals at the Unocal Terminal would result in the following advantages and disadvantages. Advantages include the following:

- The Pacific Refining Marine Terminal is offshore and served by subsea pipelines. The Unocal Terminal is served by pipelines located on the trestle to the wharf. Pipelines on a trestle are easier to inspect and maintain and, therefore, have a lower probability of a spill. Thus, if the consolidation were to occur, the subsea lines would be abandoned and new on-land/trestle lines constructed from the Pacific Refining Refinery to the Unocal Terminal.
- Access to the wharf via the trestle offers better response and evacuation in the event of an accident at the Unocal Terminal.

Disadvantages include the following:

- There would be a small potential for a spill (Class II impact) during the abandonment of the subsea pipelines.
- The addition of the Pacific Refining Co. vessels calling at the Unocal Terminal could create congestion at the Terminal and increase the potential for accidents and spills. Pacific Refining Co. historically handled approximately 85 tankers (Marine Exchange 1992) and 70 barges (SLC 1992) annually. The addition of these vessels would approximately double both the number of tankers and tank barges calling at the Unocal Terminal. The number of vessel calls associated with this consolidation would not exceed the capacity of the Terminal and would not normally be expected to cause congestion. However, coordination between the two companies would be required to ensure that congestion/queuing would not occur. No significant impacts (Class III) would be expected.

From an overall risk perspective, there would be little change in risk from the consolidation. The total number of vessel callings at the two facilities would remain the same, however, they would be concentrated at the Unocal Terminal. The addition of the Pacific Refining Co. vessels calling at the Unocal Terminal would increase congestion, resulting in an increase in the potential for accidents which is considered adverse, but not significant (Class III). Consolidation would approximately double the amount of tankers handled on an annual basis by Unocal (from 87 to approximately 175). Likewise, the risk from vessel transport would be approximately the same because there would be the same number of transits of approximately the same distance.

Since the terminals are near each other, the areas potentially impacted by a spill would not be expected to be different for the two facilities. Response capabilities should also be roughly the same.

While the risk of a spill at the Unocal Terminal could be expected to approximately double, this risk would be approximately equal to the combined risk from the two nearby terminals if they are not consolidated. Impacts and mitigation measures for spills would remain as described for the Proposed Project. In addition, the risk from the butane tank would remain.

Mitigation and Residual Impact - Mitigation for spills during pipeline abandonment includes adherence to spill prevention and response plans to reduce the impacts to a level of nonsignificance.

4.3 WATER QUALITY

4.3.1 Introduction

Environmental consequences of the Proposed Project have been assessed by identifying potential sources of contamination from project operation and accidental discharges or spills. Potential sources of contamination have been quantified where possible using information on expected volumes and known compositions of parent compounds. Where such information is unavailable, generic values from the literature have been used for compounds similar to those in the Proposed Project. This section evaluates the impacts to water quality from routine operations at the Unocal Terminal and from potential accidents. Biological implications of water quality impacts are addressed in Section 4.4.

4.3.2 Impact Significance Criteria

The significance of impacts has been considered in the context of whether discharges would be likely to result in elevations of potential toxicants above ambient water column and surficial sediment levels, and whether any identified elevations would exceed water quality objectives of the Regional Water Quality Control Board (RWQCB) or the State Water Resources Control Board (SWRCB). The significance of impacts was also considered in the context of site studies of San Pablo Bay, area studies of San Francisco Bay, and regional studies of the north coast. For example, discharges that result in changes from background which are not discernible within the context of local, area, or regional values will be considered as nonsignificant impacts.

Impacts to marine water quality are considered significant if any of the following apply:

- The water quality objectives contained in the Water Quality Control Plan for the San Francisco Basin (RWQCB 1986) (Table 4.3-1), or the 1991 California Enclosed Bays and Estuaries Plan (SWRCB 1991) are exceeded as a result of discharges or other operations,
- The water quality criteria in the California Ocean Plan (SWRCB 1990) (Table 4.3-2) are exceeded as a result of discharges or other operations, and/or
- Operations or discharges create changes in background levels of chemical constituents or elevations in turbidity that are expected to produce long-term changes in the receiving environment of the site, area, or region that would impair the beneficial uses of the receiving environment.

Table 4.3-3 lists the beneficial uses according to the SWRCB of San Pablo Bay, San Francisco Bay, and ocean waters of the north coast.

4.3.3 Proposed Project Impact Analysis

4.3.3.1 Analysis of Continuation of Existing Operations

Routine Operations

Tanker Operations and Operations at Terminal

With the exception of the discharge of treated wastewater from the Refinery, which is discussed in the following section, the only discharge at the Unocal Marine Terminal and the only discharge uniquely associated with Terminal operations is the routine release of segregated ballast waters. Ballast water is taken on at ports to provide stability and compensate for the lightening of the load when the tankers unload product. This ballast water contains those contaminants present in the water at the port where it was taken on. If this water contains higher levels of contaminants than are present in San Pablo Bay, discharge of the water at the Unocal Terminal could have an adverse water quality impact. Because the ballast tank is segregated, no contaminants are transmitted to the ballast water from the cargo and little, if any, contamination occurs from the tanker itself.

Unocal tankers unload product at Eureka, California; Coos Bay, Oregon; Pontwell, Washington; Tacoma, Washington; and Ketchikan, Alaska. Contaminant levels in San Francisco estuary can be compared to those in these other ports from data from the National Status and Trends Program for Marine Environmental Quality (NOAA 1987). This program compared contaminant concentrations in bivalves at 145 Mussel Watch Project sites and in fish livers from 43 project sites. Sites included several sites in San Francisco estuary, Humboldt Bay near Eureka, Coos Bay, three sites near Takoma, and one site in Alaska. These data showed that relative levels of contaminants varied

Table 4.3-1

WATER QUALITY OBJECTIVES* FOR MARINE SURFACE WATERS WITH SALINITIES GREATER THAN OR EQUAL TO 5 PARTS PER THOUSAND FOR SAN FRANCISCO BAY

Constituent	Units of Measurement	4-Day Average	Daily Average	1-Hour Average
Water Quality Objectives for the Protection of Aquatic Life				
Arsenic	ug/L	36	—	69
Cadmium	ug/L	9.3	—	43
Chlordane*	ug/L	—	4.0	—
Chromium (Hexavalent)[1]	ug/L	50	—	1,100
Copper	ug/L	—	—	2.9
Cyanide	ug/L	—	1.0	—
DDT*	ug/L	—	1.0	—
Dieldrin	ug/L	—	1.9	—
Endosulfan*	ug/L	—	8.7	34
Endrin*	ug/L	—	2.3	37
Heptachlor	ug/L	—	3.6	—
Hexachlorocyclohexane-gamma	ug/L	—	160	—
Lead	ug/L	5.6	—	140
Mercury	ug/L	—	—	2.1
Nickel	ug/L	8.3	—	75
PCBs*	ug/L	—	30	—
Pentachlorophenol	ug/L	7.9	—	13
Selenium	ug/L	71	—	300
Silver	ug/L	—	—	2.3[2]
Toxaphene	ug/L	0.02	—	210
Zinc	ug/L	86	—	95

Constituent	Units of Measurement	30-Day Average
Water Quality Objectives for the Protection of Human Health		
Noncarcinogens		
1,2-Dichlorobenzene	mg/L	18
1,3-Dichlorobenzene	mg/L	2,600
Endosulfan*	mg/L	2.0

Source: SRWQCB 1991
[1] This objective may be met as total chromium.
[2] Instantaneous Maximum
* These objectives are used by the Regional Water Quality Control Board primarily to establish waste discharge requirements from California Regional Water Quality Control Board, San Francisco Region, 1991.
ug/L = micrograms/liter mg/L = milligrams/liter

Table 4.3-2

TOXIC MATERIALS LIMITATIONS FROM CALIFORNIA OCEAN PLAN
(these limitations apply to ocean waters)

Constituent	Limiting Concentrations			
	Units of Measurement	6-Month Median	Daily Maximum	Instantaneous Maximum
Objectives for Protection of Marine Aquatic Life				
Arsenic	ug/L	8	32	80
Cadmium	ug/L	1	4	10
Chromium (Hexavalent)	ug/L	2	8	20
Copper	ug/L	3	12	30
Lead	ug/L	2	8	20
Mercury	ug/L	0.04	0.16	0.4
Nickel	ug/L	5	20	50
Selenium	ug/L	15	60	150
Silver	ug/L	0.7	2.8	7
Zinc	ug/L	20	80	200
Cyanide	ug/L	1		10
Total Chlorine Residual	ug/L	2	8	60
Ammonia (expressed as nitrogen)	ug/L	600	2,400	6,000
Chronic Toxicity	TUc	—	1	—
Phenolic Compounds (non-chlorinated)	ug/L	30	120	300
Chlorinated Phenolics	ug/L	1	4	10
Endosulfan	ug/L	9	18	27
Endrin	ug/L	2	4	6
HCH (hexachlorocyclohexane)	ug/L	4	8	12
Radioactivity	Not to exceed limits specified in Title 17, Division 5, Chapter 4, Group 3, Article 3, Section 30269 of the California Code of Regulations.			

ug/L = micrograms/Liter
TUc = units of chronic toxicity
Source: SWCRB 1990

Table 4.3-3

EXISTING AND POTENTIAL BENEFICIAL USES OF SURFACE WATERS

	MUN	AGR	IND	PROC	GWR	FRSH	NAV	REC 1	REC 2	COMM	WARM	COLD	ASBS	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST
Pacific Ocean			X				X	X	X	X			X	X	X	X	X	X	X	
Central Bay			X	X			X	X	X	X				X	X		X	X	X	X
San Pablo Bay			X				X	X	X	X				X	X		X	X	X	X
Carquinez Strait			X				X	X	X	X				X	X		X	X		X
Suisan Bay			X				X	X	X	X				X	X		X	X		X

Key:

MUN - Municipal and Domestic Supply
AGR - Agricultural Supply
IND - Industrial Service Supply
PROC - Industrial Process Supply
GWR - Groundwater Recharge
FRSH - Freshwater Replenishment
NAV - Navigation
REC-1 - Water Contact Recreation
REC-2 - Noncontact Water Recreation
COMM - Ocean Commercial and Sportfishing
WARM - Warm Fresh Water Habitat
COLD - Cold Fresh Water Habitat
ASBS - Preservation of Areas of Special Biological Significance
WILD - Wildlife Habitat
RARE - Preservation of Rare and Endangered Species
MAR - Marine Habitat
MIGR - Fish Migration
SPWN - Fish Spawning
SHELL - Shellfish Harvesting
EST - Estuarine Habitat

depending on the contaminant. San Francisco estuary had higher levels of some contaminants while some other Unocal tanker ports had higher levels for other contaminants. In cases in which the contaminant concentrations in the ballast water exceed the concentration in San Francisco estuary, the volume of water discharged is so small compared to the volume of water in San Pablo Bay that concentrations reach background levels rapidly. Therefore, discharge of segregated ballast water at the Unocal Terminal is not expected to have a significant impact on water quality. Discharge of segregated ballast water is considered an adverse but nonsignificant water quality impact (Class III). The introduction of exotic species is a greater concern. Introduction of exotic species in ballast water is discussed in Section 4.4, Biological Impacts.

Other wastewaters generated by vessels docked at the Unocal Marine Terminal are not released into San Pablo Bay, but are fed into the process water feed to the wastewater treatment plant. Unsegregated ballast water, cargo tank wash water, and bilge water are sent via pipeline to tank 103 onshore. The recovered oil is sent to the recovered oil system, while the remaining oily water is sent to equalization tanks at the Refinery and blended into the process water that goes to the Refinery's wastewater treatment plant (K. Guziak, Unocal, personal communication 1992). After treatment, these wastewaters are then discharged through the Refinery outfall and meet the discharge requirements of the NPDES permit. Refinery discharges are discussed in the following section, Terminal Refinery Operations.

A small amount of trace metals and organotins may be introduced into Bay waters from antifouling paints and sacrificial anodes on ship hulls. Of the substances that could leach from the hulls of tankers servicing the Unocal Marine Terminal, the possible release of organotins is of the greatest concern because of the high toxicity of these compounds to aquatic organisms. A concentration of 6 nanograms/liter (ng/L) of tributyltin (TBT) is considered the upper limit for protection of marine life (SWRCB 1988). In the past, organotins were commonly used in bottom paints of vessels as an antifouling ingredient. Recent recognition of the toxicity of these compounds has led to restrictions on their use. The California Department of Food and Agriculture has restricted the use of organotins to vessels 82 feet in length or longer.

Current legislation restricts the release rate of TBT after application of antifouling paint to 4 micrograms per square centimeter per day or less (California Code of Regulations, Section 6488, 6900). Tankers servicing the Unocal Marine Terminal would qualify for the use of TBT antifouling paint because of their size. In the past, tankers servicing the Terminal used TBT antifouling paints, but these paints are no longer used (K. Guziak, Unocal, personal communication 1992). All Unocal's vessels are currently protected by coal tar with epoxy overlay coatings.

For the purposes of comparison, TBT levels in San Francisco Bay waters are considerably lower than those measured in San Diego Bay and slightly higher than levels measured in Los Angeles/Long Beach Harbors (SWRCB 1988). Of 36 samples taken from 18 sites in San Francisco Bay, eight samples from three sites had detectible concentrations of TBT ranging from 10 to 158 ng/L. The highest concentration was found adjacent to a drydock facility. At Mare Island, 3 of 32 samples (1 of 18 sites) had detectable concentrations of TBT. The highest concentration was 46 ng/L at a yacht club. Concentrations of TBT that could clearly be toxic to marine organisms occur in San Francisco Bay, but such occurrences seem to be localized to a few shipyards and marinas. Although no testing has been done for TBT levels in the water column at the Unocal Terminal, sediments have low levels of organotins (less than 13.2 ppb). Because the use of TBT antifouling paint on Unocal tankers no longer occurs, TBT inputs to San Francisco Bay from Unocal operations at the Terminal are not contributing this substance to the waters and sediments of San Pablo Bay. Any use of TBT as an antifouling agent on tankers could have a significant adverse (Class II) impact on water quality because of its toxicity. This impact could be prevented by prohibiting the use of TBT on Unocal tankers.

In addition to these inputs of contaminants from vessel hulls, there would also be some additional contamination of Bay waters from small leaks and spills associated with Terminal use. All of these sources of low-level chronic contamination associated with Terminal use would be expected to represent an adverse, but nonsignificant (Class III) impact on water quality. The amount of material that would enter the water at any one time from one of these sources would be small. Because of the substantial amount of tidal flushing that occurs in the vicinity of the Terminal, these materials would be rapidly dispersed. Elevation in the concentration of contaminants would be expected to be discernible only in the immediate vicinity of the Terminal and only for a very short period of time.

Tankers associated with the Terminal would also be expected to introduce small amounts of contaminants from spills and leaks into the waters along their routes. As was true of substances introduced to the water at the Terminal, dispersion of such substances would be rapid. Impacts on water quality would be expected to be adverse but not significant (Class III). Although low-level chronic contamination associated with the Unocal Marine Terminal is not expected to have significant impacts on water quality, it would add to the cumulative load of contaminants in the Bay and along the north coast. Cumulative impacts are discussed in Section 4.3.8.

Terminal/Refinery Operations

Approximately 9 million bbl of crude oil per year are brought into the Refinery from the Marine Terminal. The Refinery is also served by the Oleum pipeline, which brings in about 24 million bbl per year from the Central Valley. Therefore, approximately 27 percent of the oil treated at the Unocal Refinery is associated with the Terminal. Presently, the Unocal Refinery discharges an average of 2 mgd into San Pablo Bay through a submerged outfall. Table 4.3-4 lists the flow and average concentrations of effluent component concentrations from the Refinery while the Refinery was operating at plant capacity. This table shows that the concentration of contaminants in the discharge is below the limits set in Unocal's NPDES discharge permit and also below criteria for protection of aquatic life set in the Water Quality Control Plan for San Francisco Basin (see Table 4.3-1). Of contaminants introduced from the Refinery, those discharges associated with the Terminal would be a lesser source compared to contaminants from processing of Central Valley crude oil. The Terminal is responsible for only 27 percent of the oil processed at the Refinery, and Alaskan Cook Inlet Oil, in general, is lower in contaminants than Central Valley Crude (K. Guziak, Unocal, personal communication, 1992).

Much recent attention has been focused on the relationship between refinery discharges and the levels of selenium detected in biota of San Pablo Bay, Carquinez Strait, and Suisun Bay. Because only very slight amounts of selenium (less than 0.2 ppm) are found in the crude oil carried by tankers to the Marine Terminal, oil delivered to the Marine Terminal is unlikely to make a measurable contribution to selenium emissions in San Pablo Bay. Selenium levels in Central Valley Crude Oil are considerably higher (about 1 ppm) than in Alaskan Cook Inlet Crude (K. Guziak, Unocal, personal communication 1992). Because concentrations in the Refinery effluent are below limits set in the Water Quality Plan for San Francisco Basin, the Terminal's contribution to this discharge is judged to have an adverse but nonsignificant impact on water quality. However, as shown in Table 3.2-5, water sampled in the vicinity of the Marine Terminal has been shown to have concentrations of copper, lead, and zinc which exceed objectives of the San Francisco Basin Plan. Therefore, the Refinery is contributing to the cumulative load of contaminants which may be at levels where adverse effects on aquatic life could occur. Cumulative impacts are discussed in Section 4.3.4.

Maintenance Dredging

Under the Proposed Project, Unocal would continue to perform maintenance dredging to reestablish water depths necessary for safe approach and berthing operations at the Marine Terminal. The estimated maintenance dredging needs at the Terminal are approximately 90,000 cubic yards annually. The dredged material would continue to be disposed of at the Carquinez Strait Dredged Material Disposal Site (DMDS, SF-9), which is primarily a dispersive disposal site. A dispersive disposal site is one at which the material is dispersed and does not accumulate on the bottom.

A tracer study of 1.24 million cubic meters of sediments dredged at Mare Island and released from a hopper dredge at the Carquinez Strait Disposal Site found that the dispersion of sediments released at the Carquinez Strait site was rapid and widespread (Sustar 1982). Within a month, released sediments were well distributed, both horizontally and vertically, over a 100-square-mile area that included San Pablo Bay, Carquinez Strait, and Suisun Bay. The initial movement of sediments back into the channel of Mare Island Strait was estimated to be 10 percent of the total volume dredged.

Previous chemical testing of sediments at the Marine Terminal site (Brown and Caldwell 1987; MEC Analytical Systems Inc. 1990) shows the sediments to consist primarily of sand (> 90 percent) and a small fraction of silt/clay (< 5 percent). Sediments at the disposal site have been found to consist of gravel (15.3 percent), sand (16.1 percent), silt (31.7 percent), and clay (36.9 percent) (MEC Analytical Systems

Table 4.3-4

AVERAGE COMPONENT CONCENTRATIONS IN EFFLUENT FROM UNOCAL OLEUM REFINERY

Constituent	Units	NPDES Limit (monthly avg.)	NPDES Limit (daily maximum)	1991-1992 Concentration
BOD (5 day at 20°C)	lbs/day kg/day	808.1 367.3	1,590 722.5	52.1 23.7
TSS	lbs/day kg/day	710.4 322.9	1,110 504.5	104.7 47.6
TOC	lbs/day kg/day	1,776 807.3	3,499 1,590	176.4 80.2
Oil and Grease	lbs/day kg/day mg/L	266.4 121.1 8	506.2 230.1 15	18.7 8.5 1.2
Ammonia as Nitrogen	lbs/day kg/day mg/L	337.4 153.4 10	737 335 22	< 2.2 < 1 < 0.1
Sulfide	lbs/day kg/day mg/L	4.7 2.14 0.14	42.9 19.5 0.31	< 0.2 < 0.1 < 0.1
Total Chromium	lbs/day kg/day mg/L	6.51 2.96 0.21	18.73 8.51 0.60	.19 .09 .006
Hexavalent Chromium	lbs/day kg/day mg/L	0.538 0.245 0.028	1.20 0.545 0.062	.0158 .0072 .0011
Arsenic	ug/L	—	200	3.8
Cadmium	ug/L	—	30	1.8
Chromium (VI)	ug/L	—	110	1.1
Copper	ug/L	—	200	6.1
Cyanide	ug/L	—	25	< 20
Lead	ug/L	—	56	2.7
Mercury	ug/L	—	1	0.2
Nickel	ug/L	—	71	5.4
Silver	ug/L	—	23	.1
Zinc	ug/L	—	580	16.8
Phenols	ug/L	—	500	< .01
PAHs	ug/L	—	150	< 10
Selenium	µg/L (handwritten over mg/L) lbs/day	— —	50 5.60	.32 4.47

1990). Because the sediments resuspended by dredging operations are primarily coarse-grained sediments, the amount and duration of turbidity generated would be expected to be minimal.

There is an inverse relationship between sediment grain size and associated contaminants because contaminants tend to bind to finer particles, particularly to the clay fraction of the sediment (Thompson et al. 1987). Coarse-grained sediments, such as those at the Terminal, would be expected to have a low level of contaminants. Sediments dredged at the Marine Terminal in the past have tested relatively clean with no organic pesticides, PCBs, phenols, PAHs, or phthalates detected and trace metals (cadmium [0.053 to 0.065 ppm], chromium [52.6 to 58.5 ppm], lead [11.5 ppm], and zinc [16.2 to 22.2 ppm]) and organotins (less than 13.2 ppb) detected at low levels. The only trace metal detected at elevated levels in sediments at the Marine Terminal is nickel. Nickel was detected in sediments at the Terminal at a concentration range of 48 to 52 ppm in 1987 (Brown and Caldwell Laboratories 1987). This value is above the NOAA effect-range-low (ER-L) level (Long and Morgan 1990) of 9 to 30 ppm. The ER-L level is the level above which adverse effects on benthic organisms would begin to be expected. Any elevation in water column levels of contaminants as a result of dredging would be expected to be localized in time and space. Continued dredging of sediments found at the Marine Terminal under the Proposed Project would have an adverse but not significant impact on marine water quality (Class III).

Oil Spill, Product Spill, and Other Accident Conditions

Fate of Spilled Oil in Water

To accurately assess the impacts of oil spills and chronic discharges of petroleum hydrocarbons into the marine environment, it is necessary to have an understanding of the variety of physical, chemical, and biological transformations petroleum hydrocarbons go through following introduction into the sea. Several comprehensive reviews describe the fate and behavior of petroleum introduced into the marine environment (NRC 1985; Jordan and Payne 1985) and the following discussion is drawn primarily from these documents.

The fate of spilled oil in the marine environment is determined by a variety of complex and interrelated physical, chemical, and biological transformations during its transport from the sea surface to the atmosphere, water column, or sedimentary regimes. The physical and chemical processes involved in the "weathering" process of spilled oil include evaporation, photochemical oxidation, dissolution, vertical dispersion, emulsification, and sedimentation. The rate of physical and chemical alterations of spilled oil is influenced by a variety of abiotic environmental factors (e.g., water temperature, water column particulate matter concentration), physical-chemical properties inherent to the oil itself (e.g., vapor pressure, solubility), and the relative composition of the hydrocarbon source matrix (e.g., crude oil, refined product).

The physical and chemical properties of Alaskan North Slope crude oil are highly variable depending on the season and other environmental conditions present on the day it is pumped from the ground (D. Mears, Unocal, personal communication 1992). Therefore, the chemical composition of Alaskan Cook Inlet crude delivered to the Refinery can vary with each tanker arriving at the Marine Terminal. Much attention has been given recently in the literature, regarding the fate and transport of the North Slope Prudhoe Bay crude oil in the marine environment following the Exxon Valdez oil spill (Galt et al. 1991). Both the Alaskan Cook Inlet and Coalinga Nose crude (the crude oil that is delivered to the Unocal Refinery from the San Joaquin Valley via pipeline) are relatively heavy to heavy crude oils, each with an API (American Petroleum Institute) density greater than 30. Alaskan Cook Inlet crude however is a low sulfur-content crude (0.1 percent) in comparison to Coalinga Nose and Prudhoe Bay crudes. Another difference between Alaskan Cook Inlet crude and the Coalinga Nose crude is their relative trace metal content. Alaskan Cook Inlet crude appears to have a much lower nickel and vanadium content compared to the Coalinga Nose crude. Selenium is found in very low concentrations (less than 0.2 ppm) in the Alaskan Cook Inlet crude, whereas it is found at higher concentrations (approximately 1 ppm) in the San Joaquin Valley heavy crude oils (K. Guziak, Unocal, personal communication 1992).

Other parameters of interest in providing an early indication on the fate, transport, and biological impacts of spilled oil in the sea are aqueous solubility of the crude oil, the mass fraction of aromatics, and the asphaltene and wax content of the crude oil. The mass fraction of aromatics present in a crude oil is an important indicator of the potential toxicity of a spill because aromatics are considered to be the most toxic hydrocarbons in oil (Galt et al. 1991). The asphaltene and wax content determines water-in-oil emulsion formation and is an indicator of how well the crude oil will form a stable emulsion or mousse in seawater. Prudhoe Bay has a low aqueous solubility (20 to 40 mg/L), which is similar to Alaskan Cook Inlet crude. Measurements of the mass fraction of aromatics present in Prudhoe Bay show an aromatic fraction of less than 20 percent (Galt et al. 1991). The asphaltene content of Alaskan Cook Inlet and Coalinga Nose crude is approximately 1 percent, which compares to an asphaltene content of about 2 percent for Prudhoe Bay crude. Experiments with Prudhoe Bay crude suggest it tends to form a fairly stable emulsion (Galt et al. 1991) and, thus, Alaskan Cook Inlet crude may also form a fairly stable emulsion under the right mixing conditions.

The biological processes involved in the weathering of spilled oil include microbial degradation and uptake of hydrocarbons by larger organisms and its subsequent metabolism. The biodegradation of petroleum by microorganisms is viewed as one of the principal mechanisms for removal of petroleum from the marine environment (NRC 1985). Enhancement of natural biodegradation processes by microbes may be one of the least ecologically damaging ways of removing oil from the marine environment. Uptake of hydrocarbons by large organisms usually has adverse impacts in the biota because of the toxicity of petroleum hydrocarbons.

Qualitative effects of weathering processes on the fate of spilled oil are known from both field studies of oil spills in various coastal and open-ocean environments (Conomos 1975) and from experiments using model marine ecosystems (NRC 1985). Because crude oil is a complex mixture of hydrocarbons, weathering causes considerable changes in chemical composition and physical properties of the oil. It is the dissolved hydrocarbon concentrations that are of particular concern because of their potential to exert toxic effects on biological systems.

Several competing forces occur simultaneously once oil has been released into the sea. The processes affecting the fate of spilled oil include (1) advection (drift) and spreading, (2) evaporation, (3) dissolution, (4) dispersion, (5) emulsification, (6) photoxidation/autoxidation, and (7) sedimentation. Advection or drift is measured by the movement of the center of the mass of an oil slick and is primarily controlled by wind, waves, and surface currents. Spreading of oil on water is probably the most significant process for the first 6 to 10 hours following a spill. Gravitational, inertial, and frictional forces, as well as surface tension, are the principal forces responsible for spreading oil. As the spreading process occurs, the volatile fractions of the oil are lost to evaporation or dissolution, and this leads to an increase in the viscosity and specific gravity of the remaining oil. For heavy, well-weathered oils, the spreading tendency is minimal because of the lower abundances of the volatile and lower molecular weight compounds within the parent crude.

Evaporation and dissolution are the next most important processes of degradation of oil. The majority of the more volatile compounds from the parent crude can be lost within the first 24 hours of a spill by evaporation. Predicting the evaporative behavior of spilled oil is difficult because the hydrocarbon composition of the oil, its surface area and physical properties, the sea state, the intensity of solar radiation, the wind velocity, and air and sea temperatures all influence the rate of evaporation. Nonetheless, the evaporation can account for up to 50 percent of an oil spill lost during the first 24 to 48 hours. Spills of refined products, such as kerosene and gasoline, may be completely evaporated within the first 24 hours.

In terms of mass balance, dissolution is less important than evaporation because of the low aqueous solubility of most hydrocarbon components of crude oil. Salinity, sea-temperature, and the physical properties inherent to the various components of the oil all influence the rates of dissolution of each component hydrocarbon. It turns out that the most water-soluble petroleum hydrocarbons are those with the greatest aromatic/olefinic character. Aromatic hydrocarbons, usually less abundant than the saturated hydrocarbons, contain one or more aromatic (benzene) rings connected as fused rings, such as in naphthalene or lined rings as in biphenyl (NRC 1985). The solubilities of specific crude oil components are important in predicting the potential toxicity of dissolved fractions of an oil spill to biological communities. For example, the toxic polynuclear aromatics (e.g., phenanthrene) are more soluble in seawater than the relatively nontoxic, longer chain paraffins. The toxicity of water-soluble products of Alaskan Cook Inlet or Coalinga Nose crude is unknown.

The movement of oil into the water column, or dispersion, is believed to be caused by propulsion by surface turbulence into the water column of small particles or globules of oil (ranging in size from less than 0.5 micrometer to several millimeters). Such oil-in-seawater emulsions are not stable and can only be stabilized by natural or added emulsifiers, detergents, dispersants, or suspended particulates. Generally speaking, an oil spill will begin to disperse immediately, and by 100 hours, dispersion has usually overtaken spreading as the principal mechanism for distributing the spilled oil (SAI 1984).

Emulsification arises from the dispersion of spilled oil and represents a change of state from an oil-in-water dispersion to a water-in-oil emulsion. Crude petroleums with a high asphaltene content or with high viscosities are, in general, found to form mousse emulsions with greater ease and stability than highly paraffinic crude oils (Bocar and Gatellier 1981, cited in NRC 1985). In laboratory studies, stable emulsions or mousses could not be formed at any temperature with light petroleum distillates such as gasoline, kerosene, and several diesel fuel oils (Twardus 1980 cited in NRC 1985).

Photo-oxidation processes (the action of natural sunlight in the presence of oxygen) may have considerable importance in the long-term weathering of spilled oil, both by enhancing dissolution of products and by increasing the general toxicity of the water soluble fraction. Photo-oxidation processes can also degrade toxic components indigenous to petroleum. For example, potential carcinogens such as benzo[a]pyrene have been shown to be photo-oxidized by sunlight. However, photolysis is greatly slowed in turbid water because of light attenuation and partitioning of aromatics onto suspended particulate matter (Payne and Phillips 1985). It is generally agreed that all of the oil that evaporates is photochemically oxidized in the atmosphere. In surface water, photochemical oxidation may be important on a time scale of minutes to days.

The sedimentation and sinking of spilled oil is caused by several factors, with sedimentation occurring primarily through sorption on particulates and by the ingestion of hydrocarbons by zooplankton. Weathering processes increase the density of oil, which leads to the incorporation of particulates and the agglomeration of oil-particulate mixtures and eventually to sinking. Heavier crudes may sink rapidly after release, regardless of weathering, but, in general, extensive weathering is required before the oil residue has a specific gravity greater than that of seawater. Some weathering and fractionation of oil appears to be necessary before incorporation into suspended material. Test tank studies have shown that fractionation of oil is common before it is incorporated into suspended particulate material.

Impacts of Spilled Oil in the Water

An oil spill has a minimal effect on the physical properties of seawater, the most significant impacts are to water chemistry. The physical properties of water affected by an oil spill include reduced light transmissivity and reduced warming of the sea surface. The total sea surface area affected by a spill depends on the volume of oil released and the prevailing meteorologic and wind conditions. Under the Proposed Project, the impacts on these physical properties (reduction in light transmissivity and reduced sea surface warming) by an oil spill is considered an adverse but not significant impact (Class III) to marine water quality.

A significant impact to marine water quality (Class I or II impact) will result from changes in water chemistry from an accidental spill of crude oil or crude oil product in either San Francisco Bay or within outer coast waters. The severity of the impact will depend on (1) the size of the spill, (2) the composition of the oil, (3) the characteristics of the spill (instantaneous vs prolonged discharge; surface vs subsurface spill, etc.), (4) the environmental conditions and the effect of these conditions on spill properties due to weathering, and (5) the effectiveness of cleanup operations. In the event of an oil spill, the initial impacts will be to the water quality of surface waters and the water column followed by potential impacts to sedimentary and shoreline environments. Following an oil spill, hydrocarbon fractions will be partitioned into different regimes and each fraction will have a potential impact on water quality. A spill from a tanker is the responsibility of the vessel owner/operator. Each vessel is required to have an oil plan that identifies response measures for containment, recovery, and protection of sensitive resources. While some small spills may be able to be contained (Class II), most tanker spills/accidents are large spills that result in significant (Class I) impacts.

Section 4.2 has shown that the Terminal has the response capability to handle small spills in the 50-bbl-size range. Larger spills are considered harder to contain and result in a significant (Class I) impact.

The duration of potential impacts to water quality is variable. The most toxic period for crude oil spilled into the aquatic environment is the first few days after an oil spill occurs, because during this period the volatile, low molecular weight hydrocarbons are still present (BLM 1979). After a few days, a larger portion of the spilled oil and some of the more toxic oil components will have evaporated or been reduced by other weathering processes. Oil residues that sink into bottom sediments may persist for months to years.

A product spill would be expected to be more toxic but of shorter duration than a crude oil spill. The products are made up of more volatile components than crude oil. These lighter volatile fractions are lost more rapidly to evaporation than the higher molecular weight fractions in crude oil. Toxicity tests performed on oil by the EPA have shown that aromatic constituents are the most toxic, naphthenes and olefins are intermediate in toxicity, and straight chain paraffins are the least toxic (Chambers Group 1988). Table 4.3-5 lists the products shipped from the Unocal Marine Terminal and their toxic components.

4.3.3.2 Analysis of Future Operations

<u>Routine Operations</u>

Under the assumed future conditions the level of incoming tanker traffic at the Unocal Marine Terminal would increase by 60 percent. Shipment of product is assumed to increase by 30 percent.

The future increase in the level of operations at the Unocal Marine Terminal would be expected to have a proportional increase in the level of small leaks, spills, and bilge water discharges. The increased tanker traffic might also result in a minor increase in the input of contaminants from antifouling paints and sacrificial anodes. The information suggests that the contribution of all these sources to contaminant loadings in the vicinity of the Unocal Marine Terminal is very small. The impact of minor leaks, discharges, and other inputs from tanker traffic at the Unocal Marine Terminal is projected to be adverse but nonsignificant (Class III).

Under future conditions, it is assumed that the Refinery would use less San Joaquin Valley crude oil and other domestic oil sources, and use more oil imported by tanker. The data suggest that discharges from the Refinery may be contributing significantly to selenium levels in San Pablo Bay. Because selenium

Table 4.3-5

PRODUCTS SHIPPED FROM UNOCAL MARINE TERMINAL

Product	Toxic Components
Unleaded gasoline	Gasoline, benzene, toluene, xylene, ethylbenzene
Aviation fuel jet A	Hydrodesulfurized kerosene, straight run kerosene, biphenyl, naphthalene
Diesel #2	Diesel oil No. 2, biphenyl
Bunker #6 fuel oil	Hydrocarbon mixture
Intermediate gas oil	Oil mist, petroleum distillates (naphtha), PNAs
150 neutral oil	Solvent waxed distillates, heavy paraffin
90 neutral oil	Solvent dewaxed distillates, light paraffin
190 bright stock	Solvent dewaxed residual oil
Methyl tertiary butyl ether (MTBE)	MTBE

is associated with San Joaquin crude, a reduction in the percentage of San Joaquin crude oil processed in the Refinery would be expected to result in a reduction in mass loadings of selenium to San Pablo Bay. Because no increase in the amount of wastewater discharged from the Refinery is anticipated as a result of increased tanker traffic at the Terminal, there should be no increase in the pollutant loadings of other contaminants from Refinery discharges. There may be some increase in mass loadings on discharges from the processing of ship wastewater. Because the concentration of effluent would meet concentration limits specified in the NPDES permit, the increase in ship wastewater would be an adverse but nonsignificant impact (Class III). An increase in the mass loading of contaminants, however, would have a significant (Class I) cumulative impact.

The amount of maintenance dredging required in the ship channel is a result of hydrological and sediment transport processes that cause sediment to be deposited in the channels. An increase in tanker traffic would not increase the level of required maintenance dredging.

<u>Accident Conditions</u>

An increase in tanker traffic in the future would cause some increase in the risk of an oil spill either at the Terminal or in the traffic lane. An oil spill under future conditions would have the potential to have significant adverse impacts on water quality.

4.3.3.3 Summary of Significant Impacts

The only significant impact to water quality from operations at the Unocal Marine Terminal or from tankers traveling to and from the Terminal would be a major oil spill. An oil spill of 50 bbl or greater would have a significant adverse impact (Class I or II) on water quality. Unocal has the ability to contain and clean up smaller spills. Thus, spills smaller than 50 bbl would have a potentially significant but mitigable impact (Class II), while larger spills could not be mitigated to nonsignificant (Class I).

In addition, any use of antifouling paints with TBT, would have significant impacts to water quality because of the highly toxic nature of this substance (Class II). This potential impact could be avoided by prohibiting the use of TBT on Unocal tankers.

4.3.4 <u>Cumulative Impacts</u>

The water quality of the San Francisco Bay estuary has been degraded by inputs of pollutants from a variety of sources. Major sources of contaminants include municipal wastewater and industrial discharges and a variety of nonpoint sources: urban and agricultural runoff; riverine inputs; dredging and dredge material disposal; marine vessel inputs; and inputs from air pollutants, spills, and accidents. The sources of contaminants to the San Francisco Bay estuary and the levels of contaminants throughout the estuary are discussed in detail in Section 3.2.2.4. That section shows levels of many contaminants in the water column, in the sediments, and in the biota in the estuary that either exceed water quality objectives in the San Francisco Bay Basin Plan or are at levels known to have harmful effects on aquatic organisms. The water quality of San Francisco Bay has suffered a significant cumulative adverse impact (Class I and II) from pollutant inputs.

Table 4.3-6 is a comparison showing those contaminants which are at significantly adverse levels in San Francisco Bay as a whole, in San Pablo Bay, and at the Unocal Terminal. The table shows numerous contaminants at significantly elevated levels in the San Francisco Bay estuary with a smaller subset of those contaminants at significantly elevated levels in San Pablo Bay and/or at the Unocal Terminal.

Any contribution to the waters of San Francisco Bay of a contaminant already at significantly high levels would have a significant impact at the cumulative level (Class I). Of the contaminants listed as significantly elevated in Table 4.3-6, operations at the Unocal Terminal would not contribute to TBT contamination or pesticides. Unocal tankers may have contributed to TBT contamination in the past, but Unocal tankers no longer use TBT. No pesticides are associated with the Unocal Marine Terminal.

Of the other contaminants, operations at the Unocal Terminal would contribute small quantities of metals and PAHs. Inputs from the Unocal Marine Terminal include segregated ballast water releases, small leaks and spills of oil and product, some input of contaminants in vessel paint or sacrificial anodes and a portion (27 percent) of the discharge from the Refinery. Of those sources, only the Refinery discharge is quantified. Many of the contaminants of concern in San Francisco Bay have their highest concentration either in the south Bay, south and central

Table 4.3-6

COMPARISON OF CONTAMINANTS EXCEEDING WATER QUALITY STANDARDS FOR LOCAL AND REGIONAL AREAS

San Francisco Bay	San Pablo Bay	Unocal Terminal
Water Column		
Copper* Mercury* Nickel* TBT*		Copper* Lead Zinc
Sediments		
Selenium* Mercury* Arsenic Cadmium* Chromium Copper* Lead Nickel* Silver* DDT* TBT* PCB* Chlordane* Toxaphene* PAH*	Selenium* Chromium Mercury* Nickel*	Nickel*
Biota		
Arsenic Cadmium* Chromium Copper* Lead Mercury* Selenium* Nickel* DDT* PCB*	Cadmium* Selenium*	Cadmium* Selenium*
*Pollutant of highest concern in Monroe and Kelly 1992		

Bays, or in the harbors and marinas. This information suggests that the Unocal Terminal is not one of the major contributors of tbose contaminants. Figure 3.2.1 showed that the Bay's largest municipal discharger, the San Jose/Santa Clara Water Treatment Plant (WTP) located in the south Bay, discharges 118 million gpd of treated municipal sewage.

Contaminants which are elevated in San Pablo Bay include selenium, chromium, cadmium, mercury, and nickel. The Unocal Marine Terminal would be expected to contribute at least small inputs to the contaminant loadings of all of those substances.

Contaminants that have been shown to be elevated in the immediate vicinity of the Unocal Marine Terminal include copper, lead, zinc, nickel, cadmium, and selenium. Operations at the Marine Terminal would be expected to contribute small levels of all these substances.

Table 4.3-7 compares pollutant loadings from various sources, including the Unocal Refinery discharge. The discharge from the Unocal Refinery is 2 mgd compared to a total discharge of 855 mgd from municipal treatment plants and 30 mgd total from refineries. This table shows that the largest source of most pollutants to the Bay is runoff, both urban and nonurban. With the exception of selenium, the Unocal Refinery's contribution to these loads is very small. Less than half the discharge from the Unocal Refinery is associated with the Marine Terminal. Relative to other sources, the Unocal Refinery does make a substantial contribution to pollutant loadings of selenium. This selenium is associated primarily with San Joaquin crude and not with the oil that arrives at the Refinery from the Terminal.

Unfortunately, there are no quantitative data on the total loadings that small spills and discharges from the Terminal contribute to overall contaminant levels in the Bay. However, the amount of material released from these chronic inputs would certainly be far less than the 2 mgd discharged from the Refinery with its load of approximately 20 to 50 grams per day of each of the major contaminants. For example, in 1992, a total of six spills into the Bay were recorded. All of these spills were less than 5 gallons (Entrix 1993). Furthermore, in the vicinity of the Marine Terminal, the comparatively low level of contaminants compared to the Bay as a whole would substantiate that inputs as a whole from Unocal are relatively small. In summary, continued operation of the Unocal Marine Terminal would contribute to the significant cumulative levels of certain contaminants in the San Francisco Bay estuary. However, this contribution is extremely small compared to other sources, particularly runoff and municipal discharges. Because copper, lead, zinc, nickel, cadmium, and selenium exceed water quality standards in the vicinity of the Marine Terminal, even a small increase in these contaminants as a result of Unocal operations would be a significant (Class I) cumulative impact.

Contaminant levels on the outer coast generally do not exceed water quality objectives. Unocal tankering would not have a significant impact on water quality on the outer coast except in the event of a major oil spill.

Section 4.2.4. in the Operational Safety/Risk of Accidents Section discusses cumulative oil spill risk. A major oil spill would have a significant (Class I) cumulative effect on water quality. The greatest potential for heavy oiling and, therefore, the most profound degradation of water quality would occur near the marine terminals (for spills associated with marine terminals) and, the tanker routes from the Golden Gate to Carquinez Strait (for spills from tankers).

4.3.5 Significant Impacts, Mitigation Measures, and Residual Impacts

4.3.5.1 Unocal Responsibilities

Impact - A major oil spill from the continued operation of the Unocal Marine Terminal would result in significant (Class I or II) impacts to water quality.

Mitigation and Residual Impact - The following mitigation measures can be applied to help reduce oil or other pollutant spill impacts. According to the analysis in Section 4.2, only a spill of 50 gallons or less could be contained and cleaned up effectively.

1. The most effective way to mitigate for the significant water quality impacts of a major oil spill is to prevent such a spill from occurring. Section 4.2.5.1 details a series of procedures to increase the safety of operations associated with the Unocal Marine Terminal. These measures include methods to insure the structural integrity of the wharf, methods to decrease the chances of release of hydrocarbons into Bay waters from pipelines on the trestle/wharf, measures to prevent or reduce potential spills from

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Table 4.3-7

SUMMARY OF POLLUTANT LOADINGS TO THE BAY/DELTA ESTUARY FROM MAJOR SOURCES
(metric ton/year)

Pollutant	Municipal and Industrial Effluent	San Joaquin River	Sacramento River	Urban Runoff	Total Nonurban Runoff	Atmospheric Deposition	Dredged Material	Spills	Unocal Refinery Discharge*
Arsenic	1.5 - 5.5	12	N/A	1.0 - 9.0	**10 - 120**	N/A	N/A	N/A	0.010
Cadmium	**1.8 - 4.0**	N/A	N/A	0.3 - 3.0	**0.52 - 6.0**	0.14 - 0.35	0.02 - 0.2	N/A	0.005
Chromium	12 - 13	66	N/A	3.0 - 15	**130 - 1,500**	N/A	N/A	N/A	0.003
Copper	19 - 30	80	N/A	7.0 - 59	**51 - 580**	1.9 - 3.1	1.0 - 10	N/A	0.017
Lead	11 - 16	51 - 55	N/A	**30 - 250**	**31 - 360**	6.0 - 21	1.0 - 10	N/A	0.007
Mercury	0.2 - 0.7	N/A	N/A	0.026 - 0.15	**0.15 - 1.7**	N/A	0.01 - 0.1	N/A	0.0005
Nickel	19 - 27	**51**	N/A	N/A	N/A	N/A	2.0 - 20	N/A	0.015
Selenium	2.1	**4.2**	1.1	N/A	N/A	N/A	N/A	N/A	0.740
Silver	**2.7 - 7.2**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.0003
Zinc	77 - 80	164 - 175	N/A	34 - 268	**130 - 1,450**	N/A	3.0 - 30	N/A	0.047
PCBs	N/A	N/A	N/A	**0.006 - 0.40**	N/A	N/A	0.00067 - 0.0067	N/A	N/A
PAHs	N/A	N/A	N/A	**0.50 - 5.0**	N/A	**0.8 - 4.8**	0.05 - 0.47	N/A	N/A
Total Hydrocarbons	N/A	N/A	N/A	**1,100 - 11,000**	N/A	2.1 - 45	N/A		3.1 (oil and grease)

Note: Values in bold face indicate the largest quantified sources (or sources where ranks are relatively ambiguous) of each pollutant. N/A = Data not available.

Adapted from Davis et al. 1991

*Adapted from Monroe and Kelly 1992

hydrocarbon transfers at the Terminal, measures to reduce the potential for explosions at the Terminal or onboard vessels, and measures to prevent or reduce the potential release of hydrocarbons from a tanker or barge. These measures would reduce the chances of a major spill and its significant impact on water quality to very small. Even with all feasible prevention and safety measures in place there is still a finite chance of a major oil spill that would have significant impacts on water quality.

Additional mitigation measures presented in Section 4.2.5.1 for these significant impacts are that all operations at the Terminal and by tankers are conducted in a safe manner, all equipment is operating properly, all repairs are conducted promptly to reduce the chances that a spill would occur, and that an effective containment and cleanup program be maintained to minimize the impacts if a spill does occur. Unocal's Oil Spill Contingency and Response Plan is analyzed in Section 4.2 of this document. That analysis identified several conditions at the Terminal which need to be corrected to reduce the chances of accidents.

2. If a spill did occur, impacts to water quality could be minimized by rapid containment and cleanup. Unocal's Oil Spill Contingency and Response Plan identifies that it is possible in some situations for dispersants to be used. Dispersants would only be used with approval from the USCG and the CDFG. It should be recognized that dispersants, although they may be warranted in some cases, would have a significant adverse impact on water quality. Almost all studies have shown dispersant oil mixtures to be more toxic to marine animals than oil alone (McKay 1982; Snow 1982).

If a major oil spill occurred, appropriate contaminant and cleanup procedures could reduce impacts to water quality; but impacts would be expected to remain significant for any spill larger than 50 bbl.

<u>Impact</u> - Any input of TBT into the waters of San Pablo Bay would be a significant (Class II) impact to water quality because of the toxicity of this substance.

<u>Mitigation and Residual Impact</u> - The use of TBT on all Unocal tankers and other tankers servicing the Terminal should be prohibited as a condition of the lease. Prohibition on the use of TBT will prevent any inputs of this substance into the water from operations at the Unocal Terminal.

4.3.5.2 Cumulative Actions

<u>Impact</u> - Water quality criteria for several pollutants are exceeded in the San Francisco Bay estuary resulting in significant (Class I and II) impacts.

<u>Mitigation and Residual Impact</u> - Regulations of point source discharges have led to significant improvements in the quality of municipal wastewater and industrial discharges. Thus, even though the volume of these discharges has increased, the contaminant loads have actually decreased (Monroe and Kelly 1992). As shown in Table 4.3-7, by far, the largest source of contaminants to the San Francisco Bay estuary is urban and nonurban runoff. The control of nonpoint source pollution has become a priority with the EPA. EPA has recently (1993) issued a manual providing guidance specifying management measures for sources of nonpoint pollution in coastal waters. The implementation of these management measures and practices should be used to reduce nonpoint source pollution. The manual provides management measures for agricultural sources, forestry, urban areas, marinas and recreational boating, and for hydromodification of rivers and shorelines. With the exception of forestry, most of these measures will be relevant to controlling contaminant input to the San Francisco Bay estuary. Improved control of nonpoint source pollution may reduce contaminants to levels below water quality criteria. Improved procedures for handling of hydrocarbons by Unocal as discussed in Section 4.2.5 will help to reduce Unocal's contribution to pollutant loading in San Pablo Bay. Unocal should also be prohibited from discharging ship wastewater into San Francisco estuary.

4.3.6 <u>Alternatives Analysis</u>

4.3.6.1 No Project Alternative

<u>Pier Structure Scenarios</u>

Abandonment In-Place of Marine Terminal

Abandonment in-place of the Marine Terminal would eliminate the adverse but nonsignificant impacts to water quality from leaks, spills, and discharges associated with the Terminal. Elimination of these inputs would have a minor beneficial (Class IV) impact on water quality in the vicinity of the Terminal. Abandonment of the Marine Terminal would eliminate the risk of a major spill from the Unocal Marine Terminal or from ships traveling to and from the Terminal also resulting in a beneficial (Class IV) impact.

There would be a small potential for a spill from the pipelines during the removal process. This potential is considered to be a significant (Class II) impact. This potential could be minimized by adherence to a plan addressing spill prevention and response measures during the abandonment process.

Abandonment and Removal of Marine Terminal

Like abandonment in-place of the Marine Terminal, abandonment and removal of the Marine Terminal would have a beneficial (Class IV) impact on marine water quality because it would eliminate the chronic input of contaminants associated with leaks, spills, and discharges from the Terminal and eliminate Terminal-bound ships. Risk of a major spill from the Terminal would also be eliminated. Removal of the Terminal would have adverse, but nonsignificant (Class III), impacts on marine water quality because the process of removing pilings, pipelines, and other structures from the bottom would resuspend sediments and generate localized, short-term increases in turbidity. As was true for abandonment in-place of the Marine Terminal, there would be a slight potential of a spill from the pipelines during the removal process (Class II impacts).

Retain Pier for Other Nonterminal Uses

Abandoning the Terminal and retaining the pier for other nonterminal uses would be expected to have similar impacts on water quality to abandonment in-place of the Terminal. Elimination of minor leaks and discharges, as well as the risk of a major spill from the Terminal, would have a beneficial (Class IV) impact on water quality. Removal of pipelines would have adverse, but nonsignificant (Class III) impact on water quality and a slight potential of a spill from pipelines during the removal process (Class II impacts).

<u>Refinery Scenarios</u>

Refinery Continues to Operate at Current Capacity

<u>Replacement of Crude Intake from Central Valley via Pipeline</u>

If the Terminal ceased to operate, and crude oil for the Refinery were obtained from other sources, the risk of crude oil spills from the Terminal would be eliminated. Crude oil for the Refinery would come from inland via pipeline, and the overall risk of oil spills in the Bay and along the tanker route would be reduced. Reduction in oil spill risk would have a beneficial (Class IV) impact on water quality. The replacement of Alaskan crude oil by crude oil from the Central Valley at the Unocal Refinery might cause some slight changes in the amount and composition of the discharge from the Refinery outfall. Central Valley crude oil tends to be somewhat higher in certain contaminants (such as selenium) than Alaskan Cook Inlet crude oil (K. Guziak, Unocal, personal communication 1992). Discharges from Refinery outfall would continue to meet NPDES limitations. Concentrations of contaminants in the effluent would continue to be below limits set as objectives in the Water Quality Control Plan for the San Francisco Basin. Therefore, water quality impacts from Refinery discharges from this alternative would remain adverse but nonsignificant (Class III). Mass emissions of certain contaminants such as selenium might increase slightly. An increase in the amount of selenium discharged would be a significant (Class II) cumulative impact because significantly elevated levels of selenium have been found in the biota in the area of the Unocal Marine Terminal. The cumulative impact of selenium discharges could be eliminated by prohibiting Refinery discharge into the Bay.

<u>Replacement of Crude via Pipeline from Other Marine Terminals</u>

Because the Unocal Refinery would continue to operate at capacity by using crude oil from other terminals, the total amount of crude oil transported by tanker into San Francisco Bay would not change. Although the risk of a crude oil spill at the Unocal Terminal would be eliminated, the overall risk of a crude oil spill would be essentially the same as that of the Proposed Project. Depending on which terminal received the oil, the overall risk of a spill might either increase or decrease slightly, according to the analysis in Section 4.2.6. It is most likely that shifting the impact to another terminal could increase slightly the overall risk of a spill.

If any construction were to occur of new crude oil submerged pipelines between the Unocal Refinery and other marine terminals, resuspension of sediments would cause a temporary localized increase in turbidity and, possibly, in water column contaminants. The impacts of pipeline construction on water quality would be adverse but nonsignificant (Class III).

Product Export via Pipeline to Other Terminals

The export of products from the Unocal Refinery via other terminals would eliminate the risk of a product spill at the Unocal Marine Terminal, but would increase the risk of such a spill at another terminal. According to the analysis in Section 4.2.6, product export from other terminals would increase slightly the risk of oil spills. A major oil spill would be a significant (Class I or II) impact on water quality.

If it were necessary to construct new submerged pipelines in the Bay for this alternative, there would be temporary adverse but nonsignificant (Class III) impact on water quality associated with such construction.

Truck and Rail Product Transport

Use of trucks and rail to transport products from the Unocal Refinery would eliminate the risk of an oil spill into the Bay from the loading of products at the Marine Terminal and from transporting products by tanker. Elimination of the oil spill risk associated with these operations would have a beneficial (Class IV) impact on water quality in the San Francisco Bay estuary. Truck and rail transport might have the potential for an accident that would involve an oil spill into inland waterways such as the Sacramento River. An oil spill into any inland waterway would have a significant adverse impact in the water quality of that waterway (Class I).

Refinery Would Operate at Reduced Levels

Reduction in Refinery operations would reduce the oil spill risk associated with receiving crude oil at the Terminal; consequently, this crude oil would not be received from another marine terminal. As a result of reduced Refinery operations, there would be an overall reduction in the amount of product exported from the Refinery, reducing the overall risk of a product spill in the Bay and along tanker routes. This alternative, therefore, would cause an overall reduction in the risk of an oil spill or product spill in the Bay and along tanker routes. Reduction in oil spill risk would have a beneficial (Class IV) impact on water quality.

Reduction in Refinery operations would reduce the amount of wastewater and associated contaminants discharged from the outfall. Reduction in the mass emission of contaminants from the Unocal outfall would have a beneficial (Class IV) impact on water quality.

Shutdown of Refinery

Shutdown of the Refinery would eliminate all oil spill risk associated with the Terminal and with tanker traffic involved in the import of crude oil for the Refinery and the export of Refinery products. Elimination of these oil spill risks would have a beneficial (Class IV) impact on water quality. Shutdown of the Refinery would eliminate all wastewater discharge from the Refinery. Elimination of wastewater discharge would have a beneficial (Class IV) impact on water quality.

4.3.6.2 Consolidation Alternative

The combined oil spill risk of this alternative would be virtually the same as for the Proposed Project (see Section 4.2.6.2). In other words, the overall risk of consolidating the Unocal and Pacific Refining Company Terminals would be the same as the combined risk to water quality of continuing to have the two separate terminals in operation.

If it were necessary to install submerged pipelines between the Pacific Refining Refinery and the Unocal Terminal, there would be temporary adverse but nonsignificant (Class III) impact on water quality from the resuspension of sediments. Similarly, during abandonment and removal of the Pacific Refining Wharf, there would be a temporary but nonsignificant (Class III) impact from submerged pipeline removal due to resuspension of sediments. Also, during pipeline removal there would be a small potential for a spill or leakage from the pipelines during the removal process. This is considered to be a significant (Class II) impact that can be minimized by adherence to a plan addressing spill prevention and response.

4.4 BIOLOGICAL RESOURCES

4.4.1 Introduction

This section discusses the impacts to biological resources of continued operations of the Unocal Marine Terminal. The impacts of operations (including the risk of an oil spill) at the Terminal and of tankering associated with the Unocal Marine Terminal are presented. In assessing the impacts of tankers, impacts in the San Francisco Bay estuary and along the outer north coast were considered.

Tankers using the Unocal Marine Terminal also travel along the outer coast south of San Francisco. Impacts of tankering along the coast south of San Francisco were analyzed in the Final Supplemental EIR/EIS for the GTC Gaviota Marine Terminal Project (Aspen 1992). The reader is referred to Appendix D (page 37), for a summary of those impacts.

The analysis of oil spill impacts associated with Unocal's Marine Terminal consists of several parts. The assumptions and methodologies used in the oil spill analysis are explained in the oil spill portion of this section and in Section 4.2. the Operational Safety/Risk of Accidents section.

4.4.2 Impact Significance Criteria

An impact to biological resources will be considered significant if:

- Any part of the population of a threatened, endangered, or candidate species is directly affected or if its habitat is lost or disturbed.
- If a net loss occurs in the functional habitat value of a sensitive biological habitat, including salt, freshwater or brackish marsh, marine mammal haul out or breeding area, eelgrass, river mouth, coastal lagoons or estuaries, seabird rookery, or Area of Special Biological Significance.
- If the movement or migration of fish or wildlife is impeded.
- If a substantial loss occurs in the population or habitat of any native fish, wildlife, or vegetation or if there is an overall loss of biological diversity. Substantial is defined as any change which could be detected over natural variability.

4.4.3 Proposed Project Impact Analysis

4.4.3.1 Analysis of Continuation of Existing Operations

Routine Operations

Routine operations at the Unocal Marine Terminal have the potential to impact marine life in a number of ways. First, the passage of ships using the Terminal could disturb marine organisms from the noise and activity of the ships and by disturbance to the bottom sediments from the draft of the ship. Second, the annual maintenance dredging to maintain adequate water depth for large ships at the Terminal will impact marine life in the dredging area and at the disposal site. Third, there is the chance that a ship traveling to or from the Terminal could collide with a marine mammal. Finally, marine organisms in the vicinity of the Terminal could be subjected to the impacts of chronic inputs of toxicants from the Terminal's contribution to wastewater discharge from the refinery, from the pumping of segregated ballast water from vessels using the Terminal, and from chronic leaks, drainage, and small spills. This section will discuss the impacts of routine operations of the Proposed Project on the various components of the biota. Impacts of chronic inputs are derived from Section 4.3.2, where a more detailed discussion of the impacts of routine operations of the Proposed Project on water quality is presented.

Plankton

Phytoplankton and zooplankton populations in San Pablo Bay and Carquinez Strait could be impacted by annual maintenance dredging at the Unocal Marine Terminal, by the introduction of exotic species in segregated ballast water and/or by the chronic input of pollutants associated with routine operations at the Terminal.

Dredging can impact plankton in the vicinity of the dredging operations from turbidity generated by resuspension of sediments and from the resuspension of any pollutants associated with those sediments. Turbidity can have a number of adverse effects on planktonic organisms. Turbidity can impact plankton populations by lowering the light available for phytoplankton photosynthesis and by clogging the filter feeding mechanisms and respiratory organs of zooplankton. The sediment at the Unocal Marine Terminal is comprised almost entirely of sand-sized particles (see Table 3.2.3-1). Because large particles have a rapid fall velocity, these sand-sized particles would be expected to remain in suspension for a very short time over a very small distance from the dredging operations. Therefore, the turbidity generated by annual maintenance dredging at the Terminal would be minimal. Turbidity would be expected to extend over a distance of less than 1,000 feet from dredging operations, and particles would remain in suspension less than 1 hour after dredging stopped (Chambers Group 1992). Similarly, very little turbidity would be generated by disposal of the dredged sediments at the Carquinez Strait Disposal Site.

Sand-sized particles generally have low levels of contaminants associated with them because contaminant levels in sediments are usually inversely related to grain size with clay sized particles being most closely associated with contaminants (Thompson et al. 1987). As discussed in Section 3.3, contaminant levels in the sediments at the Unocal Marine Terminal are generally low (MEC 1990). Bioassays done in 1990 resulted in LC 50 values of between 55.6 and 100 percent (MEC 1990). The LC 50 value is the concentration of the suspended particulate phase elutriate which produced 50 percent mortality in the test organism (larvae of the oyster *Crassostrea gigus*). Unocal estimated the concentration of suspended particulate phase at the disposal site 4 hours after disposal of the dredged material to be 1.25 to 1.81 percent (MEC 1990). This value was well below the 55.6 to 100 percent that would be the limiting permissible concentration based on the bioassay results. Therefore, annual maintenance dredging at the Unocal Marine Terminal would not be expected to release toxic concentrations of contaminants into the water column. The impacts of annual maintenance dredging at the Marine Terminal on plankton are expected to be adverse but nonsignificant (Class III).

Tankers servicing the Unocal Marine Terminal do not discharge unsegregated ballast water to the Bay. However, they may discharge segregated ballast water. Segregated ballast water would be expected to be relatively free of pollutants (see Section 4.3.3.1.), but the ballast water may harbor exotic species which upon release may cause problems in the ecosystem of the estuary. Exotic organisms have had a devastating effect on the estuary ecosystem (Carlton 1979). Most recently the Asian clam *Potamocorbula amurensis*, thought to have been introduced in ballast water, has all but displaced the benthic community. The Asian clam also has negatively impacted the plankton by intensive feeding on phytoplankton (Carlton et al. 1990, Nichols et al. 1990). Most product unloading and taking on of ballast by Unocal ships occurs at west coast ports. Therefore, it is unlikely that release of ballast in San Francisco Bay would introduce an organism that does not already occur in the Bay. However, if a foreign species were introduced that could flourish in the Bay, impacts to the existing planktonic communities could be significant (Class II). The potential impacts of invasive organisms in ballast water could be mitigated by requiring that all ballast water be unloaded to the waste handling facility and none be discharged to the waters of the Bay.

As discussed in Sections 3.3 and 4.3.2., chronic inputs of contaminants from the Unocal Marine Terminal are low compared to other sources of pollutants to San Francisco Bay. Because these inputs are low and because water movement in the vicinity of the Marine Terminal is good, it is unlikely that inputs from the Marine Terminal would expose planktonic organisms to a high enough concentration of a toxicant for a long enough period of time to have significant adverse effects. Therefore, the impact of chronic inputs of pollutants from the Unocal Marine Terminal on plankton populations is expected to be adverse but nonsignificant (Class III). Chronic pollutant inputs from the Unocal Marine Terminal do, however, contribute to cumulative pollutant loads in the bay. As discussed in Section 3.2, the high end of the range of concentrations in the bay for some pollutants does exceed water quality objectives. Cumulative impacts are discussed in Section 4.4-8.

Benthos

Benthic invertebrate populations in the northern reach of San Francisco Bay could be disturbed by the movement of sediment caused by the turbulence of ships travelling to and from the Unocal Marine Terminal, by annual maintenance dredging at the Terminal, by the introduction of exotic organisms in ballast water and by the chronic input of pollutants from routine operations at the Terminal.

When large ships, such as oil tankers, enter shallow water, the turbulence created by their hull and propellers can disturb the sediment in their path. Organisms living in or on the sediment could be displaced by this turbulence. Tankers passing to and from the Unocal Terminal will not be fully laden, and ship channels will be maintained at adequate depth. There may, however, still be some disturbance to benthic organisms from the draft of these large tankers. If such disturbance should occur, only minor effects would be expected on the biota. The benthic environment of the ship channels is an unstable one of shifting sand (Entrix 1987). The benthic community that lives in this environment has very low diversity and is comprised of organisms adapted to this unstable environment. Therefore, any sediments disturbed by ship turbulence would be expected to be rapidly recolonized. Impacts of tanker turbulence on benthic communities would be expected to be adverse but nonsignificant (Class III).

Annual maintenance dredging at the Unocal Marine Terminal will displace the organisms living within the dredged sediments. Benthic organisms in sediments adjacent to the dredge area may be buried by suspended sediments or may be subjected to such sublethal effects of turbidity as interference with feeding and breathing mechanisms. A study of the effects of dredging on benthic organisms in a dredging site near Mare Island in northeast San Pablo Bay showed that the density of benthic organisms was greatly reduced in the area that was dredged annually compared to an undredged area (DiSalvo 1977) (Table 4.4-1). Annual dredging at the Unocal Marine Terminal would be expected to cause a decrease in density in the dredged areas compared to what the density would be if the area were not dredged. However, the species composition would be expected to be similar. The benthic community in the vicinity of the Unocal Marine Terminal is characterized by opportunistic species, most of which are non-native (Entrix 1987; Robilliard et al. 1989a).

As discussed in Section 3.3.3.2, the benthic communities near the Unocal Marine Terminal are extremely unstable. The dominant species in this community have been completely replaced by another set of dominants at least twice in the last decade. Changes in this community seem to be related to major perturbations. In one case, the disturbance was severe flooding from the Delta, and in another, it was invasion by the Asian clam (*Potamocorbula amurensis*). Therefore, annual dredging of up to 90,000 cubic yards of sediment would be a minor perturbation compared to other events that affect this community. The dredged sediments would be expected to be quickly recolonized by a suite of species similar to those in the surrounding area. As discussed in the preceding section on plankton, the dredged sediments would consist almost entirely of sand-sized particles. Turbidity and associated contaminants would be expected to be minor.

Two epibenthic organisms of particular concern near the Unocal Marine Terminal are dungeness crab and grass shrimp. Both species are widely disturbed in the northern reach of the estuary. Because less than 7 acres will be dredged only occur once a year, turbidity would be minor, and impacts of maintenance dredging on dungeness crabs and grass shrimp are not expected to be significant. Impacts on the benthos of maintenance dredging at the Unocal Marine Terminal

Table 4.4-1

MARE ISLAND STRAIT DREDGING PROJECT NUMBER OF INDIVIDUAL BENTHIC ORGANISMS COLLECTED AND PERIODS OF DREDGING

	Month/Year									
	1/73	3/73	5/73	7/73	9/73	11/73	1/74	3/74	5/74	7/74
Dredging Dates	X					X		X		
Number of Individuals Per Liter										
Dredged Station		3.3			280	20.3		1.7		11.3
Undredged Station		8.7			501	468		393		383

X = occurrence of dredging
Source: Table 12, San Francisco District CE, DDS (Ref.3)

would be expected to be adverse but nonsignificant (Class III).

Disposal of the dredged sediments would be at the designated dredge disposal site at Carquinez Strait. Benthic organisms in the disposal area will be buried by the dredge spoils. Organisms in adjacent areas would be subjected to turbidity. Studies of benthic communities at dredge disposal sites have identified impacts to benthic communities at other sites. For example, at the designated dredge spoil disposal site near Alcatraz, impacts to benthic communities have been identified not only within the disposal area but also at a distance of 2,000 feet from the site (Segar 1988). Impacts to benthic communities at the Carquinez Strait dredge spoil disposal site would be expected to be less than at the Alcatraz site. The Carquinez Strait area has strong tidal currents that would rapidly disperse sediments rather than let them accumulate as happens at Alcatraz. The volume of material discharged annually at Carquinez Strait is also less than at Alcatraz (2 to 3 million cubic yards of material per year at Carquinez Strait compared to 4 million cubic yards at Alcatraz). Of the 2 to 3 million cubic yards of dredged material deposited annually at the Carquinez Strait site, the 90,000 cubic yards dredged annually at the Unocal Marine Terminal would contribute only 3 to 5 percent of the total. The Unocal sediments would consist of sand-sized particles with low pollutant loads. Therefore, impacts of Unocal Marine Terminal annual maintenance dredging on benthic communities at the Carquinez Strait disposal site are expected to be adverse but nonsignificant (Class III).

Discharge of segregated ballast water has the potential to introduce exotic species to the aquatic ecosystem of San Francisco estuary. Introduction of exotic species, including the Asian clam *Potamocorbula amurensis* introduced in 1986, has had a devastating effect on the benthic community of San Francisco estuary. Because Unocal tankers will primarily be taking on ballast in west coast ports the introduction of a successful exotic competitor is less likely than it would be from vessels which take on ballast in foreign ports. However, there is still the potential that invasive organisms in ballast water could have a significant impact to the benthic community (Class II impact). This impact could be avoided if discharge of ballast water in the Bay were prohibited for tankers servicing the Unocal Terminal. Segregated ballast water should be unloaded to the wastewater handling facility as unsegregated ballast water is.

Chronic inputs of toxins from the Unocal Marine Terminal could contribute to the pollutant body burden of benthic organisms in the vicinity of the Terminal. Of all the aquatic communities, the benthic community in the Unocal Marine Terminal vicinity would be most susceptible to impacts from the chronic input of pollutants associated with routine operations at the Terminal because many benthic organisms have low mobility. As discussed in Section 3.2, marine organisms of San Francisco Bay generally have elevated body levels of contaminants, but these contaminant levels are highest in organisms in South Bay and in the peripheral waterways, such as harbors, marinas, and industrial canals. Chronic inputs of contaminants from the Unocal Marine Terminal are low compared to other sources of pollution in San Francisco Bay. Table 3.2-8 shows pollutant levels in mussel tissue at several stations in San Pablo Bay. Two metals, cadmium and selenium, exceeded human health standards in mussels at the Unocal outfall. The cadmium levels, however, were lower than levels measured in mussels collected at Point Pinole. Therefore, the elevated cadmium levels in mussels are most likely more related to area-wide inputs than to inputs from the Unocal operations. Selenium, though, was much higher in mussels at the Unocal outfall than in mussels at other stations in San Pablo Bay. This pattern suggests that the elevated selenium is related to Unocal operations. The most likely source of selenium is from Central Valley crude oil. This oil is transported to the Unocal Refinery by pipeline and is not associated with operations at the Marine Terminal. Therefore, the data do not suggest that operations at the Unocal Marine Terminal are contributing significantly to the body burden of pollutants in benthic organisms. The impacts of chronic input of pollutants on the benthos from routine operations at the Unocal Marine Terminal are judged to be adverse but nonsignificant (Class III).

Fishes

Fishes could be impacted by routine operations at the Unocal Marine Terminal, such as noise and disturbance of ship traffic traversing to and from the Unocal Marine Terminal, maintenance dredging, and chronic inputs of pollutants. Suzuki et al. (1980) have reported studies showing that ship noise can affect fish behavior. These investigators believed that the sounds produced by large or high-speed vessels could frighten fish schools or cause them to change their migration routes. Studies have also been done which suggest that the noises produced by fishing vessels and by underwater construction causes avoidance behavior in fishes (Myrberg 1990). Other studies have shown only slight avoidance behavior by fishes in response to ship noise (Freon et al 1990; Neproshin 1978). Scientific SCUBA divers on Naples Reef in Santa Barbara have noticed that fishes scatter briefly as oil boats pass over the reef (Ebeling, personal communication 1985). Because ship noise represents a temporary disturbance and the ship traffic associated with operations at the Unocal Marine Terminal represents an incremental amount compared to the background noise of ship traffic in San Francisco Bay and along north coast tanker routes, noise and disturbance to fishes from routine operations at the Unocal Marine Terminal would be expected to be an adverse but nonsignificant impact (Class III).

Fish can be harmed or disturbed by turbidity associated with annual maintenance dredging at the Unocal Marine Terminal. Fishes have been found to become entrained rarely by the dredge itself (Herbold et al 1992). Fishes exposed to suspended sediments in the laboratory have been shown to suffer mortality as well as sublethal signs of stress (Soule and Oguri 1976; O'Conner et al. 1977; Neuman et al. 1982). Most fishes, however, will simply avoid the dredge and disposal areas during these operations. Dredged material disposal at the Alcatraz Disposal Site in Central Bay does not appear to cause mortality in fishes but has been observed to affect the movement of fish schools (Monroe and Kelly 1992). In a study of fish behavior at the Alcatraz Disposal Site, northern anchovy, white croaker, and shiner perch were observed to move away from the site immediately following a disposal event but returned within 1 to 2 hours. It is expected that fishes at the Carquinez Strait site would behave similarly to those at the Alcatraz Disposal site. Because dredging at the Unocal Marine Terminal would only occur once a year and the amount of material dredged would be relatively small, the impacts of maintenance dredging at the Unocal Marine Terminal on fishes are expected to be adverse but nonsignificant (Class III).

Chronic input of pollutants from routine operations at the Unocal Marine Terminal could add to the pollutant body burden of fishes in the San Francisco Bay estuary. For example, Whipple et al. (1987) have found that striped bass in the San Francisco Bay-Delta system contained relatively high levels of pollutants from several classes, especially metals and petrochemicals. Some of these pollutants showed strong correlations with poor health and condition, parasite burdens, and impaired reproduction. However, as discussed in Section 3.2 and the previous parts of this section, inputs associated with the Unocal Marine Terminal represent a small percentage of pollutant inputs in San Francisco Bay.

One measure of pollutant stress on fishes is by increased activity of certain enzymes. When fishes are exposed to certain organic pollutants, such as PAHs and PCBs, they increase the function of these enzymes. This increased enzyme activity can, thus, be used as a measure of exposure to pollutants. A relationship has been found between Mixed Function Oxidase activity, high organic contaminants, and reduced reproductive success. Measurements have been made of Mixed Function Oxidase activity in starry flounder in San Francisco Bay (Spies and Rice 1988; Spies et al. 1988). Starry flounder collected in the shallow waters of the Berkeley shoreline had the highest levels of Mixed Function Oxidase activity, while starry flounder from western San Pablo Bay had the lowest levels. Starry flounder from western San Pablo Bay also had a lower incidence of liver abnormalities than fish taken near Berkeley and Oakland.

These studies suggest that exposure to pollutants at the Unocal Marine Terminal is considerably less than in other areas of San Francisco Bay. These studies did not compare fishes in San Pablo Bay to unpolluted areas. However, the NOAA National Status and Trends program in environmental quality (NOAA 1987) compared sites from all over the country on the basis of contaminants found in fish livers. Oakland Harbor was overall one of the most contaminated sites and San Pablo Bay was neither among the most nor the least contaminated. If contaminant levels in fish livers and in bivalves are considered, sites in South Bay and Oakland are among the 15 most contaminated sites while San Pablo Bay is not on the list of 30 most contaminated sites. San Pablo Bay also was not on the list of 50 least contaminated sites. For the purposes of comparison of 12 metals measured in fish livers, concentrations in fishes in San Pablo Bay exceeded those in fishes in Bodega Bay only for copper. Chronic input of pollutants from routine operations at the Unocal Marine Terminal on fishes is judged to be an adverse but nonsignificant impact (Class III).

Marshes

Because no significant marshes are within 1 mile of the Unocal Marine Terminal, routine operations would not be expected to impact marshes. Oil spills from the Marine Terminal could impact marshes and are discussed below in the oil spill section of this analysis.

Birds

Disturbance

Seabirds, shorebirds, and waterfowl are common near the Unocal Marine Terminal but not abundant. Western gulls established 11 nests on the Terminal in 1990, pelicans may roost on the Terminal, and double-crested cormorants nest and roost in small numbers on the beacons and radar targets a short distance offshore. Shorebirds occur nearby, and a few ducks may rest on the water adjacent to the Terminal. To some extent, noise and activities resulting from normal operation of the Unocal Marine Terminal may contribute to the sparse abundance. However, the effect is not so great that birds completely avoid the area. A more plausible explanation is that birds preferentially select habitat elsewhere that provides more shelter, roosting or nesting sites, and greater access to food resources. Seabirds, shorebirds, and waterfowl are not habitat-limited in the San Francisco Bay estuary, and noise and activities at the Terminal does not appear to deprive birds of important habitat. Thus, disturbance produces an adverse but nonsignificant impact (Class III).

Discharges

Discharges and small chronic leaks and spills associated with the Marine Terminal would be below levels that would have direct impacts on birds. Effects such as soiling of feathers would be adverse but nonsignificant (Class III). Discharges from the Marine Terminal may ultimately contribute to deterioration in habitat and contamination of fish and invertebrate food resources consumed by birds.

As described in Section 3.2, several sources of contaminants affect the San Francisco Bay Area: urban and nonurban runoff, river inflow from agricultural lands in the Central Valley, municipal waste water, industrial releases, dredging, and oil/chemical spills (S.F. Estuary Project Pollution Report, cited in USFWS 1992). The most significant contaminants in regard to wildlife are cadmium, copper, mercury, selenium, and silver (Luoma and Phillips 1988, Ohlendorf and Fleming 1988a), DDT and metabolites, PCBs (Phillips and Spies 1988), and polycyclic aromatic hydrocarbons (PAHs; Wright and Phillips 1988).

Contaminants in the San Francisco Bay estuary both reduce the abundance of food for birds and directly affect the health of populations. Diving ducks which consume mussels and clams in these waters, especially scaup, scoters, and canvasback, are known to have elevated levels of selenium, silver, copper, mercury, zinc, and cadmium. Levels of selenium and mercury exceed that known to reduce or impair reproduction (J.Y. Takekawa, USFWS). Caspian and Forster's terns, black-crowned night-herons, and snowy egrets have been found to have organochlorines and mercury at levels associated with impaired reproduction and thinning of egg shells (Ohlendorf et al. 1988b).

Wastewater discharges can affect habitat in other ways. It is believed that vegetation changes, particularly in the South Bay, have been caused by sewage effluent discharges (76 percent of the total inflow occurs in the South Bay). Dominant vegetation in tidal wetlands has shifted to alkali bulrush from cordgrass and pickleweed, reducing habitat value for California Clapper Rails and the salt marsh harvest mouse (USFWS 1992).

Vessel Traffic

In the bays, waterfowl typically forage or rest in shallow waters. They are uncommon in the fast currents of the ship channel and are not likely to be affected by slow-moving tanker traffic. Along the outer coast, disruption of foraging activity of seabirds by large vessels is also unlikely (many birds will forage in the wake of ships); actual contact of large ships with seabirds on the water has never been reported. Tanker transport of oil by ships would be expected to produce nonsignificant impacts on birds (Class III).

Marine Mammals

The possibility exists for injury or death of marine mammals due to collisions with vessels. If impacts occurred, they would be significant because all species are protected under the Marine Mammal Protection Act of 1972. Within the bays, the marine mammal fauna typically includes only harbor seals, California sea lions, and harbor porpoises. Off the outer coast, the fauna (other than species listed as Threatened or Endangered) also includes fur seals, elephant seals, Dall's porpoise, and three species of dolphins. Although collision of ships with whales is documented (see below), injury or death of the smaller, fast-swimming marine mammal species has not been reported. Because of the remote chance of occurrence, the potential impacts of collision with nonlisted marine mammals from Unocal vessel traffic is judged nonsignificant (Class III).

Harbor seals and California sea lions are occasionally seen near the Unocal Marine Terminal but are uncommon. Harbor porpoises have not been reported in waters near the Terminal, and the closest stranding was at Point Richmond in central San Francisco Bay. Harbor seals haul out in the San Francisco Bay estuary only at locations that are relatively free from human disturbance; the nearest haul-out site to the Terminal is 16 km away at Tubbs Island. Noise and activities produced by continued operation of the Unocal Terminal will not result in loss of existing habitat and constitute a nonsignificant impact on harbor seals (Class III). California sea lions are much more tolerant of human activity, frequently hauling out on breakwaters, piers, and docks; disturbance from Unocal activities would produce a nonsignificant impact (Class III).

Rare/Threatened/Endangered Species

Rare, threatened, or endangered species which occur in the vicinity of the Unocal Marine Terminal include the winter run of the Chinook salmon (Federal Threatened, State Endangered), the spring run of the Chinook Salmon (State Species of Special Concern) and the California brown pelican (Federal and State Endangered). Chinook salmon might be subjected to some disturbance during maintenance dredging primarily due to turbidity. Turbidity during dredging would be expected to be so localized that impacts would be expected to occur only in the immediate vicinity of the dredging activity, However, because young chinook salmon are known to occur in the immediate vicinity of the Terminal and because the winter and spring runs are so reduced, the impacts of maintenance dredging are determined to be potentially significant (Class II). Impacts could be reduced to nonsignificant by dredging in July and August when winter and spring run smolt activity is lowest.

California brown pelicans (endangered), which use the bays in late summer and fall, are known to roost in small numbers at a few sites along the southern shore of San Pablo Bay (generally pilings and breakwaters at some distance from sources of disturbance). Any pelicans roosting near the Unocal Marine Terminal would be expected to be accustomed to noise and activity resulting from routine operations; any impacts would be nonsignificant (Class III).

Several birds listed as California Species of Special Concern may occasionally be seen in the area. These include the double-crested cormorant, the long-billed curlew, the California gull, the fulvous whistling duck and the Barrow's goldeneye, several species of foraging raptors (order Falconiformes), the black swift, and several species of passerines (perching birds of the order Passeriformes). Any impacts of routine operations on these species would consist of minor disturbance and slight degradation of water quality. Impacts would be adverse but nonsignificant (Class III).

Tanker traffic produces a risk of collision of vessels with whales. On the west coast, two collisions of tankers with large whales have been reported (National Marine Fisheries Service 1984). Also, examination of some beached carcasses of gray whales indicate collision by ships as the probable cause of death (Seagers et al. 1986). Whales only infrequently wander into the bays and, thus, the risk of death or injury from Unocal tankers is negligible. However, the potential for collisions definitely exists along the outer coast, especially in the Gulf of the Farallones, due to the heavy ship traffic. The likelihood of collisions would be greatest during the late summer and fall, when humpback and blue whales are numerous, and during the winter and early spring as many gray whales migrate through the area. Some observations have been made of bowhead whales changing direction in response to approaching ships (Richardson et. al. 1985); other whales also may actively avoid ships, thereby reducing the chance of contact.

Despite the potential for impacts, injury or mortality of whales from collisions is a very low probability event. This low probability of impact was stated in a recent Biological Opinion rendered by the National Marine Fishes Science in Section 7 Consultation under the Endangered Species Act for oil and gas development of the Santa Ynez Unit offshore Santa Barbara (National Marine Fisheries Service 1984). Because of the low probability, the National Marine Fisheries Service concluded that additional tanker activity, even in waters already subject to heavy traffic, would not be expected to produce a significant impact on endangered whales. Consistent with this opinion, it is determined that the potential for collision of ships with whales constitutes an adverse, but nonsignificant, impact (Class III) due to the very low probability of occurrence and the few individuals that potentially could be affected (see also Section 4.4.8, Cumulative Impacts).

Oil Spill, Product Spill, and Other Accident Conditions

Approach to Impacts Assessment

This assessment of impact utilizes both documented biological damage to resources from historic spill events as well as computer modeling to determine the vulnerability of the biological resources within the Bay, near the Marine Terminal and along the outer coast.

General Discussion of Impacts of Oil on Biological Resources

Documented biological damage from an oil spill has ranged from little apparent damage in the Apex Galveston Bay spill (Greene 1991) to widespread and long-term damage, such as the 1969 West Falmouth spill (Sanders 1977). The exact extent to which an oil spill can inflict long-term damage on biological communities is a subject of controversy (OCS Project Task Force 1977). Several studies have shown that recovery following a spill can take several years, but very little is known of the process of contamination i.e., the manner in which foreign compounds interfere with the normal functioning of living systems (Vandermuelen 1982). Some of the factors influencing the extent of damage caused by a spill are the dosage of oil, type of oil, local weather conditions, location of the spill, time of year, methods used for cleanup, and the impacted area's previous exposure to oil (Foster et al. 1986). Other levels of concern are the possibility of food chain contamination by petroleum products and the impact of an oil spill on the structure of biological communities as a whole. A summary of previous knowledge on the impacts of oil spills is contained in Anderson (1979) *An Assessment of Knowledge Concerning the Fate and Effects of Petroleum Hydrocarbons in the Marine Environment*, BLM (1979) *Final Environmental Impact Statement OCS Sale 48*, NRC (1985) *Oil in the Sea: Input, Fates, and Effects*, and Chambers Group (1987) *EIR/EIS Arco Coal Oil Point Project*.

Oil spilled into the ocean gradually changes in chemical and physical makeup as it is dissipated by evaporation, dissolution and mixing, or dilution in the water column. Various fractions respond differently to these processes, and the weathered residue behaves differently from the material originally spilled. Toxicity usually tends to decrease as oil weathers although a recent study by Thom et al. (1993) showed that weathered diesel oil was more toxic to bull kelp, (*Nereocystis luetkeana*) than unweathered diesel oil. The behavior of spilled oil is discussed in greater detail in Section 3.2.

Laboratory tests have demonstrated the toxicity of petroleum hydrocarbons for many organisms. Soluble aromatic compounds in crude oil are generally toxic to marine organisms at concentrations of 0.1 to 100 ppm. Planktonic larval stages are usually the most sensitive. Very low levels of petroleum, below 0.01 mg/L, can affect such delicate organisms as fish larvae (NRC 1985).

Biological impacts of oil spills include lethal and sublethal effects and indirect effects resulting from either habitat alteration and destruction or contamination of a population's food supply. Directly lethal effects may be chemical (such as poisoning by contact or ingestion) or physical (such as coating or smothering with oil). A second level of interaction is sublethal effects. Sublethal effects are those which do not kill an individual but which render it less able to compete with individuals of the same and other species.

Furthermore, because a major oil spill would have the potential to impact many components of the ecosystem, more complex secondary effects would be expected in addition to the primary effects of oiling. Although secondary effects are more difficult to document and have been difficult to predict, the disruption of community structure by a major oil spill could cause ecosystem changes that would last for many years. These ecosystem level effects can be complex and even contradictory, but changes in community structure have been observed in most locations, oils, and climates (Thomas 1982).

Computer Modeling to Predict Impacts from a Unocal Spill

Computer modeling was used to analyze the relative risk of important biological resources to contact with oil from a Unocal spill. We have used the trajectory analysis to predict whether each of the important biological resources would be at low, medium or high risk should an oil spill occur. These relative risks are thus conditional probabilities. The risk of a spill from Unocal's operation is analyzed in Section 4.2. It should be recognized that this probability is very low. Therefore, the absolute risk of any of the important biological resources being oiled as a result of Unocal's Marine Terminal operations is low. However, in the unlikely event that a spill were to occur some resources would be more likely to be contacted by oil than others. This information, when combined with sensitivities and vulnerabilities to oil of biological resources, will help in designing response and contingency plans. The criteria used to assign high, medium and low risk differs from resource to resource and is defined in the appropriate table for each resource. The receptor mode analysis was used to provide further insight on the risk of various sensitive areas to a spill.

This section also uses modeling of 14 oil spill scenarios to analyze the extent to which important biological resources might be contacted by oil from a range of oil spills that could occur as a result of Unocal's Marine Terminal operations. The methodology and assumptions used for the oil spill models are described in Section 4.2. These models were used in conjunction with GIS mapping of important biological resources. In predicting impacts to biological resources, assumptions were made about the areas where each resource would be most vulnerable to oil. These areas are generally the preferred habitat or the most productive areas for a given resource. The subsequent analysis focuses on the risk that oil would contact those crucial areas (the trajectory analysis) and the percentage of these crucial areas that would be oiled from each oil spill scenario (scenario analysis). It should be recognized that the areas that we identified as most crucial for each resource are not the only areas where that resource is found. Therefore if an identified area is not contacted by oil in oil spill scenarios, it does not mean that there will be no impacts on that particular resource. If an area identified as most important for a particular resource is not contacted by a scenario, the inference is that the majority of the population of the resource within the project area would not be contacted by oil for the modeled spill. Similarly, if the most important areas for a resource have a low probability of contact in the trajectory analysis, that resource would be at lower risk for a Unocal spill than one whose preferred areas had a high probability of contact.

Plankton

Background Information on Phytoplankton Sensitivity to Oil

Impacts on phytoplankton from oil pollution could range from lethal effects caused by high concentrations in the surface layers of the water column after a major spill to sublethal effects such as decreased photosynthesis and impaired growth from low-level concentrations. A number of laboratory studies have been conducted on the effects of oil on phytoplankton (BLM 1979). For sublethal effects from crude oil, it appears from laboratory data that phytoplankton cell division and photosynthesis can be depressed at hydrocarbon concentrations greater than 1 ppm. Lower concentrations (in the 10- to 30-ppb range) can stimulate photosynthesis for some species (Prouse et al. 1975). It is extremely difficult to predict the effects of a spill on phytoplankton because the phytotoxic effects of petroleum hydrocarbons differ in severity with respect to different phytoplankters and even to the same phytoplankter at different times of the year (Snow 1982).

Studies of oil spills have produced no strong evidence of major damage to phytoplankton communities. Without extensive baseline data and a good understanding of phytoplankton communities in the area, however, evidence of damage might be almost impossible to document even if it did occur. Because of the difficulties in documenting oil spill effects on plankton, resources are often not allocated to plankton studies in post-oil spill damage assessments. A few post-oil spill studies suggest impacts on phytoplankton. Water taken from the vicinity of the Shell spill at Martinez was found to inhibit growth of the diatom *Skeltonema costatum* (Fischel and Robilliard 1991).

On the other hand, in several oil pollution incidents, photoplankton stimulation has been recorded following the spill (Spies 1983). In the case of the Tsesis oil spill south of Stockholm, it was thought that increased phytoplankton biomass and primary productivity in the impacted area were due to decreased zooplankton grazing because zooplankton declined immediately following the spill (Johansson et al. 1980).

Vulnerability of Phytoplankton to a Unocal Spill

Phytoplankton populations on the outer coast would be expected to have a low vulnerability to an oil spill. Even if a large number of phytoplankters were affected during a spill, regeneration time of the cells (9 to 12 hours), together with the rapid replacement by individuals from adjacent waters, probably would readily obliterate any major impact on an open-coast phytoplankton community (NRC 1985). Levels of oil in the water column following major spills have been measured at between 3 and 500 ppb and have been found to return to background levels by 2 months following the spill (Gundlach et al. 1983). These relatively low levels of oil in the water column suggest that chronic effects on water column organisms are unlikely. For that reason, it is highly unlikely that an oil spill would have significant effects on phytoplankton on the open coast. Impacts to phytoplankton of a spill from a Unocal tanker in the open coast are judged to be adverse but nonsignificant (Class III).

Within the San Francisco Bay estuary, however, it is possible that an oil spill could have more severe impacts on plankton, especially if it coincided with the spring bloom in the southern reach, Central Bay, and San Pablo Bay, or with the summer bloom in Suisun Bay. Because the San Francisco Bay is a semi-enclosed system, phytoplankton might be exposed to the oil for a longer period of time than on the open coast. Furthermore, recruitment from adjoining unoiled areas might be less available. Phytoplankton communities in San Pablo and Suisun Bays might be particularly vulnerable to an oil spill because these areas are most isolated from recruitment from open ocean phytoplankton populations.

Phytoplankton levels in San Pablo and Suisun Bays have declined in recent years most likely as a result of decreased outflow from the Delta and invasion of the Asian clam (Lehman and Hymanson 1991), and a major oil spill would add to the stresses on these communities. Impacts could be particularly severe if an oil spill contaminated the null zone because this is an area of phytoplankton concentration and high productivity. If an oil spill suppressed the seasonal phytoplankton bloom, impacts on the entire estuarine food web could occur. On the other hand, if an oil spill caused an enhancement in phytoplankton productivity either by direct stimulation from low levels of hydrocarbons or destruction of grazers, eutrophication could develop. In a worst-case scenario, eutrophication could lead to oxygen depletion and fish kills. Impacts to phytoplankton of an oil spill within San Francisco Bay are judged to have the potential to be significant (Class I).

Background of Zooplankton Sensitivity to Oil

Impacts on zooplankton from oil spills could range from lethal effects for high oil concentrations in surface layers of the water column to sublethal effects, such as abnormal feeding and behavioral patterns. In the event of a major spill, zooplankton may consume increased levels of hydrocarbons while feeding. Laboratory studies show that zooplankton can be affected lethally by oil at concentrations greater than about 1 ppm and possibly as low as 0.1 ppm. Sublethal effects are observed in the 1-ppm range and include decreased feeding, inhibition and depression of growth from egg and larval stages, and interference with chemical reception mechanisms. Some zooplankton can accumulate hydrocarbons in their tissue (BLM 1979).

Most field studies of the effects of major oil spills have failed to detect any significant impacts on zooplankton populations. However, because zooplankton distribution and abundance are so variable in time and space, it is difficult to separate significant changes caused by oil spill effects from natural variation. Many investigations of oil spill effects have reported damage to individual zooplankters and/or ingestion of hydrocarbons. For example, following the Arrow spill in Chedubucto Bay, Nova Scotia, Conover (1971) observed zooplankters ingesting large quantities of small drops of Bunker C oil and eliminating them as fecal matter. Grose and Matson (1977) found that after the Argo Merchant spill, copepods had oil on their feeding appendages, in alimentary tracts, and on the surface of their bodies. One case in which a zooplankton kill was documented was in the Amoco Cadiz spill where, in an area in close proximity to the spill, zooplankton mortality was high (Sonain et al. 1979). Furthermore, in one species, *Temora longicornis*, the very low values of trypsin and amylase activity of the surviving individuals reflected a low metabolic level and, consequently, a precarious physiological state.

Johansson et al. (1980) reported severe effects of the Tsesis spill on zooplankton in the immediate vicinity of the wreck where zooplankton biomass declined substantially during the first few days after the spill.

Within 5 days, the zooplankton biomass was reestablished. Oil contamination of zooplankton was recorded for over 3 weeks.

Vulnerability of Zooplankton to a Unocal Spill

The most significant impacts of a major oil spill on the zooplankton from the Unocal project would occur if the spill happened in the spring and summer months when abundance is highest. Severe kills of zooplankton from a large spill would probably damage only the zooplankton in the immediately affected surface layers. Lethal effects would occur only if concentrations were greater than 0.1 ppm in the water column. This concentration is in the upper end of the range of water column concentration measured following major spills (Gundlach et al. 1983). Sublethal effects could include disruption of feeding behavior, growth inhibition of some larval and egg stages, and interference with chemical reception.

On the north coast, the recovery of an oil-impacted zooplankton community would be expected to be fairly rapid, mainly because of recruitment from other areas and because the intrinsic zooplankton biological characteristics of wide distributions, large numbers, short generation times, and high fecundity (NRC 1985). The impacts to zooplankton of a spill from a Unocal tanker on the open coast would be expected to be adverse but nonsignificant (Class III).

More severe impacts on zooplankton might be expected if an oil spill occurred within San Francisco Bay, especially in the northern reach. Species that would be particularly vulnerable would be the copepod *Eurytrema affinis*, which is most abundant in Suisun Bay at salinities less than 10 parts per thousand, and the opossum shrimp, *Neomysis mercedis*, which occurs in highest abundance in Suisun Bay and the western Delta at salinities between 10 and 20 parts per thousand. These species would be particularly susceptible to an oil spill because of their narrow distributions and because populations of both species have declined in recent years. If oil concentrates in the null zone, impacts would be especially severe. Impacts to opossum shrimp would have implications further up the food chain because opossum shrimp are a key item in the diet of juvenile striped bass. The impacts to zooplankton of a Unocal spill within the San Francisco Bay estuary are judged to have the potential to be significant (Class I).

Relative Risk to Plankton from a Unocal Spill

The most sensitive area for plankton within the San Francisco Bay estuary is in the null zone where phytoplankton populations and important zooplankton species such as the opossum shrimp (*Neomysis mercedis*) tend to concentrate. During periods of low flow, such as during the recent drought, the null zone is located in the eastern part of Suisun Bay and the western Delta. During periods of high river flow it is located throughout Suisun Bay and into Carquinez Strait. Plankton populations in eastern San Pablo Bay and Suisun Bay would be more vulnerable to an oil spill than populations in Central and South Bay because recruitment from the Pacific Ocean would occur less readily in the eastern bays than it would in the Central Bay and the northern part of South Bay. Within San Pablo and Suisun Bays phytoplankton and zooplankton populations are most abundant over the shallow areas.

Trajectory modeling was used to compare the relative risk of plankton assemblages to a spill that originated at the Unocal Terminal itself and to a spill that originated from tankers serving the Unocal Terminal. An oil spill that originated from the Unocal Terminal would be most likely to affect the nearby waters of San Pablo Bay and Carquinez Strait. If moderate or heavy oil (greater than 100 bbl per square km) contacted an area, direct mortality of plankton organisms would be expected to occur. Moderate oil as defined by the model would indicate a slick with a dark brown or black appearance. If a spill occurred at the Terminal, the waters immediately around the Terminal and the western half of Carquinez Strait would have the greatest chance of moderate oiling. The shallow waters of San Pablo Bay would have less than a 2-percent chance of moderate oiling and those of Suisun Bay would have less than a 0.2-percent chance of moderate oiling. The receptor mode analysis confirms that Suisun Bay is at very little risk from a spill at the Unocal Terminal. Middle point in the middle of Suisun Bay would have only a 0.5-percent chance of contact with oil from a spill at the Unocal Terminal.

Spills from Unocal tankers have the greatest probability of contacting waters near the ship channels through central and northern San Francisco Bay and San Pablo Bay. The ship channels are areas dredged to allow sufficient clearance for tankers and are not confined by any structure. The waters of the ship channels and western Carquinez Strait have a 12- to 17.5-percent chance of moderate oiling from a spill along tanker routes. The shallow waters of San Pablo Bay would mostly have less than a 10-percent chance of medium oiling while the waters of Suisun Bay would have less than a 6-percent chance of moderate oiling. The receptor mode analysis showed that if a spill occurred at Martinez, which is the eastern most segment of the Unocal tanker route, Middle Point in Suisun Bay would have a 10.8-percent chance of contact with oil.

In summary, of the areas which are most sensitive for plankton, Suisun Bay which has the most unique and vulnerable plankton populations and where the null zone is located during years of normal rainfall has a very low risk of being significantly impacted by an oil or product spill from the Unocal Terminal (less than a 0.2-percent chance of moderate or heavy oiling) and a relatively low (less than 6-percent chance of moderate or heavy oiling and about an 11-percent chance of contact with oil) of being impacted by a spill from Unocal tankers. Carquinez Strait, on the other hand, where the null zone may be during period of heavy outflow has a very high risk of oiling.

For a spill from a Unocal tanker traveling up the outer coast of northern California it was assumed that the areas of upwelling and of high zooplankton volumes would be the most sensitive to an oil spill. The trajectory model showed that oil spill risk was distributed relatively evenly along the tanker routes with the highest risk being near the Golden Gate and from Cape Mendocino north. The area around Point Reyes and just south of San Francisco Bay is an upwelling area and this area would have a relatively high risk of moderate oiling from a spill from Unocal tankers. The area around Cape Mendocino is also an upwelling area with relatively high risk of moderate oiling. If a spill occurred during the spring plankton bloom and these upwelling areas were subjected to moderate or heavy doses of oil, there could be localized significant impacts throughout the food chain. On a regional level, approximately 5 percent of the total area of identified areas of upwelling are at the highest levels of risk of moderate oiling (probability greater than 1.5 percent) from a spill from Unocal tankering. Unocal tankering, then, represents a relatively high local risk but a low risk on a regional level.

Zooplankton volumes are highest around Trinidad Head. Approximately 8.5 percent of this high volume area is in the highest risk zones (greater than 1.5 percent) for moderate oiling from a spill from Unocal tankers. Zooplankton, then, seems to be at a relatively low overall risk of direct mortality from moderate oiling from a Unocal tanker spill although there would be a relatively high probability that a portion of the densest zooplankton area would be contacted. Furthermore, if a Unocal tanker spill oiled one of the major upwelling areas around the Golden Gate or off Cape Mendocino during the spring bloom, zooplankton could be significantly impacted on the local level by loss of its food base.

The overall risk of localized effects to outer coast plankton from a Unocal tanker spill is high. Regional effects, on the other hand would not be expected because only a small percentage of the densest phytoplankton and zooplankton areas would be likely to be moderately or heavily oiled from a spill.

Oil Spill Scenarios

Scenario spills were used to estimate the range of impacts on plankton that could occur from reasonable worst case oil spills associated with operations at the Unocal Marine Terminal and with tanker operations to and from the Terminal. The percentage of open water that would be contacted in each bay for each of the modeled scenarios was used to determine the magnitude of potential impacts to plankton. These percentages are shown in Table 4.4-2. Because impacts would be most severe if the spill occurred during a phytoplankton bloom, the table indicates whether or not the timing of the modeled spill coincides with the yearly bloom.

Of the modeled scenarios, Scenarios 1, 2, 7, 8, 10, 11, and 12 would not be likely to have significant impacts on plankton. Scenario 7, a 500-bbl product spill at the Terminal in February would have the least effect on plankton because it would occur before the annual phytoplankton bloom and because less than 10 percent of the open water in any bay would be reached by oil from the spill. Scenario 1, a 1,000-bbl crude oil spill at the Terminal in March, would contact a substantial percentage (38.5 percent) of the open water habitat of San Pablo Bay during the annual bloom. This spill could have a localized, short term effect on plankton populations within San Pablo Bay during the year the spill occurred. Plankton populations would be expected to recruit from the surrounding bays the following year, however, and the effects of the spill would be short term. Scenario 2, a 1,000-bbl crude oil spill at the Terminal, and

Table 4.4-2

PERCENTAGE OF PLANKTON HABITAT IN SAN FRANCISCO BAY ESTUARY CONTACTED BY OIL SPILL SCENARIO

Bay	Scenario*											
	1	2	3	4	5	6	7	8	9	10	11	12
South San Francisco Bay	0	0	4.2	0	0	0	0	0	11.2+	38.37	16.69	20.7
Central Bay	0	0	69.75	0	0	0	0	0	96.88+	98.52	0	0
North Bay	0	0	97.47	0	0	0	0	0	89.72+	49.99	0	0
San Pablo Bay	38.5+	1.62+	85.35	59.83+	0	0	7.43	2.69	77.53+	0.32	0	0
Carquinez Strait	0	99.26+	100.00	94.8+	0	0	0	33.23	13.32+	0	0	0
Suisun Bay	0	7.10+	33.93	21.84	48.93	16.97+	0	0	0	0	0	0
West Delta	0	0	3.67	0	0	1.69+	0	0	0	0	0	0
Bay Regional Total	9.0	2.7	43.54	17.1	4.9	1.7	1.73	1.14	43.6	34.5	6.96	8.6

\+ Modeled spill occurs during phytoplankton bloom in the affected subregion of San Francisco estuary.
* Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.

Scenario 8, a 500-bbl product spill at the Terminal, would affect a substantial portion of Carquinez Strait. These spills would occur during the summer when outflow is low and the null zone would be located in east Suisun Bay and the Delta not Carquinez Strait. Because of the swift movement of water through the Strait, recruitment from surrounding bays would be rapid and impacts would be short term. Scenarios 11 and 12, 1,000-bbl crude oil spills at Anchorage 9, would only impact the northern part of South Bay. Recruitment from the Pacific Ocean would be rapid and any impacts would be short term. Finally, although Scenario 10, a 100,000-bbl tanker spill near Alcatraz in September, would impact substantial portions of northern South Bay, Central Bay, and North Bay, the spill would not occur during the time of the bloom and recruitment from the Pacific Ocean would be rapid.

Scenarios 3, 4, 5, 6, and 9 would be expected to have the potential to cause substantial adverse impacts to plankton. Spills 3, 4, 5 and 6, large spills near the Terminal (3 and 4) or spills at the east end of Carquinez Strait, would be expected to have substantial adverse impacts to plankton because each of them affected more than 10 percent of the open water habitat in Suisun Bay. Phytoplankton and zooplankton populations in Suisun Bay have been negatively impacted by low outflows from the Delta and by the invasion of the Asian clam, *Potamocorbula amurensis*. The stress of an oil spill might be enough to cause these already stressed populations to decline to a point that they could not recover for many years. These spills could be especially detrimental to plankton because they would have the potential to affect the dense phytoplankton and zooplankton populations in the null zone. Zooplankton species particularly at risk from a spill which affected a substantial portion of the open water habitat in Suisun Bay include the opossum shrimp *Neomysis mercedis* and the copepod *Eurytemora affinis*.

Scenario 9, a 100,000-bbl crude oil spill near Alcatraz in March, would also have the potential for significant impacts to plankton even though it would not oil Suisun Bay. This spill would affect almost all of Central Bay, North Bay and San Pablo Bay during the spring phytoplankton bloom. At this time of year of potentially high outflow, the null zone could be located in western Carquinez Strait or even the east end of San Pablo Bay. This spill would certainly have a major impact on phytoplankton populations during the year following the spill. It is possible that, particularly in San Pablo Bay, which is a considerable distance from the open ocean, plankton populations might take several years to recover.

Of the two oil spill scenarios that were modeled on the outer coast, Scenario 1 would contact 2 percent of the total upwelling area during March when the spring phytoplankton bloom would occur. In this Scenario, oil spread into the Farallons and the Point Reyes area, a major upwelling site, and also spread into the major upwelling areas south of the Golden Gate. This spill would have a locally significant impact on phytoplankton. Phytoplankton would be expected to recover rapidly because of the high amount of mixing in this area and significant impacts on phytoplankton would be expected to be limited to one season. However, there could be longer term impacts farther up the food chain. Loss of the base of the pelagic food chain could impact the planktonic larvae of fish or invertebrate species and could cause a year class to fail. Since many species of fishes and invertebrates recruit successfully only every several years for natural reasons, effects of loss of a season of phytoplankton in a critical area could have long term effects on other species.

Scenario 2 spread oil into 9.6 percent of the upwelling areas. This spill was modeled for October; therefore, it would not coincide with a spring phytoplankton bloom. If it did not occur during the bloom this spill would be expected to have nonsignificant impacts on phytoplankton.

Neither of the modeled outer coast scenarios contacted the densest zooplankton area off Trinidad Head. However, zooplankton in the area around the Golden Gate might suffer localized mortality from Scenario 1 as well as significant indirect impacts from the loss of their food base from impacts to phytoplankton during the spring bloom.

Benthos

Background of Benthos Sensitivity to Oil

Impacts to intertidal communities have been amongst the best documented oil spill effects (Chan 1973; North et al. 1965, Foster et al. 1971; Vandermeulin 1977). Impacts to subtidal benthic communities, on the other hand, have been much more difficult to document (Fauchald 1971; Spaulding 1989). Even for intertidal communities that are comparatively easy to study and for which a baseline existed prior to the spill, impacts have ranged from the destruction of millions of intertidal invertebrates (Chan 1973) to no apparent effect (Chan 1987). The great variability between documented effects of different oil spills makes oil spill impacts on the benthos particularly difficult to predict.

Rocky Intertidal

Most studies of oil spills have shown that rocky intertidal communities tend to suffer a harmful impact. Oil represents a physical as well as a chemical hazard, and intertidal organisms are especially vulnerable to the physical effects of oil (Percy 1982). Sessile species, such as barnacles, may be smothered while mobile animals, such as amphipods, may be immobilized and glued to the substrate or trapped in surface slicks in tidepools. Investigations of the 1969 Santa Barbara Oil Spill (Foster et al. 1971; Straughan 1971) indicated that the hardest hit area was the upper intertidal region where entire populations of the acorn barnacle, *Chthamalus fissus*, were killed by smothering. *Balanus glandula*, a larger barnacle, protruded above the oil and survived. Foster et al. (1971) also documented severe damage to intertidal surf grass (*Phyllospadix torreyi*). Similarly, Chan (1973) in a study of the January 1971 San Francisco tanker spill determined that large numbers of intertidal organisms died from being smothered by oil, with certain species, such as acorn barnacles and limpets, suffering the highest mortality. Comparison of pre-oil and post-oil transect counts showed a significant decrease in marine life after the oil spill in the affected area. Marine snails suffered less mortality than the sessile barnacles and other sedentary organisms.

It has been hypothesized (Hancock 1977) that organisms in the upper intertidal areas where the oil dries rapidly are more apt to be affected by physical effects of oil, such as smothering, whereas organisms in the lower intertidal are more exposed to the chemical toxic effect of the liquid petroleum. Straughan (1971), for example, following the Santa Barbara oil spill, showed reduced breeding rates in the lower intertidal organisms *Pollicipes polymerus* and *Mytilus californianus* but not in the upper intertidal barnacles *Chthamalus fissus* and *Balanus glandula*. She suggested that the lower intertidal organisms suffered this sublethal effect because they were more exposed to the liquid petroleum for long periods of time than the upper intertidal barnacles.

The secondary impacts of oil spills may upset the balance of intertidal communities (Southward 1982). If, for example, grazing herbivores are killed, a proliferation of opportunistic algal species may occur. Rolan and Gallagher (1991), for example, found a temporary increase in the opportunistic alga, *Enteromorpha*, following the Esso Bernicia spill in the Scotland Islands of Great Britain. The growth of algae may be followed by recolonization of some grazing herbivores, probably in larger number but with fewer species than before, and the ecosystem may undergo a series of fluctuations with different dominants before diversity and a state of equilibrium are restored.

If an intertidal area does suffer severe damage from an oil spill, it may take years for complete recovery. Vesco and Gillard (1980) have summarized data on recovery of Pacific Coast intertidal communities from disturbances. Recovery times of populations ranged from 1 month to 10 years, but complete recovery of a community (i.e., all populations reestablish) typically requires at least 2 years and often much longer. Many factors influence the length of recovery times, including the severity of the disturbance, the year or time of year of the disturbance, the geographic location, the amount of disturbance to which a population is normally exposed, the abundances of species before the disturbance and in nearby undisturbed areas, and the life history of the species. Similarly, Southward (1982) in a summary of the effects of oil on marine ecosystems concluded that intertidal and subtidal communities that have been affected either by chronic or catastrophic oil pollution can take a long time to recover, undergoing slow and subtle changes.

A recent MMS-funded study of recovery of rocky intertidal communities of central and northern California (Foster et al. 1991) suggested that the high intertidal, algal-dominated *Endocladia/Mastocarpus* community would take 1 to 6 years to recover in places where a large area had been decimated, while the midintertidal mussel bed assemblage would be likely to take more than 10 years to recover from a disturbance that affected a large area.

Documented recovery times of intertidal communities from actual oil spills have varied, but have been generally consistent with the above predictions. Chan (1977) found that within a period of 5 years, marine invertebrate populations on Duxbury Reef had recovered from the 1971 oil spill at the Golden Gate Bridge. The recovery of all intertidal plants to pre-oil status occurred within 2 years. Rolan and Gallagher

(1991) found that, for the Esso Bernicia spill in the Shetland Islands of Great Britain, the biological communities of the rocky intertidal returned to very nearly normal populations within 1 year, with the exception of areas that had been mechanically cleaned. Cleaned areas had still not recovered after 9 years.

Sandy Intertidal

Although less visible than impacts to rocky intertidal communities, the marine life of sandy beaches also has been documented to suffer impacts from oil spills. Following the 1969 Santa Barbara spill, Foster (1974) reported mortality of the polychaete worm *Euzona*, the mole crab *Emerita*, and the beach hopper *Orchestoidea*. Trask (1971), however, was unable to form any definite conclusions about the impact of the Santa Barbara spill on sandy beaches because of a lack of baseline data. A study in another part of the world by Wormald (1976) showed that the meiofauna of littoral sandy beaches in Picnic Bay, Hong Kong, was almost totally destroyed within 4 days after pollution by heavy diesel oil. Similarly, following the Urquiala spill, Gundlach and Hayes (1978) noted that at several heavily oiled, fine-grained beaches, thousands of dead amphipods were found along the high-tide swash lines. In studies of the Exxon Valdez spill, Houghton et al. (1991) found only the crustacean component of the intertidal soft bottom fauna reduced at oiled sites compared to unoiled sites. At sites that had been oiled and then cleaned by hydraulic flushing, however, littleneck clams and polychaete worms, as well as crustaceans, were reduced compared to unoiled sites.

Sand beach communities such as those on the outer coast would probably recover from a spill more rapidly than rocky communities because of the mobile nature of most sandy beach species and their adaptation to the continual disturbance of shifting sands. Gundlach and Hayes (1978) predicted that recovery of a sand beach may occur within a year, depending on the extent and persistence of the oil. On the other hand, fine-grained intertidal mudflat communities might be expected to retain the oil for a long time as occurred in the 1969 west Falmouth spill (Blurer and Sass 1972). The continued presence of oil in the sediments would prevent recovery.

Subtidal

Compared to the readily observable impact on intertidal communities, impacts on benthic subtidal communities have been more difficult to document. This lack of documented impacts has been found both in the shallow (2 to 20 m) and deep (>20 m) subtidal. However, the studies that have shown impacts have generally been of shallow water benthic habitats. Southward (1982), in a literature summary on effects of oil on marine communities, reports that little evidence of oil spill damage to offshore benthic communities has been reported, but he points out that the lack of identified impacts may be a result of a lack of knowledge of this ecosystem itself. Impacts on subtidal communities would be expected to be related to the amount of oil that sinks to the bottom. Johansson et al. (1980) reporting on the Tsesis oil spill, noted from sediment trap data that a total sedimentation of 30 to 60 tons of oil was estimated in the 42-square-kilometer (16 square miles) impacted area. This amount corresponded to 10 to 15 percent of the unrecovered oil. The mean water depth of the area affected by the Tsesis spill was 20 to 25 m. Similarly, 8 percent of the oil from the Amoco Cadiz spill was estimated to end up in subtidal sediments (Gundlach et al. 1983). In contrast, in the case of the World Prodigy spill at the mouth of Narragansett Bay in Rhode Island, impacts of the spill on the benthic community were estimated to be minimal because of the limited oil reaching the sea floor (Spaulding 1989). Similarly, in shallow subtidal SCUBA diving surveys following the 1988 Nestucca spill in Gray's Harbor, Washington, no evidence of subtidal oil deposits was found, and no sediment samples contained oil and grease above detection limits (Carney and Kvitek 1990).

Fauchald (1971) sampled the deepwater benthos of the Santa Barbara Channel at various time intervals (immediately after, 2 to 4 months after, and 8 months after) following the 1969 oil spill. He compared post-spill grab samples with historical data from the State Water Quality Control Board studies (Allan Hancock Foundation 1965). Although differences in the post-spill and historical data were noted, the differences were well within the expected variability for this very patchy community. He could find no effects directly attributable to the oil spill but, because of the natural variability of the community and the minimal amount of baseline data, the study had very poor power to detect effects.

In contrast, Dauvin (1982) reported that, immediately following the Amoco Cadiz oil spill, mortality of some sublittoral species, particularly the amphipods, occurred evidently as a result of the toxic effects of aromatic hydrocarbons. A proliferation of some opportunistic polychaete species followed concurrently with a complete absence of recruitment in some other species. Gradually, the community showed a tendency to return to prespill status.

Elmgren et al. (1983) reported a complicated response by the benthos to the Tsesis oil spill. Within 16 days, benthic amphipods of the genus *Pontoporeia* and the polychaete *Harmothoe sarsi* showed reduction to less than 5 percent of prespill biomasses at the most impacted station. The clam *Macoma balthica* was more resistant and showed little or no mortality, but the interstitial community was affected with ostracods, harpacticoids, tubelleria, and kinorhynchs showing clear reduction in abundance, while nematodes as a group were more resistant. In the winter following the spill, gravid *Pontoporeia affinis* females showed a statistically significant increase in the frequency of abnormal or undifferentiated eggs. Not until the second summer were the first signs of recovery, noted by increases in amphipods, *H. sarsi* and harpacticoids, evident at the most impacted station. In the area where amphipods had been virtually eliminated, an unusually heavy recruitment of *M. balthica* occurred. This increase in *M. balthica* most likely resulted because deposit-feeding *Pontoporeia* killed by the spill normally destroys many newly settled *M. balthica* juveniles. Three years after the spill, *Pontoporeia* biomass was still depressed, and *M. balthica* abundance was inflated. The investigators predicted that full recovery was likely to require more than 5 years and might take a decade.

Reviewers of oil spill literature (Dauvin 1982; Spies 1983) have concluded that response of the benthos to an oil spill usually follows predictable stages. The first phase is a short-term mortality of the more sensitive species. This phase is followed by a proliferation of opportunistic species. Finally, a gradual return to the prespill community composition occurs. These conclusions are based primarily on studies of shallow water benthic communities.

Most studies on the effect of oil spills on kelp have failed to detect direct negative impacts. The mucilaginous coating on the kelp is thought to protect it from the direct effect of oil. For example, Foster et al. (1971) studied the impacts of the Santa Barbara spill on kelp beds. The floating fronds held large quantities of oil, changing the color of the beds from brown to black. Most of the oil did not stick to healthy fronds, however, perhaps because of the natural covering of mucus on blades and stipes, and with changing winds, currents, and tides, most of the oil held by the kelp was eventually released. Post-spill surveys detected no abnormal decay or damage in the plants after the initial oil dose. In over 200 dives in Santa Barbara kelp beds by University of California at Santa Barbara researchers, no oil was noticed on the bottom and there were no obvious changes in the subtidal environment.

Similarly, in a discussion of the Tampico Maru spill, Neushul (1970) noted that not only was kelp apparently unharmed by the oil, but because destruction of grazing urchins freed it from its most significant predator, it proliferated following the spill. The kelp then went through a series of resurgent fluctuations in which it was destroyed by storms and then returned to very high levels of growth. Thus, while the spill did not kill kelp, the secondary effect was to cause the kelp community to undergo a series of unstable fluctuations.

In contrast to these studies in which oil spills did not damage kelp, Thom et al. (1993) found that the tissues of bull kelp, *Nereocystis luetkeana*, were damaged following direct exposure to several oil types including intermediate fuel oil, diesel fuel and Prudhoe Bay crude oil. Oil significantly affected blade and stipe photosynthetic rate and respiration. Of the oil types tested weathered diesel oil was the most toxic and weathered crude oil the least.

Furthermore, little attention has been paid to the impacts of oil on juvenile stages of kelp. Dean and Deysher (1983) have found that kelp gametophytes are much more sensitive to environmental conditions than adult kelp. An oil spill which had no discernable effect on adult kelp plants might still impact recruitment.

Finally, although the majority of evidence suggests that kelp plants would suffer at most minor damage from a spill associated with tankers, other inhabitants of the kelp community might be much more sensitive. For example, Ebeling et al. (1971) reported that the mysids of the kelp canopy showed a dramatic reduction in number following the 1969 Santa Barbara spill. Moreover, oil can cling to kelp and cause the surrounding shoreline to be repeatedly doused by oil as happened in the recent Avila spill (Togstad 1993).

Vulnerability of Benthos to a Unocal Spill

Impacts of an oil spill on the intertidal and subtidal benthic communities of the outer north coast could range from widespread destruction to undetectable. For example, Chan (1973, 1985, 1987) studied the effects of three oil spills near the entrance to San Francisco Bay on his intertidal transects on Duxbury Reef. The spill from the 1971 collision between the oil tankers Arizona Standard and Oregon Standard had dramatic effects on the intertidal biota. Within Chan's transects, the comparison between pre- and post-oil abundances revealed that between 4.2 to 7.5 million invertebrates, chiefly barnacles, were killed by the Bunker C oil. Approximately 12,000 mussels (*Mytilus californianus*) out of an estimated population of 3 million were killed. Mobile organisms, such as shore crabs (*Pachygrapsus crassipes*) suffered less severe mortalities than the sessile invertebrates. Marine algae, mainly *Endocladia muricata* and *Gigartina* spp., in the upper intertidal zone of Duxbury Reef suffered die-offs of the thallus bodies. Like the marine algae, surf grass (*Phyllospadix scouleri*), a flowering plant of the lower intertidal, had degraded leaves. Conversely, the filamentous alga, *Urospora pencilliformis*, underwent a post-spill bloom on the oil that covered the mussel bed. Marine plants recovered within 2 years and marine invertebrates within 5 (Chan 1977). In the 1984 spill of the oil tanker Puerto Rican at the Golden Gate, however, no conclusive damage to intertidal invertebrates from oil was documented (Chan 1985; Herz and Kopec 1985). Similarly, in the 1986 spill from the APEX Houston oil barge in the shipping lanes west of the Golden Gate Bridge, no effect on the intertidal marine life of Duxbury Reef was documented (Chan 1987). In the APEX Houston spill, the lack of damage was probably related to the fact that much of the oil was carried south of Duxbury reef. While oil came ashore in this spill, it did not cover the intertidal zone with a thick suffocating coat of oil as occurred in 1971. Impacts of a oil spill on the intertidal zone of the outer coast are judged to have the potential to be significant (Class I).

Impacts of an outer coast oil spill on the subtidal populations of California's north coast would be even more difficult to predict than those on the intertidal biota. Impacts to the subtidal benthos would depend on how much of the oil sank to the bottom before it weathered, was cleaned up, or came ashore. In general, impacts to the subtidal biota would be expected to be less severe than those on the intertidal because it is less likely that globs of oil would become stranded on the ocean bottom the way they can in the intertidal. The high energy of the northern California outer coast environment would be expected to stir up the bottom and disperse sunken oil. The most severe impacts on the subtidal benthos would probably occur if oil happened to reach any of the unique subtidal populations that occur off the northern California coast. For example, oil could have a significant impact if it reached the populations of the hydrocoral *Allopora californica* on Cordell Bank. This species only occurs in certain areas and does not recruit widely. Thus, an impacted population might not recover for many years. This oil spill could, in a worst case, have a significant impact (Class I) in the subtidal benthos of the open coast.

Oil would not be expected to have a significant direct impact on north coast kelp beds. Observations on effects of oil spills on *Macrocystis* (Foster et al. 1971) have failed to document effects. The mucus coating of the kelp may protect it from oiling. If oil, however, becomes trapped in kelp as occurred in the 1992 Avila Spill it might be necessary to remove the kelp to clean up the oil (Togstad 1993). Much of the kelp off northern California is the elk kelp *Nereocystis leutkeana*. The recent study by Thom et al. (1993) did document loss of coloration and death of bull kelp following the Tenyo Maru spill off the coast of Washington state. However, even if damage occurred, *Nereocystis* is an annual and would be expected to recover rapidly. An oil spill off the open coast, then, would be expected to have adverse, but nonsignificant impacts on kelp because of the expected rapid recovery time of the kelp if damage occurred (Class III).

The impacts of an oil spill on the benthos within San Francisco Bay could well be more pervasive and longlasting than on the outer coast because oil can become entrapped within the semienclosed system of the bay and be repeatedly redistributed into the sediments. For example, one of the most devastating and persistent oil spills ever documented was the 1969 spill from the barge Florida off West Falmouth, Massachusetts (Sanders 1977), which poured about 180,000 gallons of No. 2 fuel oil into the waters of Buzzards Bay. There was an immediately observable massive kill of fishes and invertebrates. In some of the most affected areas, almost no species of animal life persisted. The opportunistic, pollution-resistant worm *Capitella capitata* explosively increased in numbers shortly after the spill. Subtidally, the zone of oil pollution spread, a phenomenon that continued for years after the spill. Even after more than 20 years, the ecosystem of Buzzards Bay is not considered to have completely recovered (Holloway 1991).

Although the potential exists for an oil spill in the San Francisco Bay estuary to cause the sorts of catastrophic biological impacts that occurred in Buzzards Bay, the recent Shell spill of 400,000 gallons of crude oil at Martinez had primarily localized effects (Fischel and Robilliard 1991). Benthic organisms were absent after the spill in the upper parts of Peyton Slough where oil was present in high concentrations in the sediment.

The benthos of San Francisco Bay is dominated by introduced opportunistic species. As discussed in Section 3.3, the benthic community of the northern reach appears to have low diversity and low stability. Studies near the Unocal Marine Terminal have documented three dramatic shifts in dominant species within the last decade (Entrix 1987; Robilliard et al. 1989a). Until 1982, the small clam *Gemma gemma* was the numerical dominant. This species was reduced by strong flooding in 1982 and 1983 and was replaced by the clam *Mya arenaria* and the amphipods *Ampelisca abida* and *Grandidierella japonica*. These species were in turn replaced by the invasion of the Asian clam *Potomocorbula amurensis* in 1986. A large oil spill that resulted in the incorporation of oil into the sediments could cause another dramatic shift in species composition in this unstable benthic community. It is possible that an oil spill in the northern reach might reduce the number of Asian clams, but it is more likely that an oil spill would selectively impact more sensitive benthic species, such as amphipods, and cause the domination of the Asian clam to become even more complete. An oil spill within San Francisco Bay estuary would have the potential for significant impacts to the soft bottom subtidal benthos (Class I).

Just as oil in soft sediments within bays appears to persist longer than oil on open coast sand beaches, rocky substrate within San Francisco Bay would be exposed to oil for a longer time than rocky intertidal habitat on the north coast. Open coast intertidal rocks appear to be naturally cleaned by wave action. Oiled rocks within the Bay, however, would under go little natural cleaning. An oil spill could have significant impacts on rocky intertidal communities within San Francisco Bay estuary (Class I).

Two of the most sensitive benthic invertebrate resources that would be at risk from an oil spill in San Francisco Bay are Dungeness crab (*Cancer magister*) and the California bay shrimp (*Crangon franciscorum*). The juvenile stages of Dungeness crab are found throughout San Francisco Bay, but especially in San Pablo Bay (see Section 3.3.1.2.). The juvenile stages of this species might be particularly vulnerable to oil.

The California bay shrimp might be particularly vulnerable to an oil spill because its distribution is limited to the less saline waters of the San Francisco Bay estuary and its population has been declining in recent years (see Section 3.3.1.2). An oil spill could have significant adverse impacts on Dungeness crab or California bay shrimp (Class I).

Another marine resource within San Francisco Bay that would be expected to be particularly vulnerable to oil spill impacts is eelgrass (*Zostera marina*). Many studies on the biological impacts of oil spills have documented impacts to marine grasses. For example, surfgrass (*Phyllospadix torreyi*) was damaged by the 1969 Santa Barbara spill (Foster et al. 1971) and by the 1971 San Francisco spill (Chan 1973). Entire beds of intertidal turtlegrass (*Thalassia testudinum*) were killed by a 1986 crude oil spill just east of the Caribbean entrance to the Panama Canal (Jackson et al. 1989). In contrast, subtidal *Thalassia* survived everywhere after the spill, although leaves became brown and heavily fouled by algae for several months in heavily oiled areas. Eelgrass growth and reproduction appear to have been impaired by oil contamination from the Exxon Valdez spill (Holloway 1991). Impacts of an oil spill on eelgrass would be significant (Class I).

Relative Risk of Benthos to a Unocal Spill

The benthic organisms in the San Francisco Bay estuary which would be most vulnerable to oil spill impacts would be intertidal organisms because they are most likely to be contacted by substantial amounts of oil and sensitive subtidal species particularly juvenile dungeness crabs, bay shrimp and eelgrass.

Table 4.4-3 compares the relative oil spill risk of sensitive benthic resources in the San Francisco Bay estuary to a spill originating from the Unocal Terminal and to a spill originating from tankers servicing the Unocal Terminal.

The only rocky intertidal habitat which would have greater than a 5-percent probability of being contacted by moderate doses of oil from a spill originating at the Unocal Terminal would be rubble shoreline in the vicinity of the Terminal at the southeast end of San Pablo Bay and rubble shore in Carquinez Strait. Because between 10 and 50 percent of the rocky shore

Table 4.4-3

LEVEL OF RISK TO SENSITIVE BENTHIC RESOURCES IN SAN FRANCISCO BAY ESTUARY FROM AN OIL SPILL AT THE UNOCAL MARINE TERMINAL OR FROM UNOCAL TANKERING

Resource	Source of Spill	
	Unocal Terminal	Unocal Tankering
Rocky Habitat	M = Carquinez Strait L = All other bays	H = North Bay, San Pablo Bay M = Central Bay L = All other bays
Intertidal Mudflats	M = Carquinez Strait L = All other bays	M = Carquinez Strait, San Pablo Bay L = All other bays
Juvenile Dungeness Crab	M = Carquinez Strait, San Pablo Bay L = All other bays	H = Central Bay, San Pablo Bay M = Carquinez Strait L = All other bays
Eelgrass	L	H = North Bay M = Central Bay, San Pablo Bay
Bay Shrimp*	M = San Pablo Bay	M = San Pablo Bay

L = Lower risk - less than 5 percent probability of contacting more than 10 percent of resource.
M = Moderate risk - greater than 5 percent probability of contacting 10 to 50 percent of resource.
H = High risk - greater than 5 percent probability of contacting greater than 50 percent of resource.
* = Distribution varies from year to year - probability assigned as moderate because they have been found to be abundant at the Unocal terminal which has a greater than 5 percent chance of moderate oiling from a spill at the terminal and from Unocal tankers.

in Carquinez Strait would have a 5-percent probability of being contacted by oil from a spill at the Unocal Terminal, rocky intertidal populations in Carquinez Strait are judged to have a moderate risk to an oil spill from the Unocal Terminal. The rocky habitat in Carquinez Strait is rubble shore that would be expected to have a lower diversity of intertidal organisms than natural rocky shore in Central Bay and North Bay. Rocky intertidal habitat in all other bays would have a low risk of being contacted by moderate or heavy oil from a spill originating at the Unocal Terminal. Receptor mode analysis was run for Castro Rocks, an important rocky site near the Richmond-San Rafael Bridge. The probability of Castro Rocks being contacted with oil in a spill at the Unocal Terminal was 0.55 percent. Yerba Buena Island, an important area in Central Bay with natural rocky shore, had no chance of contact from a Unocal Terminal spill. Overall, the risk to rocky intertidal habitat from a spill originating at the Unocal Terminal is relatively low; although, because rocky shore occurs throughout much of the estuary, some portion of the habitat would be contacted in most spills.

A spill originating from a tanker servicing the Unocal Marine Terminal would have a greater than 5-percent probability of subjecting over 50 percent of the rocky intertidal habitat in North Bay and San Pablo Bay to moderate or greater doses of oil. The receptor mode analysis showed that Castro Rocks would have as much as a 28.5-percent chance of contact with oil from a Unocal tanker spill and Yerba Buena Island would have up to a 25.7-percent chance. Therefore a spill from Unocal tankers poses a high risk to rocky intertidal areas in San Pablo Bay and North Bay. An oil spill originating from Unocal tankers would have a greater than 5-percent probability of contacting between 10 and 50 percent of the rocky intertidal habitat in Central Bay with moderate or greater quantities of oil. Therefore unocal tankering poses a moderate risk to the diverse rocky intertidal communities of Central Bay. Overall, Unocal tankering poses substantial risk to the rocky intertidal communities of the northern part of the San Francisco Bay estuary.

In general, the subtidal soft bottom benthic communities of San Francisco Bay would not be vulnerable to long-term effects from an oil spill. This community is dominated by introduced opportunistic species which would be expected to recolonize rapidly affected areas. However, populations inhabiting intertidal mudflats might be subjected to long term impacts from an oil spill because beached oil might become incorporated into the sediments where it could persist for many years. The habitat might then support only the most oil resistant species.

The intertidal mudflats in Carquinez Strait would have a greater than 5-percent probability that between 10 and 50 percent of that habitat would be at least moderately oiled from a spill originating at the Unocal Terminal. Intertidal mudflats in Carquinez Strait, thus, are considered to be at moderate risk from an oil spill at the Unocal Terminal. The receptor mode run showed that the Petaluma River mouth had a 0.5-percent chance of contact with oil for a spill at the Unocal Terminal. The intertidal mudflat habitat of all other bays are judged to be at low risk from a spill originating at the Unocal Terminal.

Unocal tankering poses moderate risk to the intertidal mudflats of Carquinez Strait and San Pablo Bay. Most of the mudflats along the southern shore of San Pablo Bay and in the western end of Carquinez Strait would have a greater than 5-percent probability of being hit by moderate or greater doses of oil from a spill originating from tankers servicing the Unocal Marine Terminal. Unocal tankering thus does pose substantial risk to the intertidal mudflats of these portions of the estuary. For example, the receptor mode run showed that the mouth of San Pablo Creek had up to a 24.1-percent chance of contact with oil from a Unocal tanker spill. The Petaluma River mouth, on the other hand, had only a 1.25 chance of contact with oil from a Unocal tanker spill.

Juvenile dungeness crabs, which are abundant in the northern reach of San Francisco Bay, might be particularly vulnerable to oil spill impacts from the Unocal Terminal. San Pablo Bay is the portion of the estuary with the most consistently high numbers of juvenile dungeness crabs. These crabs are abundant in the immediate vicinity of the Terminal and would have as much as a 12- to 20.8-percent chance of moderate oiling from a spill at the Terminal.

Based on areas where juvenile dungeness crabs have been collected in San Francisco Bay estuary, between 10 and 50 percent of the juvenile crab areas in San Pablo Bay and Carquinez Strait would have a greater than 5-percent chance of being contacted by moderate oil from a spill originating at the Unocal Terminal. Juvenile crabs in other portions of the estuary would be at low risk from a spill originating at the Unocal Terminal. Overall, spills originating at the Unocal Terminal pose a moderate risk to juvenile dungeness crab because this species' distribution is primarily in the north central portions of the estuary.

Juvenile Dungeness crabs in Central Bay and San Pablo Bay would have greater than a 5-percent probability of having greater than 50 percent of the areas where they have been contacted by at least moderate doses of oil from a spill originating from Unocal Tankers. Juvenile crabs in these bays would be at high risk from an oil spill from Unocal tankers. Juvenile crabs in Carquinez Strait would have a greater than 5-percent probability that between 10 and 50 percent of the area where they have been collected would be subjected to moderate oiling from a spill from Unocal tankers. Unocal tankering is judged to pose a moderate risk to juvenile dungeness crab in Carquinez Strait. Overall Unocal tankering poses substantial risk to juvenile dungeness crabs.

Bay shrimp, *Crangon franciscorum*, would also be vulnerable to oil. Bay shrimp are widely distributed throughout the San Francisco Bay estuary and outside the Golden Gate. The location of their greatest density varies seasonally and from year to year. Large numbers of bay shrimp have been collected near the Unocal Terminal. Because both a spill from the Unocal Terminal and a spill from Unocal tankers has a greater than 5-percent probability of depositing moderate or greater doses of oil in the vicinity of the Terminal, a spill from both these sources would pose at least moderate risk to Bay shrimp.

A spill originating from the Unocal Marine Terminal would have less than a 5-percent probability of subjecting any eelgrass bed to moderate or greater doses of oil. Therefore a spill from the Unocal Terminal is determined to pose a low risk to eelgrass. Large eelgrass beds are found near San Pablo Creek and near Alameda NAS. The receptor mode run showed that San Pablo Creek has a 0.5-percent chance of contact with oil from a spill at the Unocal Terminal. Alameda NAS has no chance of contact from a Unocal Terminal spill.

A spill from a Unocal tanker wold have a greater than 5-percent probability of subjecting more than 50 percent of the eelgrass in North Bay to moderate or greater doses of oil. Between 10 and 50 percent of the eelgrass in Central Bay and San Pablo Bay would have a greater than 5-percent probability of being hit by moderate or greater doses of oil from a spill from Unocal Tankers. The eelgrass bed near San Pablo Creek would have between a 12- and 17.5-percent probability of being moderately oiled (up to a 45.8-percent chance of contact with oil) but the eelgrass in South Bay would have less than a 2-percent probability of being moderately oiled. The eelgrass at the Alameda NAS had up to a 4-percent chance of contact with oil in the receptor analysis run. Overall, a spill from Unocal tankering poses moderate risk to eelgrass in San Francisco Bay estuary.

To evaluate the relative risk to benthic resources on the outer north coast of California from tankers servicing the Unocal Marine Terminal, those significant biological areas at highest relative risk (greater than a 1.5-percent probability) of moderate oiling from a spill from Unocal tankers were identified. An oil spill from Unocal tankers would have the greatest probability of moderately oiling the shoreline between the Point Reyes area and Santa Cruz. Significant intertidal and subtidal areas most at risk would include Bodega Head, Bird Rock ASBS, Point Reyes Headland, Limantour Marine Reserve, Double Point ASBS, Duxbury Reef, James V. Fitzgerald Marine Reserve and ASBS and Ano Nuevo Point.

Oil Spill Scenarios

Spill scenarios were used to estimate the range of impacts on benthic resources that could occur from reasonable worst case oil spills associated with operations at the Unocal Marine Terminal and with tanker operations to and from the Terminal. This analysis emphasizes the most sensitive components of the benthos including intertidal populations, juvenile dungeness crabs and eelgrass.

Table 4.4-4 summarizes the impacts to rocky habitat within San Francisco Bay. Three of the scenarios would result in substantial impacts to the rocky intertidal habitat of San Francisco estuary. Scenario 3, a 20,000-bbl tanker spill near the Terminal had the largest impact on the natural rocky intertidal habitats of the estuary. This oil spill contacted over 75 percent of the natural rocky habitat in the estuary. The oil in this spill contacted most or all of the natural rocky habitat in Central Bay, North Bay, San Pablo Bay, Carquinez Strait and Suisun Bay. This spill also contacted much of the manmade hard substrate in the central and northern reaches of the estuary. Scenarios 9 and 10, 100,000-bbl tanker spills near Alcatraz, also contacted substantial percentages of the natural and manmade rocky habitat. None of the other nine spill scenarios had widespread impact on the rocky intertidal, although Scenarios 2 and, to a lesser extent 8, oiled much of the rocky shore in Carquinez Strait.

Table 4.4-5 lists the percentage of intertidal mudflat habitat which would be contacted by oil from each of the modeled scenarios. Because the intertidal mudflats of San Francisco Bay estuary are dominated by introduced opportunistic species that are widespread, not only in San Francisco Bay but throughout the world, impact significance is determined on the basis of the percentage of intertidal mudflat habitat affected by each scenario in the entire estuary rather than on a bay by bay basis. Using this criterion, the only scenarios which would result in substantial impacts to the benthic populations of intertidal mudflats were Scenario 3, a 20,000-bbl tanker spill of crude oil near the Terminal in January, Scenario 9, a 100,000-bbl tanker spills of crude oil near Alcatraz in September, and Scenario 12, a 1,000-bbl tanker spill of crude oil near Anchorage 9 in August. None of the other spills affected 10 percent or more of the total intertidal mudflat habitat in San Francisco Bay estuary although most of them affected more than 10 percent of at least one bay. The least impacting spills, that did not impact 10 percent of the intertidal mudflat habitat in any bay were Scenario 6, a 1,000-bbl tanker spill of crude oil at the east end of Carquinez Strait in July, and Scenario 7, a 500-bbl product spill at the Terminal in August.

Table 4.4-6 estimates the percentage of juvenile dungeness crabs that would be contacted by each of the oil spill scenarios. These percentages are based on the number of sites where dungeness crabs have been collected that would be hit by a modeled spill. Dungeness crabs are not generally found in the intertidal mudflats (Tasto 1983). Because the scenarios

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Table 4.4-4

PERCENTAGE OF INTERTIDAL AND SUBTIDAL ROCKY HABITAT IN SAN FRANCISCO BAY ESTUARY CONTACTED BY OIL SPILL SCENARIO

Bay	Scenario*											
	1	2	3	4	5	6	7	8	9	10	11	12
South South Bay												
Natural Rocky Shore	0	0	0	0	0	0	0	0	0	0	0	0
Manmade Rocky Shore	0	0	0	0	0	0	0	0	0	0	25.8	0
South Bay												
Natural Rocky Shore	0	0	12.3	0	0	0	0	0	32.5	12.3	0	0
Manmade Rocky Shore	0	0	94.8	0	0	0	0	0	35.9	41.9	0	0
Richardson Bay												
Natural Rocky Shore	0	0	82.9	0	0	0	0	0	100.0	28.4	0	0
Manmade Rocky Shore	0	0	26.0	0	0	0	0	0	98.9	27.2	0	0
North Bay												
Natural Rocky Shore	0	0	80.1	0	0	0	0	0	62.0	29.1	0	0
Manmade Rocky Shore	0	0	57.2	0	0	0	0	0	38.1	20.8	0	0
San Pablo Bay												
Natural Rocky Shore	0	9.9	80.2	27.3	0	0	12.8	10.4	23.0	1.1	0	0
Manmade Rocky Shore	0	11.3	51.6	26.4	0	0	1.9	11.3	25.6	3.0	0	0
Carquinez Strait												
Natural Rocky Shore	0	86.2	100.0	86.7	0	0	0	47.9	15.3	0	0	0
Manmade Rocky Shore	0	89.9	100.0	96.1	0	0	0	31.7	13.5	0	0	0
Suisun Bay												
Natural Rocky Shore	0	0	100.0	0	0	0	0	0	0	0	0	0
Manmade Rocky Shore	0	41.8	78.5	74.3	89.5	94.8	0	0	0	0	0	0
Bay Region Total												
Natural Rocky Shore	0	17.3	75.2	21.5	0	0	3.1	10.8	54.6	31.2	0	0
Manmade Rocky Shore	0	6.0	27.5	9.3	2.9	3.1	0.2	2.4	50.3	43.6	0.5	0

* Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.

Table 4.4-5

PERCENTAGE OF INTERTIDAL MUDFLAT HABITAT IN SAN FRANCISCO BAY ESTUARY CONTACTED BY OIL SPILL SCENARIO

Bay	Scenario*											
	1	2	3	4	5	6	7	8	9	10	11	12
South San Francisco Bay	0	0	0.02	0	0	0	0	0	0.07	12.9	17.0	26.0
Central Bay	0	0	11.6	0	0	0	0	0	76.1	56.3	0	0
North Bay	0	0	56.9	0	0	0	0	0	43.6	1.4	0	0
San Pablo Bay	23.0	0.1	44.3	11.3	0	0	3.7	0.15	37.3	0.02	0	0
Carquinez Strait	0	70.8	100.0	87.5	0	0	0	47.7	3.24	0	0	0
Suisun Bay	0	6.2	20.4	14.6	68.6	9.1	0	0	0	0	0	0
Bay/Region Total	7.9	1.1	20.7	6.2	5.8	0.8	1..3	0.5	18.2	8.8	8.6	12.4

* Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.

Table 4.4-6

PERCENTAGE OF JUVENILE DUNGENESS CRABS IN SAN FRANCISCO BAY ESTUARY IMPACTED BY OIL SPILL SCENARIO

Bay	Scenario*											
	1	2	3	4	5	6	7	8	9	10	11	12
South San Francisco Bay	0	0	0	0	0	0	0	0	13.3	55.5	69.2	33.3
Central Bay	0	0	65.0	0	0	0	0	0	100.0	100.0	0	0
North Bay	0	0	94.6	0	0	0	0	0	81.1	33.9	0	0
San Pablo Bay	28.0	5.2	100.0	58.4	0	0	18.2	5.2	75.3	0	0	0
Carquinez Strait	0	100.0	100.0	100.0	0	0	0	50.0	50.0	0	0	0
Suisun Bay	0	0	0	50.0	100.0	100.0	0	0	0	0	0	0
Bay/Region Total	14.0	4.9	50.0	31.3	2.4	2.4	8.6	3.7	67.5	21.4	2.9	1.2

* Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.

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model surface oil, it is not clear how much of the crabs' subtidal habitat would actually be exposed to oil. Because juvenile crabs would be sensitive to low concentrations of oil in the water column or in the sediments, juvenile crabs are considered, for this analysis, to be impacted by oil if the oil from a modeled spill contacts the surface waters at a site where crabs have been collected. This assumption would be a reasonable worst-case for the assessment of oil spill impacts on juvenile dungeness crabs. Approximately 80 percent of the juvenile dungeness crabs in the San Francisco region use the San Francisco Bay estuary as a nursery habitat. Therefore, if a substantial portion of the juvenile crab distribution in San Francisco Bay were impacted by an oil spill, a year class could be severely affected. The loss of a large percentage of a year class would have impacts on the dungeness crab population which would be discernible for several years.

Of the 12 oil spill scenarios, five would have the potential for substantial adverse impacts on dungeness crabs. The spill scenario which would have the potential to most severely impact dungeness crabs is Scenario 9, a 100,000-bbl tanker spill near Alcatraz. The oil from this spill would contact 67.5 percent of the sites where juvenile dungeness crabs have been collected.

Table 4.4-7 shows the impacts to eelgrass of each of the oil spill scenarios. Only three of the modeled spills, Scenarios 3, 9, and 10, contacted eelgrass and each of these contacted a substantial percentage of eelgrass in the Bay.

Table 4.4-8 shows the significant intertidal and subtidal areas that would be contacted by oil in the modeled outer north coast scenarios. Scenario 1 would contact much of the significant rocky intertidal habitat between the Point Reyes Headlands and the north part of Monterey Bay. In this scenario the oil did not come ashore in the lee of Point Reyes and such significant biological areas as Limantour Marine Reserve, Double Point and Duxbury Pt and Duxbury Reef were spared. Of 31 significant rocky intertidal and subtidal biological areas along the North Coast identified in this study, 19 percent were contacted by oil in this spill scenario. It is not clear what the extent of biological damage would be to those areas contacted. Duxbury Reef suffered significant biological damage in the 1971 spill from the <u>Oregon Standard</u> but recovered within 5 years (Chan 1977). In the 1986 spill from the <u>Apex Houston</u>, no damage was discernible on Duxbury Reef (Chan 1987). Substantial kelp beds north of Monterey Bay were oiled in this scenario. While kelp itself might not be damaged by oil, other members of the rich subtidal community supported by kelp beds might be more sensitive. Furthermore the recent Avila spill showed that kelp can retain oil and cause nearby areas to be subjected to repeated oiling (Togstad 1993). In a reasonable worst case analysis, Scenario 1 would be expected to have substantial adverse impacts on the benthic resources of the outer coast.

Scenario 2 would contact significant rocky intertidal and subtidal areas in the Fort Bragg/Mendocino area. Of the significant rocky subtidal and intertidal areas identified in this study, Scenario 2 would contact 22.6 percent of them. This section of coast is fringed with kelp beds. A total of 29.8 percent of the total kelp bed area on the north coast would be contacted by oil spilled in Scenario 2. Again, the tendency of kelp to retain oil might subject these significant habitats to repeated oiling. Sensitive species associated with the kelp beds might suffer extensive damage. Scenario 2 would have the potential for substantial adverse impacts on the rocky intertidal and subtidal benthos of the outer north coast.

Fishes

<u>Background of Fishes Sensitivity to Oil</u>

Although major fish kills from oil spills have rarely been reported, evidence exists that oil pollution could have negative effects on all the life history stages of fishes. Malins and Hodgins (1981), in a literature review on petroleum effects on marine fishes, concluded that ample evidence existed that fishes exposed to petroleum in sediments, water, or through the diet accumulate hydrocarbons in tissues and body fluids. The tissues are purged of these hydrocarbons when the fishes are no longer exposed, but some of the aromatic hydrocarbons are converted metabolically to suites of conjugated and nonconjugated metabolites that can remain in tissues for long periods. The higher molecular weight aromatic hydrocarbons, such as the carcinogenic/mutagenic chemical benzo[a]pyrene, are actively taken up by fishes and metabolized to derivatives that bind with DNA. This process may cause tumorous lesions of the type that have been found in flatfishes inhabiting highly polluted sediments. Laboratory studies thus have shown that the accumulation of hydrocarbons in fishes leads to a number of deleterious biological changes that can

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Table 4.4-7

PERCENTAGE OF EELGRASS AREA CONTACTED BY OIL SPILL SCENARIO

Bay	Scenario*											
	1	2	3	4	5	6	7	8	9	10	11	12
South Bay	0	0	0	0	0	0	0	0	0	100.0	0	0
Central Bay	0	0	0	0	0	0	0	0	0	0	0	0
North Bay	0	0	0	0	0	0	0	0	0	0	0	0
San Pablo Bay	0	0	100.0	0	0	0	0	0	84.0	0.2	0	0
Bay/Region Total	0	0	71.4	0	0	0	0	0	58.5	27.7	0	0

* Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.

Table 4.4-8

IMPACTS OF SCENARIOS ON SIGNIFICANT OUTER COAST RESOURCES

Scenario 1
Significant Areas Contacted = 19 Percent of Significant Intertidal and Subtidal Areas Along North Coast
Monterey Bay National Marine Sanctuary Ano Nuevo Point ASBS James V. Fitzgerald Marine Reserve and ASBS Farallon Islands ASBS Gulf of Farallons National Marine Sanctuary Kelp Beds = 56 percent of total kelp bed on North Coast
Scenario 2
Significant Areas Contacted = 22.69 Percent of Significant Intertidal and Subtidal Areas Along North Coast
Mac Kerricher State Park Tolo Bank Caspar Headlands State Reserve Point Cabrillo State Marine Reserve Pygmy Forest Ecological Reserve Russian Gulch Van Damme State Underwater Park Kelp Beds = 29.8 Percent of total kelp beds on North Coast

affect health and survival. Many of these effects were induced at relatively high concentrations that would be unlikely to be encountered in the marine environment. Moreover, adult fishes may be able to avoid an oiled area. There is some evidence of avoidance of hydrocarbons by fishes in the field but observations are few and circumstantial (NAS 1985).

Impacts of oil spills to adult fishes have varied from windrows of dead fishes observed in the west Falmouth spill (Sanders 1977) to no apparent effect. Ebeling et al. (1971) could find no effect on the fish populations of the Santa Barbara Channel after the 1969 oil spill. Collections made off Santa Barbara in 1969 generally did not differ significantly in abundance from those made in 1967 before the oil spill. Similarly, the California Department of Fish and Game reported no detectable effects on pelagic fishes from the Santa Barbara spill (Mead and Sorensen 1970).

On the other hand, damage to fishes apparently did occur from the Amoco Cadiz spill. Rocky bottom fishes in the immediate vicinity of the wreck were immediately killed by the initial release of oil (Gundlach et al. 1983) and a year class of flat fish was thought to have been lost to the spill (Vandermeulen 1982). The loss of flatfish seemed to be related to a reduction in flatfish reproduction. An increase in reproductive pathologies, as well as fin necrosis, occurred (Gundlach et al. 1983).

In the Shell Martinez spill, fish abundance was reduced in the oiled sloughs, but no region-wide impacts on fishes were detected (Fischel and Robilliard 1991). Studies following the Martinez spill showed that individuals of the staghorn sculpin (*Leptocottus armatus*) in the vicinity of the spill had enhanced hydrocarbon metabolizing enzymes (Spies 1989). These results suggest that the spill may have had localized sublethal effects on resident fish populations.

Finally, the destruction of prey by oil can translate into lower fish productivity. Elmgren et al. (1983) thought that the destruction of large numbers of amphipods by the Tsesis spill would result in lower fish productivity because amphipods were the preferred food of commercially important fishes in the area. The spill killed a substantial portion of the population of the amphipod *Pontoporeia* that normally destroy the spat of the clam *Macoma balthica*. In the absence of the amphipods, the clams settled in great numbers, making the environment suboptimal for recolonization by

Pontoporeia. *M. balthica* may live for 2 decades or more, so this situation might persist for many years. *Pontoporeia* is the preferred food of commercially important fishes in the area, and the investigators postulated that the delayed ecosystem effect would be a loss of some 100 tons of fish production.

Larval stages are sensitive to much lower concentrations of oil than those shown to affect adults. Moreover, adult fishes would be able to avoid an oiled area, but planktonic eggs and larvae would not; therefore, the egg and larval stages would be the most susceptible to adverse impacts. Experiments with herring and cod larvae show that neither species actively avoided experimental surface slicks but instead reentered them (Wells 1982). A severe spill that damaged large numbers of eggs and larvae of a certain species could potentially reduce recruitment for that species for that year class. Following the 1976 spill of 8 million gallons of fuel oil from the tanker Argo Merchant off Nantucket, the outer membrane of fish eggs showed some contamination at all stations (Longwell 1977). Oil droplets and tar adhered to roughly one-half of all fish eggs examined. In the 1989 spill of fuel oil from the tanker World Prodigy in Naragansett Bay, the early life stages of several fish species were observed to suffer significant impacts within the slick (Spaulding 1989).

Vulnerability of Fishes to a Unocal Spill

Particularly vulnerable fish populations off the California north coast include Pacific hake, which move up and down the coast seasonally and have pelagic eggs and larvae. The early life stages of this species might be particularly susceptible to becoming trapped in a surface oil slick. In spite of their potential sensitivity to oil, Pacific hake would probably not be impacted significantly by an oil spill because of their wide distribution. Impacts to Pacific hake would be expected to be adverse but nonsignificant (Class III). Other particularly vulnerable fish populations off the north coast would be species that use estuaries or coastal streams for part of their early life histories. These species, which include such flatfishes as California halibut, starry flounder, and English sole, as well as anadromous species such as green and white sturgeon, American shad, pink, chum, coho and chinook salmon, and rainbow/steelhead trout, would be especially vulnerable if the mouth of an estuary or coastal stream became fouled with oil. Impacts of an oil spill to fishes which use estuaries on coastal streams have the potential to be significant (Class I).

Particularly sensitive fish species within the San Francisco Bay estuary include those with a restricted distribution, such as the Delta smelt as well as the anadromous fishes that pass through the northern reach on their way to the Delta to spawn. All these species are at particular risk not only because a large percentage of their populations might be contacted by a single oil spill but also because their populations have been declining in recent years. The adult stages of anadromous fishes would probably be far less vulnerable to a spill than the early life stages would be. Adults pass quickly through the Bay on their way upstream to spawn and would be exposed to oil only briefly. Because most spilled oil is on the surface and the fishes are in the water column in the deep waters of the estuary they would be unlikely to come into direct contact with oil. The juvenile stages of striped bass and chinook salmon, however, tend to spend considerable time in the shallow waters of the North Bay before they pass out of the Golden Gate and into the open ocean. If oil became trapped in the shallow waters of the North Bay, young striped bass and young chinook salmon might be particularly at risk. Potential impacts of a spill within San Francisco Bay estuary on Delta smelt and anadromous fishes are judged to be significant (Class I).

Fishes that spawn in the Bay also might be particularly vulnerable to an oil spill because the egg and larval stages are so sensitive to oil. Important fish species that spawn primarily in the Bay include Pacific herring, longfin smelt, yellowfin goby, plainfin midshipman, bay goby, and topsmelt. Impacts to Pacific herring which lay thin eggs on the partially hard substrate within the estuary are judged to have potentially significant impacts (Class I). Similarly, impacts to longfin smelt which spawn primarily in the freshwater at the eastern end of the estuary could be significant if oil got up into the river (Class I). Impacts to other species that spawn in the estuary would only be expected to be significant in the case of an extremely expansive slick because these species are widely distributed (Class II for most spills). Species that spawn in both the Bay and the ocean would be less vulnerable. This latter group included Pacific staghorn sculpin, jacksmelt, and northern anchovy (Class III impacts).

Relative Risk to Fishes from a Unocal Spill

The fish species that would be most vulnerable to an oil spill associated with the Unocal Marine Terminal are those that have all or most of their population within the San Francisco Bay estuary and those that may have a substantial portion of their populations outside the Golden Gate but that use the Bay as an important spawning or nursery area. Declining species such as striped bass, Chinook salmon, white sturgeon and Delta and longfin smelt are especially vulnerable to an oil spill. Species such as northern anchovy and white croaker which are widely distributed throughout the bay and the ocean waters outside the Golden Gate are not considered to be at significant risk from an oil spill although a large spill might cause a temporary reduction in abundance within the oiled areas.

In evaluating oil spill impacts on fishes, particular emphasis was placed on oiling of shallow water habitat (defined as water depth less than 6 feet). Shallow water was emphasized for two reasons. The first reason is that fishes, especially the sensitive younger life stages, spend more time in the rich productive shallow waters of the estuary. The second reason is that oil would be more likely to contact fishes in shallow water habitats. In the deeper waters such as the ship channels and most of Carquinez Strait, the oil would primarily be in the surface layers and fishes might be able to swim under it with little apparent effect. Data on oil concentrations in the water column after an oil spill are consistent with this assumption. Levels of oil in the water column following major spills have been measured at between 3 and 500 ppb and have been found to return to background levels within 2 months (Gundlach et at. 1983). Lethal effects of oil on adult fishes and juveniles have generally been found only at concentrations greater than 1 ppm. Sublethal effects have been found at concentrations of 100 ppb and greater.

Finally, in analyzing oil spill impacts on fishes, the fish assemblages of San Pablo Bay and, especially, Suisun Bay, were considered more vulnerable to oil spill impacts than those of the other bays. Of the bays within San Francisco estuary, San Pablo and Suisun Bays have the most distinct fish assemblages and these assemblages are the most isolated from the ocean. Central Bay and South Bay have fish populations that are somewhat similar to those of the open ocean. These areas would thus recruit more readily than San Pablo and Suisun Bays and would be able to recover more readily from a major oil spill.

Relative risk of fishes to an oil spill originating at the Unocal Terminal or from a Unocal tanker is shown in Table 4.4-9. The water column species which would be most vulnerable to an oil spill in the Bay are the

Table 4.4-9

LEVEL OF RISK TO SENSITIVE FISH RESOURCES TO AN OIL SPILL AT THE UNOCAL MARINE TERMINAL OR FROM UNOCAL TANKERING

Resource	Source of Spill	
	Unocal Terminal	Unocal Tankering
Longfin Smelt	M	M
Pacific Herring Spawning	L	M
Chinook Salmon	L	M
Striped Bass	L	M
American Shad	L	L
White Sturgeon	L	L = Honker Bay, M = Over all
Suisun Marsh Assemblage	L	L
Starry Flounder	L	M

L = Lower risk - less than 5 percent probability of moderate oiling to less than 10 percent of habitat.
M = Moderate risk - greater than 5 percent probability of moderate oiling to 10 to 50 percent of habitat.
H = High risk - greater than 5 percent probability of moderate oiling to greater than 50 percent of habitat.

Delta smelt, the longfin smelt and the Pacific herring. The Delta smelt has been listed by the federal government as a Threatened Species and is discussed in the Rare/Threatened/Endangered Species section. The longfin smelt is abundant in many Pacific Coast estuaries but is seriously declining in California (Moyle and Yoshiyama 1992). However, in the San Francisco region, the population is predominantly within the bay. Therefore, an oil spill has the potential for locally significant impacts if a large percentage of the bay longfin smelt population were impacted by oil. In San Francisco Bay, the longfin smelt population has been declining in recent years because of reduced Delta outflow (Moyle and Yoshiyama 1992). Longfin smelt are distributed throughout San Francisco Bay but are most abundant in the southeastern part of San Pablo Bay. If a spill occurred at the Terminal the shallow waters of southeastern San Pablo Bay would have a 2- to 12-percent chance of moderate oiling. Longfin smelt are, thus, at moderate risk from a spill at the Terminal. Shallow waters of southeast San Pablo Bay, where longfin smelt would be most vulnerable, would have a 4- to 17.5-percent chance of moderate or greater oiling from a Unocal tanker spill. The longfin smelt is thus also at moderate risk from a spill associated with Unocal tankering.

Pacific herring lay their eggs on hard substrate mostly in Central Bay and the northern part of South Bay. Herring spawning areas have less than a 2-percent chance of moderate or heavy oiling from a Terminal spill. Therefore, herring spawning areas are at very little risk from a spill at the Terminal. Herring spawning areas are at greater risk, though, from a spill from Unocal tankering. Herring spawning areas around Richmond and Angel Island have a 12- to 17.5-percent chance of moderate oiling from a Unocal tanker spill. Other herring spawning areas would be at less risk from a tanker spill than the Richmond and Angel Island areas.

Anadromous fish species most at risk from an oil spill associated with the Unocal Marine Terminal include Chinook salmon, striped bass, American shad and white sturgeon.

The young Chinook salmon, which migrate from their birthplace in the rivers to the open ocean, would be the segment of the salmon population most vulnerable to an oil spill. During the time that the young are migrating through the waters of the northern portions of the San Francisco Bay estuary to the ocean they may spend considerable time in the shallow waters feeding. Young Chinook salmon are particularly abundant in the shallow waters on the south side of San Pablo Bay. Chinook salmon would be most likely to suffer effects from oil if they were subjected to moderate to heavy oiling. The shallow water habitat east of Pinole Point has between a 0.2- and 20.8-percent chance of moderate or greater oiling from a spill at the Terminal. The shallow water habitat between Point San Pablo and Point Pinole has between 0- and 2-percent chance of moderate oiling from a spill at the Terminal. Chinook salmon, thus, are at significant risk of suffering some oil impacts from a spill at the Terminal, but, less than 10 percent of the habitat has a greater than 5-percent probability of moderate to heavy oiling. Therefore if there were a spill at the Terminal, the risk to the population is low although some individuals would probably be exposed to oil.

Chinook salmon are at greater risk from a spill associated with Unocal tankering. Shallow water habitat between Point San Pablo and Pinole Point would have a 12- to 17.5-percent probability of moderate oiling from a Unocal tanker spill while shallow water habitat east of Pinole Point would have a 4- to 10-percent chance of moderate oiling. Because between 10 and 50 percent of the juvenile Chinook salmon preferred habitat would have a greater than 5-percent probability of moderate or greater oiling from a Unocal tanker spill, salmon are at moderate risk.

Striped bass are abundant throughout the northern portion of San Francisco Bay and would be most vulnerable in the shallow water habitats. Only the shallow water in the immediate vicinity of the Terminal has substantial risk (10 to 20.8 percent risk) of moderate oiling from a spill at the Unocal Terminal. Shallow water habitat at the south and east ends of San Pablo Bay have a 0.2- to 6-percent chance of moderate oiling while west San Pablo Bay, Suisun Bay, most of Central Bay and all of South Bay have virtually no risk of moderate oiling from a spill at the Unocal Marine Terminal. Therefore a spill at the Unocal Marine Terminal poses some risk to individual striped bass but the overall risk to the striped bass population is low. Shallow water habitat along the south and east sides of San Pablo Bay and the east side of Central Bay would have an 8- to 17.5-percent probability of at least moderate oiling from a Unocal tanker spill. Most other shallow water habitat in the Northern reach would have between a 0- and 8-percent chance of moderate oiling. Unocal tankering, thus, presents substantial oil spill risk to individual striped bass although, in a reasonable worst case, only a part of the population would be likely to be impacted by an oil spill from a Unocal tanker. Overall risk of a spill from Unocal tankers in the striped bass population is judged to be moderate.

American shad are most abundant in shallow water on the north side of San Pablo Bay and in Suisun Bay. All of these shallow waters would have less than a 2-percent chance of moderate oiling from a Terminal spill. American shad are, thus, at low risk from an oil spill at the Unocal Marine Terminal. Shallow waters on the north side of San Pablo Bay would have between 0- and 8-percent chance of moderate oiling from a Unocal tanker spill while shallow water in Suisun Bay would have less than a 2-percent chance of moderate oiling. American shad are at low risk from Unocal tankering.

White sturgeon are most abundant in the Honker Bay portion of Suisun Bay but they are also common in the shallow water of San Pablo Bay. The Honker Bay Area has almost no risk of moderate or heavy oiling from a spill at the Unocal Terminal and only the shallow water at the southeast end of San Pablo Bay has greater than 5-percent risk of moderate oiling. White sturgeon are thus at low risk from an oil spill associated with Unocal's Marine Terminal. There is also low risk that Honker Bay would be contacted by a moderate or greater dose of oil from a spill from Unocal tankers. However, because greater than 10 percent of the shallow water in San Pablo Bay has a greater than 5-percent probability of moderate oiling from a Unocal tanker spill, white sturgeon are considered to be at moderate overall risk from a tanker spill. Honker Bay, a preferred habitat for white sturgeon, was one of the areas analyzed in the receptor mode analysis. This analysis showed a 0.3-percent chance that a 10,000-bbl spill at the Unocal Terminal would contact Honker Bay. The receptor mode analysis showed that there was a 6.75-percent chance or less that a 10,000-bbl spill from the Unocal Tankers would contact Honker Bay.

The demersal fish species which would be most vulnerable to an oil spill within San Francisco Bay are the unique fish assemblage of Suisun Marsh and starry flounders which use San Pablo and Suisun Bays as a nursery area. The Suisun Marsh assemblage would have a virtually no chance of moderate or heavy oiling from a spill originating at the Unocal Terminal. The Suisun marsh fish assemblage is, thus, at almost no risk from a spill at the Unocal Terminal. The Suisun marsh fish assemblage is also at virtually no risk from a spill associated with Unocal tankering.

If oil were spilled at the Unocal Marine Terminal, starry flounders in shallow water areas of San Pablo Bay would only be at risk of moderate oiling in the immediate vicinity of the Terminal. A spill at the Unocal Marine Terminal, thus, poses low overall risk to the starry flounder population. The probability of moderate oiling from a Unocal tanker spill would be between 4 and 17 percent for shallow water habitat in the south side of San Pablo Bay and between 2 and 10 percent for the rest of the shallow water habitat in San Pablo Bay. Shallow water habitat in Suisun Bay would have less than a 2-percent chance of moderate oiling from a Unocal tanker spill. Unocal tankering thus poses moderate risk to a portion of the shallow water habitat used as a nursery area by starry flounder.

Fishes on the outer north coast would probably only be impacted by oil if moderate to heavy doses came into a stream mouth or a shallow bay. Moderate doses of oil from a Unocal tanker spill on the outer north coast have the greatest risk of coming to shore in the area around the Golden Gate. Other than the Golden Gate itself, there are no major salmon streams in this area. Fishes in Drakes Estero might be significantly impacted by oil if moderate doses came into this narrow estuary, but the trajectory model shows the relative risk of oil contacting shore near Drakes Estero as very low. Of the bays, estuaries and major streams on the north coast only Tomales Bay has a relatively high comparative risk of moderate oiling and that risk is less than 1.5 percent. Oil has a relatively high risk of contacting the scattered kelp beds between Monterey Bay and San Francisco Bay. If oil became trapped in these kelp beds, resident kelp bed fishes might suffer some impacts. Overall,though, the risk of significant impacts to fishes from a Unocal Tanker spill on the North outer coast is low.

<u>Oil Spill Scenarios</u>

Table 4.4-10 shows the amount of preferred habitat for each sensitive fish species that would be contacted in each oil spill scenario.

Longfin Smelt - Longfin smelt are most abundant in southeast San Pablo Bay. Four of the modeled scenarios would contact a substantial percentage (greater than 10 percent) of the water in southeast San Pablo Bay. Longfin smelt are water column fish and

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Table 4.4-10

PERCENTAGE OF FISH PREFERRED HABITAT IN SAN FRANCISCO BAY ESTUARY CONTACTED BY OIL SPILL SCENARIO

Fish Resource	Scenario*											
	1	2	3	4	5	6	7	8	9	10	11	12
Longfin Smelt	23.0	6.5	100.0	58.0	0	0	29.7	9.1	25.0	0	0	0
Pacific Herring Spawning	0	0	22.4	0	0	0	0	0	50.9	52.9+	0	0
Chinook Salmon	0.4	0.8	99.9	3.8	.02	.02	32.1	1.1	41.6	0.8	0.8	0.8
Striped Bass	13.2	1.3	33.2	13.4	6.4	0.9	2.1	0.5	31.9	16.1	0.8	3.5
American Shad	27.5	2.7	43.6	27.3	13.7	1.9	0	1.0	40.7	0	0	0
White Sturgeon												
Preferred Habitat Total	25.8	0.1	48.3	22.2	0.1	0	4.2	0.2	43.0	0.1	0	0
Honker Bay	0	0	26.7	39.4	2.9	0	0	0	0	0	0	0
Suisun Marsh Assemblage	0	0	0	0	0	0	0	0	0	0	0	0
Starry Flounder	21.7	0.7	43.4	20.5	10.5	1.5	3.5	0.1	36.1	0.1	0	0

* Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.
\+ Modeled spill would not occur during spawning season.

would be found in both deep and shallow water. Longfin smelt would be more likely to contact harmful quantities of oil in shallow water. Only Scenarios 3 and 7 would oil substantial amounts of shallow water habitat in San Pablo Bay. Scenario 3, a 20,000-bbl tanker spill at the Terminal, would contact all of the preferred habitat for this species. Therefore, in a reasonable worst-case analysis, a Unocal tanker spill could have very serious adverse consequences for this species.

Pacific Herring - Pacific herring lay their eggs on hard substrate around North Bay, Central Bay and the northern part of South Bay. Three of the oil spill Scenarios (3, 9, and 10) would contact a substantial amount of herring spawning area. However, Scenario 10 a 100,000-bbl tanker spill in September would not affect herring spawning because herring do not begin spawning until around December. Scenarios 3 and 9 would occur during the spawning season and would have significant impacts on the Pacific herring eggs. A lower recruitment because of a large tanker spill such as those modeled in these scenarios might be detectable in the herring population for the next several years.

Chinook Salmon - Young chinook salmon are most abundant in shallow water on the south side of San Pablo Bay. Scenario 3, a 20,000-bbl tanker spill near the Terminal in January, would reach all of this habitat with potentially substantial impacts on chinook salmon. Scenario 7 a 500-bbl product spill at the Terminal at ebb tide in February, would only reach 4 percent of the shallow water habitat in San Pablo Bay. All of this habitat would be in the preferred salmon areas on the south side of the bay, however. Approximately 32 percent of the shallow water habitat on the south side of San Pablo Bay would be reached by this spill with potentially substantial impacts on Chinook salmon. Scenario 9, a 100,000-bbl tanker spill near Alcatraz in September, would also contact shallow water habitat on the south side of San Pablo Bay. Approximately 41 percent of the shallow water habitat on the south side of San Pablo Bay would be contacted by this spill. Impacts of Scenario 9 on Chinook salmon would also have the potential to be substantial. Therefore, in the reasonable worst-case oil spill analysis, three of the modeled spills would contact a substantial amount of the preferred habitat of juvenile Chinook salmon and a large tanker spill at the Terminal (Scenario 9) would contact virtually all of this habitat.

Striped Bass - Striped bass are found throughout the northern reach of San Francisco Bay estuary down to the northern part of South Bay. Scenarios 1, 3, 4, 9 and 10, have the potential to impact a significant portion of the shallow water habitats in these areas. Scenarios 3 and 9 would have the greatest magnitude of impact on striped bass habitat. Each of these spills would impact greater than 30 percent of the shallow water habitat in the northern part of San Francisco Bay estuary.

American Shad - American shad are primarily found on the north side of San Pablo Bay and in Suisun Bay. American shad may be found throughout the water column but they would be most vulnerable in shallow water because of the greater chance of contacting oil. Five of the modeled Scenarios (1, 3, 4, 5, and 9) contacted a substantial amount of shallow water in Suisun and North San Pablo Bay and would have the potential to have substantial impact on American Shad.

White Sturgeon - White sturgeon are most abundant in the Honker Bay portion of Suisun Bay. They are also common in the shallow water of San Pablo Bay. Only three of the modeled scenarios would contact Honker Bay and only Scenarios 3 and 4 would reach a substantial portion of it. Four of the modeled Scenarios (1, 3, 4, and 9) would contact a substantial amount of total white sturgeon habitat.

Suisun Marsh Assemblage - None of the modeled oil spills would contact the Suisun Marsh assemblage.

Starry Flounder - Starry flounder use the shallow water areas of San Pablo and Suisun Bays as a nursery area. Scenarios 1, 3, 4, 5, and 9 would all have substantial impacts on starry flounder because they would all contact more than 10 percent of the total shallow water habitat in San Pablo and Suisun Bays. Of these Scenarios 3 and 9 would contact the most substantial amount of this habitat. Scenario 3 would contact 43.4 percent of the starry flounder nursery habitat and Scenario 9 would contact 36.1 percent of the habitat.

Of the two oil spill scenarios modeled for the outer coast, Scenario 1 would contact no major salmon streams or enclosed bays although it would contact several small streams with steelhead runs. Scenario 2 would contact the mouths of four major salmon streams, Ten Mile River, Noyo River, Big River and Navarro River. Scenario 1, then, a spill at the Golden Gate would not be expected to substantially impact

North Coast fishes while Scenario 2, a spill off the Mendocino Coast, would.

Marshes and Coastal Estuaries

Background of Marshes and Coastal Estuaries Sensitivity to Oil

Vegetated marshes within San Francisco estuary and coastal estuaries in the north coast are two of the habitats which would be most sensitive to an oil spill. In most oil spills that have contacted salt marshes, damage has been noted to marsh vegetation (NAS 1985). The margins of the sea seem to be especially susceptible to the impacts of oil spills because when a large spill drifts ashore, tidal areas often are subjected to heavy oiling. In the case of salt marshes, oil may become incorporated into sediments where it may persist for years.

In the case of the 1969 West Falmouth spill, marsh grasses that came in contact with the waterborne oil at high tide during the first 3 weeks after the spill were killed (Sanders 1977). In another fuel oil spill in the same area in 1974, a similar effect was observed (Hampson and Moul 1977). About 3 weeks after the spill of No. 2 fuel oil from the barge Bouchard No. 65 off Buzzards Bay, the marsh plants (*Spartina*, *Salicornia*, and *Limonium*) in Winsor Cove turned brown. Although the spill was a single occurrence, the marsh was subjected to repetitive applications of oil because of tidal oscillations. The substrate of the Winsor Cove marsh acted as a natural sink and became heavily impregnated with oil because of the marsh's porosity and interstitial absorption. Slow chronic discharge of buried oil contained toxic aromatics that leached to the surface substrate causing a continuous stress on plant regeneration. By 3 years after the spill, the marsh grass community had still not significantly reestablished itself either by reseeding or rhizome growth. In the spring of each year, some species sparsely regenerated a few seedlings or stems, but by late summer, the majority of the new recruitments had either disappeared or failed to develop. In the case of the 1970 spill of Bunker C fuel oil from the tanker Arrow at Chedabucto Bay, Nova Scotia, the cordgrass *Spartina* did recover from initial destruction, but no recovery was seen until 2 years after the spill (Vandermeulen 1977). The investigators estimated that the time required for the damaged cordgrass to recover one-half of its former population was about 3 years.

In the 1988 Shell Martinez spill, marsh vegetation dominated by bulrush (*Scirpus* sp.), cattails (*Typha* sp.), and, in some places, Baltic rush (*Juncus balticus*) was most heavily oiled along the shoreline east of Peyton Slough and at Ryer Island (Winfeld and Mendelssohn 1989; Fischel and Robilliard 1991). However, oil was not observed above the high-tide debris line. The oil also appeared to be of low toxicity because plants covered over 50 percent of their surface by oil were not killed, and unoiled surfaces remained green. Much of the oiled vegetation in the heavily oiled areas was removed by cleanup operations. The overall mean percent total live cover was greater in the fall 1989 than in the fall 1988. The increase indicated that those stations that had been heavily oiled were recovering from the spill. By fall 1989, the visual effects of oil and cleanup had almost completely disappeared. However, shoot generation and vegetative growth appeared to be reduced.

Coastal estuaries on the north coast would be expected to be sensitive to oil because of the potential for oil to become trapped within the partially enclosed waters and incorporated into the sediment. Studies of the impacts of oil spills on estuaries have shown variable results. Impacts of the 1969 oil spill from the barge Florida in Buzzards Bay, Massachusetts were devastating (Sanders 1977). After the 1988 El Omar spill at Milford Haven, United Kingdom, near the joint estuary of the Eastern and Western Cleddau, intertidal mud infauna in the inner estuary were not noticeably affected by the spill, in spite of significant increases in aliphatic and aromatic hydrocarbon concentrations in the surface sediments over a wide area (Little and Little 1991).

Vulnerability of Marshes and Coastal Estuaries to a Unocal Spill

Clearly any salt marsh, or coastal estuary on the north coast or in San Francisco Bay estuary, would be likely to suffer significant impacts if it was contacted by oil from a spill associated with the Unocal Terminal (Class I).

Relative Risk to Marshes and Costal Estuaries from a Unocal Spill

Salt marsh habitat that would be most at risk from a spill at the Unocal Terminal would be that at the northeast end of San Pablo Bay and at Benicia and at Martinez in Carquinez Strait. Of all the important tidal marshes in San Francisco estuary, salt marsh habitat at Benicia in Carquinez Strait would be most at risk from moderate to heavy oiling from a Terminal spill. Salt marsh habitat in this area would have a 12- to 20.8-percent chance of moderate oiling. Salt marsh habitat around Martinez, northeast San Pablo Bay and around Richmond would have a 0.2- to 2-percent chance of moderate oiling. All other saltmarsh habitat would have virtually no chance of moderate oiling from a spill at the Terminal. Overall less than 10 percent of the total salt marsh habitat in Carquinez Strait and San Pablo Bay would have greater than a 5-percent probability of moderate oiling from a spill at the Unocal Terminal. The risk to salt marshes from a Unocal Terminal spill is relatively low because it is unlikely that a substantial percentage of tidal marsh habitat would be impacted by a spill even though the chance that some marsh habitat would be contacted is high.

Salt marsh habitat at highest risk from a spill associated with Unocal tankering would be that at the northeast end of San Pablo Bay, Benicia, and San Pablo Point. Salt marsh most at risk of moderate oiling from a Unocal tanker spill is marsh around Benicia in Carquinez Strait and marsh around Richmond in southwest San Pablo Bay. These areas would have a 12- to 17.5-percent chance of moderate oiling from a Unocal tanker spill. Northeast San Pablo Bay marsh would have a 6- to 10-percent chance of moderate oiling from a Unocal tanker spill. Vegetated marsh at Martinez and south Suisun Bay would have a 2- to 4-percent chance of moderate oiling. Other marsh habitat in San Francisco Bay would have less than a 2-percent chance of moderate oiling from a Unocal tanker spill. Less than 5 percent of the salt marsh habitat in San Francisco Bay estuary has greater than a 5-percent probability of being contacted by moderate oil from a Unocal tanker spill. The overall risk to marshes from a Unocal tanker spill is relatively low, although should a spill occur at least some marsh habitat would be oiled.

The receptor mode analysis focused on several important marshes, Corte Madera Creek, San Pablo Creek, Coyote Hills Slough, Montezuma Slough, Napa Slough, the Petaluma River Mouth, Gallinas Creek, the Oakland Marshes, Harbor Bay, and the Sacramento River Mouth. Napa Slough had a 1-percent chance of contact with oil from a Unocal Terminal spill and the others had less than that. The only one of the target marshes with greater than 1-percent chance of contact with oil from a Unocal tanker spill was San Pablo Creek, which had up to a 24-percent chance of contact with oil from a spill from Unocal Tankers.

Coastal estuaries in the outer coast are at relatively low risk from a Unocal tanker spill.

<u>Oil Spill Scenarios</u>

Table 4.4-11 shows the percentage of marsh habitat that would be contacted by each of the scenarios modeled for oil spills in San Francisco Bay. Because vegetated marsh is an identified sensitive habitat any net loss in habitat value would by definition constitute a significant impact (Class I). All of the oil spill scenarios would result in contact with some marsh habitat. For two of the scenarios, however, so little vegetated marsh habitat would be contacted that probably no loss of functional value would occur. Scenarios 7 and 8, 500-bbl product spills at the Terminal, would contact only 1.4 percent and 0.5 percent, respectively, of the marsh habitat in San Francisco Bay estuary. The other 10 scenarios would all contact 2 percent or greater of the vegetated marsh habitat in San Francisco Bay estuary and, because of the sensitivity of this habitat, would be considered to have significant impacts on salt marsh. The scenarios which would contact the highest percentages of vegetated marsh habitat are Scenario 3, a 20,000-bbl tanker spill near the Terminal, and Scenario 9 a 100,000-bbl tanker spill near Alcatraz. These spills would contact 31.1 and 25.1 percent of vegetated marsh habitat in San Francisco Bay respectively. Scenarios 1, 4, 10, 11, and 12 would also contact more than 10 percent of the vegetated tidal marsh habitat within the estuary.

Of the two outer coast spills, Scenario 1 would contact significant marsh habitat at Pescardro Creek and a small amount of marsh at Pillar Point. Scenario 2 would contact four important river mouths, Ten Mile River, Noyo River, Big River, and Navarro River.

Birds

<u>Background of Birds Sensitivity to Oil</u>

Oil spills can affect birds directly through oil contamination and indirectly through degradation of important habitat. The direct effect of oiling on birds is predominantly contamination of feathers, removing insulative qualities and reducing buoyancy (Holmes

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Table 4.4-11

PERCENTAGE OF VEGETATED MARSH HABITAT IN SAN FRANCISCO BAY ESTUARY CONTACTED BY OIL SPILL SCENARIO

Bay	Scenario*											
	1	2	3	4	5	6	7	8	9	10	11	12
South Bay	0	0	0.03	0	0	0	0	0	0.2	16.9	48.5	42.5
Central Bay	0	0	14.9	0	0	0	0	0	67.4	74.1	0	0
North Bay	0	0	55.6	0	0	0	0	0	72.7	5.4	0	0
San Pablo Bay	36.28	0	69.3	22.5	0	0	4.3	0.01	59.7	0	0	0
Carquinez Strait	0	63.6	97.0	85.7	0	0	0	25.6	2.9	0	0	0
Suisun Bay/West Delta	0	20.6	25.9	30.6	68.3	20.1	0	0	0	0	0	0
Bay/Region Total	11.75	4.9	31.1	14.4	12.0	3.5	1.4	0.5	25.1	11.3	19.1	16.8

* Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.

and Cronshaw 1977). Oiling of feathers leads to elevated metabolic rate and hypothermia (Hartung 1967). Oiled birds may also ingest oil through preening of feathers or feeding on contaminated prey. Effects of ingested oil can range from acute irritation and difficulties in water absorption to general pathologic changes in some organs (e.g., Crocker et al. 1974; Fry 1987; Nero and Associates 1983). Ingestion of oil can also result in changes in yolk structure, and reduction in number of eggs layed and egg hatchability (Hartung 1965; Grau et al. 1977). Oiled birds that are able to return to a nest can contaminate the exterior of eggs reducing hatchability (e.g., Hartung 1965; Patten and Patten 1977).

Mortality of large numbers of birds following oil spills affects colony productivity during the nesting season because fewer birds breed. Productivity will continue to be reduced in several subsequent years due to changes in the age-structure of the population (Ford et al. 1982). During this time, a population is even more jeopardized by events or conditions that produce mortality or degrade habitat.

Indirect effects result principally from contamination of habitat where feeding occurs. These effects may be significant in shallow waters of bays, mudflats, and estuaries where waterfowl, rails, wading birds, and shorebirds feed. For these birds, loss or reduction in food resources can affect survival during migration and success of nesting efforts.

Seabirds are known to be conspicuous casualties of oil spills (e.g., Hope-Jones et al. 1970, Ford et al. 1991a, b). Those species suffering greatest mortality from past spills along the outer coast have been alcids, cormorants, loons, grebes, and scoters (Smail et al. 1972, Dobbin et al. 1986, Page and Carter 1986). These seabird groups are more vulnerable because they are found in large numbers on the water. Other birds typically spend less time on the water or will relocate from the area affected by a spill (e.g., gulls and pelicans; Sowls et al. 1980).

Alcids (family Alcidae) are diving birds that swim underwater in pursuit of small fish and may repeatedly surface through an oil slick. The group includes murres, auklets, murrelets, puffins, and guillemots. They are especially vulnerable to oil spills due to their mode of foraging and because they frequently congregate on the water in very large flocks, particularly within about 20 km of their colonies (Briggs et al. 1983). During the late- spring nesting season, Common Murres (and probably other alcids as well) may spend 40 percent of their time on the water foraging (Ainley 1976; Sowls et al. 1980). After the nesting season, the entire population (including dependent chicks) leaves the colony and remains on the water until the next year.

Cormorants have wettable plumage that must be dried in the air every few hours to provide adequate insulation and buoyancy. Consequently, they frequently return to coastal roosts rather than rest on the water. To some extent they are less vulnerable to oil spills than alcids and other species that remain on the water. Not only do they spend some time on land, they also may relocate to other roosting sites if disturbed. Cormorants are most vulnerable during the spring-summer breeding season when they have strong ties to nesting colonies. Cormorants do not have the ability to store energy as fat and consequently must forage each day regardless of the presence of oil nearby. About 85 percent of all cormorants on the water are found within 10 km of colonies (Briggs et al. 1983).

<u>Vulnerability of Birds to a Unocal Spill</u>

Large migrant or wintering populations of loons, grebes, and scoters are found along the outer coast and in San Francisco and San Pablo Bays from about October through March. Along the outer coast, loons, grebes, and scoters rest at night on nearshore waters where they can be contacted in large numbers should a spill occur. In the bays, the migrant or wintering avifauna also includes large populations of diving or dabbling ducks that spend most time on the water where they can be contacted by oil spills.

In San Francisco-San Pablo Bays, habitat of rails, terns, wading birds and shorebirds is also subject to contact from oil spills (e.g., the Shell Oil Refinery spill near Martinez in April 1988; Palawski and Takekawa 1988). Direct effects on these birds from oil spills are suspected but difficult to assess. Observations of oil-streaked shorebirds are common immediately following oil spills, but carcasses are rarely recovered (Larsen and Richardson 1990). It is likely that shorebirds and wading birds are able to avoid oiling to some extent by retreating from exposed habitat. Even if contacted, they may be able to avoid hypothermia from light oiling because they remain on land and may find some shelter in vegetation. Nevertheless, preening of oiled feathers would lead to ingestion of oil and resultant pathological effects. Another serious concern is secondary impact from contamination of food resources on beaches and mudflats. Not only could oil ingestion take place during feeding, presence of oil might substantially reduce the food available to sustain these populations.

Oiled birds recovered alive sometimes can be successfully cleaned and rehabilitated. However, the number that survive to be released depends in large part on the experience of workers and the time devoted to each bird. During the 1986 Apex Houston oil spill off the central California coast, nearly 3,700 oiled birds were collected on beaches from Monterey Bay to Bodega Head. Success of rehabilitation varied from 90 percent for centers with experienced workers and small numbers of birds, to 30 percent for centers where less experienced workers were brought in to help clean many hundreds of birds; overall success was 53 percent (Carter and Hobson 1986). Data are lacking on the long-term survival of rehabilitated birds; these individuals may subsequently die or have a lower reproductive potential than other birds in a population.

The number of beached birds recovered alive following an oil spill depends on search effort. Beaches must be searched repeatedly after a spill because birds continue to be oiled at sea and are washed ashore over a period of several days. The likelihood of finding birds alive declines sharply with time. The longer oiled birds remain on a beach, the more likely they will die from hypothermia or predation. The proportion of live oiled birds recovered, relative to total killed, can be as great as 32 percent for spills in areas such as the central California coast where many volunteers are available and can be mobilized soon after a spill (e.g., during the Apex Houston spill; Page and Carter 1986). In more remote or less populated areas, recovered birds may represent as little as 10 to 18 percent of the estimated total killed (Ford et al. 1991a,b).

Based on the above, we estimate that the success of mitigation by rehabilitation of oiled birds at 17 percent for spills in the San Francisco Bay Area, and 9 percent on the outer coast. These numbers are the product of the success of recovery effort (i.e., proportion of number of birds cleaned and released to total number of live birds collected) and efficiency of the beach search effort (i.e., the proportion of live birds recovered to the estimated number contacted by oil). For the former parameter, we use data from the Apex Houston spill (53 percent), which is well documented and most closely approximates the situation in San Francisco Bay and adjacent waters on the outer coast. For the latter parameter, we use data from the Apex Houston spill for the San Francisco Bay and nearby shoreline on the outer coast (32 percent), and the Nestucca spill (Olympic Peninsula) for recovery of beached birds on the coast north of Bodega Head (18 percent). These percentages are simply reasonable approximations of the best effectiveness of cleaning and rehabilitation that might be achieved. However, it should be recognized that the long-term survival and breeding success of oiled birds may be substantially less than that of unoiled birds.

Relative Risk to Bird Classes and Potential Oil Spill Impacts

The bird fauna potentially affected by oil spills includes shorebirds, rails and cranes, waterfowl, loons and grebes, raptors (due to foraging or scavenging oiled birds), and colonial seabirds. The determination of significance of impacts is principally based on the sensitivity of the species and the likelihood of oil spills contact with habitat. If the probability of contact is negligible, no further analysis is conducted (negligible is defined as a probability less than one- percent). If the probability of contact is 1 percent or greater, the reasonable worst-case scenarios are used to examine the magnitude of potential impacts. Impacts are considered significant if contact is likely to bring about a substantial loss of the regional population or the habitat that sustains it. With the exception of colonial seabirds, the affected population is assumed to be that of the entire San Francisco Bay estuary area; colonial seabirds in the bays are considered part of the much larger population inhabiting the Farallon Islands and the outer coast.

Shorebirds

The San Francisco Bay estuary is used by up to 1 million shorebirds as a critical feeding area in the Pacific flyway. Substantial mortality of wintering shorebirds or loss of essential habitat would likely result from oil spills and would constitute a significant impact (Class I).

Relative Risk

Should spills occur at the Unocal Terminal, waters or shoreline subject to substantial risk of contact are concentrated within 6 to 8 km of the Terminal, including all of Carquinez Strait and waters west of

Davis Point in the deeper, faster tidal currents of the ship channel. The probability of oil contact with foraging habitat of shorebirds on intertidal mudflats from crude oil spills ranges from 0.2 to 10 percent, and 0 to 5 percent for petroleum product spills. Habitat subject to contact is predominantly within San Pablo Bay and San Rafael Bays; some mudflats in South San Francisco Bay can be contacted by crude oil spills (less than a 5-percent chance), but not product spills. Intertidal mudflats subject to moderate oiling are found only from Davis Point to Pinole Point, and along Mare Island; these mudflats are subject to only a 0.2- to 2-percent chance of contact from either crude or product spills. The probability of heavy oiling of intertidal mudflats is negligible (less than 0.2 percent for any particular grid-cell).

A substantial risk of contact to intertidal mudflats is also posed from spills along the route used by Unocal tankers. Likelihood of moderate oiling is generally less than 4 percent, but may reach 6 to 12 percent along Contra Costa County from Point Richmond to Point San Pablo. Almost all intertidal mudflats in South San Francisco Bay are subject to a negligible chance of contact from either product or crude oil spills from Unocal tankers (less than a 1-percent chance).

Oil Spill Scenarios

Reasonable worst-case oil spills were modeled to verify the threat and determine the magnitude of potential impacts. Impacts were estimated for shorebirds most common on intertidal mudflats and mud shores in San Francisco and San Pablo Bays. The species included were: black-bellied and semipalmated plovers, killdeer, American avocet, willet, long-billed curlew, marbled godwit, ruddy and black turnstones, red knot, sanderling, western and least sandpipers, dunlin, and dowitchers. Data on numbers and distribution (median percent of population in different parts of the bays) were taken from USFWS data (USFWS 1992). For each species, a population estimate was made for the fall (censuses of 1988 and 1989), winter (census of 1989), and spring (censuses of 1988, 1989 and 1990), for the south, central, and north parts of San Francisco Bay, and for San Pablo Bay. (Shorebirds in Suisun Bay are believed to account for less than 1 percent of numbers in the entire San Francisco Bay estuary; Stenzel et al. 1989, USFWS 1992).

Shorebirds are present in substantial numbers in San Francisco and San Pablo Bays only in the fall, winter, and spring. Thus, impacts to the migrant population were determined only for scenarios occurring in these seasons; Shorebird foraging habitat was assumed to consist only of intertidal mudflats, and scenario spills were tracked to determine the areal extent of intertidal mudflats contacted by oil. It was assumed that shorebirds were uniformly distributed within the habitat. The percent of intertidal mudflats contacted by a scenario spill was then used as an estimate of the percent of the shorebird population potentially contacted. Separate calculations were made for southern, central, and northern parts of the San Francisco Bay, and for San Pablo Bay. Estimates of numbers potentially contacted in different parts of the Bays were then summed to determine the portion of the entire shorebird population potentially contacted by each scenario spill. The analysis may overestimate impacts to species that have secondary foraging habitat in ponds and fields not subject to contact by oil.

Numbers of shorebirds potentially contacted by each scenario were reduced by 17 percent to allow for success of bird rescue efforts (see discussion of Vulnerability of Birds, above). (It should be recognized that rescue and cleaning of birds does not guarantee their long-term survival.) The final estimate of percent mortality does not take into account the ability of shorebirds to avoid contact by relocating to other habitat. It is not clearly known to what degree shorebirds will move to uncontaminated habitat, but few shorebirds are typically found after oil spills suggesting that some relocation may take place. Table 4.4-12 summarizes the impacts on shorebirds that might be produced by each of the reasonable worst-case scenarios.

Scenario 3, a 20,000-bbl crude oil spill near the Unocal Terminal in January, resulted in contact with 14.1 percent of all shorebird foraging habitat in the San Francisco and San Pablo Bays. Most habitat contacted was in San Pablo Bay (44 percent of all mudflats/mud shore), and North San Francisco Bay (57 percent of all mudflats/mud shore); only minor contact occurred in central San Francisco Bay, and almost no contact in the South Bay. The number of shorebirds that might be killed could be debated on the basis of relocation to uncontaminated habitat. However, it is unlikely that shore birds form hard-hit San Pablo Bay and North San Francisco Bay would relocate in sufficient numbers to avoid significant impacts to the population.

Table 4.4-12

SUMMARY OF ESTIMATED IMPACTS OF SCENARIO SPILLS ON LONG-BILLED CURLEWS

Scenario[a]	Month	Mean Population[b]	Percent Habitat Contacted[c]	Percent Mortality[d]
1	March	805,517	5.3	4.5
3	January	140,398	14.1	11.7
5	February	140,398	0.0	0.0
7	February	140,398	1.0	0.8
8	August	335,598	0.04	0.04
9	March	805,517	17.4	14.5
10	September	335,598	14.5	12.0
11[e]	November	335,598	10.3	8.5
12[e]	August	335,598	15.7	13.0

[a] Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.
[b] Mean population from USFWS aerial censuses, 1988 through 1990, of shorebird species common on intertidal mudflats.
[c] Habitat limited to intertidal mudflats; calculations made using National Wetlands Inventory database.
[d] Mortality of shorebirds, expressed as percent of population, is assumed to be in proportion to percent of habitat contacted; mortality is reduced by 17 percent to account for possible success of rescue efforts.
[e] These Scenario spills originated at Anchorage No. 9, which is not typically used by vessels carrying Unocal crude oil or products.

Scenario 9, a 100,000-bbl crude oil spill in the tanker lane near Alcatraz Island in March, resulted in contact with 17.4 percent of intertidal mudflats. Most oil moved generally northward, contacting 76 percent of mudflats in the Central Bay, 43 percent in the North Bay , and 37 percent in San Pablo Bay. Although the South Bay was only lightly contacted, it cannot be assumed that shorebirds would relocate there.

Scenario 10, a 100,000-bbl crude oil spill in the tanker lane near Alcatraz Island in September, resulted in contact with 14.5 percent of intertidal mudflats. In contrast with Scenario 9, most oil contacted the Central and South Bays (56 and 13 percent, respectively), with little contact in either the North or San Pablo Bays.

Impacts of Scenarios 1, 7, and 8, involving smaller spills at the Unocal Marine Terminal, and Scenario 5, a small spill in the Carquinez Strait, contacted less than 10 percent of shorebird habitat. These three scenario spills, therefore, did not meet the criteria of significant impacts.

Although spills at the Unocal Terminal can be expected during the 40-year life of the lease (there is a 78-percent chance of one or more spills), it is likely that the quantity released would be relatively small. The chance is about 80 percent that any spill would be less than 1,000 bbl, and near certainty that any spill would be less than 6,000 bbl. Even small spills can have a significant impact if they occur repeatedly. However, the chance that more than two spills equal to or greater than 1,000 bbl might occur is less than 1 percent. Should a spill occur and not be contained, there is a 10-percent chance that it would contact intertidal mudflats in San Pablo Bay used for foraging by shorebirds; the chance of contact with habitat in

San Francisco Bay is much less. In the absence of containment, impacts that might potentially result from a reasonable worst-case crude oil spill of 1,000 bbl at the Unocal Terminal (Scenario 1) were temporary loss of 5.3 percent of shorebird habitat and mortality of 4.5 percent of the migrant population (approximately 36,000 birds). If an area of mudflat were heavily oiled, loss of habitat or food resources could persist beyond a single season.

Unocal tanker transport produces a 7-percent chance of spills over the 40-year life of the lease. The likelihood of spills greater that 1,000 bbl is 5 percent and spills greater than 10,000 bbl is 1 percent. Although the likelihood of occurrence is small, oil could contact a large part of shorebird habitat, especially in San Pablo Bay and the northern part of San Francisco Bay. The chance of contact with intertidal mudflats is generally 20 percent or less; the greatest chance of moderate or heavy oil contamination is at Point San Pablo, where the ship channel is relatively close to land, and the Contra Costa County shoreline south to Point Richmond. Reasonable worst-case spills from tankers are represented by spill Scenarios 3, 9, and 10. These are large, uncontained spills with extensive spread, contacting 14.1 to 17.4 percent of the intertidal mudflats and causing potential mortality of 11.7 to 14.5 percent of the shorebird population (approximately 16,000 to 117,000 birds). Should such spills occur, impacts on shorebirds would be significant on the basis of a certain loss of food resources by contamination of a substantial portion of total mudflats habitat, and probable mortality from direct contact (hypothermia from oiling and ingestion of oil during foraging) (Class I).

Waterfowl

The San Francisco Bay estuary is used by several hundred thousand water fowl from late fall through spring as a critical feeding ground. Substantial mortality of wintering water fowl or loss of essential habitat would likely result from oil spills and would constitute a significant impact (Class I).

Relative Risk

Because of the widespread distribution of waterfowl, any oil spill from October through about April would probably contact some portion of the population. Spills occurring at the Unocal Terminal predominantly affect nearby waters of San Pablo Bay and Carquinez Strait. Areas of high waterfowl density in the northern part of San Pablo Bay are subject to a 5- to 30-percent chance of contact from a spill at the Terminal; the chance of moderate oiling is about 2 percent, and the chance of heavy oiling is less than 1 percent. Therefore the relative risk to waterfowl from a spill originating at the Terminal is fairly low. Spills from Unocal tankers can affect a much larger area. Greatest probabilities of contact from tanker spills occur near the ship channel through San Pablo Bay, and northern and central San Francisco Bay. Areas of San Pablo Bay where waterfowl are found at highest densities are subject to a 10- to 40-percent chance of contact; there is a 6- to 8-percent chance of moderate oiling and a 1- to 2-percent chance of heavy oiling. Most waterfowl habitat in South San Francisco Bay are subject to a negligible chance of contact from either tanker spills or spills at the Terminal. The overall risk to waterfowl from a spill originating from Unocal tankers would, however, be relatively high because of the vulnerability of waterfowl in San Pablo Bay.

Oil Spill Scenarios

Reasonable worst-case oil spills were modeled to verify the threat and to determine the magnitude of potential impacts. Wintering waterfowl are abundant and widespread in waters of the Bays subject to oiling. Results of reasonable worst-case scenarios contacting habitat of wintering waterfowl are presented in Table 4.4-13. Numbers of birds potentially contacted was calculated from the number within the scenario spill perimeter, expressed as percent of mean October-March population exclusive of numbers in salt ponds (USFWS 1992, USFWS unpublished data). Estimated mortality was calculated as 10 to 40 percent of the number of birds potentially contacted (i.e., within the scenario slick perimeter), less 17 percent for mitigation by bird rescue. (Again, it is important to remember that rescue and cleaning of oiled birds does not guarantee their long-term survival.) The range of mortality of birds on the water was based on finding of hindcast studies following oil spills from the T/V Puerto Rican and Nestucca (Dobbin et al. 1986; Ford et al. 1991b). Not all birds on the water are typically contacted due to the patchy distribution of both the birds and the oil slicks.

Spills at the Marine Terminal (represented by Scenario 1) and large tanker spills (Scenarios 3 and 9) clearly have the potential to produce significant impacts to waterfowl (Class I). Waterfowl populations may recover from impacts of an oil spill

Table 4.4-13

SUMMARY OF IMPACTS OF SCENARIO SPILLS ON WINTERING WATERFOWL

Scenario[a]	Month	Percent Habitat Contacted	Percent Mean Population in Spill Perimeter	Estimated Mortality[b]
1	March	9.4	34.6	1,400 - 5,500
3	January	40.3	43.7	1,700 - 6,900
5	February	5.3	1.2	50 - 200
7	February	1.7	4.8	200 - 800
9	March	40.7	53.9	2,100 - 8,500
11	November	7.6	4.1	200 - 600

[a] Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.
[b] Calculated as 10 to 40 percent of mean population in spill perimeter, minus 17 percent to account for bird rescue.

within a year due to their high reproductive potential. However, foraging habitat may be affected longer due to degradation in water quality and contamination of mussels, clams, and other benthic organisms used for food by diving ducks.

Seabirds

Seabirds have regional populations that are centered predominantly off the outer coast. Thus, the significance of impacts from oil spills must be judged relative to the entire regional population, whether or not spills occur off the outer coast or in the San Francisco Bay estuary. Alcids, especially, are typically the greatest casualty of oil spills due to their abundance on the water and their tendency to dive rather than fly when stressed. The vulnerability of seabirds was emphasized by the Apex Houston spill in the winter of 1986 that killed more than 10,000 seabirds. Substantial mortality of alcids would be significant (Class I) because these species are recovering from impacts from oil spills and entanglement mortality in gill nets.

Relative Risk

Within the bays, seabirds have colonies at more than 100 locations; most are used by more than one species. Western gulls have nesting colonies at the greatest number of locations (60), but are not considered particularly vulnerable to oil spill impacts because they forage widely in the area, including on land, and do not spend a large portion of their time on the water. Forster's and Caspian terns have colonies at 31 and 7 locations, respectively; most are in salt ponds beyond the reach of oil spills. Other prominent nesting species are the cormorants which have colonies at 10 sites, principally on rocks and cliffs (Brandt's and pelagic cormorants), and on bridges and towers (double-crested cormorant).

Table 4.4-14 lists important colonies and the relative risk from crude oil spills from the Unocal Terminal and from spills along the route of Unocal tankers through the bays (probabilities of contact by product spills are less). Crude oil spills from operation of the Unocal Marine Terminal have a substantial chance of contacting waters and shoreline sites used by double-crested cormorants and western gulls in San Pablo Bay and northern San Francisco Bay. The colony of double-crested cormorants on Wheeler Island in Suisun Bay would not typically be reached by spills from the Marine Terminal. Spills along the route used for Unocal tankering have a substantial chance of contacting all colonies except those in South San Francisco Bay.

Seabirds off the outer coast of California have colonies at nearly 200 locations. Colonies are not usually contacted directly by oil due to their elevation above

Table 4.4-14

LEVEL OF RISK OF CONTACT OF CRUDE OIL SPILLS TO MAJOR SEABIRD COLONIES IN SAN FRANCISCO, SAN PABLO, AND SUISUN BAYS, FROM OIL SPILLS RELEASED AT THE UNOCAL TERMINAL AND BY UNOCAL TANKERS

Location	Species	Probability (percent)	
		Unocal Terminal	Unocal Tankers
N. San Pablo Bay Radar Target	DOCO	H	H
NE San Pablo Bay Beacon	DOCO	H	H
Davis Point	WEGU	H	H
Wheeler Island	DOCO	L	M
Sisters Rocks	WEGU	H	H
Brothers Rocks	WEGU	H	H
Richmond/San Rafael Bridge	DOCO	M	H
Red Rock	WEGU	M	H
Brooks Island Breakwater	WEGU	M	H
Alcatraz Island	WEGU	L	H
Pier 45	WEGU	L	H
SF Piers, North	WEGU	L	H
SF Piers, South	WEGU	L	M
Treasure Island	WEGU	L	H
Yerba Buena Island	BRCO PECO WEGU	L	H
SF/Oakland Bay Bridge, East	DOCO	L	H
Hunters Point	WEGU	L	M
Leslie/Baumberg Salt Ponds	FOTE CATE	L	L
Alviso Plant Salt Ponds	CAGU	L	L
Charleston Slough	FOTE	L	L
Bair Island Ponds	FOTE	L	L
San Mateo Bridge/PG&E Towers	DOCO	L	L

SPECIES KEY

DOCO - double crested cormorant
BRCO - Brandt's cormorant
PECO - pelagic cormorant
WEGU - western gull

CAGU - California gull
FOTE - Forster's tern
CATE - Caspian tern

L = Low risk (<1 percent chance)
M = Moderate risk (1 to 10 percent chance)
H = High risk (>10 percent chance)

the water. However, the density of birds on the water is greatest near the colonies and it is there that impacts are likely to be greatest. Thus, colony location is used only as an indicator of important habitat. Probabilities of oil contact from the trajectory model are provided in Table 4.4-15 for contact of crude oil spills with colonies of alcids (murres, auklets, murrelets, and puffins), cormorants, storm-petrels, and Western gulls (probabilities of contact by product spills are less). The trajectory analysis showed that the probability of contact with one or more colonies along the outer coast, should a spill occur, is near certainty for cormorants and Western gulls, and high for alcids. This is because colonies exist at a great many locations along the coast. Because storm-petrel colonies are found at only a few sites, probability of contact is less tban 30 percent.

Table 4.4-15

RISK OF CONTACT BY CRUDE OIL SPILLS FROM UNOCAL TANKERS TO SEABIRD COLONIES ALONG THE OUTER COAST

Species	Conditional Probability* of Contact of One or More Colonies (Percent)
Alcids	82.7
Storm-petrels	29.4
Cormorants	98.2
Western Gulls	99.3

* Conditional probability is the percent chance of contact should a spill occur in the tanker lanes.

Size of colonies varies greatly, therefore oil spill contact with one may produce more impact on the regional population than contact with another. Common murres have their largest colonies at Castle Rock at Point Saint George, rocks off Trinidad Head, and at the Farallon Islands; these colonies provide nesting habitat for three-fourths of the California population. The conditional probability of contact with more colonies at Castle Rock or Trinidad Head results only from transport of petroleum products and is less than 1 percent. (This presumes that spills originate in the tanker lane about 20 nm from shore; a grounding, of course, would produce a much higher probability of contact.) The conditional probability of contact with the Farallon Islands by crude oil spills is about 23 percent. The Farallon Islands also have the most important colonies of Cassin's auklets and ashy storm-petrels (80 percent of the world population of ashy storm-petrels).

Oil Spill Scenarios

Reasonable worst-case scenarios were used to determine the magnitude of impacts that could result from the Unocal Terminal and Unocal tankering.

Reasonable worst-case scenarios show that spills most likely to affect large numbers of seabirds in the San Francisco Bay estuary result from tanker accidents with large outflow of oil (Scenarios 3, 9, and 10). Spills at the Unocal Terminal affected small colonies of double-crested cormorants on beacons and radar targets, and western gulls at Davis Point and elsewhere in San Pablo Bay (Scenarios 1, 2, 7, and 8). Table 4.4-16 identifies seabird colonies in San Francisco and San Pablo Bays contacted and percent of population affected by reasonable worst-case scenario spills.

Although colonies exist in the bays for several seabird species, cormorants are the species most at risk from oil spills due to their frequent foraging in waters near colonies and roosts. Mortality could range from 10 to 40 percent of the population in waters contacted by oil, based on estimates from hindcast analyses (Dobbin et al. 1986; Ford et al. 1991b). The hindcast analyses derived estimates of mortality based on counts of oiled birds on the beach, trajectory of the oil slick, and known populations of birds at sea. There would be a loss of 200 to 800 birds in a very large tanker spill affecting central and northern San Francisco Bay, such as in Scenarios 3, 9, and 10. Some oiling of gulls and terns would also occur as these birds forage on the water. Gulls and terns are not known to be seriously affected by oil spills, and it is unlikely that mortality would have a measurable effect on populations. Impacts on double-crested commorant, a state species of special concern, are discussed in the Rare/Threatened/Endangered Species Section. Impacts on other nonthreatened/endangered species by oil spills in San Francisco and San Pablo Bays would be nonsignificant.

Two crude oil spills were modeled for the outer coast representing reasonable worst-case scenarios. Outer coast Scenario 1, a spill near the Farallon Islands in March could result in substantial mortality of alcids, up to about 5.6 percent of total numbers on the water from Monterey Bay to Oregon (the regional population; Table 4.4-17). Considering that it occurs

Table 4.4-16

SEABIRD COLONIES IN SAN FRANCISCO BAY ESTUARY WHICH WOULD BE CONTACTED BY REASONABLE WORST-CASE SCENARIO SPILLS AND PERCENT OF POPULATION AFFECTED

Bay	Scenario*											
	1	2	3	4	5	6	7	8	9	10	11	12
Percent Population Affected in Bay	0.4	0.2	42.0	1.4	0	0	20.1	0.1	54.6	56.5	0	0
Percent Population Affected in Bay and Outer Coast, combined	<0.1	<0.1	9.9	0.3	0	0	<0.1	<0.1	12.9	13.3	0	0
Major Colonies and Species Affected												
North San Pablo Bay Ruda Target - DOCO	X		X	X					X			
Northeast San Pablo Bay Beacon - DOCO	X		X	X					X			
Davis Point - WEGU	X	X	X	X			X	X	X			
Sisters Rocks - WEGU			X						X			
Brothers Rocks - WEGU			X						X	X		
Red Rock - WEGU			X						X	X		
Brooks Island Breakwater - WEGU			X						X	X		
San Francisco/Oakland Bay Bridge - DOCO			X						X	X		
Treasure Island - WEGU			X						X	X		
Yerba Buena Island - WEGU, BRCO, PECO			X						X	X		
Alcatraz Island - WEGU			X						X	X		
Needles/Golden Gate - PECO			X						X	X		
Pier 45 - WEGU									X	X		
San Francisco Piers, North - WEGU									X	X		
San Francisco Piers, South - WEGU									X	X		

SPECIES KEY

BRCO - Brandt's cormorant
CAGU - California Gull
CATE - Caspian tern
DOCO - double crested cormorant
FOTE - Forster's tern
PECO - pelagic cormorant
WEGU - western gull

* Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.

Table 4.4-17

NUMBERS CONTACTED AND PERCENT OF NORTHERN CALIFORNIA POPULATION FOR SEABIRD SPECIES-GROUPS AFFECTED BY REASONABLE WORST-CASE SPILLS OFF THE OUTER COAST

Scenario	Species Group	Numbers Contacted	Estimated Mortality[1]	Percent of Population[2]
1 (March)	Alcids	103,038	9,400 - 37,500	5.6
	Cormorants	3,390	300 - 1,300	4.1
	Loons/Grebes/Scoters	13,583	1,200 - 4,900	4.8
	Gulls/Terns	52,069	2,100	0.5
	Tubenoses	103,927	4,300	2.2
	Phalaropes	8,046	300	<0.1
2 (October)	Alcids	20,263	1,800 - 7,400	1.1
	Cormorants	563	50 - 200	<0.1
	Loons/Grebes/Scoters	3,143	200	0.2
	Gulls/Terns	42,782	1,800	0.7
	Tubenoses	10,876	500	<0.1
	Phalaropes	7,238	300	<0.1

[1] Mortality for alcids, cormorants, loons, grebes, and scoters is 10 to 40 percent of population contacted in perimeter of the scenario spill, after Dobbin et at. 1986, and Ford et al. 1991b, less 9 percent for best success of bird rescue on the outer coast. Mortality for other, less susceptible species is assumed to be 4.5 percent, after findings of Ford et al. 1991b, less 9 percent for best success of bird rescue on outer coast.

[2] Population in area is extrapolated from mean density in waters from Monterey Bay to Oregon out to 185 km (100 nm) from shore (data from Briggs et al. 1983).

at the start of the breeding season, Scenario 1 could produce enormous impacts on colonies at the Farallon Islands, Point Reyes, Point Resistance, and Double Point Rocks. Alcids in these colonies include common murres, pigeon guillemots, Cassin's auklets, rhinoceros auklets, and tufted puffins, with a combined population of about 135,000 (Carter et at. 1990). Scenario 1 could result in loss of 28 percent of local alcid populations; recovery would require several years during which time the population would be especially vulnerable to additional impacts. Should multiple spills occur, one or more colonies could be lost (see Section 4.3.8.2). Ashy storm-petrels, with their largest colony in the world on southeast Farallon Island, were not contacted in great numbers by Scenario 1 because they forage farther from shore. An oil spill the size of Scenario 1 (contacting about 2,500 square km) but occurring farther from shore could contact over 400 Ashy storm-petrels, or about 8 percent of the world population. Cormorants in the Gulf of the Farallones could suffer loss of about 5.8 percent of the 22,000 birds nesting in the area. The March scenario-spill also produced substantial mortality to loons, grebes, and scoters, and tubenose-birds (during this season, principally storm-petrels). Outer coast Scenario 1 would result in a significant (Class I) impact on seabirds. The October scenario-spill resulted in death of up to 10,000 birds, but these numbers might be regained without substantial threat to the health of populations. Outer coast Scenario 2 would not have substantial impacts on seabirds. Again, multiple spills could create impacts difficult to overcome.

Marine Mammals

Background of Marine Mammals Sensitivity to Oil

The effects of contact with oil by marine mammals have been reviewed thoroughly by Geraci and St. Aubin (1982, 1985, 1988). The most notable effects on cetacean species are believed to be fouling of baleen plates or the inhalation of oil or volatile components. Laboratory studies indicated that water flow through baleen was restricted by bunker oil for only a few minutes, however the baleen plates remained noticeably fouled for up to 20 hours (Geraci and St. Aubin 1982, 1988). If whales feed through contaminated baleen, some ingestion may occur leading to internal damage. Ingestion of oil causes irritation or destruction of epithelial cells lining the stomach and intestine, thereby affecting motility, digestion, and absorption. Once in the blood stream, oil can damage most organs, especially the kidneys, liver, and adrenals (Geraci and St. Aubin 1985). Health can also be affected by inhalation of volatile components should a whale, dolphin or porpoise surface in an oil slick. Effects of inhalation include irritation of the lungs and incorporation of hydrocarbons into tissues (Geraci and St. Aubin 1988). Although data are lacking, it is likely that animals already weakened by lung or liver parasites and adrenal disorders might be most affected by inhalation of vapors (Geraci and St. Aubin, 1979). In many mammals, aspiration of even small doses of oil (such as might occur if a cetacean surfaced in an oil slick) can cause acute fatal pneumonia (Geraci and St. Aubin 1985).

Direct effects of oiling on pinnipeds and sea otters include both surface contamination of fur, and possible ingestion of oil while grooming or during suckling of pups. Harbor seals, elephant seals, and sea lions rely predominantly on subcutaneous fat and a high metabolic rate to keep warm. In contrast, fur seals and sea otters depend on the integrity of an air layer trapped in clean fur to provide insulation and buoyancy. Adverse effects of oiling on northern fur seals and sea otters have been demonstrated under laboratory conditions, where oiling over 25 to 30 percent of the body surface resulted in hypothermia and an elevated metabolic rate in typical water temperatures. Researchers concluded that the oil contamination would probably cause death unless the fur was cleaned and restored to its original insulative capability (Kooyman et al. 1976; Kooyman et al. 1977; Costa and Kooyman 1980, 1982). The sensitivity of sea otters to oil spills was underscored by the death of over 1,000 animals during the Exxon Valdez oil spill in Prince William Sound (USDOC, NOAA 1991). Locally, the recent oil spill at Avila in central California, killed at least three sea otters (P.R. Kelly, CDFG, personal communication 1993).

Harbor seal pups may occasionally be born with a lanugo coat of dense woolly fur. More typically, the lanugo is shed before birth when sufficient subcutaneous fat has been stored. The presence of postpartum lanugo may indicate that insufficient fat is present to provide insulation and energy reserves. Studies have not been done, but it is probable that oil contamination of the lanugo could lead to hypothermia and death of a harbor seal pup.

Acute toxic effects of oil ingestion from grooming have been observed in polar bears (Oritsland et al. 1981) and river otters (Baker et al. 1981). Presumably, other marine mammals that attempt to remove oil from their fur, such as fur seals and sea otters, could experience similar effects. It is also possible that oil could be ingested by pinniped or sea otter pups during nursing if the mother was oiled. Variable reactions to ingestion of oil, ranging from relatively rapid recovery to sickness and death, have been reported in common (harbor) seals, gray seals, and ringed seals (Duguy and Babin 1976; Davis and Anderson 1976; Geraci and Smith 1976; Engelhardt 1982).

Sea otters, fur seals, and very young harbor seal pups are at extreme risk of mortality from oil spills. The California population of sea otters (Threatened) are restricted to nearshore waters where they can be trapped by oil. A compounding factor is the longer residence-time of oil in kelp beds relative to high-energy environments of most open beaches and rocky shore. There is no evidence that sea otters are able to successfully avoid oiling if a spill reaches nearshore waters, and both adults and younger animals are equally susceptible to death from oiling. Fur seals, while sensitive to oiling, are typically found over the continental slope and waters farther offshore. They may be able to avoid spreading oil to some degree, simply because they are free to relocate in pelagic waters as an oil spill advances. Harbor seal pups with a lanugo coat are susceptible to impacts from oil spills in the first week of life. After molt of the natal fur, and when sufficient fat has been acquired, oil contamination is not likely to have adverse effects. Elephant seal pups also depend to some extent on the natal fur. However, due to their larger heat-producing mass, oiling of the natal pelage is not likely to result in death.

Pinniped pups may ingest oil while nursing if the mother is heavily oiled. Although not easily discriminated from background variation (e.g., Le

Boeuf 1971; Brownell and Le Boeuf 1971), it is likely that some long-term adverse effects would result should a rookery be contacted during the breeding season. Sea otter pups also may ingest oil during suckling, but effects of ingested oil would be subtle compared to those resulting from contamination of fur. Observations following spills off Wales, the French coast, Nova Scotia, and Prince William Sound provide evidence that pinnipeds may have died from direct effects of heavy oiling (Davis and Anderson 1976; Duguy and Babin 1975; Mansfield 1970; USDOC, NOAA 1991).

Cetaceans have smooth skin to which oil does not readily adhere. Direct effects of oil spills are limited in large part to inhalation of volatile components and ingestion during feeding by baleen whales. Baleen whales feed opportunistically, but regularly visit specific feeding grounds where euphausiid crustaceans and other invertebrates or small fish form dense shoals. Along the outer coast, the Gulf of the Farallones and Monterey Bay are important feeding grounds in the summer and fall for humpback, blue, and fin whales. Gray whales, although abundant in winter and spring, feed infrequently and only opportunistically during migration.

The extent to which large whales will avoid oil spills is still unclear. Migrating gray whales have been noted making some attempt to avoid natural oil seeps, but the behavior is inconsistent (Kent et al. 1983). Humpback whales have been observed feeding in an area off Cape Cod where thin oil sheens were present from the Regal Sword spill (Goodale et al. 1979).

Toothed whales, which use echo-location to orient and find prey, may be able to avoid oil slicks. In studies with captive animals, bottlenose dolphins were found to reliably detect oil in a slick 1 mm thick and avoid contact (in our analysis, classified as heavy oil; Geraci et al. 1983, Smith et al. 1983). Although it is recognized that oil spills may contact waters occupied by porpoises and dolphins, no data exists upon which to base a determination of significant impact. Toothed whales are protected under the Marine Mammal Protection Act of 1972, however no dolphin or porpoise species present in the area is listed as threatened or endangered under the Endangered Species Act of 1973.

Vulnerability of Marine Mammals to a Unocal Spill

Marine mammals found in San Francisco and San Pablo Bays include harbor seals, California sea lions, and harbor porpoises (gray whales and humpback whales occasionally wander into the Bays but are not part of the typical fauna). Harbor seals in the Bays may be subject to impacts of oil spills because they breed and give birth to pups in the area. Harbor seals (particularly pups) may be subject to risk of oiling both on land and in the water. California sea lions in the Bays are migrant adult males and juveniles that are present in relatively small numbers in the fall and winter. Because they are not known to be especially sensitive to oil impacts, and have a very large and expanding population off the outer coast, any impacts of oil spills in the Bays would be nonsignificant (Class III). Harbor porpoises are rare in the Bays, relative to numbers in the Gulf of the Farallones, are highly mobile and may avoid oil slicks, and are not known to be especially sensitive to oil contact. Thus, impacts of oil spills are likely to be nonsignificant (Class III). Gray whales and humpback whales occasionally wander into the Bays but do not typically occur there; because of their rarity in the area, impacts on these species would be nonsignificant (Class III).

Off the outer coast, nonlisted species of marine mammals include the gray whale, several species of dolphins and porpoises, harbor seals, northern elephant seals, California sea lions, and northern fur seals. The northern fur seal has been designated a depleted species under the Marine Mammal Protection Act due to declining numbers. This species is also very sensitive to impacts of oiling due to its reliance on clean fur for insulation and buoyancy.

Pinnipeds

Harbor Seals

Pacific harbor seals occur both along the outer coast and in the San Francisco and San Pablo Bays, and constitute a single intermixing regional population. Therefore, the magnitude of impacts to harbor seals in the Bays must be evaluated in terms of the entire population that provides recruitment into the regional area.

Oil on land and in the nearshore waters where harbor seals forage would produce greatest damage during the spring pupping season. Although adult harbor seals can die in oil spills, this would be relatively rare and have a minor effect on the population. From data in Mansfield (1970), heavy oiling of a haul-out site might kill up to 5 percent of adult animals present. A more serious threat is oiling of newborn pups that may be protected from cold only by a dense fur (lanugo). Death could result from hypothermia, ingestion of oil, or starvation if separated from the mother.

Relative Risk to Harbor Seals from a Unocal Spill

Within the Bays, harbor seals are subject to substantial risk only from tanker transport past their haul-out sites at Tubbs Island, Castro Rocks, the vicinity of California Point, Angel Island, and Yerba Buena Island (Table 4.4-18). In combination, these sites provide habitat for resting and breeding for about 38 percent of harbor seal population in the San Francisco Bay Area. (Although all haul-out sites can be contacted by spills at the Unocal Marine Terminal, the probabilities are sufficiently small that this source of risk can be disregarded.)

Along the outer coast, harbor seals haul-out at a great many locations. Thus, there is a very high probability that one or more sites would be contacted should a tanker spill occur. As in the instance of other resources, the greatest relative risk is to harbor seals habitat in the Gulf of the Farallones and southward toward Monterey Bay.

Oil Spill Scenarios

Reasonable worst-case scenarios can be used to approximate the range of impacts. Within the Bays Scenarios 3, 9, and 10 resulted in contact with several haul-out sites. Scenario 3, a 20,000-bbl crude oil spill in the tanker lane near the Marine Terminal, contacted four haul-out sites in the north and central San Francisco Bay: Castro Rocks, the Tiburon Peninsula, Angel Island, and Yerba Buena Island. Modeled oil slicks became especially patchy and scattered in the central Bay, particularly inshore from Richmond Marina Bay south to the SF-Oakland Bay Bridge, in waters from Alcatraz Island to the Golden Gate, and in Richardson Bay. Overall, oiling in the central Bay from this scenario was the equivalent of 45 bbl/sq km ("light oiling") which, if continuous, would appear as an iridescent sheen. Scenario 3 would be expected to produce moderate oiling to the haul-out site north of California Point on the Tiburon Peninsula and to Castro Rocks, but only light and patchy oiling of Angel Island, and very light oiling to Yerba Buena Island. Because of the month of the modeled spill

Table 4.4-18

LEVEL OF RISK OF CONTACT WITH HARBOR SEAL HAUL-OUT SITES IN SAN FRANCISCO AND SAN PABLO BAYS FROM OIL SPILLS AT THE UNOCAL MARINE TERMINAL AND ALONG THE TANKER ROUTE THROUGH THE BAYS

Haul-Out Site	Maximum Count	Unocal Terminal	Tanker Lanes
Tubbs Island	34	L	M
Castro Rocks	123	L	M
California Point	14	L	M
Point Blunt, Angel Island	31	L	H
Strawberry Spit	97	L	L
Sausalito Harbor	30	L	L
Yerba Buena Island	65	L	H
Plummer Creek	53	L	L
Mowry Slough	328	L	L
Calaveras Point	98	L	L
Gaudalupe Slough	67	L	L
Greco Island	74	L	L
Corkscrew Slough	17	L	L

L = Low risk (<1 percent chance)
M = Moderate risk (1 to 10 percent chance)
H = High risk (>10 percent chance)

(January), no dependent pups would be present on these haul-out sites and the total number of animals would be less than one-quarter of the annual maximum population found on land in the summer. Although oiling of harbor seals might occur in the water, contact with skin, eyes, and nasal membranes would not be expected to produce mortality unless animals were already sick or injured.

Scenario 9 modeled the fate of a very large spill from the tanker lane near Alcatraz Island. The oil from the 100,000-bbl release was carried north by March winds and a flood tide into San Pablo Bay producing light oiling, and south as far as Hunters Point and Alameda producing moderate oiling. Most of the oil remained in north and central San Francisco Bay producing moderate to heavy oiling of haul-out sites in Richardson Bay, Angel Island, Yerba Buena Island, and Castro Rocks. The timing of the modeled spill created a worst-case for harbor seals, in that March is the beginning of the pupping season, and populations on land begin to increase. This spill would have the potential of oiling a substantial number of harbor seals, including pups; clean-up activities might cause additional impacts by displacing animals from important habitat.

Scenario 10 was also a very large spill (100,000 bbl) near Alcatraz Island during the flood tide, but was acted upon by September winds. Oil heavily contaminated waters of the central San Francisco Bay from the Richmond-San Rafael Bridge in the north to about Hunters Point and Oakland International Airport in the south. Some oil entered Richardson Bay but did not contaminate the shore. Only haul-out sites on Angel Island and Yerba Buena Island were contacted with oil. Such a spill in September would affect a sizable population of molting animals.

Off the outer coast, outer coast Scenario 1 - a 100,000-bbl tanker spill in March, spread oil over a wide area of open water, from nearly Point Reyes to Monterey Bay, and contacted shore from Point Montara to Point Ano Nuevo. In addition to contact of about 20 harbor seals at sea within the perimeter of the spill, oil contacted haul-out sites of more than 200 harbor seals along the coast of Santa Cruz and San Mateo Counties, small numbers on the Farallon Islands, and less than 100 animals in the vicinity of Point Reyes (Table 4.4-19). Had the scenario spill been structured to bring about contact to harbor seal breeding/pupping habitat at Double Point and Drakes Estero, more that 1,000 additional harbor seals, including many pups, would have been contacted.

Table 4.4-19

NUMBER OF HARBOR SEALS CONTACTED BY REASONABLE WORST-CASE SPILLS OFF THE OUTER COAST

Species	On Land[a]	At Sea[b]
Outer Coast Scenario 1 - March	344	61
Outer Coast Scenario 2 - October	201	11

[a] Mean of counts, 1980-1982, from Bonnell et al. 1983
[b] Minimum population contacted within perimeter of scenario spill; data from MMS-OCS Surveys Database

Outer coast Scenario 2 - a 100,000-bbl spill off Mendocino County in October, spread oil over a broad area of water southward from Punta Gorda. Oil was deposited along 70 km of shore from Bruhel Point north of Fort Bragg to near Point Arena. This scenario-spill principally contacted harbor seals at ten sites along this portion of coast, the most important being Laguna Point. In October, harbor seal numbers on land are less than in spring and summer as animals spend more time at sea, thus impacts would have been minimal.

Within the Bays, the greatest impacts on harbor seals was produced by Scenario 9 - a 100,000-bbl spill in March. The chance of occurrence of such very large spills in the tanker lane through the Bays is only 1 percent during the 40-year life of the lease. Although rare, spills such as this can occur. Impacts from such a spill could potentially affect about 35 percent of the local population (i.e., percent of harbor seals in San Francisco Bay); based on impacts of actual oil spills elsewhere, mortality might be as great as 50-100 animals, but would probably be less. If mortality was this great, a substantial portion of harbor seals numbers in San Francisco Bay would be lost (approximately 10-20 percent), but less than 1 percent of the estimated California population. A more serious consequence of such spills would be further degradation of the environment that provides a nursery for pups. Studies elsewhere suggest that protected waters of bays and estuaries are the preferred pupping grounds of harbor seals (Allen et al. 1989; Bonnell et al. 1991).

Off the outer coast, the reasonable worst-case spill in March had the potential to produce enormous impacts on pupping grounds. However, winds and currents driving the modeled spill did not bring about contact to important nursery areas at Double Point and Drakes Estero. Had contact occurred, mortality of adults could have been as great as about 50 animals, and mortality of pups could have been 100-200 animals or more. Rescue of pups by volunteers would have been feasible in the vicinity of the esteros but more difficult at Double Point. Long-term survival of these pups is unknown.

Given single reasonable worst-case spill events as described above, substantial mortality would occur. It is difficult to assess the magnitude of the impact on the regional population, but the spill would probably not have a measurable effect on the population's rate of growth. Habitat would not be permanently lost to harbor seals, providing that chronic impacts from oil spills or disturbance did not occur. Therefore, potential impacts would be adverse but nonsignificant (Class III).

Other Pinnipeds

The pinniped fauna of the outer coast includes, in addition to harbor seals (discussed above), northern elephant seals, California sea lions, Steller sea lions (Threatened), and northern fur seals. Guadalupe fur seals (Threatened) may also be present offshore in very small numbers, but are known to occur in the area only from a few stranding records. Because of their rarity in the area, impacts on Guadalupe fur seals are considered nonsignificant (Class III). Impacts on the Threatened Steller sea lion population are analyzed below under impacts on Rare/Threatened/Endangered species.

Should a very large spill occur from a Unocal tanker, substantial mortality of northern fur seals could result due to the species' sensitivity to oiling - a significant impact (Class I). California sea lions and northern elephant seals have large and growing regional populations. Habitat would not be permanently lost by a reasonable worst-case oil spill and effects on populations probably would not be measurable. Thus, impacts of Unocal tankers on these species would be adverse but nonsignificant (Class III).

Relative Risk to Other Pinnipeds from a Unocal Spill

Contact of oil spills with non-threatened/endangered species of pinnipeds can occur in open waters where they feed or on land where they rest and breed. Sea lions generally forage each day within 20-30 km of their haul-out sites. The likelihood of some of these waters being contacted by oil spills from the tanker lanes is near-certainty. The beaches and rocks used as haul-out sites by California sea lions are many and widespread, thus there is also a high likelihood of one or more being contacted should a spill occur (86.5 percent conditional probability of contact). Northern elephant seals do not come and go daily from their haul-out sites, nor do they forage close by. Typically, elephant seals remain on land for a month or more during the breeding season or for molting, and then disperse widely in the eastern North Pacific. They are most likely to be contacted at their colonies only when high surf can carry oil ashore; effects could be significant during the winter breeding season when pups might ingest oil during suckling. In the unlikely event that a tanker spill should occur the probability of contact to one or more northern elephant seal colonies is 37.8 percent. Northern fur seals do not haul-out on land at all in the area, but have a large pelagic population offshore in the winter and spring. The tanker lanes pass through waters used by northern fur seals and, consequently, the chance of contact should oil spills occur is very high.

Oil Spill Scenarios

Modeled oil spills were used to examine the extent of contact to pinniped habitat that might be expected from reasonable worst-case scenarios (Table 4.4-20). Outer coast Scenario 1 spread oil over a wide area of open water, from nearly Point Reyes to Monterey Bay, and contacted shore from Point Montara to Point Ano Nuevo. This spill in March contacted haul-out sites used by northern elephant seals, California sea lions, and Steller sea lions on the Farallon Islands and on Ano Nuevo Island and adjacent mainland. March is at the end of the breeding season of northern elephant seals; most pups have been weaned but remain on land after the adults have departed. California sea lions on land are part of a large seasonal population of adult males and juveniles that exploit food resources off this part of California in the fall, winter, and spring, but do not breed in the area. Steller sea lions (a Threatened species) breed in the affected area in the summer, but only a few are typically present in March (see analysis under Rare/Threatened/Endangered Species, below). Also present in deeper waters are northern fur seals that are abundant offshore only in winter and spring.

Table 4.4-20

NUMBER OF PINNIPEDS CONTACTED BY REASONABLE WORST-CASE SPILLS OFF THE OUTER COAST

Scenario	Numbers Within Spill Perimeter		
	Species	On Land[1]	At Sea[2]
1 March	Northern Fur Seal	0	21
	Northern Elephant Seals	4,058	27
	California Sea Lion	5,307	141
2 October	Northern Fur Seal	0	0
	Northern Elephant Seals	0	12
	California Sea Lion	8	120

[1] Mean of counts, 1980 - 1982, Bonnell et al. 1983.
[2] Minimum population contacted within perimeter of scenario spill; data from MMS-OCS Surveys Database.

Outer coast Scenario 2 off Mendocino County in October spread oil over a broad area of water southward from Punta Gorda. Oil was deposited along 70 km of shore from Bruhel Point north of Fort Bragg to near Point Arena. This scenario-spill contacted sites typically occupied by a total of less than 20 California sea lions in October. No breeding/pupping occurs during this season for any pinniped species, and very few northern fur seals are present offshore.

The most sensitive pinniped species to oil spill impacts is the northern fur seal. This is because of the species' reliance on clean air-filled fur for insulation and buoyancy. Mortality from contact by oil might range from 30-40 percent from encounter with a light film of oil on the water (<100 bbl/sq km), to 80-90 percent for heavy oil (>1,000 bbl/sq km) (Ford and Bonnell 1987). Scenario 1 potentially contacted 21 northern fur seals; however, some probably could avoid oiling by swimming away from the slick. In the absence of avoidance behavior, mortality could be as great as 19 animals. A large spill in the winter or spring could contact many more animals than Scenario 1 if oil was carried toward the shelf break and beyond (depth >1,000 m) where densities of fur seals are much greater. An oil spill affecting an area similar to Scenario 1 (about 2,500 sq km) and centered 50 km (27.5 nm) offshore could contact nearly 2,200 northern fur seals. Using the percentage mortality above, between 650 and 2,000 northern fur seals might die, representing 4.1 to 12.5 percent of the species' regional population (mean population, January through May, from Point Santa Cruz to Point Arena and seaward to the 2,000-m isobath; Bonnell et al. 1983).

Mortality of California sea lions and northern elephant seals may be as great as 5 percent of numbers heavily oiled (calculated from data in Mansfield 1970), but is probably less than 1 percent for most spills. This is because these pinnipeds predominantly depend on subcutaneous fat and a high metabolic rate for protection from cold. A few observations following oil spills indicate that mortality of oiled phocid seals and sea lions cannot be reliably discriminated from mortality due to natural causes (summarized in Geraci and St. Aubin 1985). Extrapolations from laboratory data suggest that seals may have to ingest 0.35-1.75 liters of oil to pose a threat of sickness leading to death (Geraci and St. Aubin 1985). The greatest impacts on phocid seals and sea lions would result from contact with a rookery (a place of breeding and birth of pups) during a season when pups were present.

The magnitude of impacts from potential oil spills on pinnipeds off the outer coast clearly depends on the season and the location of the spill. As structured for this analysis, Scenario 1 would have killed about 20 northern fur seals at sea. Although many adult California sea lions and northern elephant seals would probably have been contacted, few would be expected to die from exposure to oil. It should be noted that other possible oil spills would produce different impacts and some scenarios might do far more damage to pinnipeds.

California Gray Whale

Gray whales have not been observed to suffer from fatalities in oil spills. Migrating gray whales have been observed changing direction to avoid natural oil seeps in the Santa Barbara Channel; however, the behavior was not consistently noted (Kent et al. 1983). Gray whales in oil contaminated waters surfaced less frequently and, when they did, breathed at a more rapid rate. During the Regal Sword spill off Cape Cod, fin whales were observed swimming under patches of thick oil and humpback whales were observed feeding in an area of thin oil sheen; there was no evidence that whales suffered ill effects (Goodale et al. 1979). The Apex Houston spill off central California in 1986 occurred in late January and February during the peak of migration of gray whales. Although the spill was large enough to kill over 10,000 birds, there were no subsequent strandings of gray whales suggesting impacts form contact with oil. On the basis of the evidence, there is no clear relationship between contact with oil slicks by gray whales and subsequent mortality.

Given the lack of evidence of mortality in previous oil spills, and the probability that only a small portion of migrating whales might be contacted, impacts from Unocal tanker spills would be adverse but nonsignificant (Class III).

Relative Risk to Gray Whales from a Unocal Spill

Over a 40-year period, there is a 3.7-percent chance that Unocal tankers offshore will produce oil spills during the winter and spring when gray whales migrate along the northern California coast. The chance of spills greater than 10,000 bbl is about 1.3 percent. Most spills from tanker lanes would be carried closer to shore resulting in a 93-percent chance of contact with the gray whale migration path along the north coast, and a 99.5-percent chance of contact with the migration path from about Bodega Head to Monterey Bay by crude or product spill. Final probabilities of contact are, therefore, approximately the same as probabilities of occurrence.

Oil Spill Scenarios

Should a serious oil spill occur during months when gray whales are migrating along the coast, a portion of the population might be contacted. Some idea of the magnitude of potential impact can be gained from the results of reasonable worst-case scenarios. Outer coast Scenario 1, a 100,000 bbl crude oil spill near the Farallon Islands in March, oiled waters from Point Reyes to Point Ano Nuevo. From the mean population found in the perimeter of the spill, Scenario 1 potentially affected 267 gray whales. The timing of this scenario spill was the peak of the northward migration; thus, some calves would also be expected to be present. The northward migration is more leisurely than the southbound migration, and some opportunistic feeding may occur by the adults. Calves, of course, would be suckling en route.

Calves might ingest oil during nursing, but this is somewhat unlikely because oil does not readily adhere to cetacean skin. This principal concern is that gray whales might inhale oil potentially leading to pneumonia.

The passage of migrating gray whales through the waters affected by Scenario 1 would take from 1 to 4 days, based on the swimming speed derived from the dates when peak numbers occur at different locations along the coast. During this time, gray whales could encounter a dense, compact slick, fragmented patches of oil, or a nearly continuous sheen. Not all whales would be contacted by oil; in fact, numbers contacted might be far less than the numbers migrating through the area. In addition to their route and time in the area, contact would depend on the distribution and thickness of slicks. The oil spill of Scenario 1 resulted from release of about 4,000 bbl each hour for 24 hours. Over nearly a 9-day period, oil from the modeled spill moved north and then south until it finally was deposited on the mainland shore. During this time, considerable weathering would occur (evaporation of volatile components) and dispersion in the water column. Wind and waves would break up larger, denser slicks into smaller and thinner ones. Spread of oil over the water results in an equilibrium thickness of about 0.1 mm (International Tanker Owners Pollution Federation, Ltd., London, 1983. Tech. Info. Paper No. 6). The actual extent of water covered by crude oil slicks would be the roughly 160 sq km - the area occupied by 100,000 bbl of oil at a thickness of 0.1 mm. This area is about 6 percent of the total waters affected by the spill. Lighter oil or petroleum products would be expected to spread farther, but they would also dissipate faster. Because wind and waves completely dominate the spread of oil on the ocean, slicks would be increasingly fragmented. Sheens of 0.0001 to 0.01-mm thickness would persist in waters around heavier oiled areas (International Tanker Owners Pollution Federation, Ltd., London, 1983. Tech. Info. Paper No. 6).

As an approximation, numbers of gray whales contacted by oil slicks during migration through the area could be on the order of 15 to 30 animals (6 to 12 percent of the mean population in the affected area). Calves might ingest oil during nursing, but this is somewhat unlikely because oil does not readily adhere to cetacean skin. Adults, however, have been observed feeding on small schooling fish in the Gulf of Farallones and Monterey Bay, and may ingest oil during this activity. Gray whales also inhale oil if they surfaced in an oil slick.

Although a very large oil spill such as Scenario 1 could cause illness and perhaps eventual death of some gray whales following contact, the numbers of gray whales potentially impacted would represent about 0.1 percent of the species' world population. Gray whales have largely recovered from impacts of whaling and breeding habitat loss, and have recently been delisted. As a protected (but no Endangered) species, gray whales would be subject to adverse but nonsignificant impacts from oil spills from Unocal tankers (Class III).

Dolphins and Porpoises

Five species of dolphins and porpoises are abundant off the coast of northern California year-round: the Pacific white-sided dolphin, the northern right-whale dolphin, Risso's dolphin, Dall's porpoise, and the harbor porpoise. None are listed under the Endangered Species Act; however, harbor porpoises in the Gulf of the Farallones have been killed in large numbers in the last decade due to entanglement in monofilament fishing nets.

Dolphins and porpoises are not believed to be particularly vulnerable to oil spill impacts (Geraci and St. Aubin 1985). Although they are able to actively avoid oil slicks in captivity, their ability to do so in the open ocean has not been demonstrated. During clean-up of the huge spill from the Amoco Cadiz off the French coast, a few small cetaceans were found dead, but no causal relationship with the spill was established (Geraci and St. Aubin 1985). There is no clear indication that most species of dolphins and porpoises along the north coast would suffer serious impacts from infrequent oil spills. The most vulnerable species would be the harbor porpoise which inhabits nearshore waters. Harbor porpoises are typically found within a few km of shore and could be trapped between advancing oil and the land.

Few small cetaceans are known to have been killed in past oil spills. This is due in large part to their mobility and probable ability to avoid patches of thick oil. On this basis, impacts of oil spills from Unocal tankers are judged to be adverse but nonsignificant (Class III). Harbor porpoises would be the hardest hit by an oil spill, but mortality might be difficult to establish unless animals became stranded. Habitat would not be permanently lost and, in the absence of other impacts (e.g., entanglement mortality in fishing nets, or additional oil spills), the population would be expected to recover within 1 year, because mortality even in a reasonable worst-case oil spill would be less than annual recruitment (see Oil Spill Scenarios, below).

<u>Relative Risk to Dolphins and Porpoises from Oil Spills</u>

Because dolphins and porpoises have widespread distributions off the northern California coast, there is a near certain chance that oil spills from the tanker lanes would contact their habitat. However, the probability of a tanker spill occurring is small.

<u>Oil Spill Scenarios</u>

Numbers of harbor porpoises in the area contacted by scenario spills are provided in Table 4.4-21; numbers within about 5 km from shore account for 31 to 67 percent of these totals. Based on impacts of Scenario 2, harbor porpoises that might be trapped by oil represent about 1 percent of the regional population (Monterey Bay to Cap Mendocino). Not all of these animals would necessarily be contacted due to the patchy distribution of both the harbor porpoises and oil slicks. Further, harbor porpoises may to some extent avoid patches of oil. If they became stranded, mortality would occur unless animals were rescued and rehabilitated. In the absence of stranding, the likelihood of illness and death would depend on the degree to which a harbor porpoise inhaled or ingested oil.

As a probable maximum, mortality from oil contamination (principally inhalation of volatile components) might be on the order of 5 to 10 percent of numbers contacted. This is because oil slicks from even a very large spill at sea are patchy due to wave action. Assuming this proportion, mortality of harbor porpoises would be 10 to 26 animals (5 to 10 percent of numbers in perimeter of Scenario spills; Table 4.4-21). Harbor porpoises killed would represent about 0.2 percent of the regional population (Monterey Bay to Cape Mendocino). Habitat would not be lost and mortality would be less than annual recruitment. Therefore, impacts from Unocal tankers on harbor porpoises would be adverse but nonsignificant (Class III). Other dolphin and porpoise species, because of their speed and mobility, are less likely to be contacted by oil from a tanker spill.

Table 4.4-21

NUMBERS OF DOLPHINS AND PORPOISES AFFECTED BY REASONABLE WORST-CASE SCENARIOS[1]

Species/Group	Numbers in Spill Perimeter	
	Scenario 1	Scenario 2
Dolphins and Dall's Porpoises	32	1,992
Harbor Porpoises	261	208

[1] Calculations made from MMS-OCS Surveys Database.

Rare/Threatened/Endangered Species

Species especially sensitive to impacts include those with small populations or restricted range compared with historical levels. Because their status may be precarious, almost any impact affecting populations or habitat would be significant. In this EIR, the impacts of spills from operations associated with the Unocal Marine Terminal were analyzed for listed species which might to be contacted by oil from a spill originating at the Unocal Terminal or Unocal tankers. Analysis of potential impacts was not done for the following species because of a very low likelihood of contact, their rarity in the area, or other reasons specified below; impacts to these species are considered nonsignificant (Class III):

- Suisun thistle (Federal Candidate) - population has not recently been located
- Sacramento splittail (Federal Candidate) - population primarily found in fresh water
- Eagles, hawks, and falcons - may prey or scavenge on oiled waterfowl, terns, and shorebirds; impacts considered nonsignificant (Class III) because of few instances when scavenging might occur and uncertainty of adverse consequences to the birds (eagles, at least, in Alaska following the Exxon Valdez spills did not appear to consume the oiled feathers; Ford et al.. 1991). Other factors also influence sensitivity of these birds to oil spill impacts, especially use of open-water and shoreline habitat. Bald eagles (Federal/State Endangered) and golden eagles (State Species of Special Concern) have wintering populations that forage near lakes and Delta farmlands unlikely to be subject to oil spill impacts. The Northern harrier (marsh hawk), a State Species of Special Concern, is common year-round and known to forage for mice and voles over salt and freshwater marshes; it is expected that this hawk might take oiled waterfowl and shorebirds only if rodents were scarce. Osprey (State Species of Special Concern) are an uncommon resident year-round near the Bays with a winter population of 10 to 20 birds and few nesting attempts in recent years. This species is known to prey on shorebirds and thus might be affected by an oil spill, however there are no reports of such impacts occurring in past spills. The ferruginous hawk (Federal Candidate and State Species of Special Concern) is uncommon near the Bays, where it occurs in farmed wetlands, grasslands, and agricultural lands, as well as occasionally tidal marshes. The merlin (State Species of Special Concern) is rare and forages in grasslands, woodlands, and agricultural lands, but has also been seen over salt ponds and brackish or freshwater marshes. Sharp-shinned hawks, Cooper's hawks, and prairie falcons have been seen over tidal marshes, but typically forage in other habitats (e.g., grasslands, woodlands, and freshwater marshes) beyond reach of oil spills.
- Greater white-fronted goose (Federal Candidate) - distribution in area typically includes only Napa and Suisun Marshes beyond reach of oil spills;
- Greater sandhill crane (State Threatened) - distribution in area restricted to Delta beyond reach of oil spills;
- White-faced ibis (Federal Candidate) - typically found in freshwater emergent marshes and rice fields beyond reach of oil spills;
- Western snowy plover (Federal Candidate) - habitat is mostly dried salt ponds, levees, and islands in South Bay beyond reach of oil spills;
- Marbled murrelet (Federal Threatened/State Endangered) - only rarely reported at entrance to San Francisco Bay;

- Least bittern (State Species of Special Concern) - rare small heron that forages for small fish among tall grasses in brackish or freshwater marshes;
- Fulvous whistling duck (State Species of Special Concern) - rare in the Bays, and at the northern end of its range; this duck feeds in rice fields and farmed wetlands, and is known to occur in brackish marshlands;
- Yellow rail (State Species of Special Concern) - rare, but known to occur in brackish and freshwater marshes; data insufficient for analysis;
- White pelican (State Species of Special Concern) - a late summer/fall migrant and winter visitor with a population of more than 3,000 birds in the South Bay. They also occur in farmed wetlands around Suisun Bay and the Delta. Some groups seen roosting near shore of Suisun Bay, but habitat typically out of reach of oil spills;
- Elegant tern (State Species of Special Concern) - common in open water, intertidal mudflats, salt marshes, and salt ponds. Terns, like gulls, are not often found following spills, and may not be especially sensitive to oiling.
- California gull (State Species of Special Concern) - have large breeding colonies in the South Bay within the San Francisco Bay National Wildlife Refuge, as well as a large wintering population in the area. These gulls occupy many habitats and are not believed to be especially sensitive to oil spills;
- Burrowing owl, long-eared owl, and short-eared owl (State Species of Special Concern) -rare to uncommon; occupies a variety of habitats not typically subject to oil spills; rarely forage for rodents in tidal marshes;
- Saltmarsh wandering shrew (Federal Candidate) - limited to Grizzly Island in Suisun Bay beyond reach of oil spills;
- Suisun ornate shrew (Federal Candidate) - limited to South Bay 6 to 8 feet above water line;

The following passerine birds are present in tidal marshes but should not be affected by oil spills because they have little contact with the water:

- saltmarsh common yellowthroat (Federal Candidate, State Species of Special Concern)
- Alameda song sparrow (Federal Candidate, State Species of Special Concern);
- Suisun song sparrow (Federal Candidate, State Species of Special Concern);
- San Pablo song sparrow (Federal Candidate, State Species of Special Concern);
- tricolored blackbird (Federal Candidate, State Species of Special Concern);

The following species of amphibians and reptiles are known to occur in tidal marshes but are not commonly or consistently found in habitat affected by oil spills:

- Tiger salamander (Federal Candidate, State Species of Special Concern);
- California red-legged frog (Federal Candidate, State Species of Special Concern);
- Foothill yellow legged frog (State Species of Special Concern);
- San Francisco garter snake (Federal/State Endangered, State Species of Special Concern);
- western pond turtle (Federal Candidate, State Species of Special Concern);

Sensitive Plants

Suisun Marsh Aster (Federal Candidate) - Populations of Suisun Marsh Aster range from Bull Island which is up the Napa River through Benicia Point in Carquinez Strait through Suisun Bay and into the Delta. Probability of contact with oil from a spill at the Unocal Terminal would be highest for the population at Benicia Point. This population would have a 30- to 82.2-percent probability of contact with oil from a spill at the Terminal. For the other populations of this species within the San Francisco Bay estuary the probability of contact with oil from a spill at the Terminal would be less than 5 percent. The receptor mode analysis for Napa Slough confirmed that chance of contact with oil for this area from a Unocal Terminal spill is only 1 percent. Only the population of Suisun marsh aster at Benicia Point is at risk of moderate or heavy oiling from a spill at the Unocal Terminal. The Benicia population has a 12- to 20.8-percent chance of moderate oiling from a Unocal Terminal spill.

Unocal tankering would have a 30- to 40.8-percent chance of contacting the Benicia Point population and a 0.5- to 10-percent chance of contacting populations on Brown and VanSickle Islands in Suisun Bay. All other populations would have a 0- to 0.5-percent chance of contact with oil from a Unocal tanker spill. The Benicia Point population would have a 10- to 12-percent chance of moderate oiling from a Unocal Tanker spill. The populations on Brown and VanSickle Islands would have a 0- to 4-percent chance of moderate oiling. All other populations would have less than a 2-percent chance of moderate oiling from a Unocal tanker spill. The Napa Slough site in the receptor mode run confirmed that populations up the Napa River have at most a 2.5-percent chance of contact with oil for a Unocal tanker spill (chance of moderate oiling would be considerably less).

Any spill which contacted a population of this candidate species could have significant (Class I) impacts. Scenarios 2, 3, 4, 5, and 8, would contact Suisun marsh aster populations and, thus, would have significant impacts. Scenario 5, a 1,000-bbl tanker spill at the east end of Carquinez Strait in February, would contact Suisun Marsh Aster populations in Grizzly Bay and on Brown and Van Sickle Islands. Scenario 4, a 20,000-bbl tanker spill near the Terminal in June, would contact Suisun Marsh Aster populations at Benicia Point and Brown Island. Scenario 2, a 10,000-bbl spill at the Terminal in July, Scenario 3, a 20,000-bbl tanker spill near the Terminal in January, and Scenario 8, a 500-bbl product spill at the Terminal in March, would contact the Suisun marsh aster population at Benicia Point.

Soft Haired Birds Beak (State Rare/Federal Candidate) - Soft-haired birds beak is found in San Pablo Bay, Carquinez Strait and Suisun Bay. The only populations which would be at risk of moderate or heavy oiling from a Terminal spill would be the one at Benicia Point which would have a 12- to 20.8-percent chance of moderate oiling and the population east of Pinole Point which would have a 0.2 to 2 percent risk of moderate oiling if a spill occurred at the Terminal. All other populations of Soft Haired Birds Beak would be at virtually no risk of moderate or heavy oiling from a Terminal spill.

The Benicia Point population of Soft Haired Birds Beak would be the population most at risk from contact with oil if a spill occurred along Unocal tanker routes. The Benicia Point population would have a 10- to 12-percent chance of moderate oiling from a Unocal tanker spill. The population east of Pinole Point would have a 4- to 10-percent chance of moderate oiling from a Unocal tanker spill. The Tubbs Island population would have a 0- to 4-percent chance of moderate oiling from a Unocal tanker spill. Other populations of Soft Haired Birds Beak would have less than a 2-percent chance of moderate oiling.

Seven of the 12 modeled oil spill scenarios would result in oil contacting areas where populations of Soft-haired Birds Beak occur. These are Scenarios 1, 2, 3, 4, 5, 8, and 9. Scenarios 6, 7, 10, 11 and 12 would not contact areas where soft-haired bird's beak occurs and would not be expected to have significant impacts on this species.

Delta Tule Pea (Federal Candidate) - The Delta tule pea is distributed throughout Suisun Bay, on both shores of Carquinez Strait and up the Napa River. The Carquinez Strait population would have a 30- to 82.2-percent probability of contact with oil for a spill at the Unocal Terminal, while Delta tule peas in Carquinez Strait would have a 2- to 17.5-percent chance of moderate oiling from a Unocal tanker spill. Populations in Suisun Bay would have a 0- to 4-percent chance of moderate oiling while those up the Napa River would have less than a 2-percent chance.

Scenarios 1, 7, 10, 11, and 12, would not result in oil reaching areas with Delta tule pea populations, and, thus, would not have impacts on this species. All of the remaining scenarios would result in oil contacting areas where this species occurs and, thus, might result in significant impacts to Delta tule peas (Class I). Of the modeled scenarios, Scenario 3, a 20,000-bbl tanker spill near the Terminal would contact the most Delta tule pea habitat. This spill would contact all of the areas where the Delta tule pea occurs except Grizzly Bay. Scenario 4, a 20,000-bbl tanker spill near the Terminal would contact Delta tule pea habitat in Carquinez Strait and south and east Suisun Bay but not Grizzly Bay and not the Napa River. Scenario 5, a 1,000-bbl tanker spill at the east end of Carquinez Strait in February, would contact much of the area where Delta tule peas occur in Grizzly and Suisun

Bays, but not the Napa River or Carquinez Strait. Scenario 6, a 1,000-bbl tanker spill at the east end of Carquinez Strait would contact much of the east end of Carquinez Strait. Scenarios 2 and 8, spills at the Terminal, would contact much of Carquinez Strait and Scenario 9, a 100,000-bbl tanker spill near Alcatraz would contact some of Carquinez Strait.

Mason's Lilaeopsis (Federal Candidate) - Mason's lilaeopsis is a brackish water species which is found up the Napa River, in the marshes north of Grizzly Bay, in eastern Suisun Bay and in the Delta. The probability of oil from a spill at the Unocal Terminal contacting this species is 0 to 5 percent. There is virtually no chance of it being subjected to moderate or heavy oiling from a Unocal Terminal spill. A spill along Unocal tanker routes would have a 0- to 10-percent chance of contacting this species. There would be a 0- to 4-percent chance of individuals of this species being subjected to moderate oiling from a Unocal tanker spill.

Only three of the modeled oil spill scenarios contacted areas where Mason's lilaeopsis occurs. Scenarios 3 and 4, 20,000-bbl tanker spills near the Terminal, would both result in oil up the Napa River. Scenario 5, a 1,000-bbl spill at the east end of Carquinez Strait in February, would send oil into Grizzly Bay. These three scenarios could result in significant (Class I) impacts to Mason's lilaeopsis.

Sensitive Fishes

Delta Smelt (Federal Threatened, State Threatened) - Delta smelt are found primarily in Suisun Bay. Suisun Bay is at almost no risk of moderate oiling from a spill at the Unocal Terminal and at very low risk of receiving moderate or greater doses of oil from a spill from Unocal Tankers. Five of the 12 oil spill scenarios modeled for San Francisco Bay resulted in oil entering Suisun Bay. Of these, oil from Scenario 2 only contacted 3 percent of the shallow water habitat in Suisun Bay. The other four scenarios all contacted over 10 percent of the shallow water habitat in Suisun Bay. Scenario 5, a 1,000-bbl crude oil spill released in the tanker lane in Carquinez Strait had the biggest impact. Oil from this spill contacted 55 percent of the shallow water habitat in Suisun Bay. Because the Delta smelt population has been determined to be Threatened, all five of the oil spills which spread oil into Suisun Bay would have a significant (Class I) impact on the species.

Tidewater Goby (Federal Proposed Threatened, State Threatened) - Tidewater gobies are primarily found outside the Bay and south of San Francisco, and, thus, would not be expected to be contacted by a spill inside San Francisco Bay estuary. On the outer north coast, tidewater gobies in stream mouths between Monterey Bay and San Francisco Bay would be most at risk of moderate oiling from a Unocal tanker spill. Stream mouths in this area would be at relatively high risk. However, because tidewater gobies are brackish water species they would only be exposed to oil if it came relatively far up the river. Offshore Spill Scenario 1 contacted the area between San Francisco Bay and Monterey Bay and thus, in a reasonable worst case assumption that the oil was carried far up the stream mouth, would have significant impacts on this species. Scenario 2 would contact the Mendocino County Coast in an area where tidewater gobies have been found. Therefore, Offshore Spill Scenario 2 also might have significant impacts on tidewater gobies if the oil went far enough up the river mouths to contact tidewater goby habitat.

Spring Chinook Salmon (State Species of Special Concern) - Spring run Chinook salmon in San Francisco Bay estuary would have a low risk of contact with oil from a spill originating from the Unocal Terminal and a moderate risk from a spill originating from Unocal tankers. Spring run Chinook salmon on the outer north coast are primarily found in the Klamath and Trinity drainages as well as in other streams in the far northern portions of the California coast. These areas have a relatively low risk of contact with oil from a spill from a Unocal tanker. Of the 12 Oil Spill Scenarios modeled in the Bay only Scenarios 3, 7, and 9 would contact a substantial amount of Chinook salmon habitat. All three of these scenarios would occur during the period that juveniles are moving out of the Delta and would have the potential to significantly impact spring Chinook salmon. Offshore Spill Scenario 1 would not send oil near outer coast streams where spring salmon occur. In Offshore Scenario 2, oil went south to contact shore along the Mendocino coast. Thus neither of the oil spill scenarios for the outer coast would significantly impact spring run Chinook salmon. However, clearly other oil spills could occur at places along the tanker route where the mouths of the Klamath and Trinity drainages would be contacted and impacts on Chinook salmon could be substantial.

Winter Run Chinook Salmon (Federal Threatened, State Endangered) - Winter run Chinook salmon in San Francisco Bay estuary would have a low risk of contact with oil from a spill originating from the Unocal Terminal and a moderate risk from a spill originating from Unocal Tankers. As was true for spring run Chinook salmon, Scenarios 3, 7 and 9 would contact significant amounts of Chinook salmon habitat during the times of year when young would be moving out of the estuary and would have substantial impacts. Each of the other scenarios would impact less than 2 percent of the shallow water habitat where Chinook salmon are most abundant. Some salmon might still be contacted by oil in these scenarios, but effects on the population would be slight.

Summer Steelhead (State Species of Special Concern) - Summer steelhead spawn primarily in the Klamath and Eel River drainages. These rivers have a low relative risk of being subjected to moderate or greater amounts of oil from a spill from Unocal Tankers. Neither of the Offshore Spill Scenarios resulted in oil contacting the shore at the Klamath or Eel River mouths. However, a spill along the tanker route that would contact these river mouths is clearly possible.

Coho Salmon (State Species of Special Concern) - Coho salmon spawn in the Klamath, Trinity, Mad, Noyo, and Eel Rivers. All of these river mouths are subjected to low relative risk from a spill from Unocal tankers. Offshore Scenario 1 did not spread oil anywhere near the river mouths where Coho salmon spawn. Offshore Scenario 2, however, resulted in oil contacting the mouth of the Noyo River. Therefore Offshore Scenario 2 had the potential for significant impacts on Coho salmon. Clearly, other spills are possible that could contact other of the river mouths.

Pink Salmon (State Species of Special Concern) - In California, pink salmon spawning has only been reported from the lower Russian River. The Russian River mouth is at relatively low risk of contact with moderate oil from a spill from Unocal tankers. Neither of the offshore spill scenarios would contact the Russian River mouth. However, a spill could occur along the tanker route that would contact the Russian River mouth.

<u>Sensitive Birds</u>

California Clapper Rail (Federal/State Endangered) and California Black Rail (Federal Candidate/State Threatened) - Oil spills originating at the Unocal Terminal have only a small chance of contact with clapper or black rail habitat; the greatest chance for contact is with the mouth of Sonoma Creek in northern San Pablo Bay. Spills from Unocal tankers, on the other hand, have a chance of more than 2 percent of contacting Sonoma Creek, and a 10-percent chance or more of contacting clapper or black rail habitat between Point Richmond and Oakland. Although habitat and clapper rails are indicated for this portion of the coast from Gill (1979) and the USFWS National Wetlands Inventory, it is unlikely that adequate habitat exists along this portion of the shore to support substantial numbers. Combining all areas where birds occur, there is more than a 30-percent chance that oil spills from Unocal tankers would contact clapper rail habitat. Table 4.4-22 shows the comparative levels of risk of areas with clapper rail habitat.

Table 4.4-22

LEVEL OF RISK OF CONTACT OF OIL SPILLS FROM THE UNOCAL MARINE TERMINAL OR THE ROUTE OF UNOCAL TANKERS THROUGH SAN FRANCISCO AND SAN PABLO BAYS WITH CLAPPER RAIL HABITAT

Habitat Location	Unocal Terminal	Unocal Tankers
Sonoma Creek	L	M
Petaluma River	L	M
Gallinas Creek	L	M
Corte Madera Creek	L	M
San Pablo Creek	L	M
Albany	L	M
Emeryville	L	H
Oakland Marshes	L	L
Coyote Hills Sloughs	L	L
Redwood Creek	L	L
Plummer Creek	L	L
Coyote Creek	L	L
Alviso/Guadalupe Slough	L	L

L = Low risk (<1 percent chance)
M = Moderate risk (1 to 10 percent chance)
H = High risk (>10 percent chance)

Some indication of impacts on clapper rail habitat can be obtained from reasonable worst-case scenarios. Some scenario spills did contact clapper rail habitat, but the full extent of contamination could not be precisely estimated. This is because much of the habitat is found deep in marshes along tidal channels, and data are lacking to model the distance into these marshes that oil might penetrate. Consequently, contaminated habitat may be underestimated. On the other hand, clapper rails may move ahead of oil carried on the tide, and thus avoid direct contact. A portion of the habitat would be lost, nonetheless, and this would constitute a significant impact. Estimates of area contacted are provided in Table 4.4-23.

Table 4.4-23

MINIMUM AREA OF CLAPPER RAIL HABITAT CONTAMINATED BY OIL FROM REASONABLE WORST-CASE SCENARIOS

Scenario	Acres Contacted	Percent of Habitat[1]
1	365	4.6
3	175	2.2
9	195	2.4
10	106	1.3
11[2]	487	6.1
12[2]	445	5.6

[1] Calculated from the USFWS National Wetlands Inventory Database (tidal salt and brackish marsh habitat types).
[2] Scenario spills 11 and 12 were released from Anchorage No. 9 which is not typically used by Unocal tankers.

There is a slight chance of contact with clapper rail habitat at Sonoma Creek from spills at the Unocal Marine Terminal. In Scenario 1, a crude oil spill of only 1,000 bbl at the Marine Terminal entered Sonoma Creek and Napa Slough, and contaminated 4.6 percent of total acreage of clapper rail habitat in the San Francisco and San Pablo Bays. The chance of occurrence of Unocal tanker spills that contact clapper rail habitat is 2.1 percent. Large tanker spills off Alcatraz Island contacted 2.4 and 1.3 percent of all clapper rail habitat in the bays. It is not known how may California or black clapper rails might be directly contacted by such oil spills, but even temporary habitat loss would have a significant adverse effect on the health of these species (Class I).

California Least Tern (Federal/State Endangered) - Colonies were defined by a 3-km radius to allow for foraging habitat (principally in nearby eelgrass beds), and included all sites where California least terns presently nest or have nested in recent years. Probability of contact with a colony site should an oil spill occur at the Unocal Marine Terminal or along the route of Unocal tankers through the Bays is shown in Table 4.4-24. All of these colonies are at relatively low risk from a spill at the Terminal. Active colonies at Alameda Naval Air Station and Oakland International Airport are subject to risk of contact of 14.3 percent (high risk) and 1.6 percent (moderate risk), respectively from a spill from Unocal tankers. All risk of contact to these sites is produced by tanker transport in Segments 1 to 4 which include the traffic lanes from the Golden Gate to the precautionary area east of Alcatraz Island, and from there into northern San Francisco Bay.

Table 4.4-24

LEVEL OF RISK OF CONTACT WITH NESTING SITES USED BY CALIFORNIA LEAST TERNS SHOULD AN OIL SPILL OCCUR AT THE UNOCAL MARINE TERMINAL OR ALONG THE ROUTE USED BY UNOCAL TANKERS

Colony Site	Unocal Terminal	Unocal Tankers
Alameda Naval Air Station	L	H
Oakland International Airport	L	M
Hayward Marsh	L	L
Baumberg Plant Salt Ponds	L	L
Bair Island Salt Ponds	L	L
Port Chicago (Allied Chemical Co.)	L	L
Pittsburgh (PG&E Plant)	L	L

L = Low risk (<1 percent chance)
M = Moderate risk (1 to 10 percent chance)
H = High risk (>10 percent chance)

Scenarios 3 and 4 (both 20,000-bbl spills near the Terminal) contacted waters of eastern Suisun Bay, but produced very light and patchy oiling (2.2 and 1.7 bbl/sq km, respectively). Scenarios 5 and 6 (1,000-bbl spills at the east end of Carquinez Strait) contacted waters in Suisun Bay and also produced light oiling (2 and 20-bbl/sq km, respectively). Scenario 6 contaminated waters and shoreline near the Port Chicago Allied Chemical Plant nesting site where two California least terns were seen in 1988 (none found at this site on more recent bird censuses; Carter et al. 1990). Although oil contamination from these scenarios might have adversely affected California least terns, it would have done so principally by degradation of foraging habitat rather than direct contact.

Scenario 9 (100,000-bbl oil spill near Alcatraz Island) contacted waters adjacent to the active colony at Alameda Naval Air Station (150 birds in 1989), and Scenario 10 contacted both this colony and that atOakland International Airport (18 birds in 1989). These reasonable worst-case scenarios resulted in heavy contamination of waters that California least terns use for foraging. In such spills, it is likely that some birds would be directly contacted, and also transfer oil to eggs or chicks at their nest. Substantial degradation of foraging habitat would occur as well. Impacts would be significant (Class I).

Long-Billed Curlew (Federal Candidate) - Probability of contact to habitat of long-billed curlews from spills at the Unocal Terminals or along the route of Unocal tankers is provided in analysis of impacts to shorebirds, above. Contact with intertidal mudflats used for foraging by long-billed curlews occurs predominantly within San Pablo and San Rafael Bays and the probability ranges from 0.2 to 10 percent.

The percent of populations lost in each of the scenario spills is provided in Table 4.4-25. In the absence of mitigation, impacts that might potentially result from a reasonable worst-case crude oil spill of 1,000 bbl at the Unocal Terminal are temporary loss of 5.3 percent of intertidal mudflats and mortality of 4.4 percent of the migrant population (Scenario 1). Although the likelihood of occurrence is small, oil could contact a large part of long-billed curlew habitat, especially in San Pablo Bay and the northern part of San Francisco Bay. The chance of contact with intertidal mudflats is generally 20 percent or less; the greatest chance of moderate or heavy oil contamination is at Point San Pablo, where the ship channel is relatively close to land, and the Contra Costa County shoreline south to Point Richmond. Reasonable worst-case spills from tankers are represented by spill Scenarios 3, 9, and 10. These are large, uncontained spills with extensive spread contacting 14.1 to 17.4 percent of the intertidal mudflats and causing potential mortality of 11.7 to 14.4 percent of the long-billed curlew population. Should such spills occur, impacts would be significant on the basis of possible direct contact with birds, and certain loss of essential food resources on intertidal mudflats by oil contamination (Class I).

Double-Crested Cormorant (State Species of Special Concern) - The probability of tanker spills contacted either of these colonies over a 40-year period is greater than 25 percent. Data describing the distribution and abundance of double-crested cormorants on the water are only available for October through March (USFWS waterfowl surveys; J.Y. Takekawa, unpublished data). Assuming that these data are representative of the distribution year-round, the reasonable worst-case

Table 4.4-25

SUMMARY OF ESTIMATED IMPACTS OF SCENARIO SPILLS ON LONG-BILLED CURLEWS

Scenario[a]	Month	Mean Population[b]	Percent Habitat Contacted[c]	Percent Mortality[d]
1	March	286	5.3	4.4
3	January	767	14.1	11.7
5	February	767	0.0	0.0
7	February	767	1.0	0.8
8	August	2,128	0.04	0.03
9	March	286	17.4	14.4
10	September	2,128	14.5	12.0
11[e]	November	2,128	10.3	8.5
12[e]	August	2,128	15.7	13.0

[a] Refer to Section 4.2.1.2 for figures depicting each oil spill scenario.
[b] Mean population from USFWS aerial censuses, 1988 through 1990.
[c] Habitat limited to intertidal mudflats; calculations made using National Wetlands Inventory database.
[d] Mortality of long-billed curlews, expressed as percent of population, is assumed to be in proportion to percent of habitat contacted; mortality is reduced by 17 percent to account for possible success of rescue efforts.
[e] These Scenario spills originated at Anchorage No. 9, which is not typically used by vessels carrying Unocal crude oil or products.

scenarios can be used to approximate the number of birds on the water that might be contacted. Scenario 1, a 1,000-bbl spill at the Unocal Terminal, contacted 68 birds (11.8 percent of numbers in the San Francisco Bay estuary). Scenarios 3 and 4, both 20,000-bbl tanker spills near the Marine Terminal but acted upon by different winds and tides, contact 168 birds (29.3 percent) and 61 birds (10.7 percent), respectively. A very large tanker spill near Alcatraz (Scenario 9) contacted 232 birds (40.3 percent of the population). Mortality might be less due to relocation of cormorants from contaminated waters and areas of cleanup activity, and rescue of some oiled birds. However, mortality of adults might also result in loss of eggs and chicks should a spill occur during the breeding season. Loss to the regional population (i.e., birds in the San Francisco Bay estuary combined with those in the Gulf of the Farallones) could be as great as 10 percent from a Unocal oil spill and would constitute a significant impact (Class I).

California Brown Pelican (Federal/State Endangered) - The major roosts of brown pelicans in San Francisco and San Pablo Bays are listed in Table 4.4-26. There is a substantial chance that spills at the Unocal Terminal could contact brown pelicans roosting on the breakwater of Mare Island, but only a slight chance for contact with other major roosts in the bays. In contrast, there is a fairly high probability of contact with most major roosts from spills from Unocal tankers. Table 4.4-27 shows the risk of contact by crude or product spills from Unocal tankers to major roosts of brown pelicans.

Impacts to brown pelicans from oil spills occur on the water; roost sites are used as an indicator of habitat use in the bays because other data are lacking. It can safely be assumed that brown pelicans forage widely in deeper waters and can be contacted by spills in most parts of central and northern San Francisco Bay and in San Pablo Bay.

Reasonable worst-case spills from the Unocal Marine Terminal did not contact any major roost of brown pelicans. However, Scenario 4, a 20,000-bbl tanker spill in the traffic lane near the Terminal in June, produced heavy oiling of the Mare Island Breakwater and adjacent waters of eastern San Pablo Bay. Such a spill might affect up to 100 birds. Scenario 10, a 100,000-bbl tanker spill east of Alcatraz Island in September, extensively contaminated the central and northern San Francisco Bay with moderate to heavy oiling, including the roost on the breakwater of Alameda Naval Air Station affecting 200 to 400 birds.

Table 4.4-26

LEVEL OF RISK OF CONTACT WITH MAJOR ROOSTS OF BROWN PELICANS IN SAN FRANCISCO AND SAN PABLO BAY FROM SPILLS AT THE UNOCAL MARINE TERMINAL OR ALONG THE ROUTE USED BY UNOCAL TANKERS

Roost Site	Unocal Terminal	Unocal Tankers
Mare Island Breakwater	M	H
Sisters Rocks	L	M
Brothers Rocks	L	M
Brooks Island Breakwater	L	H
Alameda NAS	L	H
Hunters Point	L	L

L = Low risk (<1 percent chance)
M = Moderate risk (1 to 10 percent chance)
H = High risk (>10 percent chance)

Table 4.4-27

RISK OF CONTACT BY CRUDE OR PRODUCT SPILLS FROM UNOCAL TANKERS TO MAJOR ROOSTS OF BROWN PELICANS

Roost Site	Conditional Probability of Contact (percent)
San Francisco and San Pablo Bays	
Unocal Terminal	5.4
Unocal Tankers	45.4
Outer Coast Roosts (>100 birds)	
Unocal Tankers	68.2

Note: Conditional probability is the percent-chance of contact should a spill occur in the tanker lanes.

Off the outer coast, Scenario 2 simulated a 100,000-bbl spill from a tanker off Punta Gorda in October. Within the perimeter of contaminated waters, 118 brown pelicans were contacted. Such a spill would have also affected 800 to 1,000 birds on coastal roosts. Presumably, most brown pelicans would relocate from the affected area, but mortality might still be substantial. A spill in the fall that contacted waters in the Gulf of the Farallones and the Farallon Island could potentially affect several thousand birds. Mortality of brown pelicans affected by large oil spills may be somewhat less than numbers present in the area because adult birds may, to some extent, avoid oil slicks when foraging (Nero and Associates 1983).

In summary, a large spill from a Unocal tanker could do more damage in the confines of the Bays than off the outer coast; however, it could also be more easily contained. Mortality of 500 birds in a northern California oil spill in the fall would constitute a loss of about 1 percent of the breeding population of California brown pelicans (southern California colonies combined with Mexican colonies). Spills from Unocal tankers, and to a less degree the Unocal Terminal, have the potential to produce significant impacts to California Brown Pelicans (Class I).

Common Loon (California Species of Special Concern) - The common loon is found in small numbers (< 100) in deeper open water portions of the San Francisco Bay estuary in the winter months; numbers migrating along the outer coast may reach several thousand during the spring. Numbers are declining due to loss of nesting habitat, oil spills, and mortality in gill nets. The species has been designated Highest Priority California Species of Special Concern. Reasonable worst-case oil spill scenarios showed that contact of common loons in the San Francisco Bay estuary resulted principally from large tanker spills; mortality ranged from 15.7 to 52.1 percent of numbers present. Along the outer coast, Scenario 1 contacted only 27 birds; however, other very large spills along the outer coast could contact many more. This species is especially vulnerable to oil spills because of a tendency to rest in large groups on nearshore waters along the outer coast. Oil spills from Unocal tankers off the outer coast could contact many common loons; because of the species sensitive status, impacts would be significant (Class I).

Barrow's Goldeneye (California Species of Special Concern) - The Barrow's goldeneye is a diving duck found in small numbers during the winter in open waters and salt and brackish marshes of the San Francisco Bay estuary. It is widespread in the area and subject to generally the same risk of contact as other waterfowl (i.e., near certainty). Based on reasonable worst-case scenarios, birds contacted by oil spills at the Unocal Terminal are expected to represent less than 2 percent of the population. However, large spills from tankers (Scenarios 3, 9, and 10) have the potential to contact 27.7 to 42.9 percent of the population - a significant impact (Class I).

Aleutian Canada Goose (Federal/State Endangered) - Aleutian Canada Geese are found in small numbers in shallow waters of San Pablo Bay and the South Bay; most occur in the Delta and Suisun Marsh typically beyond the reach of oil spills. The risk of contact by oil spills is especially great in shallow waters of San Pablo Bay (up to 30-percent chance of contact). A spill of 1,000 bbl at the Unocal Terminal (represented by reasonable worst-case Scenario 1) could contact 10 or more birds, while tanker spills (Scenarios 3, 4, and 9) could contact 12 to 14 birds. Because of their status as Endangered Species, impacts would be significant (Class I).

Mammals

Sea Otters (Federal Threatened) - This sensitive resource is almost completely outside the model domain (which has its boundary at 37°N latitude, near the coastal town of Davenport); only the northernmost 15 km (about 8 nm) of the present sea otter range is included. Further, this analysis addresses the risk of contact to this small portion of the sea otter range only from Unocal tankers passing through the Gulf of the Farallones or along the route off the northern California coast. The risk of oil spills from tanker traffic off central California (i.e., south of San Francisco) is much greater and is described in the Gaviota Marine Terminal EIR (Aspen 1992).

There is more than a 20-percent chance that spills from tankers in the Gulf of the Farallones or farther north could contact this closest portion of the sea otter range. There is also a substantial, but lesser, chance that oil spills from the Gulf of the Farallones could strike the sea otter range in Monterey Bay or beyond. The probability of contact would be expected to diminish with distance southward from the Gulf of the Farallones. Any oil spill contacting the sea otter range would almost certainly result in mortality of sea otters - a significant impact (Class I).

A reasonable worst-case oil spill in the Gulf of the Farallones clearly has the potential to contact the northern portion of the sea otter range. Scenario 1 resulted in the death of only 10 sea otters because few are present at the northern extreme of the range. Other large oil spills, especially those involving spills off the central California coast, could reasonably be expected to contact far more. It should be emphasized that mortality of sea otters in Scenario 1 includes only that portion of the population found within the model domain. The full extent of impacts from such a scenario spill is not known. Scenario 2 would not contact sea otters.

The extent of impacts of Scenario 1, although an enormous spill, may be underestimated. Oil that moved out of the model domain may have contacted the sea otter range farther south. The loss of 10 sea otters in Scenario 1 would probably not be measurable against natural variation in numbers in the population; however, greater mortality from such a spill could have occurred outside the model domain. Oil spills from Unocal tankers in the Gulf of the Farallones have the potential to produce significant impacts on sea otters (Class I).

Steller Sea Lions (Federal Threatened) - Spills from Unocal tankers in transit through the Gulf of the Farallones and along the northern California coast have a 60.9-percent chance of contacting breeding or resting habitat of Steller sea lions on land (Table 4.4-28). The foraging range of Steller sea lions at sea is approximately 30 to 50 km, thus oil spills from the tanker lanes are nearly certain to contact these waters. Steller sea lions are at greatest abundance on land in the late spring and summer during their breeding season. Thereafter, numbers present in California decline by about one-half as animals move northward. The greatest potential for significant impacts are from Unocal tanker spills that contact a major rookery during the breeding season.

Table 4.4-28

RISK OF CONTACT BY CRUDE OR PRODUCT SPILLS FROM UNOCAL TANKERS TO HAUL OUT SITES AND ROOKERIES OF STELLER SEA LIONS. CONDITIONAL PROBABILITY IS THE PERCENT-CHANCE OF CONTACT SHOULD A SPILL OCCUR IN THE TANKER LANES

Location	Conditional Probability of Contact
All Steller sea lion rookeries/haul outs	60.9
Ano Nuevo Island	22.0
Southeast Farallon Island	23.0
Sugarloaf Rock (Cape Mendocino)	6.0
Southwest Seal Rock (Cape St. George)	4.0

Scenario 1, a reasonable worst-case oil spill of 100,000 bbl near the Farallon Islands in March, contacted 36 Steller sea lions at sea, and would also affect the nonbreeding populations of the Farallon Islands and Ano Nuevo Island. Scenario 2 off the Mendocino County coast in October did not contact Steller sea lions in the perimeter of the spill, but would have affected a few nonbreeding animals on rocks near Cuffey Point. Impacts to Steller sea lions potentially could occur as animals hauled out or departed from sites on land. Heavy oiling of these sites could adversely affect 1 to 5 percent of numbers present (calculated from data in Mansfield 1970). More severe impacts on Steller sea lions could occur from an oil spill striking one of the major rookeries (Ano Nuevo Island, Sugarloaf Rock, or Southwest Seal Rock) during the summer breeding season. Because breeding females must obtain food each day, there is a considerable chance of oiling as they come and go from the rookeries. This oiling may not adversely affect the females, but would lead to ingestion of oil by pups during nursing.

Although the probability of a spill from a Unocal tanker is low, such a spill could produce significant impacts on Steller sea lions. The California population has declined by one-half in the last 20 years, and breeding on two rookery islands now only occurs sporadically (San Miguel Island and southeastern Farallon Islands). Thus, oil spill contact in the summer breeding season could have a measurable and, perhaps, long-lasting impact on the species in this part of its range. Steller sea lions would be subject to significant impacts from spills from Unocal tankers (Class I).

Blue, Fin, and Humpback Whales (Federal Endangered) - Blue, fin, and humpback whales are abundant off northern California, and in particular the Gulf of the Farallones, during the fall as they pass through the area en route to calving grounds in tropical/subtropical waters. The months of their vulnerability to oil spills in the area is about August through November. The chance of some contact to important feeding habitat from a Unocal tanker spill is near certainty. This analysis of potential impacts focuses on the Gulf of the Farallones because these waters are a major feeding ground for these species in the fall.

Scenario 2, a 100,000-bbl oil spill in October off Punta Gorda, potentially contacted 26 blue, fin, or humpback whales (mean population in perimeter of the spill). No endangered whales were contacted by the Scenario 1 spill in the Gulf of the Farallones in March. Neither of these oil spills fully demonstrate the magnitude of impacts that could reasonably be expected to occur. Should a 100,000-bbl oil occur off Point Reyes in the fall and contaminate an area approximately equal to Scenario 1, contact with approximately 6 to 12 percent of the local population could occur (see analysis of impacts to gray whales, above, for development of this conclusion). Numbers contacted, could be 25 to 50 humpback whales, and 5 to 10 blue and fin whales. Impacts to whales would result principally from inhalation of oil and ingestion of oil during feeding.

A very large oil spill in the Gulf of the Farallones could cause illness and perhaps eventual death of blue, fin, or humpback whales following contact. As a reasonable approximation, 50 endangered whales might be contacted, and an essential feeding ground contaminated. Should mortality occur from direct contact, up to 3 percent of the North Pacific population of humpback whales could be lost, and 1 percent of the North Pacific population of blue whales. Should oil spills bring about a decline in the productivity of essential food resources (fish and krill), impacts on the population could be even greater and long-lasting. Blue, fin, and humpback whales would be subject to significant impacts from spills from Unocal tankers (Class I).

Saltmarsh Harvest Mouse (Federal/State Endangered) - The saltmarsh harvest mouse is endemic to salt and brackish marshes at scattered sites in Solano, Napa, Sonoma, Marin, Contra Costa, Alameda, and San Mateo Counties. The spill trajectory model showed that the chance in near-certainty that some portion of its habitat would be contacted by Unocal Terminal or tanker spills. Reasonable worst-case scenarios were used to examine the extent of habitat that might be contaminated. Scenario 1, a 1,000-bbl spill at the Unocal Terminal, resulted in contact with 3.4 percent of habitat in the entire San Francisco Bay estuary, including 8.5 percent of habitat in San Pablo Bay. Large tanker spills (Scenarios 3, 4, and 9) resulted in contact of 7.6 to 8.8 percent of the species' habitat. The habitat of the saltmarsh harvest mouse is already greatly restricted in the San Francisco Bay estuary and loss of additional habitat due to oil spills such as these would constitute a significant impact (Class I).

4.4.3.2 Analysis of Future Operations

<u>Routine Operations</u>

Under the projected future conditions, the level of incoming tanker traffic at the Unocal Marine Terminal would increase by 60 percent. Shipment of product is projected to increase by 30 percent.

An increase in the tanker traffic would increase the potential for disturbance to the benthic community in the ship channels by the draft from Unocal vessels. This disturbance was judged to have nonsignificant impact for the continuation of existing operations because (1) Unocal tankers are not fully laden and would probably cause little disturbance, and (2) the environment in the ship channels is constantly disturbed by currents, the draft of other vessels, and periodic dredging and the benthic community is adapted to these disturbed conditions. For these reasons, the increase in tanker traffic would not be expected to increase the projected impact. Impacts would remain nonsignificant (Class III).

The increase in tanker traffic at the Unocal Marine Terminal could increase the noise and disturbance impacts to fishes, marine mammals and birds from tankers. Because the level of disturbance in the tanker lanes is so high, Unocal's vessels would not have a significant impact over this background of high level noise and disturbance. An increase in the amount of Unocal tanker trips would not be expected to significantly increase the level of tanker noise and disturbance impacts over background conditions. Impacts of noise and disturbance would be expected to remain adverse but nonsignificant (Class III).

An increase in Unocal tanker traffic would increase the chances that a Unocal tanker might collide with a marine mammal. The risk of such a collision would be at least partially related to the number of tanker trips. Because the number of such collisions is very low in spite of the high level of vessel traffic in San Francisco Bay, the increase in risk under the future operating conditions would still be expected to remain low and nonsignificant (Class III).

The projected future increase in the level of operations at the Unocal Marine Terminal would be expected to have a proportional small increase in the level of leaks, small spills as well as a slight increase in the input of contaminants from antifouling paints and sacrificial anodes. As discussed in section 4.3.3.2., the overall contribution of these sources to contaminant loads in the vicinity of the Unocal Marine Terminal is very small. The increase in contaminants from increased tanker traffic has been judged to have an adverse but nonsignificant impact on water quality (Sec. 4.3.3.2.). The impact on the biota of a small increase in contaminants from future operations would be expected to be adverse but nonsignificant (Class III).

An increase in tanker traffic would not be expected to increase the amount of maintenance dredging required to maintain the ship channels at sufficient depth.

Accident Conditions

An increase in tanker traffic in the future would increase the risk of an oil spill either at the Terminal or in the tanker lanes. An oil spill of 1000 barrels or greater would have a significant adverse impact on biological resources (Class I).

4.4.3.4 Summary of Significant Impacts

An oil spill of 1,000 bbl or greater has the potential to have significant adverse impacts on biological resources (Class I). A spill between 50 and 1,000 bbl would also probably have significant biological impacts (Class I). A spill between 1 and 50 bbl would also have the potential for significant impacts but could be contained and/or cleaned up before such impacts occurred (Class II).

Biological resources which have the potential to suffer significant (Class I) impacts from an oil spill originating either at the Unocal Marine Terminal or from a tanker servicing the Unocal Terminal include:

- phytoplankton in San Pablo Bay, Carquinez Strait, and Suisun Bay and for a short term in localized areas off the north coast;
- zooplankton in San Pablo Bay, Carquinez Strait, and Suisun Bay and locally off the north coast;
- rocky intertidal and shallow subtidal in San Francisco Bay estuary and off the north coast;
- intertidal mudflats in San Francisco estuary;
- dungeness crab;
- Bay shrimp;
- eelgrass;
- longfin smelt;
- Pacific herring;
- Chinook salmon;
- striped bass;
- American shad;
- white sturgeon;
- starry flounder in San Francisco Bay estuary;
- salt marsh habitat;
- coastal estuaries/lagoons/river mouths;
- shorebirds (migrant population in San Francisco Bay estuary);
- seabirds (regional breeding population off outer coast);
- waterfowl (migrant population in San Francisco Bay estuary);
- Northern fur seal (regional breeding population off the outer coast); and
- double-crested cormorant (regional breeding population in northern California).

Threatened/Endangered/Candidate Species

- Suisun marsh aster
- soft-haired birds beak
- Delta tule pea
- Mason's lilaeopsis
- Delta smelt
- winter run Chinook salmon
- spring run Chinook salmon

- California clapper rail and California black rail (breeding population in San Francisco Bay estuary)
- Aleutian Canada goose (regional migrant population)
- California least tern (breeding population in San Francisco Bay estuary)
- Barrows goldeneye (regional migrant population)
- Long-billed curlew (migrant population in San Francisco Bay estuary)
- double-crested cormorant (regional breeds popular in northern California)
- California brown pelican (migrant population in San Francisco Bay)
- common loon (regional migrant population)
- Southern sea otter
- Steller sea lion (regional breeding population in California)
- Blue, fin, and humpback whales (regional breeding population in California)
- saltmarsh harvest mouse (resident population in San Francisco Bay estuary)

4.4.4 Cumulative Impacts

4.4.4.1 Routine Operations

Plankton

Plankton populations in San Francisco Bay estuary have been subjected to cumulative impacts from decreases in freshwater outflow from the Delta, introduction of exotic species, and degradation of water quality from inputs of contaminants. Plankton may also be impacted temporarily by operations such as dredging and marine construction which generate turbidity. However, turbidity would be localized in space and time. Turbidity impacts would only be cumulative if two or more major projects were generating large areas of turbidity within the same bay at the same time.

Maintenance dredging near the Unocal Marine Terminal generates limited turbidity once a year and would not be expected to contribute to cumulative impacts on plankton populations. Operations at the Unocal Marine Terminal would also not contribute to cumulative impacts on plankton from decreases in freshwater outflow. However, the discharge of segregated ballast water could contribute to impacts from introduction of exotic species. Voracious filter feeding by the introduced Asian clam, *Potamocorbula amurensis*, has contributed to marked declines in phytoplankton populations in the northern reach (especially in Suisun Bay). Introduced zooplankton species such as the copepods *Sinocalanus doerri* and *Pseudodiaptomus forbesi* are thought to have contributed to the declines of native species such as *Eurytemora affinis* and *Diaptomus* sp.

Decreases in freshwater inflow have favored oceanic plankton species at the expense of freshwater and brackish species. Thus, while operations at the Unocal Terminal probably are not the cause of these declines, the plankton assemblages endemic to San Pablo and Suisun Bays are particularly stressed and would be particularly susceptible to impacts. Any potential for introducing additional exotic species would be a significant cumulative impact (Class II). This impact could be prevented by prohibiting all discharges of ballast water in the Bay.

The release of contaminants associated with the Unocal Marine Terminal would contribute to degradation of water quality within the Bay. Pollutants would contribute to the stresses of phytoplankton assemblages already impacted by hardy introduced species and decreases in Delta outflow. Section 4.3.4. discusses cumulative impacts of degradation of water quality in San Francisco Bay estuary. Levels of many contaminants in the water column, the sediments and the biota of San Francisco Bay estuary are at levels found to have harmful effects on aquatic organisms. Within the vicinity of the Unocal Marine Terminal, copper, lead and zinc have been found at elevated levels in the water column and cadmium and selenium have been found at high levels in the biota. Operations at the Unocal Marine Terminal would contribute slightly to the levels of these contaminants but, as shown in Section 4.3.4., the Unocal Terminal contribution to mass loadings of these contaminants is at least two orders of magnitude less than other sources. Therefore, Unocal would contribute to the significant (Class I) cumulative impacts of degradation of water quality on planktonic organisms but that contribution would be small compared to other sources.

Benthos

Cumulative impacts on the benthos from routine operations could occur from disturbance of sediments during dredging and inputs of contaminants in sediments. The benthic environment of the northern reach of San Francisco Bay estuary, especially San Pablo Bay, Carquinez Strait and Suisun Bay, is one of large periodic disturbances during years of high freshwater outflow from the Delta. The available evidence indicates that benthic communities in the vicinity of the Unocal Marine Terminal undergo large shifts in species composition in response to natural perturbations and as a result of human disturbance (see Section 3.4). Recently the introduced Asian clam has become dominant in the benthic environment in the vicinity of the Terminal. Operations at the Unocal Marine Terminal could contribute to the introduction of exotic species if ballast water were discharged. Although ballast from Unocal tankers would be taken on at west coast ports, which would be unlikely to harbor species foreign to the San Francisco estuary, the potential adverse impacts of invasive species should any be introduced, could be highly significant and would occur in an environment vulnerable because of cumulative impacts of previous invasions and other disturbances (Class II). Discharge of all ballast water in San Francisco estuary should be prohibited. In addition, annual maintenance dredging will disturb the sediments at the dredge site near the Terminal and at the disposal site in Carquinez Strait. Dredging activities would contribute to the disturbance of benthic communities in these areas. Because of the annual maintenance dredging, communities in the ship channels are kept in a state of constant disturbance. Without this dredging it is possible that benthic communities would be able to increase in diversity and accommodate some species other than opportunistic early invaders before a period of high Delta outflow shifted the community back to an early successional state. Dredging at the Terminal, thus, may act in a cumulative manner with other disturbances to favor low diversity and opportunistic species. Because dredging only affects the benthos in a limited area, the cumulative effect of maintenance dredging by Unocal on benthic communities would be adverse but nonsignificant (Class III). Similarly the disposal of dredged sediments at a designated disposal site in Carquinez Strait would contribute to the continual disturbance of the benthos in that area. Again, because the area affected is limited and because it has been dedicated to that use, the cumulative impacts of dredge disposal by Unocal would be adverse but nonsignificant (III).

As discussed in Section 4.3.4, sediments in the vicinity of the Unocal Terminal are elevated in cadmium and selenium. The selenium most likely comes from discharges from the refinery which are relatively high in selenium. The selenium in the discharge stream probably comes primarily from the processing of San Joaquin crude oil which arrives at the refinery from the Central Valley via pipeline. The Alaskan crude oil which is received at the refinery from tankers using the Terminal is relatively low in selenium. Therefore, the cumulative contribution of the Unocal Terminal to elevated levels of selenium in the sediments of San Pablo Bay is not significant (Class III). Operations at the Terminal might contribute slightly to mass loadings of cadmium in San Pablo Bay sediments but inputs from the refinery which includes processing of oil received via pipeline as well as via the Terminal are almost two orders of magnitude below inputs to San Francisco Bay estuary from other sources (Table 4.3-6). Inputs from leaks and spills directly resulting from Terminal operations would be far less than the refinery discharge. Therefore, the Unocal Marine Terminal would make a very small contribution to cadmium accumulation in the sediments and in the biota. Because elevated levels of cadmium occur both in organisms and in sediments this contribution, though small, would be significant on a cumulative level (Class I).

Fishes

The fish populations in San Francisco Bay estuary have been altered by the cumulative impacts of overfishing, loss of habitat, introduction of exotic species, decreased Delta outflows and increases in contaminants (Nichols et al. 1986). Of these major factors which have affected fish populations in the Bay, continued operation of the Unocal Marine Terminal will only contribute directly to increases in contaminants. However, any stresses on fish populations as the result of the Marine Terminal will impact fish populations already stressed by the other factors. Operations at the Unocal Marine Terminal will also contribute to the cumulative impacts of maintenance dredging and vessel noise on fish populations. The cumulative impacts of these activities on fish populations appear to be minor. As discussed in Section 4.4.3.1, noise from large vessels can startle fishes and cause avoidance behavior.

Within San Francisco Bay estuary with its constant background of vessel noise, fishes have probably become adapted to the regular noise of large vessels. Fishes have been documented to avoid dredge disposal areas during disposal events. The area affected is small however and disposal events occur during a brief time period. On a cumulative level dredging and dredge material disposal would have an adverse but nonsignificant impact on fishes (Class III).

The evidence suggests that contaminant loads may be having a significant impact on fish populations in San Francisco Bay. Fishes within San Francisco Bay estuary have been documented to show liver abnormalities which are thought to be related to elevated levels of contaminants (San Francisco Bay Estuary Project 1992). However, fishes in San Pablo Bay have a lower incidence of liver abnormalities than fishes within San Francisco Bay. Pollutants have been implicated in the decline of the striped bass (Whipple et al 1987). Comparisons of contaminant levels in marine organisms (NOAA 1987) suggest that San Pablo Bay is not among the most polluted west coast sites, although it is not among the least polluted. As discussed in Section 4.3.4. operations at the Unocal Terminal may be contributing small quantities of contaminants to add to pollutant stresses on fishes in San Francisco Bay estuary. Unocal's contribution to contaminant loads is extremely small relative to other sources. However, because contaminant levels in San Francisco Bay estuary are clearly having a negative impact on fishes, the cumulative impacts of Unocal's contribution to contaminant levels in fish populations in the Bay is considered to be significant (Class I).

Marshes

Marshes in San Francisco Bay estuary have been lost and severely degraded by diking, filling, flood control and the indirect impacts of development. Routine operations at the Unocal Marine Terminal will not contribute to cumulative impacts on salt marsh habitat.

Avifauna

Routine operation of Marine Terminals produce noise and human activity, and some discharges affecting local water quality. To some extent, all of these factors influence the distribution and present patterns of abundance of seabirds, shorebirds, and waterfowl. Typically, birds common near Marine Terminals are those most tolerant of noise and human activity. These include nesting Western gulls, several other species of gulls that roost on or near Marine Terminals, occasionally brown pelicans, blackbirds, and other passerines.

Western gulls nest in substantial numbers on the wharves of the Unocal Marine Terminal at Davis Point, on the Brothers Rocks directly off the PAKTANK Terminal, on Red Rock within 1 km of the Chevron Long Wharf, on the Brooks Island breakwater near the Ports of Richmond, and on the piers of the San Francisco Port Marine Terminals. Providing that they are not intruded upon, Western gulls are apparently tolerant to some degree of noise and human activity at Terminals and ports. Thus, routine operations of these Terminals are expected to have nonsignificant impacts on this species (Class III).

Scoters and ducks typically forage or rest in shallow waters of the Bays rather than in deeper waters. They are uncommon in the fast currents of the ship channel and are not likely to be affected by slow-moving tanker traffic. They are at low abundance in the immediate vicinity of all Marine Terminals of the Richmond area, Unocal, Pacific Refining Company, and Wickland-Selby near the Carquinez Strait, and the Martinez-Benicia area. The few present would not be subject to mortality or habitat loss due to normal activities associated with vessel calls and transfer of oil or petroleum products. Although routine operations could produce adverse impacts, these would be nonsignificant because of the small number of birds that might be affected (Class III).

Discharges from Marine Terminals may affect local water quality ultimately contributing to deterioration in habitat and contamination of fish and invertebrate food resources consumed by birds. These discharges, like those of other industrial activities in the Bays, are regulated by the California Regional Water Quality Control Board. Pollutants found in especially high concentrations in scoters and ducks include selenium, silver, copper, mercury, zinc, and cadmium. These metals are contained in the mussels, clams, and other benthic organisms consumed by water fowl, and are the accumulation of many years of discharges from a variety of sources. Overall, Unocal's contribution to contaminant levels in San Francisco Bay estuary, though small, is considered to be significant in a cumulative level (Class I).

Cumulative tanker traffic through the Bays, in the Gulf of the Farallones, and along the north coast involves movement of 11 times as many tankers as Unocal alone. Impacts of this cumulative or total tanker transport, other than oil spills, include a small potential for mortality of birds on the water or disruption of foraging activities. Because of the small probability of impacts and the small number of birds that might be affected, cumulative tanker transport is determined to produce nonsignificant impacts on birds (Class III).

Marine Mammals

The possibility exists for injury or death of harbor seals or harbor porpoises due to collisions with vessels. If impact occurred, they would be significant because both species are protected under the Marine Mammal Protection Act of 1972. There have been no reported instances of collisions of large vessels with these agile marine mammals anywhere in their range. It is unlikely that a harbor seal or harbor porpoise would be contacted by a slow-moving tanker. Because of the negligible chance of occurrence, the impacts of collision with the marine mammals in the Bays from normal vessel traffic in the Bays is nonsignificant (Class III).

Harbor porpoises are predominantly seen in waters near the Golden Gate and east to about Alcatraz Island. Because of their distribution, they are unlikely to be affected by discharges at Marine Terminals including those that affect local water quality. Harbor seals are also rare in the immediate vicinity of Marine Terminals and unlikely to be affected by discharges. Although cumulative discharges certainly produce a deterioration in water quality (an adverse impact), the measurable impact on marine mammals is nonsignificant (Class III).

Marine mammals not listed as threatened or endangered that occur off the outer coast include sea lions, fur seals, elephant seals, harbor seals, Dall's porpoise, harbor porpoise, and three species of dolphins. These species and a few more are known to be common in waters used for transport of crude oil and oil products. To some extent, all are subject to death or injury from collision by tankers in the Gulf of the Farallones and along the north coast. However, the probability of contact is extremely remote considering the speed of movement and agility of these species. Potential impacts of collisions of cumulative tanker traffic with nonlisted marine mammals are considered nonsignificant (Class III).

Rare/Threatened/Endangered Species

Winter and spring run Chinook salmon occur in the immediate vicinity of the Unocal Marine Terminal. Contaminants associated with the Terminal might contribute to the body burden of young salmon although individuals, would only remain near the Terminal for a short while before they migrated to the ocean. Because salmon spend their adult lives off the open coast they are not subjected to the high level of contaminants in San Francisco Bay for more than a short while, the cumulative impact of contaminants on Chinook salmon is judged to be adverse but nonsignificant (Class III).

No rare, threatened, or endangered bird species typically occur in the immediate vicinity of Marine Terminals in the Bay. An exception may be the California brown pelican (Federal and State Endangered), which uses the San Francisco Bay estuary in late summer and fall. California brown pelicans are known to roost in small numbers at sites throughout the area (generally pilings and breakwaters at some distance from sources of disturbance). Sites near Marine Terminals used for roosting by substantial numbers of birds include the Brothers Rocks off the PAKTANK Terminal, the Brooks Island breakwater off the Port of Richmond, and the Alameda Naval Air Station breakwater off the Ports of Oakland/Alameda. Presumably, pelicans roosting near Marine Terminals are accustomed to noise and activity resulting from routine operations; any impacts would be minor and nonsignificant (Class III). It should be noted that, although brown pelicans nesting in California are listed as Endangered, the majority of individuals using central and northern California roosts in the summer and fall are migrants from larger, nonlisted colonies in Mexico.

Endangered least terns have an important colony at the Alameda Naval Air Station. Because of the distance (about 2 km), this colony should not be affected by routine operations (Class III - nonsignificant).

Several California Species of Special Concern may occasionally be seen near Marine Terminals. These include double-crested cormorants, long-billed curlews, California gulls, some ducks, several species of foraging raptors (Order Falconiformes), the black swift, and several species of passerines (perching birds of the Order Passeriformes). Double-crested cormorants have an important colony on the Richmond-San Rafael Bridge near the U.S. Navy Terminal at Point Molate. Numbers at this colony are increasing, thus double-crested cormorants probably are subject to nonsignificant impacts from the Terminal (Class III).

Among mammals, a few San Pablo voles (a State Species of Special Concern and a Federal Candidate for listing) might be found in nearby salt marsh and transition habitat. Routine operations should have a nonsignificant impact on San Pablo voles (Class III).

Noise and activities associated with routine operations at Marine Terminals are not expected to produce any mortality or loss of habitat for any rare, threatened, or endangered species. Any adverse effects of disturbance or discharges are likely to be minor and nonsignificant (Class III).

Cumulative tanker traffic involves movement of 11 times as many tankers through the Gulf of the Farallones and along the north coast as Unocal alone. Thus, the potential for collision of ships and whales is substantially greater than that produced by Unocal tankering. It is known that collisions with large whales have occurred off California (collisions have been reported and carcasses recovered), and will continue to occur (Seagers et al. 1986). Further, this source of impact on whales cannot be mitigated by standing a "whale watch" on the ships as they pass through waters known to be used by whales because ships have too great a mass to slow or turn should a whale be sighted ahead.

Although collision by ships is a known cause of mortality to large whales, it is considered a low probability event (National Marine Fisheries Service 1984). This may result from the somewhat sparse abundance of whales (even during migration), and the likelihood that whales can hear and usually avoid ships. The overall probability of collisions cannot be determined because data are lacking. However, the standing record suggests that one or two collisions occur every few years off California. In consultation required by Section 7 of the Endangered Species Act, the National Marine Fisheries Service stated that tanker traffic would not be expected to have significant effects on populations of whales. This Biological Opinion was rendered for the Santa Ynez Project for waters with similar density of both tankships and whales as the Gulf of the Farallones.

Because of the low probability of collisions and the small number of animals that might be affected, we considered cumulative tanker traffic to produce an adverse but nonsignificant impact on endangered whales (Class III).

4.4.4.2 Oil Spills, Product Spills and Other Accident Conditions

<u>Probability of Impacts</u>

Cumulative conditions produce a greater threat that oil spills will occur than the risk from the Unocal Terminal alone, because of the greater quantities of oil handled or transported, and the greater number of vessel calls (Section 4.1). Further, oil or product spills from all Terminals combined, or from all tanker segments combined, may impact upon more resources than Unocal alone simply due to the wider distribution of potential sources of spills. Table 4.4-29 contrasts the final probability of oil spills occurring and contacting sensitive habitat from Unocal activities and from the cumulative, or combined, activities of all Marine Terminals and tanker transport. Especially in the Bays, the potential for impacts is many times greater from cumulative Terminals and tankers. For most resources the chance is at least 50 percent that they will be impacted by one or more spills of 1,000 bbl or greater during the 40-year life of the lease. For some resources the risk that they will be contacted by a small spill is near certainty. For spills of 10,000 bbl or greater, the chance ranges from about 13 to 45 percent for impacts from one or more spills during the 40-year life of the lease. Along the outer coast, the chance of impacts of large spills from cumulative tankers is as much as 10 times that of Unocal tankers.

Although the overall absolute probability that some portion of a resource will be contacted by a spill during the 40-year lease period is dramatically higher when the cumulative impact of all Terminals and tankers is considered compared to activities at the Unocal Terminal alone, the relative risk in many cases does not change. The relative risk considers the percentage of a resource that has a high probability of being oiled should a spill occur. Thus, there is a much higher chance for many resources that they will have some contact with oil from some spill during the next 40 years when all Terminal and tankering activities are considered, but once a spill has occurred the risk that a substantial portion of the resource will be contacted by oil does not change for many resources. A few resources, however, were at greater relative risk that a substantial portion could be

Table 4.4-29

FINAL PROBABILITIES OF OIL SPILLS OCCURRING AND CONTACTING SENSITIVE POPULATIONS OR HABITAT WITHIN A 40-YEAR PERIOD FROM UNOCAL ACTIVITIES AND FROM THE CUMULATIVE OR COMBINED ACTIVITIES OF ALL MARINE TERMINALS AND TANKER TRANSPORT

Sensitive Habitat	Final Probabilities[1] (percent)			
	Unocal		Cumulative	
	Barrels			
	>1,000	>10,000	>1,000	>10,000
San Francisco, San Pablo, and Suisun Bay				
Birds				
shorebirds - mudflat foraging habitat	12.2	0.5	73.2	23.0
waterfowl - open-water habitat	12.2	0.5	73.2	23.0
Western gull - colony sites	10.4	0.9	97.6	44.2
Marine Mammals				
harbor seal - haul-out sites	2.5	0.5	74.4	30.2
Fishes				
white sturgeon habitat	2.8	0.2	26.0	4.6
Chinook salmon habitat	23.6	1.0	96.5	44.8
American shad habitat	23.7	1.0	99.9	45.4
herring spawning areas	8.9	1.0	99.5	45.5
Invertebrates				
juvenile dungeness crab (April-May)	23.7	1.0	99.9	45.5
juvenile dungeness crab (September-December)	23.7	1.0	99.9	45.5
Other Sensitive Habitats				
eelgrass bed	17.4	0.9	92.7	40.5
vegetated tidal marshes	23.7	1.0	99.9	45.5
shallow water habitat	23.7	1.0	99.9	45.5
Rare/Threatened/Endangered Species				
California clapper rail and California black rail - breeding habitat	2.9	0.3	48.4	19.1
California least tern - colonies	0.5	0.1	42.6	13.1
double-crested cormorant -				
colony sites,	13.4	0.8	84.7	33.9
open-water habitat	23.7	1.0	99.9	45.5
common loon - winter open-water habitat	11.8	0.5	50.0	22.7
long-billed curlew - mudflat foraging habitat	12.2	0.5	73.2	23.0
brown pelican - roosts	1.6	0.2	48.5	15.4
Barrow's goldeneye - open water habitat	12.2	0.5	73.2	23.0
Aleutian Canada goose - open water habitat	12.2	0.5	48.5	15.5
saltmarsh harvest mouse - tidal marsh habitat	23.7	1.0	99.9	45.5

Table 4.4-29
(Continued)

FINAL PROBABILITIES OF OIL SPILLS OCCURRING AND CONTACTING SENSITIVE POPULATIONS OR HABITAT WITHIN A 40-YEAR PERIOD FROM UNOCAL ACTIVITIES AND FROM THE CUMULATIVE OR COMBINED ACTIVITIES OF ALL MARINE TERMINALS AND TANKER TRANSPORT

Sensitive Habitat	Final Probabilities[1] (percent)			
	Unocal		Cumulative	
	Barrels			
	>1,000	>10,000	>1,000	>10,000
Outer Coast				
Birds				
alcid colonies	4.3	1.4	17.7	8.0
storm-petrel colonies	0.9	0.3	6.2	2.8
cormorant colonies	9.6	3.4	60.9	27.5
Western gull colonies	9.7	3.5	61.6	27.8
Marine Mammals				
harbor seal - haul-out sites, >50 seals	3.7	1.2	30.8	13.9
California sea lion - haul-out sites	3.2	1.1	28.0	12.6
Northern elephant seal - colonies	0.9	0.3	7.3	3.3
dolphin and Porpoise - open-water habitat	7.5	2.5	62.0	28.0
gray whale migration path	3.4	1.2	57.7	26.0
Other Sensitive Habitats				
Areas of Special Biological Significance (ASBS)	5.6	1.9	53.6	23.8
salmon streams/rivers	2.3	0.8	25.2	11.2
rocky shore and offshore rocks	7.2	2.5	61.9	27.5
estuaries	0.4	0.1	3.7	1.6
upwelling areas - February through July	3.6	1.3	31.1	13.8
Rare/Threatened/Endangered Species				
common loon - nearshore waters	3.6	1.3	30.9	13.7
California brown pelican - roosts >100 birds	1.7	0.6	13.6	6.2
Steller sea lion - rookeries and haul-outs	4.6	1.5	12.5	5.7
blue/fin/humpback whales - Gulf of Farallones habitat	2.5	0.8	20.5	9.2
sea otter range - north of Monterey Bay	1.5	0.5	14.3	6.4

[1] Final probability is the product of the probability that an oil spill will occur and the probability that, if it occurs, it would contact a particular sensitive resource. Final probability is multiplied by proportion of year sensitive resource is present.

contacted by a single spill from the cumulative tankers and Terminals compared to Unocal alone. Intertidal mudflats, for example, were at moderate risk from a Unocal tanker spill only in Carquinez Strait and San Pablo Bays, while they were at a moderate overall risk from cumulative tankering. In other words, if all tankering is considered, between 10 and 50 percent of the intertidal mudflats within the San Francisco estuary have a greater than 10-percent chance of being contacted with moderate to heavy doses of oil should a spill occur. From Unocal alone only the intertidal mudflats in San Pablo Bay and Carquinez Strait were at moderate risk. Similarly, juvenile dungeness crab were at high risk only in Central Bay and San Pablo Bay from a Unocal spill. When cumulative tankering is considered juvenile dungeness crab are at high overall risk. Again, American Shad were at low risk of medium oiling from a Unocal spill but they are at moderate risk when all tankering is considered.

Although the probability of contact by oil spills is greater for cumulative conditions, the severity of impacts of individual oil spills is of the same scale as for Unocal. The reasonable worst-case spill scenarios used above to describe potential impacts from Unocal activities apply as well to impacts that would likely occur from cumulative Terminals or tanker transport. The important difference between the risk presented by Unocal operations and cumulative operations is in the likelihood of multiple spills during the 40-year life of the lease.

Unocal operations produce a risk of about 38 percent of two or more spills at the Marine Terminal, and 18 percent of three or more (Table 4.4-30). Cumulative risk of spills from all Marine Terminals is much greater For spills equal to or greater than 1,000 bbl, the risk is 60 percent for three or more spills, 41 percent for five or more spills, and 2 percent

Table 4.4-30

PROBABILITY OF OCCURRENCE OF MORE THAN ONE SPILL AT THE UNOCAL TERMINAL AND FROM UNOCAL TANKERS AND CUMULATIVE OPERATION OF ALL TERMINALS AND ALL TRANSPORT OF OIL OR PRODUCTS[1]

Spill Location	Number of Spills					
	1	2	3	4	5	6
Unocal Terminal > 1,000 bbls	20	2	<1			
Cumulative Terminals > 1,000 bbls	99	64	60	52	41	29
Unocal Tankers in the Bay > 1,000 bbls > 10,000 bbls	5 1	<1 <1				
Cumulative Tankers in the Bay > 1,000 bbls > 10,000 bbls	94 46	57 12	44 3	27 <1	14	6
Unocal Tankers Along Outer Coast > 1,000 bbls > 10,000 bbls	8 3	<1 <1				
Cumulative Tankers Along Outer Coast > 1,000 bbls > 10,000 bbls	62 28	24 4	8 <1	2	<1	

[1] Probabilities of spills are for occurrences equal to or greater than number shown.

for ten or more spills. Assuming that only spills greater than 1,000 bbl can do significant damage to sensitive resources, there are even odds (better than a 52-percent chance) that four or more spills of 1,000 bbl or more will occur at Marine Terminals during the 40-year life of the lease.

Unocal tankers in the Bays produce a 5-percent chance of a spill equal to or greater than 1,000 bbl, and less than a 1-percent chance of more than one. In contrast, cumulative tankers produce a 94-percent chance for spills in the Bays, a 57-percent chance for two or more, a 44-percent chance for three or more, a 27-percent chance of four or more, and about a 1-percent chance for 8 or more spills. For large to very large spills of 10,000 bbl or more, the risk from cumulative tankers is 12.2-percent chance for two or more spills, a 2.5-percent chance for three or more spills, and less than a 1-percent chance for more than three spills.

Several resources were judged to be subject to significant impacts from Unocal operations alone (Section 4.3.7); the potential impacts of cumulative conditions upon these resources is greater due to the likelihood of multiple spills during the 40-year life of the lease. As an example, shorebirds and waterfowl in the Bays could be subject to losses of 25 to 50 percent of their migrant populations or foraging habitat from cumulative (i.e., existing) conditions during the 40-year life of the lease. Such impacts would obviously be significant on a hemispheric scale. Although still capable of significantly affecting the health of the populations, spills would do less damage if they occurred infrequently (e.g., every 2 to 3 years) and contacted waters and shoreline in different parts of the Bays.

Oil contamination of mudflats, rocky shore and open waters would not be expected to preclude use for foraging by birds and mammals beyond the year of a spill. This is because oil would become fully weathered and tarlike over a period of a few months. However, repeated contact with tidal marshes would almost certainly result in a net loss of habitat for California Clapper rails (Endangered) and black rails (Threatened) in the San Francisco Bay estuary. These species are surviving in already restricted habitat. Multiple spills also increases the likelihood that California least terns (Endangered) could be subject to impacts that, in combination, could decimate the already very small breeding population.

Other resources, found to be subject to nonsignificant impacts from spills from Unocal operations alone, are subject to significant impacts from cumulative operations. These are cormorants, storm-petrels, and loons, grebes, and scoters along the outer coast. Cumulative conditions produce a significant probability of three or more spills. Therefore, impacts on these species could be three times as great as impacts from single reasonable worst-case spills from Unocal tankers. Cormorants could lose 12.3 percent of the regional breeding population, Ashy storm-petrels could lose 13.5 percent of their world breeding population, and loons, grebes, and scoters could lose 14.4 percent of their regional migrant population.

Some resources remain subject to adverse but nonsignificant impacts despite the likelihood of contact from multiple spills over the 40-year life of the lease. These include widespread coastal and Bay fishes, subtidal soft bottom benthos in the Bay and outer coast, gulls and terns in the Bays and along the outer coast, harbor seals in the Bays, gray whales, and dolphins and porpoises off the outer coast. Many fishes would avoid most contact with oil and widespread species would be at little risk of having a substantial part of their populations contacted. Subtidal soft bottom benthos might not be contacted with oil because in some spills little oil sinks to the bottom. Most soft bottom benthic species are widespread and would be able to recover if they were oiled. Gulls and terns may be able to evade oiling to some extent by shifting their foraging activities to uncontaminated waters. Harbor seals in the Bays could be impacted by oil spills including those at Anchorage 9 off San Francisco and Redwood City. Spills from this location have a probability of 5 to 10 percent of contacting the large harbor seal pupping grounds in the South Bay. However, spills would have to occur during the months of March, April, and May to contact nursing pups or very small pups in lanugo fur. Oil contact with independent juveniles and adults would not be likely to cause death unless animals were already sick or injured. Harbor seal pups killed by oil from multiple spills over the 40-year life of the lease would represent a small portion of annual recruitment in the Bays and less than 1 percent of the species' California population. Gray whales generally do not feed during migration and would be unlikely to ingest oil; oil contact, in and of itself, would not be expected to cause death (this species has recently been removed from the list of Endangered species). Dolphins and porpoises are widespread in

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distribution and may be able to avoid impacts by moving away from waters contaminated by oil spills.

4.4.5 Significant Impacts, Mitigation Measures and Residual Impacts

4.4.5.1 Unocal Responsibilities

Impact - Introduction of exotic organisms in ballast water.

Mitigation and Residual Impact - All ballast water including segregated ballast water should be unloaded to the Unocal wastewater handling facility. No tankers servicing the Unocal Terminal should discharge ballast water to the Bay. This mitigation would mitigate to nonsignificant the potential for introducing invasive organisms to the San Francisco estuary ecosystem.

Impact - Entrainment of young winter and spring run Chinook salmon by the dredge.

Mitigation and Residual Impact - Conduct dredging in July and August when winter and spring run smolt activity is lowest. Impacts would be reduced to nonsignificant.

Impact - Significant impacts on biological resources from a major oil spill.

Mitigation and Residual Impact - Several levels of mitigation exist for significant impacts on biological resources from a Unocal spill. These levels of mitigation are: (1) prevention, (2) containment, (3) avoidance of sensitive resources, (4) cleanup and rehabilitation of oiled areas, and (5) restoration and/or compensation for damaged resources and habitat. The residual impact will increase from (1) prevention to (5) restoration or compensation. Prevention of spills would prevent all oil spill impacts to biological resources. Containment and/or avoidance of sensitive areas might reduce impacts to adverse but nonsignificant if the spill did not occur in the immediate vicinity of sensitive resources. If spills cannot be contained and/or sensitive areas cannot be avoided the residual impact would certainly be significant (Class I) and cleanup, rehabilitation, restoration and compensation could at best be hoped to reduce those significant impacts. Each level of mitigation is considered below.

1. **Prevention of Oil Spills** - Prevention of spills is the most effective level of mitigation and the only one that will prevent all biological impacts. Detailed measures to prevent spills are presented in Section 4.2.5.1. With strict adherence to these measures, the chances for some types of spills will be reduced to nonsignificant. However, even with the mitigation measures, it is determined that some types of spills such as spills during hydrocarbon transfers at the Terminal and potential release of hydrocarbons from a tanker or barge will remain significant (Class I).

2. **Containment of Oil and Procedures to Reduce Damage of a Contained Spill** - Unocal's equipment and capabilities for containment of oil to the immediate vicinity of the spill are discussed in Section 4.2.3.3. The Unocal Terminal and Unocal tankers have the equipment required by regulations for containment and cleanup. This equipment is probably sufficient to contain a small spill. If oil is contained in the immediate area of the spill widespread biological damage can be avoided and in most cases sensitive shoreline resources including tidal marshes, intertidal mudflats, intertidal rocks, seabird roosting and breeding areas and marine mammal haul out areas can be avoided. If the spill were to occur from a tanker on the outer coast it is possible that by containing oil around the tanker in offshore waters, biological impacts could be reduced to nonsignificant. However, even with containment, it is anticipated that within San Francisco Bay estuary, there is still the potential for significant damage. Sensitive resources in the immediate vicinity of the Terminal include Dungeness crab, chinook salmon, white sturgeon, and striped bass. Even if a spill at the Terminal were immediately contained, oil might contact these resources. Because these organisms are found either in the water column or close to the bottom, the amount of damage would depend on the amount of oil that sinks. It may be that if oil can be contained and rapidly cleaned, that little will sink and significant impacts will be avoided. For this reason, oil should be removed from the water as soon as possible and sinkants should not be used. If a spill occurred along tanker routes and the oil were contained, the amount of damage would depend upon where on the route the spill occurred. If the spill occurred near the double-crested cormorant colonies on the Richmond-San

Rafael Bridge, there would be immediate danger to the birds which forage in the waters of the Bay near their colony. Attempts should be made to scare birds from the area of the spill. The Unocal Oil Spill Contingency/Response Plan (Unocal 1993) recommends the use of a propane canon to scare birds. This method would be appropriate during the nonbreeding season but during the breeding season it might frighten the birds on their nests and interfere with breeding activities. During the breeding season a gentler method of scaring birds such as shouting and arm waving should be used. Decision on methods to be used to flush birds from the oil spill area should be made by CDFG and USFWS biologists. If a spill occurs near the cormorant colony, experts in bird rehabilitation should immediately be brought to the site to rescue and begin immediate care of any oiled birds.

3. Avoidance - In the event of a spill larger than 1,000 bbl, containment would not be likely. In that case the most important mitigation measure is to prevent the oil from reaching sensitive biological resources. The Unocal Oil Spill Contingency/Response Plan (Unocal 1993) identifies sensitive biological resources in the vicinity of the Terminal but in most cases it does not provide specific measures for the protection of those resources. The San Francisco Bay/Delta Area Contingency Plan (OSPR, USCG 1993) does provide specific recommendations for the protection of significant biological areas.

Based on the analysis in Section 4.4.3.2., the highest priority areas for protection from a Unocal spill have been identified. These priorities were selected based on the sensitivities of the resource and their level of risk from a Unocal spill. It should not be implied that these are the only resources that could be impacted by a Unocal spill, or that these are the only resources Unocal should be responsible for protecting. However, because these particular areas were identified in this EIR as at highest risk of Unocal spills, specific protection measures for these resources are identified from protection measures recommended in the Bay/Delta Contingency Plan. Unocal should take responsibility for being prepared to implement those protection measures.

- Marshes at River Mouths. The most vulnerable areas and those which should have the highest priority for protection in the event of a Unocal spill are the tidal marshes of San Pablo Bay and Carquinez Strait. Tidal marshes themselves are one of the most endangered habitats in the United States. These areas contain endangered species including California Clapper Rails (Federal/State Endangered) and California Black Rails (State Threatened/Federal Candidate). Tidal marshes have been found to be extremely vulnerable to oil and once oil has contaminated marsh sediments it remain there for many years. Spills at the Unocal Terminal and from Unocal tankers have the greatest probability of contacting salt marsh habitat in Southampton Bay in Carquinez Strait near Benicia Point and marshes east of Point San Pablo. Tidal marshes along the northern shore of San Pablo Bay are less at risk from a Unocal spill. Because of the extreme sensitivity of these areas, however, and because they are within the same bay as the Terminal, protection measures for these areas are also discussed.

  - Southampton Bay near Benicia - Use of diversion boom at the southern end of Southampton Bay between pilings and Dillon Point. A diversion boom should also be used from the Benicia waterfront to the city wharf.

  - San Pablo Creek - Use of a diversion boom at the creek mouth.

  - Corte Madera Marshes - Due to the large mudflats near Corte Madera and other scattered salt marshes and mudflats, strategy will primarily focus towards protection of creek outlets and salt flats. A diversion boom should be deployed at the mouths of these creeks. The salt marshes at the Corte Madera Ecological Reserve are close to roads and will be more feasible for protection than the mudflats which, although they have a large biodiversity, will flush out due to tidal action. If a pollutant is entering from a southern or northern point into the bay, then a diversion boom can be set out. If coming from the north, then a diversion boom off Point San Pedro should be used to push the oil into the current and take it through the Raccoon Strait and out to sea for natural dissipation and landfall cleanup. If the pollutant comes from the south, then a diversion boom cannot be used since it will push the oil into the current and take it into San Pedro Bay.

- Napa Marshes - Use of a diversion boom to prevent oil from reaching the shore.

- Sonoma Creek/Napa Slough - The confluence of Sonoma Creek and Napa Slough is just before the mouth into San Pablo Bay. Any pollutant coming into the mouth must be stopped immediately before it spreads into the numerous passages and channels that feed into Sonoma Creek and Napa Slough. Both the creek and the slough should be spanned by an exclusion boom. If this is not permitted by heavy outflow, a diversion boom should be set up to collect the pollutant at the Highway 37 bridge.

- Gallinas Creek - Charts do not properly reflect the mouth of the Gallinas Creek. The creek is drained through the main channel and smaller channels use the salt marshes. The first priority is to deploy an exclusion boom around the channels that drain the creek. A diversion boom should also be placed across the main channel of Gallinas Creek. The salt marsh extending from Rat Rock to the southern boundary of Hamilton Field can be protected by a diversion boom, hay bales, or a combination of both. If a pollutant enters from a south to northeast direction, a diversion boom can be set up extending from Rat Rock of China Camp.

- Eelgrass Beds - After the protection of major salt ~~marshes,~~ eelgrass beds should have the highest priority for protection. Eelgrass beds are used for foraging by the California Least tern (Federal/State Endangered). Eelgrass beds are also important to juvenile fishes. Marine grasses have been found to be extremely sensitive to oil in previous spills. Important eelgrass beds are located near Point Richmond and near Alameda. These areas should be protected with booms and curtains. If placed from shore, personnel should not tramp over the eelgrass or drag equipment over it. In general, dispersants and sinkants should not be used in the vicinity of the eelgrass beds.

- Double-crested cormorant colonies near the eastern ends of the Richmond-San Rafael Bridge and the San Francisco-Oakland Bridge - These colonies should receive high priority for protection from oiling using booms and curtains from about April to June when nesting occurs. Again, attempts should be made to flush birds from the oiled waters but extremely disturbing devices such as canons should not be used during the nesting season. Expert bird rehabilitators should be onsite to rescue oiled birds.

4. **Cleanup and Rehabilitation of Oiled Areas** - In many oil spills, cleanup has done at least as much damage as the spill itself. Extreme sensitivity should be used in any sensitive areas. For example attempts to approach an alcid colony off the outer coast risks scaring the birds off the rocks and causing them to dive into the oiled areas. In many cases oiled areas are best left alone to recover naturally. If cleanup is deemed appropriate (a decision that should be made with input from CDFG and USFWS biologists), an access route for cleanup personnel should be established and marked. This route should attempt to avoid as much as possible the most sensitive areas. The Unocal Oil Spill Contingency/Response Plan recognizes the sensitivity of oiled areas to cleanup and provides a matrix of cleanup techniques for different shoreline sensitivities and oil types. This matrix allows for some fairly destructive measures such as sand blasting. All cleanup attempts should be done under the supervision of CDFG and USFWS biologists. Destructive cleanup methods should be a last resort. Eelgrass beds should not be cleaned in most cases but be allowed to cleanse naturally. Procedures should be made specific for the rehabilitation of oiled birds. The Unocal plan includes a discussion of rehabilitation of oiled birds but needs to be more specific of exact methods, procedures, and training.

5. **Compensation and/or Restoration** - If damage occurs, the last resort is restoration and compensation. Documentation of damage is critical to this effort. To ensure that the loss of resources is documented as soon as possible after a large spill, the sampling methods and sampling design should be determined beforehand, and the plan should include provisions for getting resources onsite as soon as possible so that post spill studies can begin immediately.

Table 4.4-31 summarizes significant biological resources, their relative risk from a Unocal spill, and specific mitigation recommendations.

4.4.5.2 Cumulative Actions

Significant cumulative impacts to biological resources include impacts from cumulative degradation of water quality and cumulative risk of a major oil spill. Mitigations to control cumulative degradation of water quality are addressed in Section 4.3.5.2. The most significant actions to decrease cumulative loadings of pollutants to the San Francisco Bay estuary are the new regulations and recommended practices by the Environmental Protection Agency to control nonpoint source pollution (EPA 1993). The largest source of contaminants to the San Francisco Bay estuary is urban and nonurban runoff. The implementation of management measures and practices to control nonpoint source pollution could significantly improve water quality in San Francisco Bay.

The Clean Bay Co-operative is an effective measure to mitigate the cumulative risk of oil spills. Future cumulative mitigations for oil spills should focus on developing measures such as onsite booms to rapidly protect the most sensitive biological areas such as river mouths.

4.4.6 <u>Alternatives Analysis</u>

4.4.6.1 No Project Alternative

<u>Pier Structure Scenarios</u>

Abandonment In-Place of the Marine Terminal

Abandonment in place of the Marine Terminal would eliminate the adverse but nonsignificant impacts to marine life from decreased water quality from leaks, spills and discharges associated with the Terminal. Elimination of these inputs would have a minor beneficial impact on marine life in the vicinity of the Terminal (Class IV). Abandonment of the Marine Terminal would eliminate the risk of a major spill from the Unocal Marine Terminal or from ships traveling to and from the Terminal. (Class IV). There would be a small potential for a spill from the pipelines during the removal process (Class II). This small risk could be minimized to nonsignificant by adherence to a plant that addressed spill prevention and response measures during the amendment process.

Abandonment and Removal of the Marine Terminal

Like abandonment in-place of the Marine Terminal, abandonment and removal of the Marine Terminal would have a beneficial (Class IV) impact on marine life because it would eliminate the chronic input of contaminants associated with leaks, spills, and discharges from the Terminal. The risk of a major spill from the Terminal would also be eliminated. Removal of the Terminal would have adverse but nonsignificant (Class III) impacts on marine life because the process of removing pilings, pipelines and other structures from the bottom would create disturbance and would resuspend sediments and generate localized, short term increases in turbidity. As was true for abandonment in place of the Marine Terminal, there would be a slight potential of a spill from the pipelines during the removal process (Class II). Impacts on birds would be reduced if the demolition were scheduled for late summer or early fall after western gulls have departed and before migrant waterfowl and shorebirds have arrived. Marine organisms living on the pilings would be destroyed when these structures were removed. Fishes and crustaceans that use the Terminal for shelter would lose habitat.

Retain Pier for Other Nonterminal Uses

Abandoning the Terminal and retaining the pier for other non-Terminal uses would be expected to have similar impacts on marine life to abandonment in place of the Terminal. Elimination of minor leaks and discharges as well as the risk of a major spill from the Terminal would have a beneficial impact on biological resources (Class IV). Recreational use of the pier for fishing would have a minor adverse impact on resident sport fish populations (Class III).

<u>Refinery Scenarios</u>

Refinery Continues to Operate at Current Capacity

<u>Replacement of Crude Intake from the Central Valley Via Pipeline</u>

Replacement of Alaskan crude oil by central valley crude oil pumped through pipelines would eliminate

Table 4.4-31

SENSITIVE RESOURCES THAT SHOULD RECEIVE PRIORITY FOR PROTECTION FROM OIL SPILLS[1]

Sensitive Habitat (Breeding Season)	Conditional Probability of Contact		Mitigation Measure
	1,000-bbl spill	10,000-bbl spill	
San Francisco Bay Estuary			
Birds			
shorebirds - mudflat foraging habitat (October-May)	20.2	10.5	Containment and booming to prevent oiling of intertidal mudflats; flushing birds from threatened mudflats; rescue and rehabilitation.
waterfowl - open-water habitat (October-May)	99.9	99.9	Containment and booming to prevent oiling of shallow waters; flushing birds with loud sound; rescue and rehabilitation.
Western gull - colony sites (April-June)	90.9	31.2	Containment and booming around colony sites; avoid intrusion on colonies; rescue and rehabilitation.
Marine Mammals			
harbor seal - haul-out sites (April-August)	46.6	1.1	Containment and diversion to keep oil out of mud/sand flats used for pupping and molting; avoid intrusion/disturbance.
Fishes			
white sturgeon habitat	18.5	10.0	Containment and diversion to keep oil out of shallow water habitat in San Pablo Bay and Honker Bay.
Chinook salmon habitat	99.9	99.3	Containment and diversion to keep oil out of shallow water habitat,
American shad habitat	99.9	99.9	Containment
herring spawning areas	99.9	22.9	Containment and diversion to keep oil from eelgrass beds and hard substrate.
Invertebrates			
juvenile dungeness crab	99.9	99.9	Avoidance of the use of sinkants in deep water habitat in San Pablo and Central Bays.
Other Sensitive Habitats			
eelgrass bed (year-round)	93.5	68.7	Containment and booming; do not use dispersants and sinkants, do not clean - allow to recover naturally.
vegetated tidal marshes (year-round)	99.9	99.9	Containment and booming; do not clean - allow to recover naturally.
shallow water habitat (year-round)	99.9	99.9	Containment and diversion to keep oil in deeper waters.

Table 4.4-31
(Continued)

SENSITIVE RESOURCES THAT SHOULD RECEIVE PRIORITY FOR PROTECTION FROM OIL SPILLS[1]

Sensitive Habitat (Breeding Season)	Conditional Probability of Contact		Mitigation Measure
	1,000-bbl spill	10,000-bbl spill	
Rare/Threatened/Endangered Species			
California clapper rail/California black rail - tidal marsh habitat (year-round)	26.7	99.9	Containment and booming of tidal marsh habitat, especially creek/river access for oil into sloughs; do not clean - allow habitat to recover naturally.
California least tern - colonies (April-June)	16.2	0.8	Containment and booming within 3 km of colonies, and especially nearby eelgrass and other vegetation; avoid intrusion on colonies; do not clean - allow nearshore foraging habitat to recover naturally; rescue and rehabilitation.
double-crested cormorant - colony sites (April-June)	78.5	1.1	Containment, diversion, and booming within 5 km of colonies on east end of Bay Bridges; some flushing of birds from path of spill; avoid intrusion/ disturbance of colonies during breeding season; rescue and rehabilitation.
common loon - winter open-water habitat (October-April)	11.8	50.7	Containment and diversion to keep oil out of shallow open waters; rescue and rehabilitation.
long-billed curlew - mudflat foraging habitat (October-May)	20.2	10.5	Containment and booming to prevent oiling of intertidal mudflats; flushing birds from threatened mudflats; rescue and rehabilitation.
brown pelican - roosts (September-December)	45.4	5.4	Flushing of birds form path of oil; rescue and rehabilitation.
Barrow's goldeneye - open water habitat (October-May)	99.9	99.9	Containment and booming to prevent oiling of shallow waters; flushing birds with loud sound; rescue and rehabilitation.
Aleutian Canada goose - open water habitat (October-May)	99.9	99.9	Containment and booming to prevent oiling of shallow waters; flushing birds with loud sound; rescue and rehabilitation.
saltmarsh harvest mouse - tidal marsh habitat (year-round)	49.9	49.9	Containment and booming to prevent oiling of tidal marshes; do not clean - allow habitat to recover naturally.
Outer Coast			
Birds			
alcid colonies (April-June)	59.6	—	Source control and containment; if possible tow leaking vessel from waters densely occupied by foraging birds; avoid disturbance to colony; rescue and rehabilitation.
storm-petrel colonies (April-June)	12.5	---	Source control and containment; avoid disturbance to colony; rescue and rehabilitation.
cormorant colonies (April-June)	31.4	---	Source control and containment; avoid disturbance to colony; rescue and rehabilitation.
loons, grebes, scoters (October-April)	49.9	---	Source control and containment; keep oil from reaching sheltered nearshore waters where birds rest at night; rescue and rehabilitation.

Table 4.4-31
(Continued)

SENSITIVE RESOURCES THAT SHOULD RECEIVE PRIORITY FOR PROTECTION FROM OIL SPILLS[1]

Sensitive Habitat (Breeding Season)	Conditional Probability of Contact		Mitigation Measure
	1,000-bbl spill	10,000-bbl spill	
Marine Mammals			
harbor seal - haul-out sites, >50 seals (April-August)	51.3	—	Avoid intrusion/disturbance of beaches and rocks used for pupping and molting.
Northern fur seal - shelf break and beyond (January-May)	55.5	—	Source control and containment; use dispersants of oil slicks move offshore where fur seals abundant.
gray whale migration path (December-May)	47.2	—	Stand whale-watch on cleanup vessels - attempt to avoid whales.
Other Sensitive Habitats			
Areas of Special Biological Significance (ASBS) (year-round)	77.2	—	Diversion and herding, use of dispersants in deep water to avoid these areas may be warranted, do not clean - allow to recover naturally.
salmon streams/rivers (year-round)	32.3	—	Diversion and herding and possible use of dispersants to avoid area, boom rivers or close with berm.
rocky intertidal (year-round)	99.6	—	Diversion and herding, use of dispersants in deep water to avoid these areas may be appropriate, do not clean - allow to recover naturally.
Rare/Threatened/Endangered Species			
common loon (October-April)	49.9	—	Source control and containment; keep oil from reaching sheltered nearshore waters where birds rest at night; rescue and rehabilitation.
California brown pelican - roosts >100 birds (September-December)	23.6	—	Flushing of birds from path of oil; rescue and rehabilitation.
Steller sea lion - rookeries and haul-outs (May-July)	31.9	—	Source control and containment; avoid intrusion or disturbance to colonies.
blue/fin/humpback whales - Gulf of Farallones habitat (July-November)	34.7	—	Stand whale-watch on cleanup vessels - attempt to avoid whales.
sea otter range - north of Monterey Bay (year-round)	20.8	—	Source control and containment; use dispersants if oil slicks move toward sea otter habitat; rescue and rehabilitation.

[1] Probability of contact, conditional on occurrence of an oil spill, estimated for persistent oil released at Unocal Terminal or along route of Unocal tankers (spills >1,000 bbl) during portion of year when resource is present or especially sensitive (e.g., breeding or migration season).

the risk of crude oil spills at the Marine Terminal and reduce risks along the tanker transport route. Reduction in oil spill risk would constitute a Class IV beneficial impact to birds and marine mammals. The risk of product spills would continue at the present level due to use of the Marine Terminal for loading product carriers. An increase in the amount of crude oil processed from the Central Valley might increase the mass emissions of certain contaminants such as selenium. An increase in the amount of selenium discharged would be a significant (Class I) cumulative impact because significantly elevated levels of selenium have been found in the biota near the Terminal.

Replacement of Crude Intake Via Other Marine Terminals

Should crude oil be supplied to Unocal's refinery entirely via pipeline from other Marine Terminals, the risk of crude oil spills would be eliminated at the Davis Point Marine Terminal and along portions of the tanker transport route. However, it is presumed that the total quantity of crude oil imported would not decrease, thus the overall probability of crude oil spills would remain the same as in the Proposed Project. The distribution of risk would change because greater quantities of crude oil would be transported over certain portions of the tanker transport routes and vessel calls would increase at some Marine Terminals. Depending on which Terminal received the oil, the overall risk of a spill might either increase or decrease slightly according to the analysis in Section 4.2.6. Shifting the impact to another Terminal would be most likely to increase the overall risk of a spill sightly. The risk of product spills would continue at the present level due to use of the Unocal Marine Terminal for loading product carriers. Oil spill impacts of this alternative would not be substantially different from that of the Proposed Project and would remain Class I.

Construction of new crude oil submerged pipelines between the Unocal refinery and other Marine Terminals could be required for this alternative. If it occurred, pipeline construction would resuspend sediments and cause noise and disturbance. Resuspension of sediments would cause temporary localized increase in turbidity and possibly in water column contaminants. The impacts of pipeline construction on marine life would be adverse but nonsignificant (Class III). Noise and disturbance of pipeline construction might cause some birds to avoid the area during construction. These impacts would be adverse but nonsignificant (Class III).

Product Export Via Other Marine Terminals

The export of products from the Unocal refinery via other Terminals would eliminate the risk of a product spill at the Unocal Marine Terminal but would increase the risk of such a spill at another Terminal. According to the analysis in Section 4.2.6, product export from other Terminals would increase slightly the risk of oil spills. A major oil spill would have a significant (Class I) impact on biological resources. Impacts of this alternative would not be substantially different from that of the Proposed Project. If it were necessary to construct new pipelines for this alternative, there would be adverse but nonsignificant (Class III) impacts on biological resources associated with such construction.

Truck and Rail Product Transport

To the extent that product exports through the Marine Terminal were reduced by use of truck and rail transport, the risk of product spills at the Davis Point site would be reduced. An equivalent reduction in risk of spills along the transport route used by product carriers would also occur. These changes would constitute a Class IV beneficial impact to biological resources in San Francisco Bay estuary. However, an oil spill into any inland waterway would have a significant adverse impact on aquatic resources (Class I). This alternative also might be adverse but nonsignificant impacts to terrestrial organisms from decreases in air quality and increases in noise and disturbance from the truck and rail traffic (Class III).

Refinery Would Operate at Reduced Levels

Reduction in refinery operations would eliminate the oil spill risk associated with receiving crude oil at the Terminal. Because refinery operations would be reduced, this crude oil would not be received from another Marine Terminal. In addition, because refinery operations would be reduced there would be an overall reduction in the amount of product exported from the refinery which would reduce the overall risk of a product spill in the bay and along tanker routes. This alternative, therefore, would cause an overall reduction in the risk of an oil spill or product spill in the bay and along tanker routes. Reduction in oil spill risk would have a beneficial (Class IV) impact on biological resources.

Reduction in refinery operations would reduce the amount of wastewater and associated contaminants discharged from the outfall. Reduction in the mass emission of contaminants from the Unocal outfall would have a beneficial (Class IV) impact on water quality and on marine life.

Shutdown of the Refinery

Shutdown of the refinery would eliminate all oil spill risk associated with the Terminal and with tanker traffic associated with the import of crude oil for the refinery and the export of refinery products. Elimination of these oil spill risks would have a beneficial impact on biological resources (Class IV). Shutdown of the refinery would eliminate all wastewater discharge from the refinery. Elimination of wastewater discharge would have a beneficial (Class IV) impact on water quality and marine life.

4.4.6.2 Consolidation Alternatives

Consolidation of Unocal and Pacific Refining Company Terminals at Unocal Terminals

The oil spill risk of this alternative would be virtually the same as the Proposed Project. In other words, the overall oil spill risk of consolidating the Unocal and Pacific Refining Refinery Terminals would be the same as that of the two Terminals operating independently.

If it were necessary to install submerged pipelines between the Pacific Refining Refinery and the Unocal Terminal there would be temporary adverse but nonsignificant impacts on biological resources from the resuspension of sediments and from noise and disturbance (Class III). Similarly, during abandonment and removal of the Pacific Refining Refinery Wharf there would be a temporary adverse but nonsignificant (Class III) impact from resuspension of sediments and from the noise and disturbance of removing pipelines and pier structures. In addition, during pipeline removal there would be a small risk of a spill or leak from pipelines during the removal process (Class II impact). Adherence to a plan addressing spill prevention and response would reduce this risk to nonsignificant.

4.5 COMMERCIAL AND SPORT FISHERIES

4.5.1 Introduction

Impacts on fishing, aquaculture, and kelp harvesting are assessed in this section. Commercial and recreational fish harvesting is impacted by routine operations, spills, and other accidents. Impacts on kelp harvesting and aquaculture would occur outside the Golden Gate and are assessed in the north coast study area analysis. Discussions of the continuation of existing conditions and future conditions are combined within the analyses of routine operations and accident conditions. Resource impacts are fully explained in Section 4.4; when relevant, they are summarized in this section and included in the assessment of harvesting impacts.

4.5.2 Impact Significance Criteria

The following criteria are used to determine the significance of impacts and are consistent with criteria used in other EIR/EISs (Chambers Group 1986; Jacobs Engineering Group, Inc. 1988; Aspen Environmental Group 1992).

An impact on commercial or recreational fisheries is considered significant if it temporarily reduces any fishery in the local (Bay) or regional (coastal) study area by 10 percent or more during a season, or if it reduces any fishery by 5 percent or more for more than one season. For kelp harvesting and aquaculture, an impact is considered significant if it affects harvest areas by 5 percent or more.

4.5.3 Proposed Project

4.5.3.1 Routine Operations

For the continuation of existing conditions, as well as for future conditions, fishermen are and will be unable to fish at or near the Terminal or in the direct path of transitting tankers and barges (preclusion impacts). Routine dredging of Bay shipping channels, impacts from filled lands, and other indirect impacts are discussed in Section 4.5.4, Cumulative Impacts.

<u>Terminal/Vessel Operations</u>

All Terminal operations occur in CDFG Block 308 and NMFS BASES Blocks D and 6 (Figures 3.4-1 and 3.4-2). According to CDFG statistics (refer to Section 3.4.3), commercial landings in Block 308 are comprised of shrimp and rockfish. Recreational effort targets mainly bass, perch, salmon, and sturgeon. The area represented in Blocks 308 and D is approximately 30 and 120 square miles, respectively. BASES Block 6 encompasses approximately 27 linear miles of shoreline.

As previously discussed in Section 3.1, the Terminal operates 24 hours a day, 365 days a year. The Unocal ship berthing structure is 1,250 feet long and 136 feet wide. The Terminal provides an area for product unloading and loading primarily for West Coast Shipping Company vessels. Currently, and on average, 87 tanker and 54 barge trips are made each year. Over the next 20 years the number of trips is assumed to increase 60 percent, raising the average annual trips to 139 (tankers) and 86 (barges). Over this same period of time, barring unforeseen major changes in development regulations, habitat, and harvesting methods, fisheries in the immediate vicinity are expected to remain as they are now. Impacts on fisheries during this period will continue, except that the increased number of tanker and barge trips would cause more frequent disruptions and increase the risk of accidents.

The length of the tanker route from the Golden Gate Bridge to the Terminal is about 26 nm. Tankers access the Terminal from the south and, thus, traverse through CDFG Blocks 488, 301, and 308, or NMFS BASES Blocks C and D during transit. These blocks represent an area of approximately 200 square miles; it takes approximately 4 hours for transit, while tanker unloading/loading operations take roughly 15 hours.

During unloading activities, a certain percentage of the product is transferred onto barges, then transported to other facilities within the Bay. Barges travel in various directions, but approximately 35 percent of the approaches/departures will be from the south. Barges travel a distance of approximately 15 nm one-way, which takes roughly 3 hours. Barges may traverse through CDFG Blocks 488, 301, 308, 302, or NMFS Blocks C, D, and E to reach the Terminal. These blocks represent approximately 243 square miles. Unloading/loading activities at the Terminal take about 10 hours.

Impact Assumptions

To determine the impacts associated with a reasonable worst-case operations scenario, the following assumptions were made:

- The analysis considers tanker movement and operations associated with the Unocal Marine Terminal, not with other facility operations.
- Tankers and barges approach from the south, and their travel-time durations overlap with each other's as they approach the Terminal.
- Tankers and barges traverse an area approximately 200 square miles.
- The average size of a tanker vessel is approximately 660 feet long by 100 feet wide (areal displacement of 66,000 square feet).
- The average size of a barge is approximately 300 feet long by 70 feet wide (areal displacement of 21,000 square feet).
- Fishing operators normally navigate a safe distance from a vessel to avoid collision and entanglements. A 0.25-mile buffer around transitting vessels and a 0.5-mile buffer extending from the point where the Terminal intersects with the shoreline constitute fishery exclusion zones for all fishing operations.
- Terminal operation preclusion impacts are based on comparison of area calculations of commercial and recreational fisheries within CDFG Block 308 and NMFS BASES Blocks D and 6, and which intersect the 0.5-mile buffer. Areal preclusion of transitting tankers is compared to total fishing area (200 square miles) of the traversed blocks.
- Ballast waters are not discharged into the Bay.
- Unocal tanker and barge routine operations, including roundtrip transit time, average 2,865 hours per year, or 33 percent of the time available in a year. In the future, operations are expected to increase to 4,573 hours per year, or 52 percent of the time.

Routine Operations at Marine Terminal

The Unocal Terminal area harbors several recreational fisheries: salmon, sturgeon, bass, and perch. The buffer excludes about 0.3 percent of the recreational boat and approximately 4 percent of the shoreline salmon, sturgeon, and bass fishing areas in NMFS Blocks D and 6. Approximately 2 percent of the perch fishing area in Block 6 is excluded, as well. Impacts to fisheries near the Terminal are expected to be nonsignificant (Class III) for the following reasons: the areas precluded to anglers are less than the 5-percent threshold identified in the significance criteria, impacts on fish and its habitat are expected to be Class III (see Biological Resources), and fishing activities are light within the Terminal exclusion zone. These estimated impacts occur for about 120 days. In the future, impacts are expected to occur for more than 6 months (about 190 days) out of each year.

Within the Terminal buffer, maintenance dredging occurs annually to ensure that adequate water depth is maintained for the tankers and barges. Little disturbance to fishing activities is anticipated, and disturbance to bottom and water column fish and shellfish is expected to be minimal. Disposal of dredged materials takes place in the Carquinez Strait, an area subject to scouring due to Bay conditions. Some smothering of organisms are expected, but impacts on bay shrimp and other species is expected to be minimal (Class III). Impacts on fisheries, due to preclusion, are expected to be nonsignificant because dredging occurs once a year within the buffer, and disposal involves only 90,000 cubic yards of relatively clean material. Impacts on fish and habitat are expected to be nonsignificant as well, as presented in Biological Resources. Consequently, impacts from dredging and dredge disposal on fisheries in the area are expected to be adverse but nonsignificant (Class III). Future impacts are expected to occur at the same level.

Routine Operations Within Bay

As tankers and barges traverse the shipping channels, fisherman cannot access the area and, thus, temporarily lose a small portion (1.0 square mile) of their fishing area. This exclusion area is about 0.5 percent of the water area available for fishing and is considered nonsignificant (Class III).

Herring fishing and shipping, in particular, can conflict with each other because of the fishing methods and location of fishing grounds near docks and piers, and in shipping channels. CDFG works with concerned parties to minimize conflicts; however, some fishing areas may be inaccessible. Herring fishing occurs predominantly within CDFG Blocks 488 and 489. In Block 488 (central Bay), fishing currently occupies about 2,644 acres or 4.13 square miles. Fishing in south Bay takes up about four times that area or 10,697 acres (16.7 square miles). In all, herring fishing occupies nearly 21 square miles of the Bay. These figures compare to nearly 43 square miles of spawning habitat. Fishing migrates around the habitat area, depending on spawning behavior through the years.

In Block 488, shipping corridors used by Unocal tankers and barges pass through current herring fishing areas around Angel Island, off Alcatraz, and along portions of the Tiburon shore. At any one time, a tanker would take up nearly 25 percent of the fishing area. Fishing in Block 489 should not be disturbed by Unocal vessels. Impacts in Block 488 and the Bay, as a whole, are determined to be a significant impact (Class II) and can be mitigated by conformance to agreements developed between Unocal, CDFG, and other interested parties. In the future, impacts on herring fishing may vary because the fish change their spawning locations. Future impacts could range from Class II to III.

4.5.3.2 Accident Conditions

A significant impact to fisheries will likely result from an accidental spill of crude oil or crude oil product in either San Francisco Bay or within outer coast waters now and in the future. The severity of the impact will depend on (1) the size and location of the spill, (2) the composition of the oil, (3) the characteristics of the spill (instantaneous vs. prolonged discharge; surface vs subsurface spill, and so forth), (4) the environmental conditions and the effect of weathering on spill properties, and (5) the effectiveness of cleanup operations.

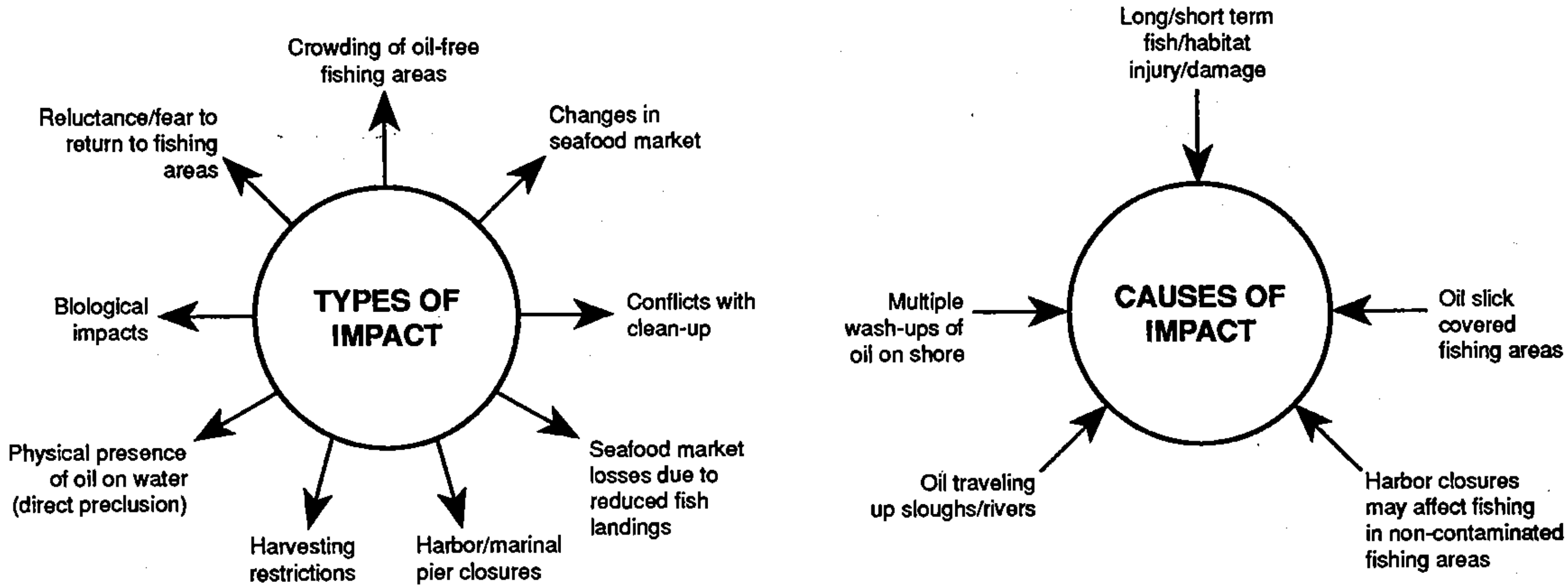
Determining oil spill impacts is a three-step process: (1) estimating the risk that fisheries face from oil spills, (2) determining what fishing areas would be covered with oil if spills from certain terminals or if tanker route segments were to reach identified locations (San Francisco Bay only); and (3) estimating the impacts of individual modeled spills. Fundamental to all steps is comparing oil spill trajectories (as explained in Section 4.2) to fishing patterns illustrated on Figures 3.4-2 and 3.4-4 through use of GIS. Furthermore, relevant conclusions from Section 4.4.3 (Biological Resources) and 4.11.3 (Land Use/Recreation) are incorporated to complete the analyses.

General Description of Fishery Impacts

Causes and types of impacts on fisheries are illustrated on Figure 4.5-1. Fisheries would be impacted by oil spills in many different ways, including the following:

- physical presence of oil on water;
- fishing restrictions imposed by public agencies to ensure that no tainted seafood reaches market;
- harbor closures to keep oil in or out;
- spatial conflicts with cleanup operations;
- long- and short-term biological effects on fish and habitat;
- changes in seafood markets due to public fears of eating contaminated seafood;
- fishermen avoiding areas for fear of contaminating gear and catching tainted fish;
- fishing area closures forcing fishermen to other areas, thus crowding those areas and reducing overall catches; and
- public reluctance to return to an area for recreational fishing after a spill.

Impacts on harvesting activities presented in this section should be considered as minimum impacts for several reasons: (1) spreading of oil according to modeled scenarios takes into consideration first washup of the spills, after which further washups would increase the duration of impacts beyond the modeled timeframes; (2) actual spills may travel farther up sloughs than indicated by the model; (3) during an actual spill, closure of local harbors or other events may prevent vessel operators from accessing uncontaminated areas, causing further reduction in landings; and (4) long- and short-term biological impacts are unknown. Other factors to consider are (a) the effects of fishing losses on fishing-related



OIL SPILL IMPACT TYPES AND CAUSES

Figure 5-1

businesses, including bait suppliers, fish processors, tackle and equipment outlets, and tourism, and (b) resultant seafood losses on related markets and the consumer. Depending on the affected fisheries and the extent of impacts, these impacts can be small and localized or large and affect whole regions.

Spill impact timeframes are not included in the quantification analysis; however, the time allotted for cleanup operations is briefly discussed based on past spills. Limited data on five spills were reviewed. For some spills, cleanup operations ceased before all of the spilled oil was picked up, leaving some areas contaminated. Sometimes, leaving an area to clean itself is the most environmentally desirable option.

The 1984 Puerto Rican spill involved approximately 25,000 to 35,000 bbl of oil, and 18 days were spent in cleanup; the 1988 Shell-Martinez spill involved 8,700 bbl of oil and 107 days for cleanup; the 1989 Exxon Valdez spill involved 268,000 bbl of oil and cleanup lasted two summers; the 1990 American Trader Huntington Beach spill involved 9,525 bbl of oil and about 1 month for cleanup, and the 1992 Unocal Avila Beach spill involved 150 bbl of oil and 4 weeks for cleanup. Based on these spills, the amount of time associated with cleanup operations is variable. Each spill is unique to the area of occurrence and cleanup operators must consider the area's specific tidal regimes, wind patterns, and other factors. Because cleanup time requirements are variable, the amount of lost fishing time, due to areal preclusions, is also variable and difficult to predict.

Accident Conditions within Bay

Fisheries at Greatest Risk

The first step of the oil spill analysis uses the conditional probability maps that illustrate light oiling of persistent oil. Thousands of modeled spills were run to determine the probability of oil covering areas of the Bay. Results of these runs are discussed in Section 4.2. Maps created by the models are compared to mapped fishing areas via GIS to determine the probability of oil covering individual fisheries; conclusions from Section 4.4 (Marine Biology) are incorporated to estimate the risks to fisheries from oil spills.

Fisheries at moderate to high risk are those having a greater than 10-percent chance of having more than 10 percent of their area covered by the modeled spills. Table 4.5-1 summarizes the risks to specific commercial and recreational Bay fisheries.

Table 4.5-1

OIL SPILL RISKS FROM UNOCAL TERMINAL AND TANKERS

Fisheries	Sources of Spills						
	Total Species Area	Unocal Terminal			Unocal Tankering		
		Area at Risk	Percent Area at Risk	Moderate to High Risk	Area at Risk	Percent Area at Risk	Moderate to High Risk
Commercial							
Bay Shrimp (acres)	26,042	6,377	24	yes	6,463	25	yes
Herring (acres)	13,338	0	0	no	8,374	63	yes
Recreational							
Salmon (acres)	132,791	46,059	35	yes	105,593	80	yes
Sturgeon (acres)	82,271	44,843	55	yes	58,313	71	yes
Halibut (acres)	60,743	0	0	no	33,419	55	yes
Rockfish (acres)	26,132	180	1	no	24,409	93	yes
Smelt (mi)	253	0	0	no	81	32	yes
Bass (acres)	170,995	44,890	26	yes	70,775	41	yes
Perch (mi)	356	13	4	no	118	33	yes
Clambeds (mi)	21	0	0	no	3	14	yes
Suisun Bay (acres)	13,997	6,708	48	yes	4,628	33	yes
Herring Spawning (mi)	253	0	0	no	91	36	yes

Persistent oil models are chosen over nonpersistent oil models because most of the nonpersistent oils would likely evaporate within 24 to 36 hours, with complete evaporation in 2 to 3 days. Impacts on most fisheries would likely be nonsignificant, unless a severe spill was concentrated during a peak fishing season and area, in which case significant (Class II) impacts on herring, salmon, and sturgeon fishing could result.

The 10-percent threshold criterion considers the reasonable worst case. "Light oiling" models are chosen because of (1) the potential to contaminate gear and harvested fish, (2) the likelihood of fishing closures to ensure that no contaminated fish reach market, and (3) the adverse public reaction to spills.

The second step compares the receptor mode run results (Tables 4.2-1 and 4.2-2) to areas along the Bay shoreline with moderate to high risk levels. Fisheries at these sites are identified. For each of the sites, the average probability of contact from a 10,000-bbl spill from all transport segments or terminal locations is calculated, and the sites with the highest average are identified in the text; results from modeled spills at the Unocal Terminal and from tanker route segments near the Terminal are highlighted.

Spills at Unocal Terminal

Moderate to high risks of spills (persistent oil) from the Unocal Terminal concentrate around the Terminal. Moderate to high risks also occur in the Carquinez Strait and the mouth of Suisun Bay.

The only commercial fishery with a high to moderate risk of oil from Unocal Terminal spills is bay shrimp. Fishing areas in the Carquinez Strait are at highest risk. In addition, shrimp resources are particularly vulnerable to oil due to a limited distribution and population declines and because their habitat has a high risk of oil contact.

Four recreational fisheries are at a high to moderate risk of spills from the Terminal. Salmon, sturgeon, and bass fishing areas are at risk in northeast San Pablo Bay, Carquinez Strait, and at the mouth of and in the Napa River and associated sloughs. These species are particularly sensitive to oil because, combined with population declines, large percentages of their populations could be contacted by oil. Bass and sturgeon resources are at low risk of contact, while salmon resources are at moderate risk.

Suisun Bay fishing areas at the mouth of the Bay are also at a high to moderate risk. Species caught in Suisun Bay vary with movement of the null zone. Generally, salmon, sturgeon, steelhead, shrimp, and bass are consistently caught. Droughts bring seawater intrusion, and thus, halibut, perch, crab, and other marine species are sometimes caught in the Bay, as well. Section 4.4.2.2 concludes that fish in San Pablo and Suisun Bays would be most susceptible to spills because the fish assemblages are distinct and isolated from the ocean.

A 10,000-bbl spill from the Unocal Terminal has a high (nearly 58 percent) chance of contacting Mare Island Strait. Table 4.2-2 indicates that the other receptor sites have probabilities ranging from 0- to 1-percent chance of being contacted by a spill originating from the Unocal Terminal.

When considering the probability of contact from all identified terminals in the Bay, the most vulnerable sites with a high to moderate risk of contact are

- Emeryville (smelt, perch, salmon, halibut fishing, and herring spawning) (31 percent chance of contact),
- Castro Rocks (bass, sturgeon, perch, salmon fishing, and herring spawning) (18 percent),
- Alameda Naval Air Station (bass, smelt, perch, halibut fishing, herring gillnetting, and herring spawning) (18 percent), and
- Mare Island Strait (bass, sturgeon, and salmon fishing) (13 percent).

In addition, Honker Bay (crayfish, Suisun Bay fisheries) and San Pablo Creek (bass, sturgeon, perch, salmon fishing and herring spawning) are particularly vulnerable to a 10,000-bbl spill from Bay terminals: 11 and 17 percent, respectively. However, these fisheries are at a low overall risk from spills originating from the Unocal Terminal.

Spills from Unocal Tankers

Spills from transitting Unocal tankers are expected to contact more fisheries than spills originating from the Terminal. High to moderate risks are more broadly distributed, extending roughly from Treasure Island, in central San Francisco Bay, to northeast San Pablo Bay, to the Unocal Terminal, and into the western portion of the Carquinez Strait.

Bay shrimp and herring commercial fisheries are at a high to moderate risk of contact. Shrimp fishing in the Carquinez Strait and San Pablo Bay are particularly vulnerable. Herring fishing areas around Angel and Treasure Islands and along the Alameda and Tiburon Peninsula shores are in risky locations. Herring spawning habitat along the southeast San Pablo Bay, Richmond, Tiburon, and Angel Island shores is at risk of spills from Unocal tankers.

Most recreational fishing areas are at a moderate to high risk of contact. Salmon fishing in eastern San Pablo and central San Francisco Bays, and in the Napa River is at risk. Sturgeon fishing areas in the western Carquinez Strait, east San Pablo Bay, and in the Napa River are also at risk. Concern is also raised for western Suisun Bay fisheries. Halibut and rockfish fishing is vulnerable in central Bay, as well; bass fishing is at risk in San Pablo and north San Francisco Bays. Smelt fishing along the Tiburon shore and on Angel Island and Berkeley Pier is at risk of contact. Risky locations for perch are the east San Pablo Bay, central Bay, Angel Island, Berkeley Pier, and Tiburon shorelines. Clambeds beneath the Richmond/San Rafael Bridge have a moderate to high chance of contact, as well.

A 10,000-bbl spill from two tanker segments just east and west of the Unocal Terminal has a 63-percent chance of contacting Mare Island Strait. The probability of spills from those segments contacting other receptor sites ranges from 0 to 2 percent.

When considering the probability of contact from all identified tanker route segments in the Bay, the most vulnerable sites with a high to moderate risk of contact are

- Mare Island Strait (18 percent),
- San Pablo Creek (7 percent),
- Yerba Buena Island (bass, perch, halibut, salmon fishing, herring purse seining) (7 percent),
- Emeryville (5 percent), and
- Alameda Naval Air Station (5 percent).

In general, Honker Bay has a high chance of contact (15 percent) from a 10,000-bbl spill from the tanker routes, but has a low overall risk from Unocal tanker spills.

Conclusion

Fishing areas in the local study area that are especially vulnerable to oil spills, according to the risk models include

- commercial shrimp (Carquinez Strait and eastern San Pablo Bay) and herring (central San Francisco Bay),
- recreational salmon, sturgeon, and bass (San Pablo Bay, San Francisco Bay, Carquinez Strait, and Napa River), western Suisun Bay fisheries, halibut and rockfish (central Bay), smelt (Tiburon, Angel Island, and Berkeley Pier), perch (San Pablo Bay, central Bay, Angel Island, Berkeley Pier, Tiburon), and clambeds (Richmond), and
- herring spawning (southern San Pablo Bay, central Bay, Oakland/Alameda).

In particular, Mare Island Strait and the Napa River are vulnerable and harbor salmon, sturgeon, and bass fishing and resources are vulnerable. Honker Bay and the Sacramento River mouth have a high vulnerability to 10,000-bbl spills, although risks from spills, in general, are low.

Mitigation in Section 4.5.5 recommends that appropriate oil spill response resources be located so that shoreline along western Suisun Bay, Honker Bay, at the Sacramento River mouth, Mare Island Strait, Carquinez Strait, eastern San Pablo Bay, central San Francisco Bay including Richmond, El Cerrito, Emeryville, Oakland, Alameda, Tiburon, Yerba Buena Island, and Angel Island can be protected in a timely manner.

Oil Spill Scenario Impacts

Methodology

The third step of the analysis illustrates the possible effects of 12 different modeled oil spills based on actual hydrologic, wind, wave, and current conditions for a set period of time. The purpose of the scenarios is to present examples of possible impacts from hypothetical oil spills.

Maps of each oil spill scenario and fishery are overlaid to determine the amount and percentage of fishing area affected by each spill. In addition, each oil spill scenario is compared to CDFG and NMFS blocks (Figures 3.4-1 and 3.4-2) and fishing seasons. The following fishing seasons are considered:

- commercial herring: December through March,
- recreational sturgeon: November to May, and
- recreational salmon: March through October.

For the three fisheries, it is assumed that all fishing for each species occurs during the corresponding season. Other Bay fisheries are treated as year-round activities. Rough estimates of the amount of commercial landings that could be lost are calculated. For these calculations, catches are assumed to be evenly distributed throughout the mapped fishing areas.

The percentage of affected fishing areas is compared to the 10-percent impact threshold explained in Section 4.5.2. Impacts on piers and marinas are profiled in Section 4.11 (Land Use/Recreation). Preclusion (i.e., short-term) impacts are expected to last no more than one fishing season. Resource (biological) impacts, as presented in Section 4.4, may last for more than one season, but because of many uncertainties, impacts on fishing activities are difficult to quantify. Economic impacts caused by impacts on Bay fisheries resources may also be long term, depending on public reaction, public education on the spill's effects, seafood markets, and other factors.

Impact Descriptions

Based on the oil impact scenarios and the methodologies previously presented, the following minimum impacts, from short-term preclusion are expected; Table 4.5-2 summarizes these impacts. Refer to Tables E.2-1 and E.2-2 in Appendix E.2 for acreage impacted, the percentage of areas impacted, and impact classifications.

Mitigation for the described impacts appears in Section 4.5.5.1. The measures focus on timely oil spill response and cleanup, compensation for financial and environmental damages, and evaluation of the effectiveness of the response measures.

Scenario 1 - Scenario 1 (1,000-bbl crude oil spill during March) originates at the Unocal Terminal. The spill spreads throughout most of the eastern portion of San Pablo Bay. Although not modeled, oil could also go up into Sonoma Creek and nearby sloughs northeast of the Bay, depending on water and weather conditions.

The only commercial fishery that could experience preclusion impacts in the affected CDFG block (301) and San Francisco Bay as a whole would be bay shrimp (Class III). Bay shrimp is a year-round fishery. Thus, examples of the amount of landings lost due to a projected closure of the impacted area to fishing could be minimal, accounting for less than 1 percent of the 7-year averaged annual landings, and range from 73 (1-month closure) to 219 pounds (3-month closure).

Recreational fisheries likely to experience preclusion impacts include salmon, bass and sturgeon (Class I in NMFS Block D and in the Bay), and perch (Class III in NMFS Block D). If the oil would spread salmon, perch, bass, and sturgeon fishing in Sonoma Creek would also be impacted.

Scenario 2 - Scenario 2 (1,000-bbl crude oil spill during July) also originates at the Terminal, but progresses east into the Carquinez Strait and the extreme western portion of Suisun Bay. Oil may also enter Pacheco Creek and nearby sloughs, including those near Martinez.

Commercial bay shrimp trawling could experience significant (Class I) impacts (in CDFG Block 308 and the Bay). Examples of the amount of landings lost due to closure of the impacted area to fishing range from 1,250 (1-month closure, 1 percent of the annual catch) to 3,750 pounds (3-month closure, 4 percent of the annual catch). Losses in shrimp landings could affect the availability of bait for the bass and sturgeon fisheries.

The following recreational fisheries could experience impacts: salmon and bass (Class I- NMFS Block E, Class III-NMFS Block D and in the Bay), perch (Class III in NMFS Block D), and Suisun Bay fisheries (Class III in NMFS Block E). If oil would spread, Suisun Bay fisheries (mainly salmon, halibut, steelhead, bass, and flounders) in Pacheco Creek and related sloughs could be impacted.

Scenario 3 - Scenario 3 (20,000-bbl crude oil spill, January) originates near the Terminal and spreads throughout central San Francisco Bay to areas south of Alameda, San Pablo Bay, excluding most of the

Table 4.5-2

OIL SPILL SCENARIO IMPACTS ON SAN FRANCISCO FISHERIES[1]

Impact Descriptions	Oil Spill Scenario																							
	1[2]		2		3		4		5		6		7		8		9		10		11		12	
	IC[3]	%[4]	IC	%	IC	%	IC	%	IC	%	IC	%	IC	%	IC	%	IC	%	IC	%	IC	%	IC	%
COMMERCIAL																								
Bay Shrimp	III	<1	I	1-14	I	6-18	I	4-13							III	<1	I	4-13			I	2-5		
Brine Shrimp																					I	8-23		
Crayfish									III															
Herring					I	6-24											I	12-46	N/A					
Impact Descriptions	IC		IC		IC		IC		IC		IC		IC		IC		IC		IC		IC		IC	
RECREATIONAL																								
Salmon	I		III		N/A		I						N/A		III		I		I					
Sturgeon	I		N/A		I		N/A						III		N/A		I		N/A					
Shark/Ray																			I		I		I	
Halibut					I												I		I					
Rockfish					I												I		I					
Steelhead																							I	
Smelt					I												I		I		III		III	
Bass	I		III		I		I						III		III		I		I		III		III	
Perch	III		III		I		III						III		III		I		I		III		III	
Suisun Bay			I		I		I		I		III				III		III							
Clambeds					I												I		I		I			

1 Addresses short term preclusion impacts for modeled oil spills only. Impacts would likely be greater and long term due to migration of the spilled oil, injury to fish and habitat, additional closures of fishing areas, effects on fish markets, and other variables discussed in Section 4.4.2.2.
2 Numbers in this row refer to the oil spill scenarios.
3 Impact Classification: (I = Class I) (III = Class III)
4 Percent of 7-year (1985-1991) averaged annual landings potentially lost due to short-term impacts from the oil spill.

northern and eastern areas, into Carquinez Strait, and into the eastern portion of Suisun Bay. Oil could also spread into sloughs and channels flowing into the southern portions of San Pablo Bay and the southeastern shores of Suisun Bay. This scenario and Scenarios 9 and 10 could cause the most widespread and severe impacts on fisheries.

Impacted (Class I) commercial fisheries could include

- bay shrimp (CDFG Blocks 301 and 308 and the Bay); examples of lost landings due to closures could range from 5,206 (1-month closure, 6 percent of total annual catch) to 47,550 pounds (3-month closure, 18 percent of the annual catch), and
- herring (CDFG Blocks 488 and 489 and the Bay); the herring fishery lasts approximately 4 months; thus, examples of lost landings range from 1,003,218 (1-month closure, 6 percent of total annual catch) to 4,012,872 pounds (4-month or seasonal closure, 24 percent of the annual catch). These losses would affect some or all of the 416 herring permit holders. Herring fishery impacts could increase or decrease as spawning migrates around the Bay.

The following recreational fisheries would suffer impacts: sturgeon (Class I in NMFS Blocks C, D, E and the Bay), halibut and rockfish (Class I in NMFS Blocks B and C and the Bay), smelt (Class I NMFS Block C and the Bay, and Class III NMFS Block B), bass (Class I NMFS Blocks C, D, E and the Bay; Class III NMFS Block B), perch (Class I Blocks C, D and the Bay, and Class III NMFS Block B), Suisun Bay fisheries (Class I- NMFS Block E and the Bay), and clambeds (Class I- NMFS Block C and the Bay). Spreading of the oil could impact Suisun Bay and perch, sturgeon, and bass fisheries in southern San Pablo Bay. These impacts are depicted on Figure 4.5-2.

Scenario 4 - Scenario 4 (20,000-bbl crude oil spill, June) originates near the Terminal and spreads throughout central San Pablo Bay, through the Carquinez Strait, and into Suisun Bay to Chipps Island. Oil could also enter sloughs and channels that flow into the northeastern shore of San Pablo Bay, the Carquinez Strait, and the southeastern shore of Suisun Bay.

The only commercial fishery with modeled impacts would be bay shrimp (Class I CDFG Blocks 301 and 308 and in the Bay). Examples of lost landings range from 3,972 (1-month closure, 4 percent of total annual catch) to 11,916 pounds (3-month closure, 13 percent of total catch).

The following recreational fisheries could also experience impacts: salmon and bass (Class I NMFS Blocks D and E and the Bay), perch (Class I NMFS Block D; Class III in the Bay), and Suisun Bay fisheries (Class I NMFS Block E and the Bay). Spreading of oil could impact salmon and bass fisheries in the Napa River and sloughs and Suisun Bay fisheries.

Scenario 5 - Scenario 5 (1,000-bbl crude oil spill, February) originates at the east end of the Carquinez Strait and spreads to the northeast into Suisun Bay. Sloughs, marshes, and drainages west of Montezuma Slough, on Simmons Island, and the southeastern shore of Suisun Bay may also be oiled. This scenario, and Scenarios 6 and 7, cause the least impacts of the 12 scenarios.

The crayfish commercial fishery should expect Class III impacts, as would Suisun Bay recreational fisheries (Class I Block E and the Bay). Suisun Bay fisheries could be impacted even more if the oil spread as described above.

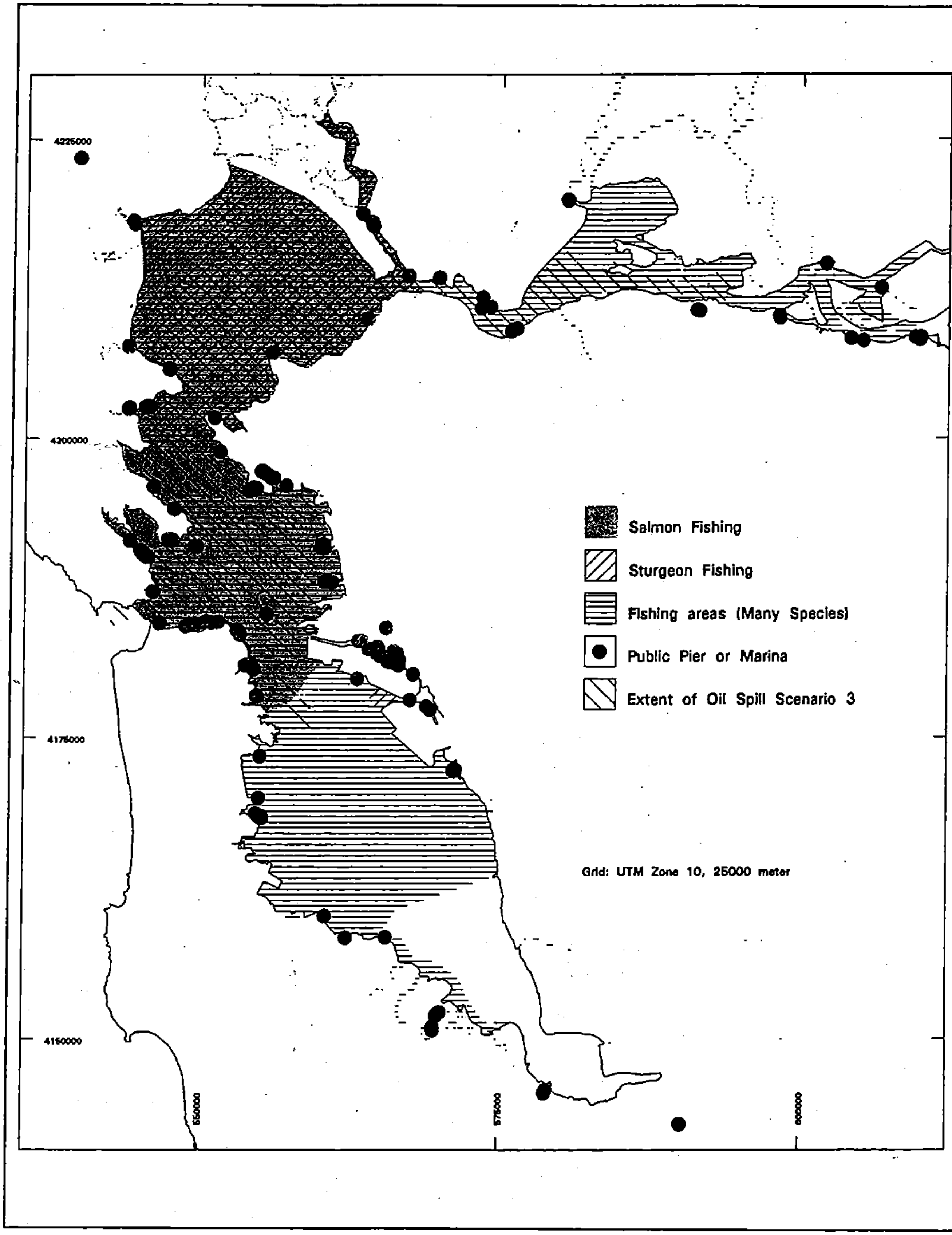
Scenario 6 - Scenario 6 (1,000-bbl crude oil spill, July) also originates at the east end of Carquinez Strait, but the oil concentrates along the southeastern shore of Suisun Bay. Thus, sloughs and marshes in this area could likely be oiled also.

No commercial fisheries would likely experience measurable impacts. The Suisun Bay recreational fisheries could experience impacts (Class III Block E and the Bay). Impacts in Suisun Bay could increase if oil spread.

Scenario 7 - Scenario 7 (500-bbl product spill, February) originates at the Terminal and concentrates around the Unocal Terminal.

Commercial fisheries should expect no measurable impacts from this scenario.

Recreational fisheries (sturgeon, bass, and perch) could likely experience Class III impacts in NMFS Block D and the Bay.



SAN FRANCISCO BAY AREA RECREATIONAL FISHING AREAS IMPACTED BY OIL SPILL SCENARIO 3

Figure 4.5-2

Scenario 8 - Scenario 8 (500-bbl product spill, August) also originates at the Terminal and is limited to Carquinez Strait and Southampton Bay. Marshes and sloughs that drain into Southampton could also be impacted, depending on water and weather conditions.

The only commercial fishery with expected impacts is bay shrimp (Class I CDFG Block 308 and Class III for the Bay region). Examples of lost landings would likely be less than 1 percent and could range from 221 (1-month closure) to 663 pounds (3-month closure).

The following recreational fisheries could experience impacts: salmon and bass (Class I Block E; Class III Block D and the Bay), perch (Class III Block D), and Suisun Bay (Class III Block E and the Bay). Southampton Bay fisheries (similar to those in Suisun Bay) could be impacted if oil spread as described above.

Scenario 9 - Scenario 9 (100,000-bbl crude oil spill, March) originates near Alcatraz Island and spreads into central San Francisco Bay, into most of San Pablo Bay, and into eastern reach of the Carquinez Strait. Sloughs and channels draining into the northwestern shore of San Pablo Bay could be oiled as well.

As shown on Figure 4.5-3, impacted commercial fisheries could include

- bay shrimp (Class I CDFG Block 301 and in the Bay; Class III CDFG Block 308); examples of lost landings range from 3,778 (1-month closure, 4 percent of total annual catch) to 11,334 pounds (3-month closure, 13 percent of total annual catch), and

- herring (Class I CDFG Blocks 488 and 489 and in the Bay); examples of lost landings range from 1,922,835 (1-month closure, 12 percent of total annual catch) to 7,691,340 pounds (4-month or seasonal closure, 46 percent of total catch). Herring fishery impacts could increase or decrease as spawning migrates around the Bay.

The following recreational fisheries could experience Class I impacts: salmon and bass (NMFS Blocks B, C, D, E, and in the Bay); sturgeon (NMFS Blocks C, D, E and the Bay); halibut, rockfish, and smelt (NMFS Blocks B, C and the Bay); perch (NMFS Blocks B, C, D, and the Bay); and clambeds (NMFS Block C and the Bay). Suisun Bay fisheries could experience Class III impacts (NMFS Block E and the Bay). If oil would spread to the Napa River and nearby sloughs, salmon, sturgeon, and bass fisheries could face increased impacts.

Scenario 10 - Scenario 10 (100,000-bbl, crude oil spill, September) originates near Alcatraz Island and spreads into central San Francisco Bay and the northwestern portion of South San Francisco Bay.

Historic herring fishing spawning areas could be smeared with oil, but the modeled spill did not occur during the season. If oil contamination lingers into the season, fishing activities could be restricted or prohibited, and landings could be lost.

The following recreational boat fisheries could experience impacts: salmon (Class I NMFS Blocks B and D and in the Bay; Class III NMFS Block D); shark and ray (Class I NMFS Block B and the Bay); halibut, rockfish, and smelt (Class I NMFS Blocks B and C and the Bay); perch and bass (Class III NMFS Block D; Class I NMFS Blocks B and C and the Bay); and clambeds (Class I NMFS Block C and the Bay). The sturgeon fishery could also be impacted if oil lingers into the fishing season.

Scenario 11 - Scenario 11 (1,000-bbl crude oil spill, November) originates at Anchorage 9 and remains in the central portion of south San Francisco Bay. Sloughs and channels around San Mateo and Redwood City could also get oiled.

Commercial fisheries likely to be impacted (Class I) include

- bay shrimp (in CDFG Block 489 and the Bay); examples of lost landings range from 1,398 (1-month closure, 2 percent of total annual landings) to 4,194 pounds (3-month closure, 5 percent of landings)

- brine shrimp (in CDFG Block 489 and the Bay); examples of lost landings range from 42,373 (1-month closure, 8 percent total annual landings) to 127,119 pounds (3-month closure, 23 percent of landings)

The following recreational fisheries could be impacted: shark and ray (Class I NMFS Block B and the Bay), bass (Class I NMFS Block A; Class III NMFS Block B and the Bay), smelt and perch (Class III NMFS Block B and the Bay), and clambeds (Class I NMFS Blocks A, B and the Bay). Bass fishery impacts could increase if oil would spread as described above.

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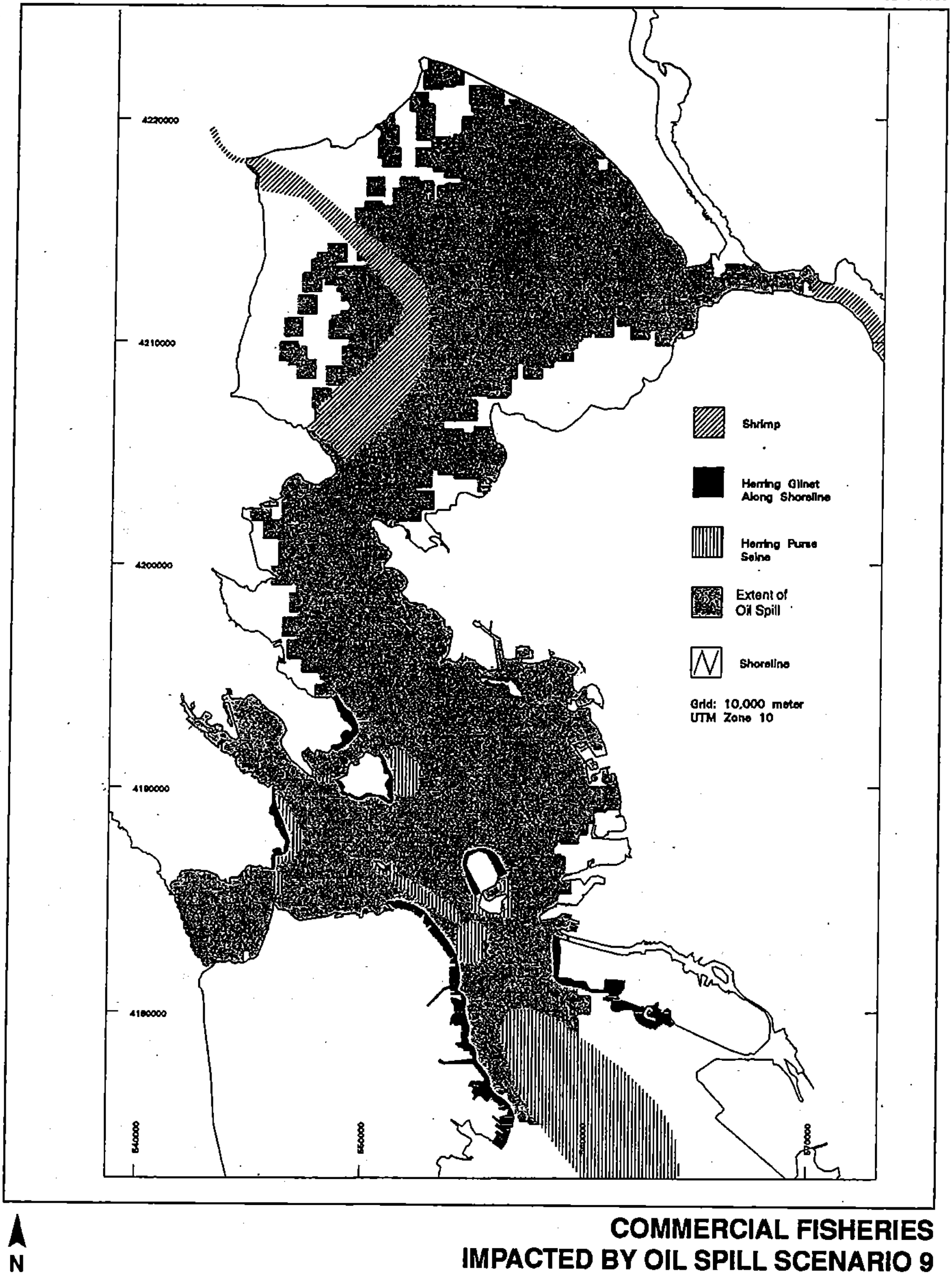


COMMERCIAL FISHERIES IMPACTED BY OIL SPILL SCENARIO 9

Figure 4.5-3

Scenario 12 - Scenario 12 (1,000-bbl, crude oil spill, August) also originates at Anchorage 9, but spreads into the southern portions of south San Francisco Bay to Dunbarton Point.

The following recreational fisheries could be impacted: shark and ray (Class I NMFS Block B and the Bay), steelhead (Class I NMFS Block A and the Bay), bass (Class I NMFS Block A and the Bay; Class I NMFS Block B), smelt (Class III NMFS Block B), and perch (Class III NMFS Blocks A and B).

<u>Accident Conditions Along Outer Coast</u>

Analyzing oil spill impacts on outer coast fisheries involves two major steps:

- determining the risk to fisheries from oil spills originating from Unocal tankers, and
- illustrating which fisheries would be covered with oil should certain types of spills occur.

Fisheries at Greatest Risk

For purposes of this analysis, fisheries at a moderate to high risk of being oiled are those having a 5-percent or greater chance of light oiling from persistent oils.

The methodology used here is generally the same as described for the San Francisco Bay analysis, except that the probability level is lowered to 5 percent in order to account for differences between the coastal and Bay oil spill models.

Fisheries along the extreme southern Del Norte county shore to Davenport (southern study area boundary) are at a high to moderate risk of being contacted by an oil spill from a Unocal tanker. From southern Del Norte county to Shelter Cove, offshore fisheries with a high to moderate risk of contact include Dover and petrale sole, sablefish, rockfish, pink shrimp, and salmon. In nearshore waters around the Eel River, Dungeness crab areas are also at risk. Salmon are at particular risk if oil enters anadromous fish streams or estuaries.

Fisheries from Shelter Cover to Point Arena have a low risk of contact. From Point Arena to Point Reyes, nearshore and offshore fisheries (including those mentioned above, except for pink shrimp) are at a high to moderate risk of oiling. Sea urchin areas off Point Arena and the Farallone Islands are also at risk.

From Point Reyes to San Francisco, rockfish, petrale sole, gillnet (halibut, rockfish), and salmon fishing is at risk of oil contact. From San Francisco to Davenport, virtually all offshore fisheries are at a high to moderate risk of impact, including halibut, petrale, Dover and English sole, rockfish, lingcod, sablefish, and salmon. In nearshore waters, Dungeness crab and sea urchin grounds are also at risk.

Oil Spill Scenarios

Commercial and recreational fishing areas, kelp beds, and aquaculture sites are compared to the mapped spill scenarios. If oil reaches the mouths of bays and harbors, it is assumed that related aquaculture sites would be effected, related marinas would be closed, and any fishing activities from those ports and marinas would cease. For kelp beds and shoreside access areas, harvesting activities would cease, as well. These are all considered to be significant (Class I and II) impacts. It is also assumed that impacts would last for the duration of the spill and beyond. Table E.2-3 in Appendix E.2 provides data on kelp bed and shoreside fishing access point impacts.

<u>Scenario 1</u> - Scenario 1 (100,000-bbl crude oil spill, March) was launched off the Farallone Islands. The oil spread from a point just north of Point Reyes, south to Davenport, and into the Monterey area.

Commercial Fishing - The following fishing seasons are considered when assessing preclusion impacts:

- Salmon - Generally May 1 to September 30, in open areas, as determined by the Pacific Fisheries Management Council;
- Crab - December 1 to July 15, south of Mendocino the season begins November 15; and
- Sea urchin - August 1 to June 30, May 1 to September 30 (excluding July), fishing is allowed 4 days/week.

Most fisheries within the spill area could suffer significant preclusion impacts. Fishing grounds from Point Reyes to Monterey, including those off the Farallone Islands, and the San Mateo, Santa Cruz, and Monterey County coasts could be covered with oil.

Sea urchin and salmon fisheries would likely escape impacts, as long as the spill dissipated before the seasons opened. During March, coastal streams would normally have enough outflow to prevent oil from going upstream and contaminating anadromous fish spawning areas and migration routes.

Piller Point, Santa Cruz, Moss Landing, and Monterey harbors could be closed (Class I impacts). These four harbors equal 27 percent of the 15 harbors on the outer coast within the study region. Harbor closures would eliminate access for vessels wanting to land fish or to those wanting to fish in non-oiled areas. The curtailed activities in the closed harbors would likely reduce fishing-related business activity.

Aquaculture - Aquaculture sites in Monterey Bay and off Santa Cruz could be covered. Depending on the extent of tidal influence, operations in Elkhorn Slough could be impacted, as well. The four operations total about 17 percent of the 24 operations within the regional study area. Long-term impacts may occur as well, depending on the vulnerability of the cultured species to the spilled oil. Expected impacts would be significant (Class I).

Kelp Harvesting - Kelp beds from Point Montara south to Monterey Bay could be impacted. Oil could contact nearly 56 percent of kelp bed acreage in the regional study area, a significant (Class II) impact. Long-term impacts on kelp harvesting are not expected as kelp is resistant to oil.

Recreational Fishing - Recreational fishing grounds in areas described in the commercial fishing section directly preceding could be covered with oil. Nearshore areas between Point Reyes and San Pedro Point would be spared, unless currents or winds shifted. Salmon fishing could be curtailed during the early part of the season but should not experience significant impacts unless the spill lingered into the season. In addition, recreational fishing and charter boat access to and from the harbors closed by the spill could be curtailed, reducing fishing-related business activity.

Numerous shoreside fishing areas would be impacted. Thirty fishing access points and seven piers would be closed. These numbers compare to 148 access areas, including parks, and 16 piers in the coastal study region. Impacts would be significant (Class I).

Scenario 2 - Scenario 2 (100,000-bbl crude oil spill, October) was launched from a point about 16.5 nm southwest of Punta Gorda and remained over the shelf break to about the latitude of Cape Viscaino. It then traveled to shore and beached along a 27.5-nm stretch from Bruhel Point to Navarro Head.

Commercial Fishing - Most offshore fishing areas from Punta Gorda to the Albion River could be covered with oil. However, nearshore shrimp fisheries north of Bruhel Point could be spared. South of the point to Navarro Head, sablefish grounds near the shore could be covered with oil. Salmon and sea urchin fisheries could escape preclusion impacts because the spill would occur after the seasons close. Crab fisheries could also be spared as long as the spill dissipated before opening of the season in December.

Long-term habitat effects could adversely affect the fisheries. If anadromous stream outflows are low, oil could travel up the waterways and contaminate spawning gravels and nursery areas. Nearshore crab spawning and nursery areas, as well as intertidal habitats for rockfish and other species, may also be contaminated from sinking oil.

Noyo Harbor would likely be closed, prohibiting access in or out by fishing vessels. Harbor closure would likely reduce fishing-related business activity. Although only one of the 12 regional study area harbors/marinas would be impacted (a regionally nonsignificant [Class III] impact), the local impact would likely be extremely significant (Class I) given that Noyo is the only year-round harbor between Bodega and Humboldt Bays. Stranded vessels would have to wait offshore for the harbor to open or possibly travel over 100 miles to reach port. Conversely, vessels in the harbor would be unable to fish in noncontaminated areas, further aggravating preclusion impacts.

Aquaculture - It is unlikely that oil would come in contact with any known aquaculture sites.

Kelp Harvesting - Kelp beds from Bruhel Point to Navarro Head could be contacted by the spilled oil; about 30 percent of the acreage in the regional study area could be affected. This is considered to be short-term, significant (Class II) impact on kelp harvesters because oil spill impacts on kelp generally only last one season. The kelp is hardy and regenerates easily. Mitigation to a level of nonsignificance includes contributions to offset financial losses.

Recreational Fishing - Because of adverse weather and ocean conditions, recreational boat fishing operations stay close to shore and near harbors. Therefore, the spill could cover much of the area, from Cape Vizcaino to Albion, fished by Mendocino County recreational boat anglers.

Several shoreside fishing areas would be contacted with oil: nine public access points, including parks and two harbors. Access point closures would be regionally nonsignificant (Class III), but locally significant (Class I) because there are only 16 points in Mendocino County. Harbor impacts would be significant (Class I).

4.5.4 Cumulative Impacts

This cumulative impacts analysis considers effects from past, present, and identified future oil and non-oil related development on marine resource harvesting. The analysis takes into consideration cumulative terminal operations and tanker traffic for both the Bay and the coast. The analysis is based on the project summaries presented in Section 3.2.4.

As noted in Monroe et al. (1992), over the past 140 years more than 500,000 acres of wetlands in the San Francisco Bay estuary have been filled or converted to farmland. In the Bay proper, approximately 82 percent of the wetlands have been filled or altered; the areal extent of the Bay's open water has decreased by one-third.

In addition to fill, significant degradation has occurred from pollution, both point and nonpoint, dredging, increased tankering, and other activities. Future development would likely cause significant impacts, as well.

This rapid overdevelopment has resulted in a significant decline of biological resources. Increased freshwater diversion and an altered flow regime, increased pollutant loadings, and increased dredging and waterway modifications have also contributed substantially to the decline. The historical record shows that the current status of the Bay has been significantly degraded and is substantially less productive than it was earlier. It is prudent to conclude that cumulative impacts from activities, such as Unocal's and other industrial, urban, and agricultural concerns, are significant (Class I). The Bay's future is likely dependent on whether these impacts are effectively mitigated and reduced.

Future development of the Bay is expected to continue to degrade the condition of valuable habitat and to further reduce fish populations. In addition, other activities, including continued increases in the human population and expansion/development of undeveloped and agricultural lands, will result in additional impacts that will further reduce or degrade habitat and directly affect many species of fish. Although some species will likely flourish, others may not unless

- wetlands and portions of the estuary are restored,
- Bay filling is restricted and any necessary fill is adequately mitigated by successful habitat reclamation and restoration,
- further limits are placed on water pollution and point and nonpoint water pollution sources,
- dredging and materials disposal are conducted in an environmentally sound manner and dredge materials are reused as much as possible, and
- fishing activities are permitted for fish populations that can withstand harvesting pressure, and those which cannot are restored.

Precautions must be taken or the Bay and estuary carrying capacity will continue to deteriorate.

Future resource management may be affected by efforts such as the Long Term Management Strategy (LTMS) for dredging and dredge material disposal, and the San Francisco Estuary Project. The LTMS is a set of criteria, policies, and protocols that help ensure environmentally sound dredging and dredge spoils disposal or reuse.

The Estuary Project is developing an action plan for improving management and resources of the Bay. The draft San Francisco Estuary Project Comprehensive Conservation and Management Plan for the Bay and Delta (San Francisco Estuary Project 1992) (CCMP) calls for developing new funding mechanisms for protecting estuary resources, identifying wetlands and other areas for restoration, and creating other initiatives to improve the estuary and rejuvenate fisheries and other biota. These actions would be performed by public agencies, developers, landowners, nonprofit organizations, and others. Proposed funding sources include developer fees, as well as public and private programs.

Unocal's historical contribution to Bay-wide problems is small, but adverse. Its portion of Bay fill constitutes about 7.5 acres. Interference with herring and other fishing activities is created by marine vessels using the Ports of San Francisco, Oakland, Richmond, and other harbors as well as those using the Unocal Terminal. Unocal's expected 225 vessel trips equal about 8 percent of the total tanker movements in San Francisco Bay (2,760), see Table 2.4-1. Additionally, the Bay is continually dredged to allow passage of tankers and barges, Unocal's included, and the Refinery discharges contaminants into the Bay.

Oil Spill Risks

Refer to Table 4.5-3 for a summary of risks to fisheries.

Spills from Terminals - Generally, areas at highest risk from terminal spills in the Bay (all terminals, including Unocal's) are adjacent to the Unocal Terminal, in the Carquinez Strait and southern Suisun Bay, and nearshore areas from Point San Pablo to Richmond. In addition, portions of the central Bay are at risk.

Bay shrimp areas in Carquinez Strait and herring grounds off Tiburon and Angel Island are commercial fishing areas with a high to moderate risk of contact from terminal spills. Herring spawning areas from Point San Pablo to Richmond are also at risk.

Recreational fisheries at high to moderate risk include salmon (along the east shore of northern central Bay), sturgeon (near the Terminal), halibut (off Alameda), rockfish (in the middle of central Bay), bass (off San Pablo Creek and the mouth of the Carquinez Strait), and Suisun Bay fisheries, excluding those in the extreme northern portions of the Bay.

Spills from Tankers - The risk of spills from all tankers in the Bay is much greater and more widespread than spills from Bay terminals. Generally, highest risks occur from the Carquinez Strait through eastern San Pablo Bay, into San Francisco Bay south to Alameda, and west to the Golden Gate. Fisheries in the central portion of the Bay (off San Francisco, Oakland and Tiburon) are at an extremely high risk of contact (30 to 39 percent).

The two main commercial fisheries at a high to moderate risk are bay shrimp in the Carquinez Strait and herring off Tiburon, Angel, and Treasure Islands; off Oakland; and south of Yerba Buena Island. Risky

Table 4.5-3

OIL SPILL RISKS FROM SAN FRANCISCO BAY TERMINALS AND TANKERS

Fisheries	Source of Spills						
	Total Species Area	Cumulative Terminal			Cumulative Tankering		
		Area at Risk	Percent Area at Risk	Moderate to High Risk	Area at Risk	Percent Area at Risk	Moderate to High Risk
Commercial							
Bay Shrimp (acres)	26,042	2,659	10	yes	5,832	22	yes
Herring (acres)	13,338	3,281	25	yes	12,258	92	yes
Recreational							
Salmon (acres)	132,791	33,053	25	yes	94,872	71	yes
Sturgeon (acres)	82,271	18,344	22	yes	49,395	60	yes
Shark/Ray (acres)	17,549	0	0	no	2,740	16	yes
Halibut (acres)	60,743	7,139	12	yes	43,361	71	yes
Rockfish (acres)	26,132	5,538	21	yes	23,212	89	yes
Smelt (mi)	253	16	6	no	96	38	yes
Bass (acres)	170,995	18,408	11	yes	72,706	43	yes
Perch (mi)	356	24	7	no	120	34	yes
Clambeds (mi)	21	2	9	no	3	12	yes
Suisun Bay (acres)	13,997	12,719	91	yes	4,871	35	yes
Herring Spawning (mi)	253	27	11	yes	105	42	yes

areas for herring spawning are off Angel Island and Tiburon and along the eastern central Bay shore.

All recreational fisheries, excluding steelhead in southern San Francisco Bay, are at risk. Salmon is at risk in eastern San Pablo Bay and in central Bay out to the Golden Gate. Sturgeon are at high to moderate risk in northeastern San Pablo Bay. Shark and ray fisheries have a high to moderate risk off Oakland Airport. Halibut are at risk in eastern central Bay south to Alameda. Rockfish have a high to moderate risk of contact in central Bay and west to the Golden Gate. Smelt are at risk around Angel Island, in eastern central Bay, and along the Tiburon shore. Bass are at highest risk of oiling in eastern San Pablo Bay south to Richmond, in eastern central Bay, and from Oakland to Alameda. Risky areas for perch are along the eastern shore from San Pablo Creek to Alameda, around Angel Island and along Tiburon. Clambeds along the El Cerrito shore are also at risk, as are Suisun Bay fisheries in the eastern Carquinez Strait and mouth of Suisun Bay.

Outer Coast Impacts

As discussed for the Bay, cumulative impacts along the coast may also be significant as a result of future development, ocean dumping, additional pollution from increased onshore and offshore development, dredging, and other activities. Impacts from normal tankering are not expected to contribute substantially to cumulative impacts along the coast; therefore, impacts from Unocal's tankers are expected to be nonsignificant (Class III).

Impacts related to coastal oil spills are expected to be compounded by accident-related impacts from other development and vessels. These impacts are expected to be significant (Class I). Impacts would be similar to those described in the previous spill scenario section associated with the Proposed Project (Section 4.5.3).

Risks from all tankers traversing the coast would generally be greater than risks from just Unocal tankers, mainly along the stretch of coast from Shelter Cove to Point Arena. Risks from Unocal tankers are low along this stretch; conversely, risks from all tankers are high to moderate. Major offshore fisheries in this area are sablefish, salmon, petrale, and Dover sole. Nearshore fisheries with a high to moderate risk are Dungeness crab and urchin off Albion and Point Arena. Risks along other portions of the coast are similar to those described for Unocal tanker spills along the coast.

4.5.5 Significant Impacts, Mitigation Measures, and Residual Impacts

4.5.5.1 Unocal Responsibilities

Impact - Conflicts between Unocal vessels and herring fishing activities would cause significant (Class II) impacts.

Mitigation and Residual Impact - To reduce operational conflicts between Unocal vessels and herring fishing activities, Unocal would conform its vessel activities to agreements developed between CDFG, herring harvesters, and other interested parties. Annually, as part of the CEQA review of herring regulations, CDFG develops mitigation to minimize conflicts between transitting vessels and herring activities. Depending on the effectiveness of the CDFG measure residual impacts would range from none to Class I.

Impact - Significant (Class I) impacts to fisheries would result from contact with oil from a spill. Shoreline fishing areas at highest risk of oil spill contamination are

- western Suisun Bay*
- Honker Bay*
- Sacramento River Mouth
- Mare Island Strait (Napa River)*
- Carquinez Strait
- eastern San Pablo Bay
- Central San Francisco Bay from Richmond to Alameda*
- Tiburon
- Yerba Buena Island*
- Angel Island

The areas with an asterisk (*) are listed as priority response areas by the USCG (San Francisco Bay/Delta

Area Contingency Plan 1993). Detailed response strategies, including equipment, personnel, and protection strategies are provided in Annex E – Area Assessments of the Plan. Unfortunately, the Plan inadequately discusses Bay fisheries; however, protection strategies (as presented below) should adequately protect fisheries at the asterisked sites and at other areas on the list.

<u>Mitigation and Residual Impact</u> - For those fishing areas listed above and other areas that would be contacted by oil spills, Unocal should apply the following mitigation measures to minimize the areas precluded to fishing during a spill and subsequent cleanup and help to offset the monetary loss to harvesters and businesses dependent on harvesting activities:

- immediate cleanup procedures as discussed in the Section 4.2 and protection of sensitive resources as discussed in Section 4.4, including (1) booming of sensitive sloughs, creeks, and streams; (2) ensuring response resources reach the spill sight in order to contain the spill and/or limit its spread; and (3) providing timely response in other areas to limit damage from spreading oil;

- financial compensation in accordance with Article 80.5, Chapter G of the California Oil Spill Prevention and Response Act;

- contribute to public or private organizations for habitat enhancement to reclaim or restore fisheries habitat;

- contribute to public or private organizations for education/promotion to lure the public to safe and clean fishing areas closed due to spills and reassure seafood consumers that fish from the spill area are safe to eat;

- contribute to public agencies to pay for seafood inspection programs to ensure that no tainted fish reach markets; and

- contribute to public or private organizations to evaluate the effectiveness of the measures listed above (results of the assessment would be available to public decision-makers to ensure refinement, if necessary, of mitigation measures).

The above contributions would be determined by level of impact and cooperation with the various organizations and agencies.

The oil spill mitigation measures would help directly address impacts to harvesters and related businesses. However, some harvesting interests may not be compensated, and opportunities and seafood would be lost while harvesting areas are inaccessible. Residual impacts are expected to remain significant for Scenarios 1 through 5 and 9 through 12. These impacts should be expected to last over the short and long term. Over the long term, impacts could result if, for example, public fears of eating contaminated seafood create a change in the seafood market. Market changes would reduce demand, thereby reducing fishing income. Fishermen would probably target other species, if natural and regulatory conditions allow; otherwise, they would likely suffer financial loss.

4.5.5.2 Cumulative Actions

<u>Impact</u> - Cumulative impacts from oil tankering, refineries, and other industrial and agricultural sources in the Bay Area have the potential to pollute the water and cause significant (Class I) impacts to fisheries.

Compliance with the listed mitigation measures (Section 4.5.5.1) and the following measures will help reduce some but not all cumulative impacts to levels of nonsignificance:

- abide by agency criteria, policies, and protocols for dredging and disposal of dredged materials developed pursuant to the LTMS or other management and planning strategies that help ensure environmentally sound dredging and dredge spoils disposal or reuse; and

- contribute to mitigation and restoration programs designed to restore and enhance Bay fisheries. The level of Unocal's contribution would be commensurate with its contribution to impacts, when compared to other impacts on the Bay. Implementation of this measure would take place once Unocal's contribution is determined by the Estuary Project or studies conducted pursuant to the CCMP. To facilitate implementation, periodic (every 3 to 5 years) (1) evaluation of Unocal's operations and compliance with the lease terms, and (2) assessment of mitigation measures should be conducted by SLC. Such evaluation would identify improvements to mitigation measures or revised lease terms and identify Unocal's level of responsibility for mitigating its share of contributions to cumulative impacts.

4.5.6 Alternatives Analysis

The following discussion addresses several different alternatives to the Proposed Project. Preclusion and biological impacts would be similar to those described for the Proposed Project, in some cases. For those alternatives calling for abandoning or removing the Terminal, or reducing or eliminating Refinery operations, fisheries would benefit by opening up previously precluded areas and reducing or eliminating dredging and wastewater discharges in the vicinity of the Unocal Terminal. Short-term adverse effects would result from abandonment and decommissioning activities. For the Consolidation Alternative, offshore pipeline/facility construction would cause short-term disruptions in fishing, although over the long-term fisheries would benefit. Table 4.5-4 summarizes and compares impacts from the Proposed Project and the alternatives.

4.5.6.1 No Project Alternative

Accident Conditions

Without the Marine Terminal, Unocal would have no contribution to oil spills in the Bay due to Terminal actions, thus a beneficial (Class IV) impact would result. However, the risk of spills occurring at other terminals may be greater because it could be assumed that Unocal tanker activity could relocate at those locations (refer to Section 4.2, System Safety). Otherwise, oil spill-related impacts and mitigation

Table 4.5-4

IMPACT COMPARISONS OF PROPOSED PROJECT AND ALTERNATIVES

Impacts	Proposed Project	Abandonment in Place	Abandonment and Removal of Pier	Retain Pier	Replacement of Crude	Reduced Refining Operation or Closure	Consolidation at Unocal Terminal
Preclusion from Transitting Vessels	III	III	III	III	III	III	III
Herring Preclusion from Vessels	II	II	II	II	II	II	II
Preclusion at Unocal Terminal	III	III		III	None or III	None or III	III
Dredging, Dredge Disposal	III						III
Shoreline Impacts	III	III	III	III	III	III	III
Decommissioning		III	III	III		III	III
Preclusion at Other Terminals			III	III	III	III	
Opening of Fishing Buffers			IV	IV	IV	IV	IV
Unocal Terminal Removal			III		None or III	None or III	
Additional Fishing Pier				IV	None or IV	None or IV	
Elimination of Dredging		IV	IV	IV	IV	IV	IV
Reduction/Elimination of Waste Water Discharge						IV	IV
Pipeline Installation							III
Oil Spills	I, III	I, III	I, III	I, III	I, III	I, III	I, III
CUMULATIVE IMPACTS							
Normal Operations	I	I	I	I	I	I	I
Oil Spills	I, III	I, III	I, III	I, III	I, III	I, III	I, III

would be similar to those described in Sections 4.5.3.2 and 4.5.3.3 above.

Pier Structure Scenarios

In addition to those assumptions listed in Section 4.5.3.1 (Routine Operations), it is assumed that tankers and barges would deliver and/or pick up their product at other facilities within San Francisco Bay, traversing through an available area of approximately 450 square miles (200 square miles are traversed by tankers using the Proposed Project).

Abandonment In-Place of Pier Terminal

In this alternative, the Terminal would be retained, but the number of tanker and barge visits would gradually decrease until operations are completely discontinued. Removal of pipelines and pumping facilities would require the temporary use of vessels and equipment operating within the Unocal Terminal 0.5-mile radius fishing buffer. Decommissioning activities would be short term; impacts would be temporary and nonsignificant (Class III).

Following decommissioning, the 0.5-mile fishing buffer would be available for commercial and recreational boat fishing; therefore, boat fishing would experience slight beneficial impacts (Class IV). Similar shoreline impacts as the Proposed Project would exist because (Class III) this alternative would not open additional shoreline fishing areas. Dredging would cease, resulting in beneficial (Class IV) impacts to habitat.

Assuming the transfer of Unocal vessel activities to other Bay facilities would increase the number of vessel calls at other docks and piers. Assuming that fishing boats keep the 0.25-mile buffer around transitting tankers and the 0.5-mile radius buffer around each docking facility, it is unlikely that the increased activity would require additional space. Therefore, the size of fishing buffers around existing facilities would remain unchanged. Depending on the alternative locations, relative to fishing activity, displacement impacts may be less or greater than impacts from the Proposed Project; however, impacts are not expected to exceed Class III.

Tanker and barge routine operations would require about the same amount of time as discussed for the Proposed Project. Also, this alternative should not alter the number of trips associated with current or future Unocal vessel operations; however, vessel trips would divert to other parts of the Bay. At any time, transitting tankers and barges would occupy 1.0 square mile of total area or about 0.22 percent of the water area available for all fishing within the Bay. Because the total area precluded to fishermen would be less than the 5-percent threshold identified in the significance criteria, vessel trip lengths and the number of trips would not differ from those discussed for the Proposed Project (Section 4.5.3.1); future impacts would be nonsignificant (Class III). Conflicts with the herring fleet would be expected to be significant (Class II), unless some terminals can be accessed without crossing any herring fishing areas. In that case, no impacts would be expected.

Abandonment and Removal of Pier

At any time, transitting tanker and barge impacts would be similar to those in the previously discussed Abandonment In-Place of the Marine Terminal Alternative. Impacts would range from Class II to III.

Removal of the Marine Terminal would temporarily preclude fishing within the fishing buffer footprint described in Section 4.5.3. Removal would require two barges (one with a crane) and take approximately 2 to 3 months. Biological impacts from disturbances caused by dismantling activities would be nonsignificant (see Section 4.4.3.1, Marine Biology). Combined short-term impacts from displacement and habitat disturbances are also expected to be adverse, but nonsignificant (Class III).

After removal of the Terminal, the entire buffer area would be available for both commercial and recreational boat fishing. It is assumed that Unocal would not grant additional easements to, or along, the shoreline for fishing or other public uses; over the long term, this Alternative would provide additional fishing area for both commercial and recreational boat fishermen, reduce bay dredging and fill, and result in slight beneficial impacts (Class IV). Nonsignificant (Class III) impacts on shoreline fishing would remain.

Retain Pier for Other Nonterminal Uses

Transitting tanker and barge impacts on fishing would be similar to those discussed for the Abandonment In-Place of the Marine Terminal Alternative. Impacts would range from significant (Class II) to nonsignificant (Class III).

Impacts from removing the pipelines and pumping facilities would be nonsignificant (Class III; see Abandonment In-Place of the Marine Terminal, above). Following decommissioning, the 0.5-mile fishing buffer would be available; therefore, boat fishing would experience nonsignificant beneficial impacts (Class IV). This alternative would also provide pier access for public use, including fishing. Consequently, the number of recreational fishing piers in the Bay would be increased by approximately 4 percent. The additional pier could provide a beneficial impact (Class IV) in the local study region and in San Pablo Bay.

<u>Refinery Scenarios</u>

In addition to assumptions listed in 4.5.3.1 (Routine Operations), it is assumed that the Unocal Terminal would be abandoned, and existing tanker and barge trips would be transferred to other Bay facilities.

Replacement of Crude from Other Sources

Impacts associated with this alternative would be similar to the impacts outlined in the Pier Structure Scenarios discussion above; impacts would range from beneficial (Class IV) to adverse but nonsignificant (Class III).

Reduced Refinery Operation or Refinery Closure

The Terminal would be dismantled and offshore pipelines and pumping facilities removed. Wastewater discharges from the Refinery would be reduced or eliminated, resulting in a beneficial (Class IV) impact to commercially and recreationally important fish and habitat.

Temporary fishing displacement impacts would be similar to the impacts outlined for the Abandonment and Removal of Pier alternative, discussed above. Impacts would range from beneficial (Class IV) to significant (Class II).

4.5.6.2 Consolidation Alternative

This section concentrates on impacts from normal decommissioning and operation activities. Impacts from oil spills and other accidents are presumed to be similar as those described for the Proposed Project, Class I and III. However, the risk of spills occurring would increase, based on discussion in Section 4.2.3 (System Safety).

This alternative could involve installation of submerged pipelines extending from the Pacific Refining Refinery to the Unocal Marine Terminal. Pipeline installation would be short term and require a corridor width of no more than 280 feet (assuming an average water depth of 20 feet and water depth to barge anchor line length ratio of 1:7). The size of the pipeline corridor is expected to be about 0.01 square mile, or less than 1 percent of the available commercial or recreational boat fishing areas in CDFG Block 308 (which totals 30 square miles). Fishing in the immediate vicinity appears to be light. Because no public pier or shore fishing areas lie between the two facilities, no impacts on related recreational fishing are anticipated. Therefore, short-term pipeline installation impacts on fishing access would be nonsignificant (Class III) as would be impacts on fish and habitat (Section 4.4.4.1., Marine Biology). Total short-term impacts on commercial and recreational fishing activities are also expected to be nonsignificant (Class III).

Vessel trip lengths, numbers of vessel trips, and fishing buffers would be the same as described in Section 4.5.6.1 Abandonment In-Place of the Pier Terminal. Impacts would range from minimal to Class II.

Abandonment of the Pacific Refining Refinery wharf would have impacts similar to those discussed in Section 4.5.6.1 Pier Structure Scenarios. Impacts are expected to range from adverse but nonsignificant (Class III) to beneficial (Class IV).

4.6 AIR QUALITY

4.6.1 Introduction

Air quality impacts are presented for the continuation of current operations and for a 20-year future conditions analysis assuming that Unocal tanker deliveries increase by 60 percent and that product export via tanker increases by 30 percent. Rail and highway shipments would then be required to deliver the other 30 percent of the processed product. The effects of the various alternatives are also examined. The ramifications of the various no project alternatives focus on air quality impacts most relevant to construction issues of abandonment and removal of the pier structure, and alternatives that would require construction of new pipelines for crude import or product export.

4.6.2 Impact Significance Criteria

Section 15002 of the CEQA Guidelines defines *"Significant Effect on the Environment"* as "a substantial adverse change in the physical conditions which exist in the area affected by the Proposed Project." Local jurisdictions apply the definitions and develop daily criteria levels to determine the significance of a project.

Within the jurisdiction of the BAAQMD, the level of emissions from direct and indirect sources would be considered significant if changes in the current operations result in a net difference where any contaminant equaled or exceeded the level of significance criteria established by the BAAQMD. The levels for criteria pollutants are as follows:

Pollutant	Pounds per Day
Precursor Organic Compounds	150
Nitrogen Oxides	150
Sulfur Dioxide	150
PM_{10} Particulates	150
Carbon Monoxide	550

Furthermore, BAAQMD specifies significance levels for noncriteria pollutants. These, however, vary by source and because none are produced by the Proposed Project or its alternatives, are not presented here. (These levels are, however, presented in Appendix F.)

The CCAA requirements for a no net increase permitting program for NO_x and POCs have been incorporated into the rules and regulations and the CAP of the BAAQMD. BAAQMD Regulation 2, Rule 2 (New Source Review) requires facilities with direct source emissions of NO_x and POC and major sources of with PM_{10} and SO_x emissions to offset, at a 1.1 to 1.0 ratio, cumulative increases since April 5, 1991, that exceed 1 ton per year. The requirement of offsetting at a ratio greater than 1.0 to 1.0 results in a beneficial impact on air quality. Where the cumulative change is less than 1 ton per year, the direct source emissions should be added to the indirect source emissions prior to making a determination of significance from the indirect sources associated with a project.

4.6.3 Proposed Project

4.6.3.1 Analysis of Continuation of Existing Operations

In terms of local air quality, the adoption of a new lease for the Unocal Marine Terminal will not change the quantity or affect the quality of air emissions. As presented in existing conditions, the direct sources of emission from the Unocal Marine Terminal are associated with operation of the thermal oxidizer, loading operations, ballasting, and fugitive sources (pumps, valves, and flanges). Indirect emission sources result from mobile operations including trucks, rail, barges, tankers, tugboats, and so forth, as they travel through the area to and from the Marine Terminal. Table 4.6-1 recaps the direct and indirect emissions. Total vehicular traffic, petroleum liquids loaded and unloaded, and hours of operation of the terminal are not expected to change for the continuation of existing conditions. Because the significance criteria are based on increases over the existing conditions, no air quality impacts are associated with the Proposed Project as long as operations remain unchanged.

Some emission reductions have been recently mandated by the BAAQMD, and the control equipment (i.e., the thermal oxidizer) has been installed. During the life of the new lease, emissions are expected to be less than those that occurred under the original lease. Indirect project emissions will continue to be reduced in accordance with the control measures in BAAQMD's "Bay Area '91 CAP" and the FCAA SIP. These future changes would contribute to a beneficial (Class IV) impact.

Table 4.6-1

PROPOSED PROJECT DIRECT AND INDIRECT EMISSIONS (pounds per day)

Emission	PM_{10}	SO_x	NO_x	POC	CO
Direct	23.0	14.2	65.2	180.3	52.1
Indirect	1,090.4	4,626.3	5,292.6	567.1	975.9
Total	1,113.4	4,640.5	5,357.8	747.4	1,028.0

The health risks of the Marine Terminal are not considered significant and will not change with the Proposed Project. A Health Risk Assessment Report (HRA) prepared by Brown and Caldwell (1991) in response to AB 2588, Air Toxic "Hot Spots," was submitted to the BAAQMD on February 14, 1991. The HRA analyzed the risks associated with toxic air emissions from the Unocal Refinery. An analysis of the Marine Terminal was included in this assessment. Toxic air emissions from the Marine Terminal were estimated using historical emissions from marine loading berths M1 and M2 for the calendar year 1989. According to the report, toxic compounds emitted were benzene, toluene, xylene, and gasoline vapors. These compounds are also classified as POCs.

The assessment indicated that the contribution to the excess cancer risk by the Marine Terminal was 5.6×10^{-7} at the location of the maximum exposed individual (MEI). The MEI is that point in a receptor grid having the maximum exposure to carcinogens from a specific facility. The MEI is located approximately 1 mile northeast of the Marine Terminal on the outskirts of the City of Crockett. Where other receptors are located nearer to the facility, the excess risk at those receptors is less due to the prevailing wind direction (Appendix F). This excess cancer risk was calculated prior to installation of the vapor recovery control system. With the vapor recovery control system now in place to control over 95 percent of POC emissions, the excess cancer risk contributed by the Marine Terminal is adjusted to 2.8×10^{-8}. This is less than the level of significance of one excess cancer case in one million (1×10^{-6}). Because the control measures for criteria pollutants in the CAP and SIP referenced above are implemented, the excess cancer risk will continue to decrease, resulting in a beneficial (Class IV) impact.

4.6.3.2 Analysis of Future Operations

Terminal operations are not expected to remain static, and future operations (i.e., in about 20 years) have the potential to increase substantially. For this analysis, future operations are assumed to result in a 60-percent increase in crude import and 30-percent increase in product export by tanker. The remaining 30 percent to be exported is assumed to be moved by both trucks and rail cars. Because data on the future operational emissions produced by ships will depend on future regulations as well as the best available control technology applicable at the time, it is not possible to accurately represent these emissions. Therefore, to present a reasonable worst-case scenario, existing tanker operations were raised by 60 percent for import as well as 30 percent for export. The proportion of the additional 30 percent to be moved by rail and truck was assumed to be similar to the existing proportion of rail-to-truck product movement. As with vessel emissions, future truck and rail emissions will depend on future regulations and best available control technology and cannot be accurately determined at this time. Current emission factors are then used for this analysis and represent a worst-case scenario, but would also be expected to overestimate future vehicle emissions. Even though these rail and truck emissions may be overestimated, they are still relatively small when compared to the emissions predicted for marine vessels operating within the Bay Area.

In addition to increases in these indirect emissions, additional crude and product would infer additional direct emissions as additional material is moved through the system. However, for pumps, valves, and flanges, the presentation of emissions for existing conditions considered that product is always present within these fixtures and emissions are produced 24 hours per day, 365 days per year. Therefore, these emissions would not increase above the predicted levels even with the movement of additional product.

These future operational emissions (both indirect and direct) are presented in Table 4.6-2. Note that with the exception of CO, all future emissions will exceed the daily significance thresholds, producing a potentially significant impact (Class II). The reason this impact is considered as potentially significant is because the future predicted emissions do not consider reductions in emissions due to the use of future best available control technology, reductions in vehicle emissions due to the use of continually stricter vehicle emission standards, and any offsets that may be necessary.

Table 4.6-2

FUTURE EMISSIONS FOR BOTH DIRECT AND INDIRECT SOURCES[1]

Emission Source	PM_{10}	SO_x	NO_x	POC	CO
DIRECT SOURCES					
Vapor Recovery/Thermal Oxidizer	5.5	3.4	15.5	0.0	12.4
Loading Operations[2]	0.00	0.00	0.00	9.0	0.00
Ballasting	0.00	0.00	0.00	14.6	0.00
Pumps, Valves, and Flanges[3]	0.00	0.00	0.00	16.9	0.00
Total Direct Losses	5.5	3.4	15.5	40.5	12.4
Total Direct Losses (pounds per day)	30.1	18.6	84.9	221.9	67.9
INDIRECT SOURCES					
Vessels	255.8	1,115.0	1,276.5	135.2	227.8
Trucks	1.4	13.5	11.1	2.7	8.7
Railroad	0.1	0.3	1.8	0.5	0.7
Total Indirect Losses	257.3	1,128.8	1,289.4	138.4	237.2
Total Indirect Losses (pounds per day)	1,409.9	6,185.2	7,065.2	758.4	1,299.7
COMBINED SOURCES					
Total Losses	262.8	1,132.2	1,304.9	178.9	249.6
Total Future Losses (pounds per day)	1,440.0	6,203.8	7,150.1	980.3	1,367.7
Total Existing Losses (pounds per day)	1,113.4	4,640.5	5,357.8	747.4	1,028.0
Net Increase in Daily Losses (pounds per day)	326.6	1,563.3	1,792.3	232.9	339.7
Significance Level (pounds per day)	150	150	150	150	550

1 All emissions are in tons per year unless otherwise noted.
2 Unloading operations produce negligible POC emissions.
3 These emissions are considered continuous 24 hours per day, 365 days per year and therefore will not increase over the existing emissions due to augmented operations.

4.6.4 Cumulative Impacts

The Proposed Project consists of continuing an operation that began in 1955. The Proposed Project and other projects in the region will generate air emissions from direct and indirect sources that will continue to contribute to cumulative emissions to the region. Until the facility augments its current operations, these emissions are within the existing conditions and will not contribute additional emissions to the cumulative impact.

4.6.5 Significant Impacts, Mitigation Measures, and Residual Impacts

Impact - Future emissions, with the exception of CO, would exceed daily significance thresholds (Class II).

Mitigation and Residual Impact -Mitigation focuses on the use of the best available control technology available at the time. These increased operations would require additional permitting through the BAAQMD, which would set limitations on allowable emissions levels. Offsets may also be required. Through the use of improving technology, retrofit of existing with improved equipment, and BAAQMD requirements, the impact would be reduced to a level of nonsignificance.

4.6.6 Alternatives Analysis

Conversation with Joe Steinberger of the BAAQMD (personal communication, January 2, 1993) revealed that project alternatives should be based on the reduction or increase in emissions relative to the current operation of the Marine Terminal and that although offsets may be obtained for reductions in emissions, these offsets should not be applied to the CEQA review of the project. This premise was carried through the alternatives analysis.

4.6.6.1 No Project Alternative

The No Project Alternative would result if the SLC does not grant a new lease to Unocal for the continued operation of the Marine Terminal. The scenarios that could result from this action include the abandonment of the Marine Terminal, the replacement of crude oil volumes from other sources, and/or the reduction of Refinery operations or closure of the Refinery. The potential impacts of each of these scenarios are discussed below.

Pier Structure Scenarios

Without a new lease, the Marine Terminal would cease to be operated for the import and export of petroleum products. The Terminal structure could either be abandoned in-place, removed, or retained for other nonterminal usages (e.g., fishing pier).

Abandonment In-Place of Pier Terminal

In this scenario, the Terminal would be abandoned and left in-place. It is likely that the pipelines and pumping facilities would require removal. This removal would require the use of heavy equipment. This equipment, if not already located onsite, would be brought to the site. Once onsite, the equipment would remain for the duration of the removal and then be removed. The removed pipelines and pumping equipment would probably remain onsite and would not be relocated. If the fixtures are to be relocated, they would be hauled offsite via heavy trucks.

Short-Term Emissions - If the Terminal is abandoned and left in-place, it is likely that pipelines and pumping facilities would be removed using about eight pieces of heavy-duty diesel-powered equipment each operating 7 hours per day. It is assumed that this project would take 30 days at 7 hours per day. In addition, it is anticipated that 25 workers will travel to the site and four trucks will haul debris away daily. The average worker's trip is assumed to be 30 miles roundtrip and the haul truck's average trip is 45 miles. Table 4.6-3 presents the expected short-term emissions from abandonment in place. Calculations are presented in Appendix F. These demolition emissions would result in a temporary adverse, but nonsignificant (Class III) impact.

Table 4.6-3

DEMOLITION EMISSIONS FOR ABANDONMENT IN-PLACE (pounds per day)

Description	PM_{10}	SO_X	NO_X	POC	CO
Construction Equipment	8.7	11.3	102.7	8.7	55.3
Haul Trucks	0.7	7.3	6.0	1.3	4.7
Passenger Vehicles	—	—	2.0	3.3	23.3
Total	9.4	18.6	110.7	13.3	83.3

Long-Term Emissions - The abandonment in-place of the Marine Terminal would result in the elimination of the long-term direct and indirect source emissions. Presented below is a listing of the reduction in emissions that are directly or indirectly associated with operation of the Marine Terminal:

Pollutant	Reduction in Pounds per Day
POC	747.4
Nitrogen Oxides	5,357.8
Sulfur Dioxide	4,640.5
PM_{10} Particulates	1,113.4
Carbon Monoxide	1,028.0

Note that the reduction in emissions presented above includes both those produced at the Terminal and from the ships that carry petroleum to and from the Terminal while operating within the Bay Area. If these ships could not unload or load at the Unocal Marine Terminal, they would most likely use alternate terminals within the region. However, for CEQA purposes, these emissions would no longer be associated with the Marine Terminal at the Unocal facility. Loading and unloading of petroleum at other terminals then become a part of the areal cumulative impact.

BAAQMD Regulation 2, Rule 4 would allow for banking of the emission reductions generated from the shutdown of the Marine Terminal. These banked emissions could then be used to offset new or modified facility installations within BAAQMD that are the same or a closely related type of facility. Depending on the pollutant, the emission offsets would be used in a greater than 1.0 to 1.0 ratio. Based on the assumption that the import and export of petroleum liquids would continue at an alternative terminal, the air quality impact from the total elimination of the Marine Terminal may be limited to the benefit derived from the offset ratio, but this would still constitute a beneficial (Class IV) impact because a reduction in emissions would result.

Abandonment and Removal of Pier Terminal

Here, the Terminal would be abandoned and removed. Most impacts would be the same as for the Abandonment In-Place Alternative; however, this alternative would require that large amounts of demolition debris be removed from the area. This removal could be by truck, rail, barge, or some combination thereof.

Short-Term Emissions - A worst-case scenario would be the removal of the Terminal by truck because these would hold the least amount of debris and would result in the most indirect short-term emissions. As with the Abandonment In-Place Alternative, eight pieces of heavy equipment each operating 7 hours are envisioned. Furthermore, 25 workers are anticipated on a daily basis with 10 haul trucks used to remove the debris.

Again, the average worker's trip is assumed to be 30 miles roundtrip, and the haul truck's average trip is 45 miles. Table 4.6-4 presents the expected short-term emissions from abandonment in-place. Calculations are presented in Appendix F. These demolition emissions would result in a temporary adverse, but nonsignificant (Class III) impact.

Table 4.6-4

DEMOLITION EMISSIONS
FOR ABANDONMENT AND REMOVAL
(pounds per day)

Description	PM_{10}	SO_X	NO_X	POC	CO
Construction Equipment	8.7	11.3	102.7	8.7	55.3
Haul Trucks	1.3	14.7	12.0	2.7	9.3
Passenger Vehicles	—	—	2.0	3.3	23.3
Total	10.0	26.0	116.7	14.7	87.9

Long-Term Emissions - Long-term impacts are as predicted for the Abandonment In-Place Alternative and would result in a beneficial (Class IV) impact.

Refinery Scenarios - Continued Operation at Current Capacity

Without the Marine Terminal, the Refinery could continue to operate at current capacities through the intake of petroleum liquids from other sources and the development of alternatives for product export. The following presents the potential impacts for increased crude intake and alternatives for product export.

Replacement of Crude from Central Valley Via Pipeline

Short-Term Emissions - Unocal may be able to purchase additional crude oil from the San Joaquin Valley. The existing capacities of the "common carrier" pipeline may be adequate to transport the approximately 25,000 bpd (9 million bpy) used by the Refinery. Several of these existing pipelines are presently operating at approximately 60 percent of maximum capacity (California Independent Petroleum Association 1992).

The construction of a separate pipeline and storage facility to service the Unocal Refinery exclusively would require a review under CEQA.

Emissions during pipeline construction were based on a typical equipment list and emissions data as discussed with ARB, Inc., a construction company (personal communication, October 12, 1992). All equipment is diesel powered. The analysis assumes that 12 pieces of equipment are in operation 7 hours each day. The analysis also assumes that 25 workers and 10 haul trucks are used. Worker commutes are based on a distance of 30 miles, while haul trips are assumed at 45 miles. These emissions are quantified in Table 4.6-5. Note that NO_X emissions are expected to exceed the 150-pound-per-day significance threshold, and a significant (Class II) impact is projected.

Table 4.6-5

PIPELINE CONSTRUCTION EMISSIONS
(pounds per day)

Description	PM_{10}	SO_X	NO_X	POC	CO
Construction Equipment	13.1	17.2	154.2	13.0	83.0
Haul Trucks	1.3	14.7	12.0	2.7	9.3
Passenger Vehicles	—	—	2.0	3.3	23.3
Total	**14.4**	**31.9**	**168.2**	**19.0**	**115.6**

In addition to exhaust emissions, fugitive dust would be raised by the excavation of the trench as well as equipment usage on unpaved surfaces. It is assumed that in a typical day 1,800 feet of pipeline can be laid. The total disturbed area is 25 feet to either side of the trench. Water spray will be used for 50-percent dust control. If it is assumed that an area of approximately 50 feet in width is disturbed, then approximately 2 acres are disturbed on a daily basis or 60 acres on a monthly basis. Based on EPA (1985), 1.2 tons of total suspended particulates (TSP) per month or 110 pounds per day are generated for each acre of land disturbed from construction activities. The PM_{10} fraction typically composes about 45 percent of the TSP. Therefore, for the 2 acres disturbed approximately 99 pounds of PM_{10} would be raised on a daily basis. The PM_{10} fraction, even when combined with that predicted for exhaust particulates, would not be anticipated to exceed the significance criterion of 150 pounds per day, and an adverse, but nonsignificant (Class III) impact would be produced.

<u>Mitigation and Residual Impact</u> - Short-term construction emissions are predicted to exceed the significance criteria for NO_x, and mitigation is necessary to reduce these emissions to a level of nonsignificance. Mitigation measures for NO_x focus on methods to make the construction equipment as efficient as possible and include the following:

- All equipment should be kept in a proper state of tune per manufacturers' recommendations.
- Equipment should incorporate an additional 4 degrees of ignition retard.
- Equipment should use "clean burning" low sulfur diesel.
- Equipment should not be left idling for prolonged periods.

The incorporation of these mitigation measures would reduce the impact to a level of nonsignificance.

<u>Long-Term Emissions</u> - Upon completion, the pipeline would be used to transfer crude from the Central Valley. Because the pipeline would be welded and buried, emissions could only occur at pump stations. The emissions' points at a typical pump station are listed in Appendix F as are the emissions associated these points. This analysis assumes the use of a pump station with a 10-million-Btu-per-hour heater. The emissions associated with this operation are presented below.

Pollutant	Pounds per Day
POC	82.5
Nitrogen Oxides	22.9
Sulfur Dioxide	0.1
PM_{10} Particulates	21.1
Carbon Monoxide	4.6

Note that these emissions are considerably less than those produced by operation of the Marine Terminal, resulting in a beneficial (Class IV) impact.

Replacement of Crude Via Pipeline from Other Marine Terminals

Under this option, Unocal would continue to import petroleum liquids and ship out its product, but would be required to use an alternate terminal for intake.

Short-Term Emissions - This alternative may require that a pipeline(s) be constructed to the selected terminal where crude would ultimately be delivered. Construction emissions could be on the order of those predicted in Table 4.6-5 and may create a temporary significant (Class II) impact. Dust emissions would be as predicted for the replacement of crude from the San Joaquin Valley Alternative if pipe is laid over land. Pipeline laid in water will not create substantial dust.

Mitigation and Residual Impact - Mitigation for these short-term emissions is as presented for the Replacement of Crude from the Central Valley via Pipeline Alternative and would reduce the construction emissions to a level of nonsignificance.

Long-Term Emissions - The actual quantity of long-term vessel emissions is unaffected in that the number of tanker calls will not be reduced or increased within the region. For the purposes of CEQA, however, these emissions would no longer be associated with the Unocal Marine Terminal. Additional pipelines and transfer points will be required, and this could increase fugitive emissions, although not significantly (Class III impact).

The emissions attributed to increased throughput of each terminal may have to be offset at a ratio of greater than 1.0 to 1.0, depending on the existing permit limitations of the alternative terminal and, on the whole, this could create a beneficial (Class IV) impact.

Product Export Via Pipeline to Other Marine Terminals

Under this alternative, the long-term direct and indirect emissions associated with export of petroleum liquids at the Unocal Marine Terminal will be eliminated. However, increases in emissions will occur at alternative terminals to accommodate the export of product for Unocal.

Short-Term Emissions - Short-term construction impacts and mitigation for the construction of the pipeline(s) would be as predicted for the Replacement of Crude via Pipeline from Other Marine Terminals Alternative (Class II).

Mitigation and Residual Impact - Mitigation for these short-term emissions is as predicted for the Replacement of Crude from the Central Valley Alternative and would reduce the construction emissions to a level of nonsignificance.

Long-Term Emissions - For CEQA purposes, loading and vessel export emissions would no longer be associated with the Unocal facility. Long-term direct source emissions due to additional pipelines and transfer points could increase fugitive emissions, although not significantly (Class III impact). Increased operations at the terminal selected for product export may require offsetting at a greater than 1.0 to 1.0 ratio depending on the permit conditions. The offset ratio would reduce overall emissions resulting in an overall beneficial (Class IV) impact. Long-term indirect source emissions would remain unchanged from existing levels.

Truck and Rail Product Transport

If the Marine Terminal was no longer available for use, the import and export of petroleum product could take place via truck, rail, or a combination of the two. In accordance with AP-42 (EPA 1985), loading losses for trucks and tank cars are approximately twice than predicted for ships. Furthermore, it is anticipated that a thermal oxidizer would be used. These emissions include those produced from the loading of petroleum, vehicle emissions, and, because no IGS would be used, transit vapor losses. Table 4.6-6 presents the emissions that would occur for either trucking or rail shipment of both raw material and product. Note that in actuality a combination of both truck and rail would probably be used and the anticipated emissions would lie between the values presented for truck and rail. These emissions are in addition to the truck and rail emissions identified under the project's existing conditions.

Note that if these materials were shipped by truck, by rail, or some combination thereof, a net decrease in emissions would be produced resulting in a beneficial (Class IV) impact.

Refinery Would Operate at Reduced Levels

According to Unocal, seven refinery process units would be shut down without Alaskan Cook Inlet crude. In addition, certain other units would be operated at reduced capacity. Air emissions from these units would be eliminated or reduced, thereby improving local air quality resulting in a beneficial (Class IV) impact. The emissions would be banked in accordance

Table 4.6-6

TRUCK AND RAIL EMISSIONS FOR IMPORT AND EXPORT OF PETROLEUM LIQUIDS
(pounds per day)[1]

Transport Type	Truck[2]	Rail[2]	Existing Terminal Emissions[3]	Net Decrease (Truck/Rail)
POC	303.5	225.2	733.7	430.2/508.5
Nitrogen Oxides	619.2	287.1	5,303.6	4,684.4/5,016.5
Sulfur Dioxide	693.7	48.4	4,568.2	3,874.5/4,519.8
PM_{10} Particulates	88.8	37.8	1,106.8	1,018.0/1,069.0
Carbon Monoxide	489.9	130.5	988.5	498.6/858.0

1 Methods of calculation are presented in Appendix F.
2 Assumes the use of a thermal oxidizer and pumps, valves, and flanges as used for the existing Marine Terminal. Assumes loading losses are two times greater than for ships. Includes engine emissions and transit vapor losses.
3 Includes thermal oxidizer, loading operations, ballasting, pumps, valves, flanges, and indirect vessel emissions. Note that these existing terminal emissions exclude the truck trips associated with the delivery of coke, lube oil, sulfur, and crude that would continue at their current rate.

with BAAQMD rules and used for installation of new facilities of a similar activity. The emissions would be used in a ratio of greater than 1.0 to 1.0. Products such as lubricating oil currently marketed in the local area would be supplied from exterior sources via mobile transport units with associated storage points. This would increase nonproject-related mobile sources within the air district but not to the extent of those produced from the action of the combined Terminal and Refinery.

Shutdown of Refinery

Unocal has indicated that the Refinery might not be economic without the Marine Terminal. If the Refinery is actually shut down and not sold to another operator, air emissions from both the Terminal and the Refinery would be eliminated, resulting in a beneficial (Class IV) impact. These emissions would be quantified and banked for utilization by a similar facility at a greater than 1.0 to 1.0 offset ratio. All products distributed in the local area produced by the Refinery would be imported, resulting in a nonproject-related increase in truck and rail traffic. Furthermore, storage units, both exempt and nonexempt, would be increased. Nonexempt units would be offset, further reducing areal emissions.

Alaskan crude could be shipped to other refineries for processing. Based on the locations of these refineries, these emissions could still occur within the air basin.

4.6.6.2 Consolidation Alternative

Short-Term Emissions - Consolidation would result in abandonment of the Pacific Refining Refinery Terminal. The short-term emissions associated with the abandonment are discussed in Section 4.6.6.1. In addition, pipelines would need to be constructed to transport petroleum liquids between the refineries, which would result in short-term emissions as discussed in Section 4.6.6.1. In both cases, these short-term emissions would either be Class II or III depending on the level of demolition/construction.

Mitigation and Residual Impact - Class II impacts would be mitigated to a level of nonsignificance using the various methods presented in Section 4.6.6.1 for the Replacement of Crude from Central Valley Alternative.

Long-Term Emissions - Consolidating operations of the marine terminals within the BAAQMD would cause an increase in capacity or throughput of petroleum liquids at the Unocal Terminal and thereby raise its emissions. However, the long-term direct source emission increases may have to be offset at a greater than 1.0 to 1.0 ratio depending on the pollutant and existing permit conditions and the emission decreases from the elimination of the Pacific Refining Marine Terminal would create a net reduction of emissions resulting in a beneficial (Class IV) impact. This net reduction in emissions could be banked and would be available for use by similar operations.

The indirect source emissions from ship traffic would remain unchanged if the Unocal and Pacific Refining Refineries maintain their existing production levels. However, even if the import and export of petroleum liquids continue via truck and/or rail transport, the decrease in direct source emissions would outweigh the increase in indirect source emissions, and a beneficial (Class IV) impact would result.

4.7 VEHICULAR AND RAIL TRANSPORTATION

4.7.1 Introduction

This section provides an analysis of vehicular traffic impacts from continued operation of the Marine Terminal and alternatives to the Proposed Project. Vehicular traffic is comprised of trucks associated primarily with the transport of product from the Refinery with some import of products brought to the facility for use in the refining process. Rail traffic is also considered. The primary focus of this section is on alternatives to the Proposed Project. In the event that no new lease is granted for the Marine Terminal, there is the potential that vehicular and rail transport could increase substantially.

In order to gain a better understanding of traffic terminology and potential impacts, the following discussion is provided.

Traffic is typically measured and averaged over a 24-hour period. This average daily traffic (ADT) is often based on an actual 24-hour traffic count taken during mid-week. In some cases, traffic is measured at various times during the day and extrapolated to the ADT. Seasonal variations may also be taken into account by collecting data during different months during the year.

The capacity of a roadway segment or intersection is the maximum rate of vehicular traffic flow under prevailing traffic, design, and operational conditions. Factors affecting capacity include traffic controls, lane widths, grades, the amount of truck and bus traffic, the availability of on-street parking, parking turnover, and turn movements. Capacity is commonly defined for hourly periods of time. However, for generalized planning purposes, it is useful to define capacity as the maximum volume of traffic that a roadway may be expected to carry during a 24-hour period to maintain a level of service (LOS) E. Hourly capacities as defined in the "Highway Capacity Manual" for various facilities under ideal conditions are listed in Table 4.7-1.

The LOS of a roadway segment or intersection is a qualitatively defined measure of prevailing traffic, design, and operational conditions. The LOS, denoted alphabetically from A to F, best to worst, is a summary evaluation of the degree of congestion, roadway design constraints, delay, accident potential, and driver discomfort experienced during a given period of time (peak hour for intersections and 24 hours for roadway segments). While LOS A is the most desirable operational condition for a roadway or intersection, LOS C is considered a benchmark for planning purposes. In heavily urbanized areas, LOS D is an accepted, though undesirable, condition for peak hour travel, particularly on freeways. The LOS may be quantitatively calculated by a number of methods that generally compare traffic volumes with the physical and operational capacity of the roadway under study. For roadway segments and controlled intersections, the volume/capacity (V/C) ratio is indicative of the LOS. The level of service interpretation is presented in Table 4.7-2.

Table 4.7-1

DAILY CAPACITIES FOR MAJOR AND MINOR ARTERIALS

Facility Geometrics	Capacity in Vehicles Per Day (LOS E)
8-lane Divided Regional Arterial	80,000
8-lane Divided Major Arterial	72,000
6-lane Divided Major Arterial	54,000
4-lane Divided Major Arterial	36,000
4-lane Undivided Major Arterial	30,000
2-lane Undivided Major Arterial	15,000
4-lane Minor Arterial	24,000
2-lane Minor Arterial	12,000

Table 4.7-2

LEVEL OF SERVICE INTERPRETATION

Level of Service	Volume-to-Capacity Ratio
A	0 - 0.60
B	0.61 - 0.70
C	0.71 - 0.80
D	0.81 - 0.90
E	0.91 - 1.00
F	> 1.00

4.7.2 Impact Significance Criteria

Traffic impacts are considered significant if any of the following apply:

- project traffic or construction activities must use an access road that is already at or exceeds a LOS E or brings a roadway up to this LOS E;

- project traffic or construction activities would result in a substantial safety hazard to motorists, bicyclists, or pedestrians;

- construction of the proposed alternative would result in the restriction of one or more lanes of a primary or secondary arterial during peak hour traffic, thereby cutting its capacity and creating congestion; and/or

- project implementation results in insufficient parking.

4.7.3 Proposed Project

4.7.3.1 Analysis of Continuation of Existing Operations

The Proposed Project consists of tbe renewal of the current lease with continued operations. Because this is the current status of the project, no additional traffic will be generated and no impacts will occur.

Table 4.7-3 shows local access routes and their current LOS. Additionally, I-80 operates with approximately 99,000 to 107,000 ADT in the project area. The freeway is six lanes in this area and operates at LOS F. SR-4 (John Muir) operates as a two-lane arterial with an ADT of 30,000, also placing it at LOS F.

4.7.3.2 Analysis of Future Operations

As stated in Section 3.6.1.1, traffic is anticipated to increase 6.5 percent by the year 2005. Based on this projected growth rate, traffic would increase by about 0.5 percent per year. Therefore, a 10-percent growth would be projected over a 20-year period. Table 4.7-4 shows the projected existing traffic volumes, as well as the ADT for access routes in 20 years. Though not included in the table, both I-80 and SR-4 will continue to operate at LOS F unless roadway improvements are provided.

Based on the future projected operations at the Terminal, 60 percent more crude is projected to be

Table 4.7-3

EXISTING TRAFFIC VOLUMES AND LOS ALONG ACCESS STREETS IN PROJECT AREA

Road Name	Location	ADT	Equivalent ADT[1]	Capacity	Existing LOS[2]
San Pablo Avenue	West of Wanda	3,542	3,804	24,000	A
San Pablo Avenue	North of California	4,989	5,358	24,000	A
San Pablo Avenue	South of Willow	6,526	7,009	24,000	A
Parker Avenue	North of 4th Street	12,366	13,281	24,000	A
Willow Avenue	South of San Pablo	11,839	12,715	24,000	A

[1] Based on an average of 7.4 percent heavy trucks with each truck counting as two cars.
[2] Based on Equivalent ADT.

Table 4.7-4

FUTURE TRAFFIC VOLUMES AND LOS IN PROJECT AREA[1]

Road Name	Location	ADT	Equivalent ADT[2]	Capacity	Future Existing LOS[3]
San Pablo Avenue	West of Wanda	3,896	4,184	24,000	A
San Pablo Avenue	North of California	5,489	5,895	24,000	A
San Pablo Avenue	South of Willow	7,179	7,710	24,000	A
Parker Avenue	North of 4th Street	13,603	14,610	24,000	B
Willow Avenue	South of San Pablo	13,023	13,987	24,000	A

[1] Considers 20 years into the future.
[2] Based on an average of 7.4 percent heavy trucks with each truck counting as two cars.
[3] Based on Equivalent ADT.

delivered through the Terminal. Half of this material would then be shipped out by tanker leaving the remaining half to be transported by both truck and rail. Based on a current volume of approximately 8,797,450 bpy, the import volume would go up to 14,075,920 bpy for an increase of 5,278,470 bpy. Half of this volume (2,639,235 bpy) would then removed from the site by trucks and rail cars. If all of this material were to be moved by truck (worst-case scenario), 13,891 additional truck trips would be generated on a yearly basis or 38 trucks on a daily basis. Converting to passenger car equivalents, this would place an additional 152 ADT on the access roads. If this volume of traffic was added to Parker Avenue, north of 4th Street (worst-case scenario) the ADT along this route would rise to 14,762, leaving the road at LOS B and no significant impacts would be produced. However, as most of these trucks would ultimately use I-80 and some may use SR-4, both of which operate at LOS F, a significant (Class II) impact would result.

4.7.4 Cumulative Impacts

Cumulatively, traffic impacts are due to the placement of vehicles on I-80, San Pablo Avenue, SR4, and other streets. Class I and/or II impacts occur at congestion points, especially during rush hours. Unocal's contribution to the cumulative impact is minor, as most Unocal truck traffic occurs during nonpeak use.

4.7.5 Significant Impact, Mitigation Measures, and Residual Impact

4.7.5.1 Unocal Responsibilities

Impact - Based on assumed future conditions, the trucking of product onto I-80 will result in a Class II impact.

Mitigation and Residual Impact - Mitigation includes the following measures:

- Unocal should restrict truck hauls to off peak hours or ship by rail.

Furthermore, to make up for the inclusion of the additional truck trips, Unocal should be required to develop and implement program(s) to reduce other site-generated vehicle trips at a rate of two cars per each added truck trip through a combination of the following measures:

- develop a trip reduction plan to achieve 1.5 persons per vehicle for all employees,
- provide peripheral park-n-ride lots,
- provide preferential parking to high-occupancy vehicles and shuttle services, and
- charge parking lot fees to low occupancy vehicles.

The mitigation measures presented for trucking and reductions in employee trips and/or the shipment of product by rail could reduce the impacts to levels of nonsignificance.

4.7.5.2 Cumulative Actions

Impact - Class I and II cumulative impacts could result at congestion points on I-80, San Pablo Avenue, SR-4, and other streets.

Mitigation and Residual Impact - All cumulative project operators should apply the following mitigations for congestion for cumulative impacts:

- development of a trip reduction plan to achieve 1.5 persons per vehicle for both construction and permanent employees,
- coordination of scheduling of materials haul trips during offpeak hours,
- provide a local shuttle for residential use,
- provide bicycle storage areas and onsite locker facilities,
- provide peripheral park-n-ride lots,
- provide preferential parking to high-occupancy vehicles and shuttle services,
- charge parking lot fees to low-occupancy vehicles,
- promote Transportation Management Associations (TMAs), and
- work with the city/developers/citizens in the region to implement Transportation Demand Management (TDM) goals.

Through the inclusion of these measures, additional volumes will be kept to modest or reduced levels, reducing the impact to a level of nonsignificance.

4.7.6 Alternatives Analysis

4.7.6.1 No Project Alternative

Under this alternative, no new lease will be granted for the use of the pier. This could result in any of the following scenarios.

Pier Structure Scenarios

Abandonment In-Place of Pier Terminal

The Terminal would be abandoned and left in-place. It is likely that the pipelines and pumping facilities would require removal. This removal would require the use of heavy equipment. This equipment, if not already located onsite, would be brought to the site. Once onsite, the equipment would remain only for the duration of the removal. The removed pipelines and pumping equipment would probably remain onsite and would not be relocated. If the fixtures are to be relocated, they would be hauled offsite via heavy trucks.

Traffic impacts would be associated with workers' travel to the site, as well as the movement of heavy trucks that remove equipment and piping from the facility. It is anticipated that as many as 25 workers will travel to the site on a daily basis. Haul truck trips to remove materials from the site would be fairly limited as the amount of equipment to be removed is relatively small. Two haul trucks are anticipated to visit the site on a daily basis for the period of demolition. Assuming that each haul truck is equivalent to two passenger cars and that each vehicle makes two trips (coming and going), the construction ADT volume is 58. As a worst-case scenario, this entire volume of traffic was assigned to the most congested possible access route and then checked against the significance criteria for the anticipated level of service.

San Pablo, Parker, and Willow Avenues are four-lane nondivided roadways (minor arterials) each with an LOS capacity of 24,000 vehicles per day. To remain at LOS D, traffic would have to remain at or below 21,600 ADT. Parker Avenue, the most crowded of the three roads, currently operates at 12,366 ADT, with approximately 7.4 percent heavy trucks. When these trucks are converted to passenger car equivalents, the ADT rises to 13,281 for an LOS A. The addition of 58 ADT will leave the roadway at LOS A, and an adverse but nonsignificant (Class III) impact is associated with the additional traffic.

Some or all of the 58 ADT would access San Pablo from I-80. The freeway currently has an ADT of 99,000 to 107,000 between Willow Avenue and the Carquinez Bridge. In accordance with Caltrans, this stretch has six lanes of travel (three in each direction) and is currently operating at LOS F. Thus, the inclusion of additional traffic on this freeway constitutes a short-term significant (Class II) impact.

Mitigation and Residual Impact - Applicable mitigation should be implemented by Unocal for significant impacts. These are presented below.

Haul trips

- schedule haul trips to avoid peak-hour traffic, and
- stockpile the debris onsite for subsequent removal by rail or barge.

Worker trips

- stagger the work schedule so that peak-hour traffic can be avoided, if workers other than those currently employed by the site are to be used,
- develop a trip reduction plan to achieve 1.5 persons per vehicle for both construction and permanent employees,
- provide peripheral park-n-ride lots,
- provide preferential parking to high-occupancy vehicles and shuttle services, and
- charge parking lot fees to low-occupancy vehicles.

The inclusion of these, or similar measures, would then reduce the impact to a level of nonsignificance.

Abandonment and Removal of Pier

In this action, the Terminal would be abandoned and removed. Most impacts would be the same as for abandonment in-place. However, unlike abandonment in-place, this alternative would require that large amounts of demolition debris be removed from the area by truck, rail, barge, or by a combination of these methods. A worst-case scenario would be removal by truck as these would hold the least amount of debris and would proceed through populated areas and along overcrowded freeways. Here, 25 workers are anticipated on a daily basis with five haul trucks used to remove the debris. When two-way traffic is considered, the ADT in passenger car equivalents is then calculated at 70 ADT. A nonsignificant (Class III) impact is associated with this removal while the traffic remains on surface streets. However, once on I-80, the vehicles would be subject to travel on a freeway operating at LOS F and a short-term significant (Class II) impact would be produced.

Mitigation and Residual Impact - Mitigation for the removal of the Terminal equipment would be as presented for the Abandonment In-Place Alternative.

Refinery Scenarios - Continued Operation at Current Capacity

Replacement of Crude from Central Valley Via Pipeline

As a worst-case scenario, a new pipeline would be installed from the Refinery to the Central Valley to make up for the approximately 9 million bpy that would be lost from having no Marine Terminal. Furthermore, plant modification would be required to process this Central Valley crude. With no lube crude, the Refinery process that produces lubricating oil and waxes would be shut down. In actuality, the Refinery may tie into a common carrier line, thus substantially reducing the length of new pipeline construction. Impacts are presented below for pipeline construction and operation on a daily basis.

This alternative has the potential to create significant impacts (Class I and II) during construction of the pipeline and the subsequent operation of the Terminal.

Construction - Installation of the pipeline would require the use of manpower and heavy equipment. Most heavy equipment (about 16 pieces) would be moved onsite and remain until pipeline completion. This would require travel on various roadways, some of which are undoubtedly already at or over capacity (LOS E or F). For undeveloped areas, once off the main roads, pipe-carrying trucks will have no further impact on roadways. Therefore, placement of staging areas within undeveloped areas is not anticipated to significantly alter the circulation patterns on roads at, or exceeding, rated capacity.

Daily traffic would consist of worker commutes and would probably not exceed 50 ADT. Pipe deliveries may require that one truck make a daily trip. Alternatively, pipe may be stockpiled in the staging areas. In addition to pipe deliveries and worker commutes, additional trips are associated with the transport of displaced soil. It is assumed that the pipeline is to be placed so that the top is 3 feet beneath the soil. Based on a diameter of 16 inches and a finish compaction of 90 percent, approximately 12.2 cubic yards of soil must be disposed per every 100 feet of pipe. Based on the assumption that a double semi can haul 16 cubic yards of soil per haul, a truck would be required for every 130 feet of pipe placed. Thus, pipe and soil hauling could require as many as three trucks per day (12 passenger car equivalents when both trip-ends are considered).

Depending on the chosen route and the LOS on access roads, this temporary additional volume could result in significant (Class II) impacts when added to the present vehicle volumes. In proximity to the facility, access would entail the use of I-80 and a temporary significant (Class II) impact would be incurred.

A second potential area of temporary significant (Class I) impacts is where the pipeline comes into proximity with any roads. Pipeline crossings may necessitate the closure of each half or all of the road for 1 to 2 days. Similarly, if the line parallels or is constructed within the confines of any roads, one or more lanes may require closure. Lane closures have a significant impact as the ensuing congestion extends back to the previous intersection and reduces the traffic-carrying capacity of that intersection. Closing one lane of a two-lane road causes a reduction of more than 50 percent. This is because not only the number of lanes is reduced by half, but the speed in the vicinity of the closure is also reduced because of (possibly) narrowed lanes, traffic control mechanisms (cones, flagmen, etc.), and the "rubbernecking" phenomenon (i.e., the tendency of motorists to want to see what is causing the impairment, thus compounding the problem).

Alternative routing of traffic during construction along a roadway segment may slightly mitigate congestion.

However, the increase in traffic on nearby adjacent roadways typically causes traffic slowing and backups on those roadways and will only slightly mitigate the problems associated with roadway construction.

Operations - Impacts would not be restricted to the construction of the pipeline and long-term impacts could also be incurred. If the Terminal were not able to accommodate ships, the product currently tankered out would be accommodated by trucks and/or rail. Based on 1987 records, product export is estimated at 2,047,800 tons per year. A worst-case scenario assumes that the entire load is transferred by tanker trucks. This analysis assumes that tanker trucks which carry crude, typically hold 10,000 gallons and those that move product typically hold 8,000 gallons. Based on this premise, 81,835 truckloads would be exported on a yearly basis. Based on a 6-day-per-week operation, approximately 264 truckloads would be shipped on a daily basis. When ADT trips are considered, this value is doubled and 528 trips would be produced each day. This value would then be doubled to convert the truck counts to passenger car equivalents. The addition of 1,056 passenger car equivalents would leave the local surface streets at an LOS A and produce a nonsignificant (Class III) impact. However, these trucks would ultimately be forced onto I-80, which operates at LOS F and a significant (Class II) impact would be produced.

Construction Mitigation and Residual Impact - Mitigation for worker commutes (Class II) is as described above for the Pier Structure Scenario Alternatives. Unocal should provide mitigation for the delivery and installation of pipe crossing roadways and removal of soil (Class I) as presented below.

- Conduct delivery of the pipe to the various staging areas and removal of soil during nonpeak hours.
- Avoid closing any lanes entirely during construction unless absolutely necessary.
- Keep all lanes open during peak traffic hours and schedule necessary lane closures during offpeak hours if possible. This may require construction at night when activities necessitate the closure of lanes from two down to one, and dictate that short segments of pipeline be completed prior to beginning the adjacent segment.
- Use signing and flagmen where construction equipment is to interface with traffic and give sufficient warning so cars can choose an alternate route if possible.
- Institute public information programs so motorists can avoid congested areas. In addition to placement of signs, this includes placement of public notices in local newspapers and the distribution of fliers in the project area.

Even with the proposed mitigation measures, the impact remains significant (Class I) during the construction period.

Operations Mitigation and Residual Impact - The trucking of product onto I-80 would produce a significant (Class II) impact. Unocal should provide the following mitigation:

- restrict truck hauls to offpeak hours, if feasible; based on an 8-hour day operational schedule, a truck would have to be deployed every 1.7 minutes or based on a 12-hour day, every 2.6 minutes; and
- use rail shipment for at least three-quarters of the daily volume of product transport. This would require about 40 rail cars (one train).

The mitigation presented for trucking would reduce the impact, but the residual would still be anticipated to be significant. Shipment by rail could reduce the impact to a level of nonsignificance.

Replacement of Crude Via Pipeline from Other Marine Terminals

Impacts would be as predicted for the Replacement of Crude from the Central Valley Alternative above. However, it is assumed that these other terminals would be local and pipeline placement would not take place through developed urban areas. Thus, the level of impact would be reduced as would the duration of pipeline construction. Still, if roads are to be crossed or paralleled, short-term Class I impacts are anticipated. Furthermore, additional traffic, both during construction and subsequent operations, would be forced onto I-80 and this would present a Class II impact.

Mitigation and Residual Impact - Mitigation and residual impacts are as presented for the Replacement of Crude from Central Valley Alternative via Pipeline.

Product Export Via Pipeline to Other Marine Terminals

It is assumed that material would come to the Terminal by truck or rail and be exported via tanker. It is anticipated that new pipelines would still be installed between facilities in order to make transport easier before it is loaded on a tanker. With the exception that import would be overland and export over water, impacts would be as predicted for the Replacement of Crude via Pipeline from Other Marine Terminals Alternative.

Mitigation and Residual Impact - Mitigation and residual impacts are as presented for the Replacement of Crude from Central Valley vie Pipeline Alternative.

Truck and Rail Import and Export

If the Marine Terminal was no longer available for use, the crude and product import and product export could take place via truck, rail, or a combination of the two. In 1987, 1,200,000 tons of crude and 221,000 tons of product were imported, while 2,047,800 tons of product were exported by tanker. The import volume could be accommodated by 138 trucks or 54 tank cars per day. Both truck and rail export of product are as per the crude from Central Valley via Pipeline Alternative. If all materials were to move by truck (both import and export), 804 ADT would be produced. This value would then be doubled to convert the truck trips to passenger car equivalents, raising the LOS along Parker Avenue to B and a Class III impact would be produced. However, travel on I-80 would produce a significant (Class II) impact.

Mitigation and Residual Impact - Mitigation and residual impacts for vehicle travel are as presented for the Replacement of Crude from the Central Valley via Pipeline Alternative, except rail shipments should include both crude and product that can be accommodated through the existing rail system.

Refinery Would Operate at Reduced Levels

Under this alternative, there would be a reduction of approximately 25,000 bpd. Both lube and wax shipments would cease. This could reduce product deliveries by truck by approximately four to five roundtrips per day. Furthermore, the loss of 100 jobs would further reduce areal traffic. This would produce a beneficial (Class IV) impact by reducing vehicles on both the surface road access and I-80 by a small but nonsignificant amount.

Shutdown of Refinery

Under this alternative, the Refinery would be shut down completely, dismantled, and hauled off. It is not anticipated that the removal of the facility would require the volume of trucks currently deployed on a daily basis. Furthermore, the demolition crew would undoubtedly be smaller than the current staff of the facility. Thus, beneficial short- and long-term Class IV impacts would be anticipated along all access routes.

4.7.6.2 Consolidation Alternative

Under this alternative, Pacific Refining Company would share the Unocal Marine Terminal. The Pacific Refining Wharf would be abandoned. The currently used Marine Terminal would be abandoned as per Section 4.7.6.1, and a short-term significant (Class II) impact is anticipated due to the addition of workers and haul trucks on I-80. Construction would be necessary to run the new pipelines from the Pacific Refining Wharf to the Unocal facility. This could extend the timeframe for the impact along I-80. No additional operational traffic is associated with this alternative, and no long-term impacts would be produced.

Mitigation and Residual Impact - Mitigation for short-term Class II construction impacts is as presented for the Pier Abandonment In-Place Alternative.

4.8 NOISE

4.8.1 Introduction

This section presents an analysis of the noise impacts associated with the continuation of operations of the Marine Terminal and the various alternatives associated with the No Project Alternative and the Consolidation Alternative.

4.8.2 Impact Significance Criteria

Impacts were considered significant if noise levels (either ambient or project-produced) exceed County or local noise ordinances or noise regulations (such as OSHA) promulgated on the federal or state level. Figure 4.8-1 graphically presents the land use compatibility guidelines for community noise environments.

Summarized, the figure shows that project implementation would cause a significant impact if any of the following would expose:

- low-density residential areas to an Ldn noise level in excess of 60 dBA;
- multifamily residential and transient lodging areas to an Ldn noise level in excess of 65 dBA;
- schools, libraries, hospitals, nursing homes, offices and commercial areas, and open space areas, such as parks and playgrounds, to an Ldn noise level in excess of 70 dBA; and/or
- golf courses, riding stables, cemeteries, and water recreation areas and industrial, manufacturing, utilities, and agricultural areas to an Ldn noise level in excess of 75 dBA.

However, if the ambient noise in these areas already exceeds the above values, an impact is considered significant if the project raises the ambient noise level by 3 dBA Ldn (a barely perceptible amount), or 5 dBA Ldn (clearly perceptible), and remains below the levels set forth above. These noise level criteria are as measured at the perimeter of any structure housing sensitive receptors.

Increases in traffic-generated noise levels were considered significant if the Proposed Project traffic increases the road noise level along the access roads by an audible level of at least 3 dBA Ldn, if the resultant level exceeds the levels stated above; or 5 dBA Ldn if the resultant noise remains below the levels set forth above.

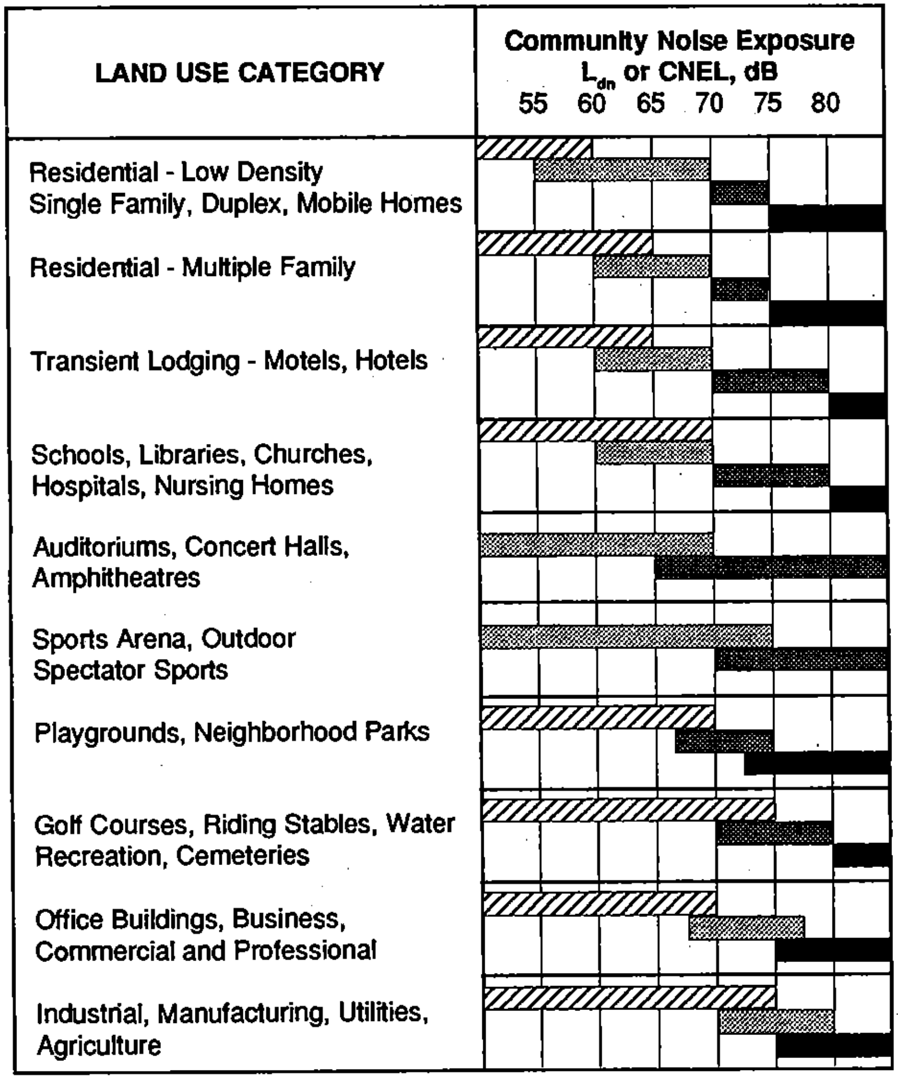
4.8.3 Proposed Project

4.8.3.1 Analysis of Continuation of Existing Operations

The Proposed Project consists of the renewal of the current lease with continued operations through the next 40 years. Because this is the current status of the project, no additional noise will be generated from the loading and unloading of tankers at Davis Point. During operations involving use of the thermal oxidizer (TO) an Leq noise level of 61.6 dBA was obtained at a distance of 200 feet from the TO. At distances to any offsite sensitive receptors such noise is inaudible. No impact results. Furthermore, the project will not generate additional traffic over the current levels and, thus, will not add to the traffic-generated noise along any of the access routes. Thus, no significant impacts will occur and no mitigation is warranted.

4.8.3.2 Analysis of Future Operations

As per the growth patterns in the area, traffic would increase by about 0.5 percent per year, 10-percent growth over 20 years. To this traffic, additional truck and rail traffic from the movement of additional Refinery product would be added. As calculated in Section 4.7.3.2, if all of the additional product was transported by truck, an additional 38 trucks would be required on a daily basis, adding an additional 76 truck-trips to the access routes. Based on the assumption that the percentage of cars, medium trucks, and heavy trucks is the same in the future as measured near the site, Table 4.8-1 presents the resultant noise levels from areal growth. To these vehicle volumes, the 76 truck trips were then added and the model was rerun. In all cases, the additional volume of trucks raised the noise level by less than 1 dBA Ldn, and no significant impacts would be associated with augmented operations. Similarly, if all additional product were to be moved by rail, the additional activity would raise train-generated noise by less than 1 dBA Ldn and no significant impacts would be produced.



LEGEND

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

Conditionally Acceptable
New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design.

Normally Unacceptable
New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made with needed noise insulation features included in the design.

Clearly Unacceptable
New construction or development should generally not be undertaken.

For lands within 3 miles of Buchanan Field and the East Contra Costa County Airports noise compatibility shall be adjusted to those of the ALUC which are roughly 5 CNEL lower than shown on this table.

LAND USE COMPATIBILITY FOR COMMUNITY NOISE ENVIRONMENTS
Figure -1

Source: Contra Costa County General Plan Noise Element

Table 4.8-1

MODELED FUTURE NOISE LEVELS ON LOCAL ROADS IN PROJECT AREA

Road Name	Location	ADT	Ldn (dBA)[1]
San Pablo Avenue	West of Wanda	3,896	68
San Pablo Avenue	North of California	5,489	69
San Pablo Avenue	South of Willow	7,179	70
Parker Avenue	North of 4th Street	13,603	73
Willow Avenue	South of San Pablo	13,023	73
I-80	SR-4 Interchange - Carquinez Bridge	108,900 - 117,700	83 - 84
SR-4	I-80 - Willow	33,000	79

[1] As measured at a distance of 50 feet from the centerline of the road.
[2] Based on equivalent ADT.

4.8.4 Cumulative Impacts

Noise in the cumulative environment can be considered to be the same as that of the Proposed Project; as described in Section 3.7, current conditions, including the surrounding environment. The cumulative noise environment includes that localized area where noises can be transmitted and heard; thus, they are local and not regional in nature.

Cumulatively, future noise in the surrounding area would increase as growth in the area continues. Noise increases can be expected, primarily, from nonrefinery-related uses, including new residential, commercial, and other industrial uses. Unocal would not contribute significantly to future increases in noise.

4.8.5 Significant Impacts, Mitigation Measures, and Residual Impacts

No significant impacts (Class I or II) have been identified, and no mitigation is warranted.

4.8.6 Alternatives Analysis

4.8.6.1 No Project Alternative

Under this alternative, no new lease would be granted for the use of the pier. This could result in any of the following scenarios.

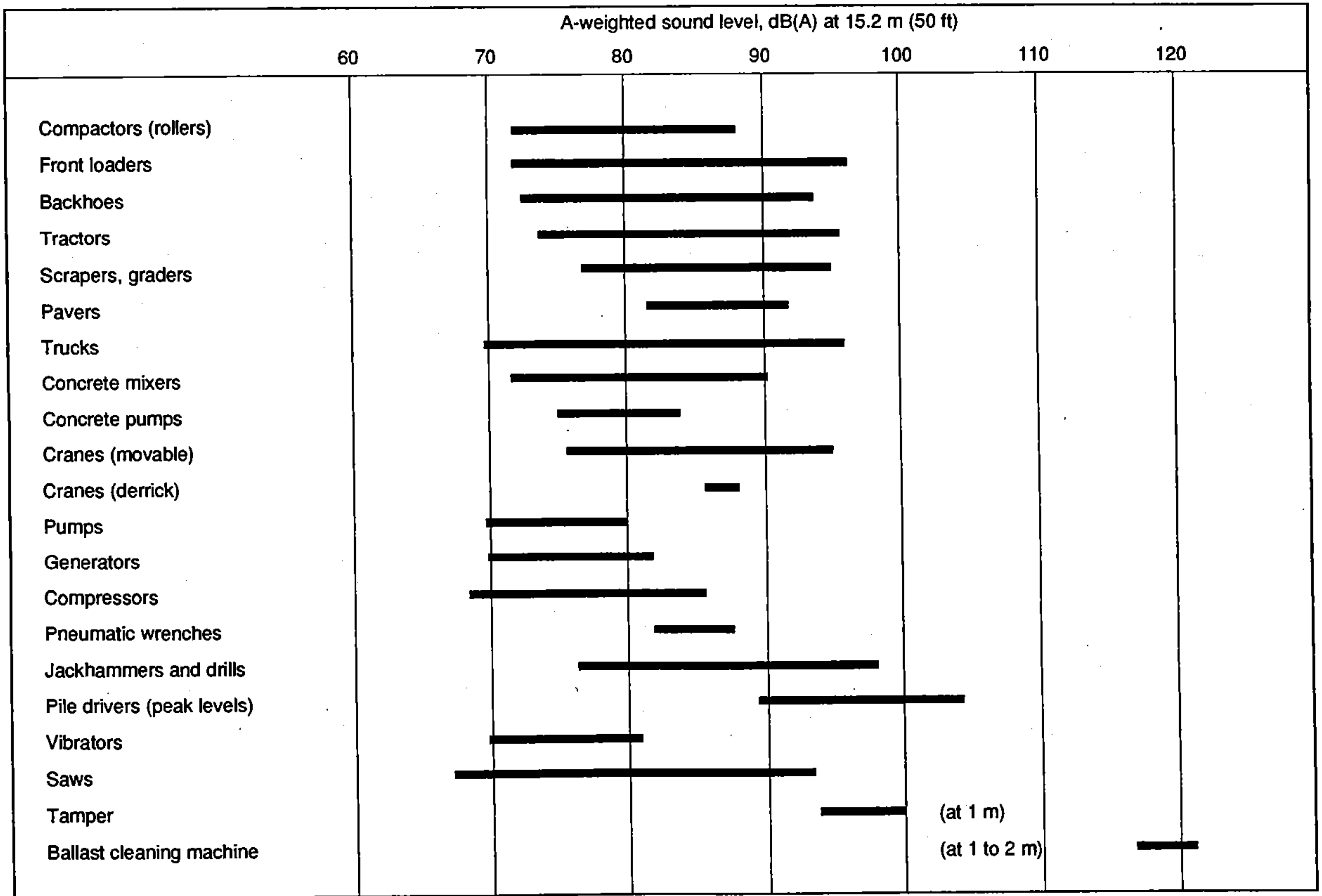
Pier Structure Scenarios

Abandonment In-Place of Pier Terminal

The Terminal would be abandoned and left in-place. It is likely the pipelines and pumping facilities would require removal. This removal would require the use of heavy equipment. Figure 4.8-2 illustrates the noise produced from heavy equipment.

The noise of construction is best characterized by Bolt, Beranek, and Newman (USEPA, December 31, 1971). In their study, construction noise is presented as 89 dBA, as measured at a distance of 50 feet from the construction effort. This value takes into account both the number of pieces and spacing of the heavy equipment used in the construction effort. Though the removal of the Terminal fixtures is an act of destruction rather than construction, the anticipated noise generated by this act would not be anticipated to exceed that produced by construction and could be considerably less. Thus, 89 dBA is used as a reasonable worst-case scenario.

Based on a noise level of 89 dBA for the removal of Terminal fixtures and an 8-hour work day, the Ldn noise level would be 84 dBA at 50 feet. The 75-dBA Ldn level (for industrial areas) would fall at a distance of 141 feet. This distance is well within the confines of the Unocal Refinery and would not be audible on offsite land. The 60-dBA Ldn level would fall at a distance of 792 feet from the Terminal and because no residential land uses are located within this distance, would not create any significant impacts.



Source: Bolt, Beranek & Newman, Inc.
EPA PB-206-717/BE

CONSTRUCTION EQUIPMENT NOISE
Figure 4.8-2

Abandonment and Removal of Pier

Here, the Terminal would be abandoned and removed. The noise produced by this removal is not expected to exceed the 89 dBA predicted for the removal of the pumping facilities; any impacts would be the same as for abandonment in-place. However, unlike abandonment in-place, this alternative would require that large amounts of demolition debris be removed from the area. This removal could be by truck, rail, barge, or some combination. A worst-case scenario would be removal by truck, as these hold the least amount of debris and would proceed through populated areas. Further, the greatest impact would be produced if these trucks were to proceed southwest through the town of Rodeo.

Noise along San Pablo, Parker, and Willow Avenues varies from approximately 67 to 73 dBA Ldn at a distance of 50 feet from the centerline of the roads and, thus, already exceeds the county ordinance for any residential dwellings located in proximity to the road. A significant impact would be produced if the traffic associated with the removal of the Terminal raises the traffic-generated noise levels by 3 dBA. This rise of 3 dBA would essentially require a doubling of the current traffic volume.

The current volume along this route varies from as little as 3,542 to as many as 11,839 vehicles per day. Based on the ratio of cars, medium, and heavy trucks recorded in the field (and assuming this ratio is constant throughout the day), the number of heavy trucks along this route varies from 220 to 734 on a daily basis. The greatest impact would be along the stretch, which currently contains the fewest vehicles the project would make the greatest contribution (percentage-wise) to this volume. Based on the FHWA Highway Noise Prediction Model, as many as 50 roundtrips for workers and 178 roundtrips for trucks could be added to the 3,542 average daily volume without the resultant noise level rising by 3 dBA. This volume of additional traffic is not anticipated for the demolition of the Terminal, so a nonsignificant impact (Class III) is anticipated for the removal of the debris.

<u>Refinery Scenarios - Continued Operation at Current Capacity</u>

Under this scenario, without Marine Terminal usage, crude intake would be obtained from sources other than the Marine Terminal, and alternatives be developed for product export. The options follow.

Replacement of Crude from Central Valley Via Pipeline

<u>Construction</u> - Under this scenario, as a worst case, a new pipeline would be installed from the Refinery, all the way to the Central Valley, to make up for the approximately 9 million bbl per year lost from having no Marine Terminal. Furthermore, plant modification would be required to process this Central Valley crude. With no lube crude, the refinery process that produces lubricating oil and waxes would be shut down. In actuality, the Refinery may be able to tie into a common carrier line, thus reducing, substantially, the length of new pipeline construction. Impacts are presented below for daily noise levels.

This alternative has the potential to create significant impacts during the construction of the pipeline. As with industrial construction, noise generated along the pipeline route could be on the order of 89 dBA, as measured at a distance of 50 feet from the construction effort. Assuming a 12-hour construction day, beginning after 7:00 a.m., significant adverse (Class II) impacts would be anticipated if the pipeline were to come within the following distances:

- low-density residential areas - 998 feet,
- multifamily residential and transient lodging areas - 561 feet,
- schools, libraries, offices, commercial areas, and open space areas, such as parks and playgrounds - 315 feet, and
- golf courses, riding stables, cemeteries, and water recreation areas, and so forth - 177 feet.

Haul trips could also produce adverse (Class III) and potentially significant (Class II) impacts if substantial amounts of spoils were removed and large volumes of pipeline and ancillary materials delivered over roads currently carrying low volumes of traffic because these trucks and workers could conceivably raise noise levels by 5 dBA on roads which see little use. (Roads that are already at or approach noise levels deemed significant would probably not raise by 3 dBA and would not be subject to significant impacts.)

The additional onsite construction at the Refinery would not raise offsite noise levels, and no significant impacts (Class III) are projected for facility modifications.

Operations - If the Terminal were not able to accommodate ships, the product that is currently tankered out would have to be accommodated by trucks and rail. Based on 1987 records, product export is estimated at 2,047,800 tons per year. A worst-case scenario assumes that the entire load is transferred by tanker truck. Because these trucks can typically haul 8,000 gallons, using a specific gravity of 0.75, the 2,047,800 tons are equivalent to 654,680,000 gallons or 81,835 truckloads on a yearly basis. Based on a 6-day-per-week operation, approximately 264 truckloads would be shipped on a daily basis. When one-way trips are considered, this value is doubled, and 528 trips would be produced each day. If all of the trucks were to proceed in the same direction, this additional volume of trucks would raise the CNEL along San Pablo by 3 dBA, along the stretch containing 3,542 average daily vehicles, and would produce a significant (Class II) impact.

If the material is to be removed from the site by train and 550-bbl tank cars are used, approximately 23,945 carloads would be required on a yearly basis. This would amount to approximately 77 carloads per day, or one complete (or two small) trainload(s) per day. This additional rail traffic would raise the Ldn along the railroad lines by approximately 1 dBA and would not produce a significant impact (Class III). Further, a combination of train and truck would probably be used and, as both the road and rail noise would be slightly elevated, no significant impact would be produced (Class III).

Construction Mitigation and Residual Impact - Construction of the pipeline has the potential to create noise impacts (Class II). Applicable mitigation measures to reduce impacts to a level of nonsignificance include the following:

- The pipeline route should avoid residential and sensitive areas if at all possible.
- Pipeline construction should only occur between the hours of 7:00 a.m. (8:00 a.m. on Saturdays) and 7:00 p.m, with no construction performed on Sundays or holidays.
- All internal combustion powered equipment should be equipped with properly operating mufflers and kept in a proper state of tune to alleviate backfires.
- Portable equipment should be located as far as possible from any sensitive areas.
- Portable noise barriers should be used in proximity to sensitive receptors. As the barriers would be lower than the exhaust stacks of the equipment, they would only afford a modicum of noise attenuation. This attenuation will vary with the distance of the equipment and the receptors from the barrier. Additionally, as the construction is short-lived, it should be performed out of the nesting and breeding season for any sensitive bird species located in proximity.

Operations Mitigation and Residual Impact - The trucking of product has the potential to elevate noise levels along San Pablo to levels that are considered significant (Class II). Unocal should be responsible for implementation of the following mitigation to reduce this noise to a level of nonsignificance:

- Where possible, product should be shipped by rail.
- Splitting haul trips between the northwest direction and the southeast direction would produce no significant impact. Furthermore, if truck traffic is held to less than an additional 180 roundtrips (360 trip-ends), no significant impacts would be produced.
- If a larger volume of trucks is to be used, the site should be accessed from the northeast, because far fewer sensitive receptors are located in this area.
- Trucks should not access or leave the site prior to 7:00 a.m. or after 10:00 p.m.
- All trucks should be equipped with properly operating mufflers and kept in a proper state of tune.

Replacement of Crude Via Pipeline from Other Marine Terminals

Impacts would be as predicted for the Replacement of Crude from the Central Valley via Pipeline Alternative. However, here it is assumed that these other terminals would be local and pipeline placement would not take place through developed urban areas.

Thus, the level of impact would be reduced, as would the duration of pipeline construction. Still, if sensitive areas are crossed, significant impacts (Class II) are anticipated.

Mitigation and Residual Impact - Mitigation is as presented for the Replacement of Crude from Central Valley Alternative.

Product Export via Other Marine Terminals

Impacts would be as predicted for the Replacement of Crude via Pipeline from Other Marine Terminals Alternative above.

Mitigation and Residual Impact - Mitigation is as presented for the Replacement of Crude from Central Valley via Pipeline Alternative.

Truck and Rail Import and Export

If the Marine Terminal were no longer available for use, the crude and product import and product export could take place via truck, rail, or a combination of the two. In 1987, 1,200,000 tons of crude and 221,000 tons of product were imported, while 2,047,800 tons of product were exported by tanker; using a specific gravity of 0.846 for crude and 0.75 for product, 339,943,343 gallons of crude and 70,653,521 gallons of product were imported. The import volume could be accommodated by 138 trucks or 54 tank cars per day. Volumes for both truck and rail export of product are as per the Replacement of Crude from Central Valley via Pipeline Alternative. If all materials move by truck (both import and export), 804 one-way trip-ends would be produced, and a significant impact (Class II) would be produced along San Pablo if all trucks were to proceed along the stretch containing 3,542 average daily vehicles. Even if this volume of trucks divides so some proceed northeast while others proceed southwest, either one, the other, or both directions would increase in noise by 3 dBA or more, and a significant (Class II) impact would be produced. If the material were transported by rail, the Ldn would raise by less than 3 dBA and no significant impacts (Class III) would be produced. Finally, a split between both truck and rail would produce no significant impact (Class III) if truck volumes are limited to approximately 180 roundtrips (360 trip-ends) to either the northeast, the southwest, or both.

Mitigation and Residual Impact - Mitigation for vehicle-generated noise is as presented for the Replacement of Crude from the Central Valley via Pipeline Alternative.

Refinery Would Operate at Reduced Levels

Under this alternative there would be a reduction of approximately 25,000 bpd. Both lube and wax shipments would cease. This could reduce product deliveries by truck by approximately four to five trips per day. Subsequently, the loss of 100 jobs would further reduce areal traffic. This would have a beneficial impact (Class IV) by reducing vehicle-generated noise by a small but nonsignificant amount.

Shutdown of Refinery

Under this alternative, the Refinery would be shut down completely, dismantled, and hauled off. Short-term impacts (Class II) could occur if the demolition was conducted on a large enough scale and enough haul trucks were put on the road at any one time. However, this would be extremely unlikely, and the removal of the facility would probably generate fewer daily trips than its current operations. In actuality, a long-term beneficial impact (Class IV) would be produced as Refinery noise would be curtailed completely as would be its vehicle traffic from employees, haul trucks, and rail.

4.8.6.2 Consolidation Alternative

Under this alternative, Pacific Refining Company would share the Unocal Marine Terminal. The Pacific Refining Wharf would be abandoned and demolished. Demolition and removal would be via barge operating offshore as there is no access to shore. Due to its locale away from any sensitive receptors, no demolition impacts (Class III) are anticipated. Furthermore, no traffic-generated noise impacts would be produced. Construction would be necessary to run the new pipelines from the Unocal Terminal to the Pacific Refining Refinery, either on land or at sea. Due to the distances involved to sensitive receptors, no significant impacts are anticipated for the construction; because operations at Unocal would remain as they are and with no additional traffic, no significant operational impacts would be produced.

4.9 EARTH RESOURCES AND STRUCTURE STABILITY

4.9.1 Introduction

The impacts to earth resources and stability of the wharf structure are presented in this section. Earth resources (geotechnical issues) focus on the wharf's susceptibility to damage from earthquakes and from the secondary effects of earth movement, including liquefaction, settlement, tsunami, or shoreline failure. The structural condition of the wharf is examined with respect to corrosion, weathering, fatigue, or erosion, as well as future uses that would involve increased loading.

4.9.2 Impact Significance Criteria

Geotechnical impacts of the Proposed Project are considered to be significant if any of the following apply:

- there is the potential for ground movement that could be detrimental to the structural integrity of project components, or has the potential to damage the facility to the extent that crude or product could be released into the environment; and/or

- there is a potential that secondary effects of seismic ground motion (i.e., liquefaction, settlement, tsunami, shoreline containment failure, and so forth) could result in damage to structures and the release of crude, product, or other hazardous material into the environment.

Structural stability impacts to the project components are considered to be significant if any of the following would occur:

- natural (i.e., corrosion, weathering, fatigue, or erosion) or manmade alteration of the structure could result in reduction of structural safety capacity and/or cause excessive deflections causing the decrease in capacity or use; and/or

- increased loading (i.e., increase of specific gravity of stored materials), vessel size, or vessel numbers could overstress existing facilities and/or cause excessive deflections.

4.9.3 Proposed Project

4.9.3.1 Faulting and Seismic Ground Shaking

The site and the structures on it are susceptible to the effects of strong earthquakes. It is estimated (Working Group on California Earthquake Probabilities 1990) that there is a 28-percent chance that a Richter magnitude earthquake, 7.0 or greater, will occur on the northern segment of the Hayward Fault within the next 30 years, well within the timeframe of the Proposed Project lease. This is not the maximum credible earthquake for the Hayward Fault (see Table 3.8-1), but an estimate of a potential seismic event size and periodicity. Similar probabilities exist for strong earthquakes on other major faults within the San Francisco Bay Area, underscoring the likelihood of a significant seismic event within the lifespan of the project.

No known active faults underlie the site. Thus, fault rupture does not pose a significant impact (Class III) to project components.

In the event of a major earthquake on one of the several active faults in the Bay Area, projected seismic intensities of shaking for the project site may reach VIII to IX (Modified Mercalli scale) (Davis et al. 1982). This is sufficient to cause considerable damage in designed structures, throw some structures off of their foundations, cause conspicuous ground cracking, and break underground pipes (Davis et al. 1982). The potential for structural damage caused by a major earthquake to either the Marine Terminal and its pipelines or the butane tank, as a result of the effects of strong ground shaking is presented below.

Though the area can be expected to experience the effects of ground shaking due to an earthquake on any of the referenced faults (Section 3.8.3), both the Terminal and the butane tank are constructed on piles designed to withstand the credible accelerations produced by these earthquakes.

GeoResources Consultants compared the timber test pile driving data (blows per foot) (Unocal Engineering Drawing No. 52M05-A01, July 17, 1953) with the subsurface conditions encountered in the two test borings (Woodward-Clyde 1970; Geomatrix 1990) completed at the Marine Terminal. Reasonably good agreement on subsurface conditions between the data was found. The pile driving data for the other six test piles were used to estimate the depths to the medium-stiff to stiff silts and clays encountered below the soft Bay Mud deposits at other locations.

On this basis, estimated depths to the medium-stiff to stiff silts and clays may range from 87 feet (EL -70 feet) below the elevation of the concrete at the wharf (elevation 17.2 feet), to 77 feet (EL -60 feet) at the northern half of the approach, and to 67 feet (EL -50 feet) at the southern half of the approach. This information implies that all the frictional support for the Marine Terminal structure's piles is from the medium-stiff to stiff silts and clays.

Thus, the Marine Terminal and its connecting wharf are founded on piles extending through the Bay Mud and significant thicknesses of cohesive soils into dense sands and bedrock. In addition to withstanding earthquakes, the Terminal was designed to withstand the impact loads caused by the mooring of ships and wind and current loads. Because other loads would be higher than anticipated seismic loads, it is expected there would be no significant adverse impact (Class III) to the Marine Terminal during a maximum credible seismic event.

If a seismic event would occur during a loading/offloading operation, the potential for release of crude oil, product, or hazardous materials from the Marine Terminal pipelines is considered remote because the offloading and piping system is flexible at critical locations. However, in a major event, pipelines, valvings, support bracings, and so forth, could fail, resulting in a significant Class II impact.

4.9.3.2 Seismic Induced Secondary Effects (Liquefaction, Differential Settlement, Lateral Spreading, and Lurching)

Secondary effects of seismic ground motion have the potential to result in damage to or degradation of project components. These effects include liquefaction, differential settlement, racking, and tilting.

Liquefaction

The Marine Terminal and its connecting wharf structure are adequately supported by vertical and battered piles founded on dense sands and bedrock. In the 1989 Loma Prieta earthquake, no damage to wharves of similar construction was reported (Benuska 1990). The potential impact to the wharf structure from liquefaction is considered to be adverse, but nonsignificant (Class III).

The area beneath the butane sphere is comprised of fill material with a high water table similar to those conditions of the Marina District of San Francisco, which experienced extensive damage to structures and utilities from the 1989 Loma Prieta earthquake. These filled land areas are susceptible to the effects of liquefaction. Whether damage from liquefaction could occur to the butane sphere facility depends on the adequacy of the pile foundation support. Lack of such information leads to a conclusion of potentially significant adverse impact (Class II).

Differential Settlement

The settlement of structures founded on weak soils, particularly Bay Mud and artificial fill materials, is exacerbated by seismic shaking. The shoreline acreage at the Unocal Refinery has the potential for a similar response in the event of severe ground shaking. A potential for damage to the butane sphere containment berm, paved areas, rail spur, and to the riprap lined shore as a result of seismically induced differential settlement exists. A potentially significant adverse impact (Class II) results.

Lateral Spreading

Because fill areas within the project area are generally confined behind manmade barriers and embankments, the potential for lateral spreading is low. There is, however, some potential for spreading by Bay Mud in the vicinity of the riprap lining the margins of the shoreline acreage from seismic ground shaking. This could result in damage to the riprap wall, depending on the force of the shaking and strength of the Bay Mud. However, the Mud has been surcharged by fill for decades, and the potential for spreading is much reduced. There is some potential for damage to the butane sphere as a result of seismically induced lateral spreading if the pile foundations are not adequately supported in firm materials beneath the Bay Mud. A potentially significant adverse impact (Class II) results.

Lurching

The area on the project site most susceptible to lurching from seismic ground shaking is the riprap lining the shoreline acreage. The riprap, piled on the bayward face of the shoreline acreage, consists of boulders of concrete rubble and rock up to 24 inches in diameter. Some ravelling of material could occur during an earthquake, reducing the effective erosion protection of the barrier; there is a potential for a significant adverse impact (Class II) to the project as a result of ravelling of riprap material.

4.9.3.3 Tsunami Potential

It is estimated that a tsunami with a wave height or runup of 20 feet could pass through the Golden Gate every 200 years (Ritter and Dupre 1972). As a result of attenuation within the Bay, a 20-foot wave would diminish proportionately eastward and farther into the Bay toward the site. The wave height would be less than 2 feet when it arrived at the site.

Mean higher high water at nearby Selby (less than 1 mile east) is 6.3 feet (Bill Watson, personal communication 1992). If a tsunami of 2-feet wave-height arrived at the highest high tide of the year, it would not overtop the riprap lined shore, which stands at an elevation of about 13 feet. The effects of such a wave are considered to be nonsignificant (Class III).

4.9.3.4 Structural Conditions of Terminal and Butane Facility

Marine Terminal

Based on a review of all the available data, estimated capacities of the existing 18-inch-square concrete piles under combined dead and live load conditions for a factor of design (F.D.) of 2.0 are as follows:

Locations	Bearing Capacities, (F.D.=2.0)
At the Wharf	33 tons
Northern Half of Approach	40 tons
Southern Half of Approach	47 tons

To resist transient seismic and wind loads, the above values can be increased by one-third with a factor of design of 1.5. For consideration of their adequacy during a major earthquake event without reducing foundation support of the Marine Terminal to point of failure, the values in the above table can be increased by 74 percent with a factor of design of 1.15. Thus, the present design of the approach structure, wharf, and dolphin are adequate for the ongoing use of the facility for the anticipated mooring and deck loads.

Given the long-term nature of the proposed lease, if mooring of larger displacement vessels would be a future consideration, there could a potential for structural impacts related to the dolphin and/or wharf from wind and current loads transferred from the vessel into the wharf, mooring tension loads on deck restraints, and berthing loads (higher inertia because of mass, even though the speed is the same). These could result in potentially significant adverse impacts (Class II) to the structural integrity of the pier.

It is possible, however, for an accident to occur if a mooring vessel rams the wharf (see Risk/Safety Section 4.2). These vessels are sometimes assisted by tugs, but are moored during all weather conditions. On at least one occasion, there was damage to the fendering piles, which if are not in good condition, could result in wharf damage. The present structural condition of the Marine Terminal indicates that corrosion of the structural steel in batter piles and reinforcing steel in cast-in-place beams may have reduced the load carrying and transferring capacity of these members. Damage is also apparent directly under the VRS and one bent closer to shore. Over time, these conditions are expected to be exacerbated and, eventually, tbe factors of design will be reduced to unacceptable levels, resulting in the potential for significant impacts (Class II) from failure or excessive deflections.

Numerous preventive maintenance measures can be applied to mitigate these impacts. Secondary significant impacts (Class II) could also occur if pipes fail in the pipe runs and spill crude or product into the Bay as previously presented in Section 4.2.

Butane Storage

Specific subsurface conditions immediately beneath the butane sphere are uncertain. Data were interpolated from two borings drilled 300 to 400 feet away to make a preliminary evaluation of the subsurface conditions. If data from these borings (DM-1 and DM-2, Dames and Moore 1948) are representative of the subsurface conditions beneath the butane sphere, the cast-in-place reinforced concrete piles would bear into the firm sands and shales that underlie soft clays. Assuming confirmation that the cast-in-place reinforced concrete piles were, in fact, extended deep enough into the firm sands and shales (similar to those encountered in the Dames & Moore's borings), the existing piles should support the present 30-ton design load with a factor of design of 2; and up to 40 tons with a factor of 1.5 to resist transient wind and seismic loads. The capacity of the existing piles for renewed loads such as additional structural and/or seismic loads, cannot be assessed without further construction data or subsurface information at the site.

No significant structural adverse impacts (Class III) are foreseen from the continued use of the spherical tower-supported storage tank for butane use. If the tank is used later to store material of a heavier specific gravity, it is possible significant (Class II) static, pseudodynamic, and overturning impacts could result.

4.9.4 Cumulative Impacts

The marine and industrial facilities located along the shoreline of the San Francisco Bay are susceptible to potential damage resulting from a strong earthquake on active faults in the region. The Port of Oakland experienced severe liquefaction damage to fill areas in the 1989 Loma Prieta earthquake; refineries reported stretched anchor bolts on vertical vessels and extensive tank damage where such structures were located on soft-soil sites (Benuska 1990). The primary and secondary effects of strong ground shaking may cause significant levels of damage to container terminals constructed on fill by toppling cranes, rupturing pipelines, and causing failure of large storage tanks at refineries all producing a significant (Class I) impact. Wharves, constructed on vertical and batter piles into bedrock and designed to withstand large lateral forces, experienced no damage in the quake. There are no significant impacts (Class III) expected from the effects of earthquakes for these wharves in the cumulative environment.

A 20-foot tsunami passing through the Golden Gate has the potential to damage shoreline marine and industrial facilities at the Ports of San Francisco, Oakland/Alameda, Richmond, as well as naval terminals at Treasure Island, Alameda, and Point Molate. Outside the immediate areas of San Francisco Bay, abutting or facing the Golden Gate, the potential for damage from a tsunami is much reduced.

4.9.5 Significant Impacts, Mitigation Measures, and Residual Impacts

4.9.5.1 Unocal Responsibilities

Impact - There is the potential of oil spillage from the Terminal infrastructure from a major seismic event (Class II).

Mitigation and Residual Impact - A routine inspection program of the pipelines, valvings, and supporting bracings should be conducted. The inspection program should consider the condition of these elements with respect to seismic integrity. Seismic retrofit incorporating design for expected large earthquakes at any weakened or deteriorating areas, should be performed to reduce any impacts to a level of nonsignificance.

Impact - The secondary effects of seismic ground motion have the potential to result in significant (Class II) impacts.

Mitigation and Residual Impact - Within the shoreline acreage, densification of loose foundation materials, surcharging of areas prone to liquefaction, special grouting techniques, and local lowering of the water table in areas subject to liquefaction, may be necessary. Flexible piping and connections on the wharf are recommended, where not already in place.

Soil stability analyses shall be required to determine the condition of subsurface materials in the vicinity of the butane sphere. Future borings should be conducted, as necessary to supply pertinent soil data. The removal of deleterious soils in specific areas, as a result of stability analyses, should be conducted, as necessary. The potential for some damage to the shoreline portions of the site will be reduced to a level of nonsignificance.

Surveys of the shoreline portions of the site should be performed after seismic events to determine whether settlement has occurred. If it is determined that settlement has occurred, it will be necessary to bring the affected area(s) back up to grade by placing additional fill material. Along the shore, additional riprap may be required. Impacts would be reduced to nonsignificant.

Periodic inspection of the riprap lining of the shoreline is recommended to track any lateral spreading and lurching. Some damage to the shoreline portions of the site from the effects of seismically induced lateral spreading and/or lurching would require repair through reinforcement. The impact would be reduced to nonsignificant.

Impact - Recent inspection of the Terminal has discovered potential deficiencies in the structural integrity of the wharf. Both the wharf and the butane tank could be susceptible to significant structural (Class II) impacts.

Mitigation and Residual Impact - This potential impact can be mitigated to a level of nonsignificance by the following measures:

- Unocal shall conduct a structural and safety system audit of the Terminal in concert with the SLC and a third party consultant as described in the Commission's "Marine Terminal Audit Program" document. The purpose of the audit is to:
  - identify safety system, mechanical, electrical, and fire detection and suppression deficiencies;
  - identify structural damage or weaknesses that might affect the continued fitness-for-purpose of the facility;
  - advise whether these deficiencies have been properly assessed; and
  - advise what safety improvements should be taken to correct, prevent, or minimize these potential hazards.

  The audit will be conducted with teams composed of SLC, Unocal, and consultant personnel. Upon completion of the audit, Unocal shall implement the safety improvements in accordance with a scheduled plan.

- To prevent or minimize damage to the wharf and vessel, Unocal shall install an Allision Avoidance System (AAS) that provides information to the vessel master regarding the approach rate to the wharf.

- The approach structure and wharf should undergo a thorough structural inspection in order to evaluate the remaining life of the structures, identify members that need immediate replacement or repair, and develop a preventative maintenance program. Repair should be made to the wharf under the VRS and one bent closer to shore.

- In the future, if larger displacement vessel(s) are intended to be moored at the facility, an evaluation shall be made by a California registered civil engineer or structural engineer as to whether the loads imposed by the vessel(s) can be adequately and safely carried by the structures. This evaluation should be made in accordance with U.S. Army Corps of Engineer's design criteria or with U.S. Navy's NAVFAC DM-25 and DM-26 criteria. Any potential impacts would be reduced to nonsignificant.

- In the future, if different material, besides butane, shall be stored in the spherical tank, then an evaluation shall be made by a California registered civil engineer or structural engineer as to whether the loads imposed can be adequately and safely carried by the structure under both static and dynamic loading conditions. The SLC shall have the opportunity to review such reports. Compliance with this measure will reduce any potential impact to nonsignificant (Class III).

4.9.5.2 Cumulative Actions

Impact - Cumulatively, facilities constructed on fill in the San Francisco Bay Area could result in significant (Class I) impacts from seismic events.

Mitigation and Residual Impact - The potential for seismic damage to structures at shoreline marine and industrial facilities within the cumulative environment remain, regardless of precautionary steps taken. Inspection of existing facilities at marine and industrial facilities, and seismic retrofitting, where needed, are recommended. All new structures should incorporate design for maximum credible earthquakes on faults within the region.

Inspections conducted to ensure seismic preparedness and proper design for maximum credible earthquake should be sufficient for tsunami, as well. Facilities, likely to be impacted by tsunami (near the Golden Gate), should develop and have ready a plan for evacuation in the event of a tsunami.

4.9.6 Alternatives Analysis

4.9.6.1 No Project Alternative

Pier Structure Scenarios

If the Marine Terminal is withdrawn from use and is dismantled in part or in entirety, the effects of strong ground shaking, including liquefaction, settlement, lateral spreading, and lurching would result in no adverse significant impacts because there would be no structures or operating facilities to be damaged. Because the pipeline and pumping infrastructure would be removed, any spills into the Bay from damaged lines would not occur. This would result in a beneficial impact (Class IV).

Refinery Scenarios - Continued Operation at Current Capacity

Cessation of the use of the Marine Terminal would require alternative transportation scenarios for delivering crude to and some product export from the Refinery. The San Francisco Bay region is seismically very active; any pipeline or overland transport scheme would be subject to some element of risk from disruption by a major earthquake in the region: consequences include possible rupture of pipeline, or damage to surface roads and/or rail systems.

Pipelines are generally constructed with some tolerance for flexure. During the 1989 Loma Prieta earthquake, only one pipe main failure as reported: a buried 20-inch water line ruptured at an overrestrained elbow (Benuska 1990). However, where pipelines cross areas of contrasting support conditions, ruptures may be anticipated (Davis et al. 1982). While connections at Terminal facilities are also vulnerable due to the differing response between buried pipe and rigid structures, flexible connections can help to reduce any significant impact. Generally, no significant adverse impact (Class III) would be expected from pipeline rupture up to the maximum credible earthquake design of a pipeline. Corrosion of aged pipelines, vandalism, or damage can result in significant impacts (Class II).

Rail systems in the San Francisco Bay Area are vulnerable to disruption by earthquake because track alignments must be precise and the track clear of debris. Davis et al. (1982) envision a scenario in which the principal rail corridors leading to the Bay Area would be subject to major damage in the event of a Richter-magnitude 8.3 earthquake on the San Andreas Fault in the Bay Area. Rail systems in some locations are constructed on land reclaimed from coastal areas underlain by Bay Mud. Normal rail operations may be temporarily disrupted by relatively minor displacements of rail alignments as a result of fault rupture, liquefaction, lateral spreading, settlement, and lurching. If materials were to spill during a seismic event, significant impacts (Class II) would result.

The consequences of a pipeline or overland spill could result in impacts to other environmental resources as presented in other sections of this document.

Mitigation and Residual Impact - Mitigation to minimize seismic hazards to new pipelines is through careful route evaluation and engineering design and placement of safeguards within the pipeline system. Also, periodic inspection and retrofit of pipelines as they age must be conducted to safeguard against breakage due to corrosion.

Mitigation for spills from rail mishaps include adherence to spill response and control measures as set forth by regulatory requirements. Because Unocal would contract out rail shipment services, spill cleanup would be beyond Unocal's responsibility.

Refinery Operation at Reduced Levels or Shut Down of Refinery

With no new lease, there could be a reduction or closure of Refinery operation. There would be a reduced potential for release of materials from structural damage if the Refinery volume were lowered (Class IV impact). With no Refinery, there would be no impacts resulting in the release materials during a seismic event because there would be no materials to release. Other concerns would result if the Refinery were to close, including issues associated with dismantling of the Refinery and concern for contaminated soils and the ability to use the site for other purposes.

4.9.6.2 Consolidation Alternative

Consolidation of the Pacific Refining Refinery and Unocal Terminals to the Unocal Marine Terminal would require Pacific Refining Company to abandon and remove its marine terminal. In this case, the impacts and mitigation measures as presented above for the Proposed Project would apply. No new geologic or seismic impacts are foreseen.

4.10 AESTHETICS

4.10.1 Introduction

Impacts to the visual environment are presented for continuation of operations of the Marine Terminal, as well as for the consequences of the No Project Alternatives and the Consolidation Alternative. The impacts of normal operations and accident conditions resulting in visual oiling of the water and shoreline are presented for the Unocal Marine Terminal, the Bay, and for the outer coast.

4.10.2 Impact Significance Criteria

4.10.2.1 Description of Visual Impact Significance Methodology

Studies of visual perception uses factors, such as visual character, visual compatibility and viewer sensitivity, as measures to determine impact significance. Visual character can be defined as landscapes composed with a distinctive variety of form, line, color, and/or texture and are made up of elements such as landforms, structures, water, and vegetation patterns. The visual character of a site may be composed of a combination of the existing elements of foreground (close-in shubbery and trees), middleground (lake or water body), and background (distant rolling hills) as strong visual elements. The stronger the influence exerted by these elements, the more interesting the landscape.

Visual compatibility (or incompatibility) is determined by the degree to which the introduction of an anomalous structure or element into the visual landscape blends in or is compatible with the existing landscape. Proximity and relative scale are factors used in defining compatibility.

The level of significance of modifications to a viewshed is further defined by viewer sensitivity. Viewer sensitivity is a noneconomic measure of public concern for scenic quality. It is a measure of the changes in the expectation of viewers, and the relative importance of viewsheds to those who have views of a particular site. Factors contributing to sensitivity include character and compatibility, as well as duration. Duration is the relative time that the project component would be visible either to a permanent or mobile viewer. For the Proposed Project, examples may include other shoreline properties which view the Marine Terminal, recreational users in the Bay, who see the Terminal and/or activities in shipping lanes, and viewers from other shoreline areas that may be subject to affects of tanker accidents and oil spills.

4.10.2.2 Impact Criteria

Impacts for visual assessments are considered to be significant if one or a combination of the following apply:

- changes at the site, including changes to form, line, color, and/or texture, substantially degrade the character of the site, degrade an existing viewshed, or alter the character of a viewshed by the introduction of anomalous structures or elements; and/or

- changes at the site that result in changes in the expectations of viewers (measured against the relative importance of those views) and result in a negative impression of the viewshed.

Because of the time factor involved in oil dispersion, impacts are considered to be Class I if residual impacts would remain for greater than a 3-month time period.

4.10.3 Proposed Project

This analysis considers the occurrence of accidental spills as separate from normal operations. In general, the potential impacts resulting from such an occurrence will degrade the visual quality of the water and shoreline encountered with spilled materials. The degree of impact is influenced by factors not limited to location, spill size, type of material spilled, prevailing wind and current conditions, the vulnerability and sensitivity of the shoreline, and response capability.

The greatest risk of a spill is that of small accidents at the Terminal during normal operations. While there is less risk of spill during tankering, the size of a spill that could result is much greater. The areas most susceptible to oiling have been shown in the probabilistic modeling as presented in Section 4.2. Oil spill modeling also has been conducted to model the migration of 12 possible oil spill scenarios. These represent possible paths of migration under variously defined conditions, but do not represent every possible spill that would occur. The following discusses, in general terms, the potential visual impacts reasonably expected to occur in the event of a spill.

4.10.3.1 Analysis of Continuation of Existing Operations

<u>Routine Operations</u>

The Proposed Project would not result in any changes to the visual environment over those presently existing. The Terminal blends into the surrounding industrial environment. No changes to form, line, color, or texture will result. The Terminal and Refinery have been in place for many years. The public's perception of these structures is that they are part of the Refinery operation. Thus, public sensitivity toward these structure is low and because there are no proposed changes to the structures, there will be no changes in viewer expectations. No significant (Class III) impacts would result.

Unocal tanker movements within the Bay are a portion of the cumulative visual activity that has occurred in the Bay for years. No changes are proposed to this activity and no impacts would result. Public sensitivity is such that tanker movements are acceptable visual actions in the Bay. The expectations of the public would not change from activity under the Proposed Project. No significant (Class III) impacts will result.

Unocal tanker movements along the outer coast are a portion of the generally accepted visual activity. No changes are proposed to this activity and no impacts will result. Public sensitivity is such that tanker movements are acceptable visual actions in the shipping lanes. The expectations of the public would not change from activity under the Proposed Project. No significant (Class III) impacts would result.

<u>Accident Conditions</u>

Spills originating at or near the Marine Terminal have the potential to impact the north portion of San Pablo Bay and into Carquinez Strait as shown in Scenarios 1, 2, 3, 4, 7, and 8. Spills along the shipping channel in the Bay have the potential not only to impact San Pablo Bay, but also to the south in San Francisco Bay. Visually, oiling conditions could range from light oiling, which appears as a surface sheen, to heavy oiling including lumps of floating tar. Shoreline marina and pier facilities that would be impacted by the various scenarios are presented in Appendix H, Tables H-3 and H-5.

The presence of the oil on the water would change the color and, in heavier oiling, textural appearance of the water surface. The presence of the oil on shoreline surfaces or nearshore marsh surfaces would result in the covering of these surfaces with a brownish to almost blackish slick to a gooey covering. Duration of the impact has the potential to last for long periods of time, depending on the level of physical impact and cleanup ability. In events where light oiling would disperse rapidly, significant (Class II) impacts can generally be expected. In events where medium to heavy oiling is encountered over a wide-spread area, and where cleanup efforts and residual effects of oiling may be observed for periods in excess of 3 months, significant (Class I) impacts can generally be expected. The physical effort involved in cleanup in itself, including the equipment that would be used, would contribute to the visual impact.

In addition, the sensitivity of the area to viewers tends to change during such events. The public, as they become aware of a spill situation, generally reacts negatively to the visual effects of a spill event. Sensitivity levels become high and changes in viewer expectations could turn negative. Thus, unless a spill is contained by immediate booming and cleanup, the visual effects of even a relatively small spill of 500 bbl can be significant (Class II).

Spills along the outer coast have the potential to result in significant impact (Class I and Class II), as spills would change the color and texture of water and shoreline conditions. The level of public sensitivity and expectations along the outer coast shoreline has more variation than that of the Bay. Along many portions of the outer coast, public usage is low. In such areas, the public perception and expectations of viewers would not change. However, in outer coast areas where coastal park and beach areas, ecological preserve areas, communities and harbors exist, and any other areas where there are viewers, visual sensitivity to spills could become high and significant impacts (Class I and Class II) will result. Coastal access points were previously shown on Figure 3.10-3.

4.10.3.2 Analysis of Future Operations

Over the long-term, it is expected tankering activity may increase by as much as 60 percent. This would result in an increased risk of accidents, both during normal operations and tankering; however, no significant visual impact (Class III) would occur. The impacts remain the same in the event that a spill or accident occurs.

4.10.4 Cumulative Impacts

4.10.4.1 Routine Operations

The Proposed Project and other ongoing and foreseeable projects in the Bay Area would continue to approximate existing visual conditions. No actions are expected that would result in significant changes to the visual environment.

4.10.4.2 Accident Conditions

A spill can begin as a very localized incident and spread over a very large area. If more than one spill event would occur within a very short timeframe within the bay, significant visual impacts (Class I or II) would result.

4.10.5 Significant Impacts, Mitigation Measures, and Residual Impacts

4.10.5.1 Unocal Responsibilities

Impact - Oil spills have the potential to result in significant (Class I and II) visual impacts upon surface waters and shoreline landforms.

Mitigation and Residnal Impact - Mitigation measures for oil spill impacts include those measures provided for contingency planning and response in Section 4.2 and for biological resources in Section 4.4. These measures would provide for minimizing oil spills and maximizing cleanup efforts, resulting in less impact to the visual environment. Even with such mitigation, the visual effects of a spill would remain significant (Class I or II) until natural dissipation occurs. Depending on the severity of a spill, any areas still impacted after 3 months would be considered as Class I impacts.

When planning for oil spill response equipment and locational needs, consideration should be given to the visual effects of the storage and placement of this equipment. Where equipment may be stored in areas of visual sensitivity, such as near ecological areas, storage sheds should be designed to blend in with any other structures, and should be painted compatible colors or screened with vegetation, which is also compatible with the surrounding vegetation in the area. This would reduce any visual incompatibility or intrusion the storage structure may have. Visual impacts would be reduced to a level of nonsignificant with the use of this measure.

4.10.5.2 Cumulative Actions

Impact - Oil spills have the potential to result in significant (Class I and II) visual impacts.

Mitigation and Residual Impact - No effective cumulative mitigation is available after a spill occurs. Cleanup efforts help reduce the length of time the residual effects would have on the visual environment. Visual impacts would remain significant (Class I or II) until natural dispersion occurs over time. Mitigation planning includes contingency planning and review of all marine terminals and tankering the Bay for spill potential. Such efforts are presently underway by response contingency planning agencies as presented in Section 3.1.

4.10.6 Alternatives Analysis

4.10.6.1 No Project Alternative

Pier Structure Scenarios

Abandonment In-Place of Pier Terminal

If the Marine Terminal is abandoned and left in place, the Terminal would essentially remain as described in existing conditions. Based on the assumption that general maintenance is performed for the pier, no impacts would result (Class III). However, over a long period of time, without maintenance, the pier could suffer visually from the effects of neglect. Because the number of viewers in proximity to the Terminal is small, impacts would be considered to be adverse, but not significant (Class III).

Abandonment and Removal of Pier

If the Marine Terminal were abandoned and removed, adverse, but not significant, impacts (Class III) could occur during the removal process. This is assuming that one or two barges worked offshore, and heavy equipment onshore, during the removal process. This process would be of a duration of approximately 3 to

4 months. Because the work would be localized to the immediate area of the pier, and because barges and equipment are typical of activity in industrial water-borne areas, impacts would be considered to be adverse and not significant (Class III). After deconstruction, a slight beneficial (Class IV) visual impact will result.

<u>Refinery Scenarios - Continued Operation at Current Capacity</u>

Without the Marine Terminal, crude intake would need to be obtained from other sources. These could include construction of a new pipeline from the Central Valley to a common carrier or to other marine terminals from the Unocal Refinery, or from an increase in truck and/or rail transport. Temporary significant visual impacts (Class II) could occur within areas of pipeline construction. These would result from the visual impact of grading, trenching and pipeline placement. Areas of greatest potential for significant impact would include non-industrial areas and areas determined to be of high visual sensitivity. This may include unique open space, park, or other landforms, or areas containing visually interesting vegetation covers that could be lost. Potential for residual impact from the scarring of the landscape until regrowth occurs exists in such areas. In some areas, revegetation occurs only over long periods of time.

Increases in truck and rail traffic have the potential to result in a visual impact due to the addition of vehicles. While no viewsheds are actually affected by the placement of more vehicles, more vehicles or trains travelling through an area can become visual annoyance. As presented in Section 4.7 (Traffic), if all materials were to move by truck, there would be an additional 528 one-way trip-ends. This would add to the visual disturbance of trucks on the roadway and the sensitivity of viewers, especially nearby residents and businesses, would rise. A nonsignificant visual (Class III) impact would result. Rail transport would not be significant (Class III), requiring only 54 tank cars. These would most likely be added into existing rail transport or accommodated by the addition of one train per day.

<u>Mitigation and Residual Impact</u> - Mitigation measures for areas affected by pipeline construction vary, but generally include repaving, or revegetation to existing conditions to reduce any impact to nonsignificant.

<u>Refinery Would Operate at Reduced Levels</u>

Reduced Refinery operation would not result in a significant change to the visual environment. It is expected that some portions of the Refinery would slow or shut down; however, the general character of the Refinery would remain the same. No significant impacts (Class III) would result. The Marine Terminal would be abandoned in-place or removed as presented above.

<u>Shut Down of Refinery</u>

If the Refinery were to close, with the facility totally dismantled and the site cleaned up, the visual effect of this in the nearby community could result in a variety of visual effects. In the most likely scenario, the facility would be retained for other industrial uses, and the visual effect would be similar to that of the existing Refinery. If commercial or low intensity industrial uses were put in, refinery structures would be replaced with one- to two-story buildings. No significant impacts (Class III) would result from these types of uses. If the site were converted to open space or recreational uses, the visual effect would be most substantial. The general expectation of the community would most likely be that of a beneficial visual change (Class IV impact) in the general area. There could be obstacles to the site for public use, including its cleanup for hazardous waste materials.

4.10.6.2 Consolidation Alternative

Consolidation of the Unocal and Pacific Refining Refinery Terminals at Unocal would result in little visual effect in this part of San Pablo Bay. The localized area in the vicinity of the Unocal, Pacific Refining Company, and Wickland Terminals comprises only about 1¼ miles of an area that is highly industrial. From the shoreline, change would include the elimination of the Pacific Refining Wharf, an offshore structure. No significant impacts (Class III) would result. Public sensitivity to the area would also not be changed to the negative. A slight beneficial impact (Class IV) could result for some of the residential communities in Rodeo that have views of the Pacific Refining Company or Unocal Terminals. This is expected to be slight, as the industrial nature of the nearshore environment, which is the primary focus of the viewer, would not change.

4.11 LAND USE/RECREATION

4.11.1 Introduction

Impacts to land use, including both shoreline and water-related recreational resources, are presented in this section. Discussions focus on normal terminal operations as well as oil spill accident conditions that have the potential to impact land use and recreational resources at the Marine Terminal, within the Bay, and along the outer coast.

4.11.2 Impact Significance Criteria

Land use/recreation impacts are considered significant if the following apply:

- the Proposed Project or the alternatives would result in conflicts with established and proposed land use or recreational policies and adopted general or specific plans,
- the Proposed Project or the alternatives would result in a conflict with current and/or projected recreational uses, and/or
- vessel operations or oil spills would result in substantial disruption or reduction of areas used for recreational boating, or shoreline recreation.

Because of the time factor involved in oil dispersion, impacts are considered to be Class I if residual impacts will remain for a period exceeding 3 months.

4.11.3 Proposed Project

In general, no significant impacts result from normal operating conditions. However, the potential impacts resulting from oil spill occurrences would degrade or preclude the use of shoreline land and/or recreational activity at the site of the spill and to the areal extent of its oiling. The degree of impact, however, is influenced by many factors including, but not limited to, spill location, spill size, type of material spilled, prevailing wind and current condition, the vulnerability and sensitivity of the resource, and response capability.

The risk of spills hitting various water and shoreline areas was presented through probabilistic modeling and discussed in Section 4.2. The greatest risk of spills occurs at the Marine Terminal. In general, these are small spills that can occur during normal operations. There is less chance of a spill occurring from a tankering accident; however, such an event generally results in a much larger and more severe spill. For representative examples, oil spill modeling was conducted to model the migration of a spill under 12 different scenarios. These models represent possible paths of migration under variously defined conditions, but do not represent every possible spill that could occur. The following discusses, in general terms, the potential land use and recreation impacts that are reasonably expected to occur in the event of a spill.

4.11.3.1 Analysis of Continuation of Existing Operations

Routine Operations at Marine Terminal

The Proposed Project would not result in any conflicts with existing land use designations or policies. The continuation of existing operations would be allowed upon granting of the new lease for the Unocal Marine Terminal at Rodeo. Because no physical change of the existing Terminal is proposed under this action, no changes in the existing land uses are expected. Therefore, no changes in the current County land use designation or zoning would be required. No significant adverse land use impacts would result.

Existing recreational uses adjacent to the Terminal would not be affected. Access through the site via San Pablo Avenue/Old Highway 40 would remain the same. All existing open space, parks, waterfront, and recreational uses in the surrounding areas such as Bennett's Marina in Rodeo and marinas into Carquinez Strait, would remain accessible to the public. Shoreline access points for fishing including piers would not be affected. Therefore, no adverse or significant impacts are expected.

Planned recreational land uses by the County and the EBRPD include the development of a recreational bicycle trail that would run along San Pablo Avenue through the Unocal Refinery (see Section 3.10.1.3). The Refinery and the Terminal preempt the use of the shoreline for recreational uses (Class II impact). Dedication of right-of-way or an easement from Unocal would be required in order to develop the required trail improvements as a part of the overall trail system plan which would connect Lone Tree Point in Rodeo with the Carquinez Strait Regional Shoreline east of Crockett.

Accident Conditions at Marine Terminal

Oil spill modeling Scenarios 1, 2, 3, 4, 7, and 8 show that oil spills originating at or near the Marine Terminal would potentially impact the project site, Carquinez Strait, as well as northern sections of San Pablo Bay, including the San Pablo National Wildlife Refuge and the southern shoreline around Wilson Point at Pinole. Because this modeling is representational, it does not preclude the fact that other areas may also be contacted by oil given the right wind and current conditions. Recreational facilities that could be affected include the Martinez and Point Benicia Fishing Piers, Point Pinole Regional Shoreline, Point San Pablo Yacht Harbor, Crocket Marine Service and others listed in Appendix H, Table H-3. Shoreline and water-related uses at these facilities as well as the Marine Terminal would be disrupted by the presence of oil on the shoreline and in the water. Tankering would be stopped and operations at the Terminal would be slowed or stopped for potentially long periods of time depending on the amount of oil present and the amount of cleanup required. Refinery operations would most likely continue, but levels of production may vary if loading and transport of oil is slowed or stopped. Immediate spill response and containment by booming would also influence the extent of impacted shoreline. Oiling of the shoreline that occurs to the east has the potential to disrupt Terminal operations at the Wickland Oil Selby Terminal. Transport ships and other vessels would be rerouted around or away from the spill area. Barge shipments and other vessels may also be barred from entering/leaving Carquinez Strait until cleanup or dissipation occurs, affecting land-related operations in other portions of the Bay. Overall, impacts would be significant (Class I or II).

While there are no recreational uses at the Terminal site, limited fishing off the Terminal is available to Unocal personnel, but not to the general public. In the event of a spill at the Terminal, this occasional activity would be disrupted. No shoreline recreational areas are present immediately to the north (Wickland Oil Selby Terminal). Further east, residential marinas located in Crockett can be impacted by a spill as it progresses through the Carquinez Strait. To the west, there is potential for an oil spill to impact the waterfront area in Rodeo, as shown in Scenarios 3, 4, and 7 including Joseph's Fishing Resort and Bennett's Marina. Oil on the shoreline and in the water would disrupt recreational activities and limit or preclude access to harbors, marinas, fishing piers and the Bay for boating and fishing activities during the spill and cleanup, resulting in a significant (Class I or II) impact. Access, via inland routes to coastal parks, trails, and other areas, to view the scenic coastline would not be disrupted by an oil spill into the Bay; however the quality of views enjoyed from these areas would be degraded. Visual impacts of oil spills at the Marine Terminal are further discussed in Section 4.10.

Routine Operations within Bay

Under the Proposed Project, tanker movements to and from the Unocal Marine Terminal and the associated activity on land during normal operations would continue as they currently exist. No changes in land use designation or zoning would be required; therefore, no impacts will result (Class III).

Accident Conditions within Bay

Portions of the San Francisco/San Pablo Bay shoreline and the Carquinez Strait would be impacted by an oil spill as shown under all the modeled Scenarios 1-12. As discussed above concerning spills at or near the Terminal, oiling of shoreline in other locations throughout the Bay would result in the disruption of shoreline and waterfront-related uses and recreational uses. In addition, there are extensive areas of sensitive and protected marshlands, wetlands, and ecological preserve areas at the north and south ends of the bay and to the east in Suisun Bay. Access to these areas via inland trails would not be affected; however, access via boats from points throughout the Bay may be limited by spills spreading through the Bay. In addition, the presence of oil will result in a degradation and reduction of these areas as prime, undeveloped coastal habitat and open space.

Recreational boating and fishing activities within the Bay in the area of the spill would be precluded for a period of time. The area impacted would depend on the extent of the spill and cleanup activities. Modeling shows that under Scenarios 2, 3, 4, 8, 9, 10, and 11, both marinas and piers would be affected. Appendix H (Tables H-3 and H-5) presents the modeling results. The resulting impacts to shoreline uses and recreation in the Bay would be significant (Class I and II). A summary of the results for those scenarios is presented in Table 4.11-1.

For example, Scenario No. 3, a 20,000-bbl crude spill from the tanker route under January wind and ebb tide conditions (Figure 4.2-3) shows wide spread oiling

Table 4.11-1

NUMBER OF MARINAS AND PIERS IMPACTED BY SCENARIO BY SUBAREA

Scenario	Subarea	Number of Marinas		Number of Piers	
		Subarea	Impacted	Subarea	Impacted
2	Carquinez Strait	5	4	2	2
3	Carquinez Strait	5	5	2	2
	Central San Francisco Bay	27	5	9	1
	North San Francisco Bay	7	4	1	1
	San Pablo Bay	11	4	3	2
4	Carquinez Strait	5	5	2	2
	San Pablo Bay	11	2	3	0
8	Carquinez Strait	5	2	2	0
	San Pablo Bay	11	1	3	0
9	Carquinez Strait	5	1	2	0
	Central San Francisco Bay	27	23	9	8
	North San Francisco Bay	7	3	1	1
	Richardson Bay	8	8	0	0
	San Pablo Bay	11	2	3	1
	South San Francisco Bay	34	6	7	2
10	Central San Francisco Bay	27	23	9	9
	North San Francisco Bay	7	1	1	1
	Richardson Bay	8	4	0	0
	South San Francisco Bay	34	7	7	1
11	Southern, South San Francisco Bay	5	2	1	1

with beached oil all along the southeastern shoreline of San Pablo Bay from Pinole Point well into Carquinez Strait. Beached oil would result at Mare Island and the southern end of Vallejo as well. Recreational facilities including those at Rodeo, Crockett, and Benicia would also be affected.

As another example, Scenario No. 9, which is a 100,000 bbl crude spill near Alcatraz under March wind and flood tide conditions shows significant oiling in central San Francisco Bay which also extends into San Pablo Bay (Figure 4.2-9). Beached oil would occur around Treasure Island, Angel Island, Alcatraz, part of the north and most of the eastern shoreline of San Francisco (including Fisherman's Wharf), from Point Bonita around Richardson Bay to Tiburon, the shoreline from San Leandro north to Richmond, and portions of the southeastern shoreline of Mare Island to Tubbs Island. Because of the extent of oiling in this example, it would be expected that not only shoreline access and recreational uses would be significantly impacted, but that all types of water transport would be curtailed until cleanup efforts would be well under way. As shown in Table 4.11-1, this scenario would impact 23 of 27 marinas and 8 of 9 piers in central San Francisco Bay.

__Parks and Ecological Reserve Areas within Bay__

Scenario modeling was overlain by use of GIS, with mapping of parks and ecological reserve areas throughout the Bay. Ecological reserves were included as they are considered a source of passive recreation to view nature. The acreages presented do not include wetlands areas included within the NWI. Ecological reserve areas as well as the NWI are considered within the Marine Biology section of this EIR.

Approximately 40,716 acres of major established parks and ecological areas were presented based on approximate boundaries of those areas identified on Figure 3.10-2 (Section 3.10). The percentage of combined parks and ecological areas that would be hit by oil under each scenario were calculated through the GIS. Table 4.11-2 presents a summary of results for those scenarios which would impact parks and ecological reserve areas.

Of the scenarios in Table 4.11-2, which would impact major parks and ecological reserve areas, GIS further showed percentages of impact by subarea. This is summarized in Table 4.11-3. Because of the high percentages of resources impacted through these representative scenarios, extensive disruption to both active and passive forms of recreation would result. Impacts are considered to be significant (Class I and II) as more severe spills can have residual effects for periods exceeding 3 months.

Table 4.11-2

PERCENTAGE OF IMPACT OF PARKS AND ECOLOGICAL RESERVE AREAS BY SCENARIO

Scenario No.	Total Acres of Resource in Bay	Acres Impacted in this Scenario	Percent Resource Impacted
1	40,716	7,476	18.4
3	40,716	6,264	15.4
4	40,716	1,701	4.2
9	40,716	9,915	24.6
10	40,716	1,100	2.7
11	40,716	4,065	10.0
12	40,716	2,050	5.0

Table 4.11-3

PERCENTAGE OF PARKS AND ECOLOGICAL AREAS IMPACTED BY SCENARIO BY SUBAREA

Scenario No.	Subarea	Percent of Resource Impacted
1	San Pablo Bay	62
3	Carquinez Strait	91
	Central S.F. Bay	62
	San Pablo Bay	39
4	Carquinez Strait	82
	San Pablo Bay	14
9	Richardson Bay	100
	Central S.F. Bay	85
	San Pablo Bay	58
10	South S.F. Bay	13
	Central S.F. Bay	83
	Richardson Bay	15
11	South S.F. Bay	45
12	South S.F. Bay	22

Routine Operations along Outer Coast

Unocal tanker movements along the outer coast will not change land uses or recreational uses along the shore. No changes are proposed to this activity; therefore, no adverse or significant impacts are expected.

Accident Conditions along Outer Coast

Spills along the outer coast will result in potentially significant impacts (Class II) to the various uses and recreational access points along the coastline. Compared to the Bay, existing land uses and recreational areas along the outer coast are more diverse, with many undeveloped and inaccessible shoreline areas. In these remote portions of shoreline, a spill would not substantially decrease the availability of recreational opportunities. In contrast, a spill that washes into heavily-used areas and recreational points would limit or preclude these uses and result in a significant impact (Class I or II). Oil that spreads to beaches, sand dunes, tidepools, shoreline reserves, harbors, marinas, and other recreational boating and fishing facilities would limit access to and from these areas where there is oil, containment equipment, or cleanup activities. The northern coastline is especially known for its spectacular scenic views. As discussed above and in Section 4.10, the presence of oil in the nearshore waters and onshore would reduce the scenic quality of views from coastal parks, lookouts, trails and highways, communities, and any other areas where scenic resources are accessed.

4.11.3.2 Analysis of Future Conditions

According to the County General Plan, growth is expected to occur over the next 20 years at a rate of

0.5 percent per year, or 10 percent overall. As the population increases, so too will the demand for recreational facilities. In the future, more recreational facilities could be potentially impacted by spill events. As is the case with present conditions, two levels of significant (Class I or II) impacts could occur, depending on the various characteristics of a spill and its residual effects.

Increases in recreational boating and tanker traffic will increase the potential for accidents resulting in an adverse but nonsignificant (Class III) impact. Small boats are highly maneuverable and are able to get out of a tankers way. Also, tankers and barges travel at slow speeds within the Bay. Any accidents that may occur are typically the fault of the recreational boater not being aware of his surroundings. The Harbor Safety Committee works to educate boaters on safety issues including awareness of other traffic. In addition, all proposed events, such as a regatta are required to have notification given to the U.S. Coast Guard. Notification is posted and published in the Local Notice to Mariners.

4.11.4 <u>Cumulative Impacts</u>

4.11.4.1 Routine Operations

As part of the cumulative environment for this project, the 26 marine terminals located throughout the Bay Area include several existing oil terminals. Of these, the Unocal Terminal, the Wickland Oil Terminal, the Pacific Refining Company Wharf, and Mare Island Naval Shipyard are in San Pablo Bay. The existing pattern of land use and the current county designations reflect the presence of these industrial uses in this section of the Bay. The Proposed Project, and other current and future projects within the Bay Area, would continue to approximate existing conditions that show a mixture of shoreline-related uses. Existing shoreline recreational uses would continue and additional recreational areas would be acquired and developed as described in Section 3.10.1.

Given the long-term nature of the proposed lease (40-year), future projects along the shoreline of the Bay and outer coast have the potential for inducing growth within neighboring areas and encouraging development on vacant lands such as open space and agricultural areas. General Plan Amendments and Zone Changes would be necessary to accommodate proposed land use changes. Assuming future cumulative development conforms with the appropriate land use plans and policies, cumulative impacts to land use are considered adverse, but not significant (Class III).

Near shore growth including expansion of private and commercial recreation docks have the potential to encroach into waterways used for recreational boating resulting in an adverse, but nonsignificant (Class III) impact. Also, in the future, as more marinas are established, along with a greater volume of tanker and barge activity, the potential for accidents will increase as recreational craft cross tanker lanes and as tankers travel near marinas.

4.11.4.2 Accident Conditions

If a localized oil spill were to spread over a large area, or more than one spill event were to occur simultaneously within the bay, significant adverse (Class I and II) land use and recreational impacts could result. Shoreline and water-related uses, recreational uses, and marine terminal activities could be disrupted or stopped for the duration of the spill and cleanup. Sensitive and protected lands would be damaged and or reduced. Vessels and boat traffic would be rerouted around or away from the spill area.

4.11.5 <u>Significant Impacts, Mitigation Measures, and Residual Impacts</u>

4.11.5.1 Unocal Responsibilities

<u>Impact</u> - Oil spills would result in significant (Class I and II) impacts to shoreline land uses and shoreline and water related recreational uses.

<u>Mitigation and Residual Impact</u> - Mitigation measures for oil spill impacts to land and recreational uses include those measures for Unocal's contingency planning and spill response, as presented in Section 4.2, and measures to prevent impacts to biological resources, as presented in Section 4.4. These measures would provide for <u>minimizing</u> oil spills and maximizing cleanup activities to reduce impacts to shoreline uses, recreational uses, and the scenic environment. However, even with such mitigation, the potential of a spill occurring would remain. Therefore, the residual impacts would remain significant for those resources still affected by oil 3 months after the spill event.

Impact - The Refinery and Terminal preempt the use of the shoreline for recreational uses. Without access through the Refinery along San Pablo Avenue, a significant (Class II) impact with planned recreational policies would result in that a planned trail system from Rodeo to Crockett could not be completed.

Mitigation and Residual Impact - Unocal should dedicate a right-of-way or easement and provide improvements for the proposed bicycle trail along a portion of San Pablo Avenue. Requirements should be set forth by the County and EBRPD and implemented by the SLC through their lease agreement with Unocal. With implementation of this measure, the impact is reduced to a level of nonsignificance.

4.11.5.2 Cumulative Actions

Impact - Significant (Class I and II) impacts would result to land use and recreational activities from oil spills.

Mitigation and Residual Impact - Mitigation planning for cumulative impacts includes oil spill contingency planning and review of all marine terminal and tankering procedures for all Bay Area facilities to assess the potential for spills to occur. Response contingency planning is presently underway by Bay Area agencies, as discussed in Section 3.1.5.4.

Planning for shoreline uses should include development of appropriate land use plans that locate industrial land uses away from sensitive and protected open space such as marshlands and regional shorelines. Planning would reduce some land use impacts to a level of nonsignificance; however, those resources still affected by oil after a period of 3 months would remain significant.

4.11.6 Alternatives Analysis

4.11.6.1 No Project Alternative

Pier Structure Scenarios

Abandonment In-Place of Pier Terminal

With abandonment, the Marine Terminal would no longer be used for oil/product transfer and handling. The Terminal would be left in place to remain as described in existing conditions.

Abandonment and Removal of Pier

If the Marine Terminal were to be abandoned and removed, the submerged tidelands would become available for other uses. The nearshore water area that was occupied by the Terminal could become available for nearshore recreational uses by boat access.

For both of these scenarios, no adverse or significant adverse oil spill impacts would result. However, the Refinery would still preempt use of the shoreline for recreational access, thus the need for a right-of-way or easement along San Pablo Avenue would remain as described for the Proposed Project. Without this right-of-way, a significant (Class II) policy impact would result.

Mitigation - Mitigation for dedication of right-of-way would remain the same as that of the Proposed Project, except that the SLC could require the dedication as a condition of the quit claim of the lease area.

Refinery Scenarios - Continued Operation at Current Capacity

Under this alternative, the use of the Marine Terminal would cease, and existing levels of crude intake would be maintained by the construction of additional pipeline facilities (on a worst case) from the Central Valley, or from other marine terminals, or to a common carrier line. Construction of pipeline corridors would result in temporary adverse, but not significant (Class III) land use impacts by precluding land uses along the areas of pipeline construction. Designation of easements would be needed for the installation of new pipeline routes; however, no conflicts with County General Plan land use designations are expected.

The impact and mitigation measures regarding the recreational trail would remain the same as those for the Pier Structure Scenarios.

Refinery Would Operate at Reduced Levels

Reduced Refinery operation would not result in any change to the current land use designation on the project site or with the surrounding area. No impacts are expected.

The impact and mitigation measures regarding the recreational trail would remain the same as that for the Pier Structure Scenarios.

Shut Down of Refinery

If refinery closure would include dismantling the entire facility and site cleanup, then complete remediation of the site would be required before another use of the land would be allowed. The current land use designation would allow other industrial uses on the site and no impact from these uses would be expected. If nonindustrial uses were proposed, such as open space or recreational uses, then the land use designation in the General Plan and zoning for the site would have to be changed. Assuming no incompatible land uses would be permitted by SLC or the County on this site, no significant adverse impacts to land use would be expected. If the Refinery facility were retained, other industrial uses may be allowed onsite and no land use impacts would result.

As long as Unocal retains property ownership, the impact and mitigation for the recreational trail would remain the same as for the Pier Structure Scenarios.

4.11.6.2 Consolidation Alternative

No significant adverse impacts to land use or recreation are expected from consolidation to the Unocal Terminal. Both Unocal and Pacific Refining Company Terminals are designated by the County for heavy industrial uses. These designations would remain. Therefore, consolidation would not result in land use or recreation conflicts with any land use or recreational policies.

The impact and mitigation measures regarding the recreational trail would remain the same as that for the Pier Structure Scenarios.

4.12 CULTURAL RESOURCES

4.12.1 Introduction

Impacts are presented for cultural resources. The focus is on those resources that would be affected by new pipeline construction associated with alternatives to the Proposed Project.

4.12.2 Impact Significance Criteria

Impacts are considered to be significant if prehistoric or historic resources are disturbed by the Proposed Project without prior data recovery.

4.12.3 Proposed Project

The continued operation of the Marine Terminal under a new lease would not require or involve modifications to the existing facility. No impacts to cultural resources would occur. Future increases in tankering activity will also not have any significant impacts to cultural resources.

4.12.4 Cumulative Impact

Cumulative projects and future development in the greater area would result in the potential for adverse impacts to cultural resources. Each project would require investigation into the extent of resources and impacts for that specific project. Unocal should not contribute to any major disturbances of prehistoric or historic resources within the cumulative environment.

4.12.5 Significant Impact, Mitigation Measures, and Residual Impact

No mitigation is required for the Proposed Project. Mitigation associated with cumulative projects should be developed on a project-specific basis that may include having an archaeologist present during excavation actions.

4.12.6 Alternatives Analysis

4.12.6.1 No Project Alternative

Pier Structure Scenarios

With no new lease, if the Marine Terminal and/or associated facilities, both above ground and below ground, are planned to be relocated, replaced, or removed in entirety, then there would be a potential for a significant impact (Class II) to cultural resources. If major amounts of the pavement covering the Davis Point portion of the Marine Terminal or adjacent, underdeveloped shoreline areas within the greater Unocal facility were to be removed as part of planned remodeling, replacement, or abandonment of the existing facilities, there is the potential that cultural resources could be significantly impacted (Class II).

Since the original Marine Terminal wharf and associated structures were destroyed by fire in 1952, the existing facility, which was built in 1955 and redesigned and reconstructed in 1970, would not constitute a recordable historic property under current federal guidelines. At 40 years old, eligibility of structures can be reviewed for possible listing in the National Register, especially where permit reviews by the California Coastal Commission are concerned. Because of modifications to the Terminal, the fact that no unique construction methods were used, and because it is similar to many other structures constructed in the mid-1950s, the eligibility potential would be considered low. No adverse or significant adverse impacts are expected, relative to historic resources.

Mitigation and Residual Impact - The presence of an archaeological monitor should be required during any ground disturbing activity, especially if located near the oil tank group south and east of Davis Point where CCo-257 is plotted. This would be to identify any additional sites that were not previously recorded.

Further archival research would also be performed prior to the removal of facilities to assess both the archaeological and geological potential (i.e., related to the possible presence of native living or fossil shellfish populations). If sensitive localities are defined, then the presence of an archaeological monitor is warranted, especially in the Davis Point area, since there is a potential for underground and buried prehistoric remains.

Because CCo-257 is reputed to have contained human burial remains, it would also be required that contact be made with appropriate local Native American groups to develop a procedure to quickly assess the discovered remains and provide reverent treatment of burials and associated mortuary goods that might still persist in the disturbed site remnant.

With these measures, impacts would be reduced to a level of nonsignificant.

Refinery Scenarios - Continued Operation at Current Capacity

The Refinery scenarios involve the construction of additional pipeline to connect to a common carrier, other marine terminals or, as a worst-case, to oil resources in the Central Valley. It is highly likely that prehistoric resources could be encountered along selected pipeline routes. There is a lesser probability of historic resources being encountered. Any resources identified would have the potential to be impacted, resulting in a significant (Class II) impact.

Mitigation and Residual Impact - Mitigation measures to reduce impacts to nonsignificance include evaluation of the potential for resources and records searches during route selection. Any identified resources would require proper evaluation as to their significance and data recovery, if necessary. Also, during all excavation, an archaeological monitor would be required to be present in the event that new, unrecorded sites are discovered.

Refinery Would Operate at Reduced Levels or Shut Down

Under the reduced operation scenario, or the Refinery shutdown scenario, there could be a potential for disturbance of sites not previously recorded during excavation to modify or remove facilities. This has the potential to result in a significant (Class II) impact.

Mitigation and Residual Impact - Mitigation is as presented above for the Refinery scenario of Continued Operation at Current Capacity.

4.12.6.2 Consolidation Alternative

Consolidation of the Pacific Refining Company and Unocal Marine Terminals to the Unocal Terminal may result in the potential for disturbance to submerged resources from removal of underwater pipelines. However, it is expected that any resources in this area would have been disturbed during underwater pipeline construction where the pipelines were installed. Thus, no impacts are expected from their removal.

Construction of new pipelines between the Unocal and Pacific Refining Refineries may have the potential to disturb previously unrecorded sites. Potential for a significant Class II impact results.

Mitigation and Residual Impact - Mitigation remains as that for Continued Operation at Current Capacity.

4.13 ENERGY

4.13.1 Introduction

This section addresses the impact of the Proposed Project and various alternatives on the overall energy picture of the Bay Area and the remainder of northern California. Discussion focuses on the supply of crude oil, changes in overall refining capacity and shipment of product.

4.13.2 Impact Significance Criteria

Impacts to energy supplies are considered significant if changes in Bay Area refining capacity or availability of refined product are reduced, resulting in at least a minor disruption to the Bay Area energy supply and/or require changes to the Bay Area's present refining and product transportation scenario.

4.13.3 Proposed Project

4.13.3.1 Analysis of the Continuation of Existing Conditions

Issuance of the new lease will result in the continuation of the existing quantity of crude oil deliveries, refining capacity, and product shipment. No impact will occur.

4.13.3.2 Analysis of Future Conditions

On a longer term basis, it is anticipated that Unocal's crude oil supply will remain relatively constant. Several factors contribute to this assumption. It is highly probable that several small refineries may close due to the economics of updating their facilities to comply with new regulations, thus transferring their crude supplies to other Bay Area terminal including Unocal. Also, because the production of SJV as well as Alaska crude is expected to decline, it is reasonable to expect that there will be an increase in tankering of foreign crude oil into the Bay Area, as well as the Unocal Marine Terminal. Because of these potential imports, no adverse impacts to energy use would be expected.

4.13.4 Cumulative Impact

It is expected that the overall oil deliveries and refining aspects will remain in the same relative relationship as present for the same reasons given above for future conditions. Assuming the California economy recovers, there will be a low, but steady, increase in demand for crude delivery to the Bay Area via tanker.

4.13.5 Significant Impact, Mitigation Measures, and Residual Impacts

No significant impacts have been identified, so no mitigation is required.

4.13.6 Alternatives Analysis

4.13.6.1 No Project Alternative

Three scenarios could occur if the No Project Alternative were implemented:

1. the Refinery operates at a lower level commensurate with the volume of crude oil delivered via the Marine Terminal.
2. the Refinery operates at a level similar to present through obtaining crude oil from other sources, and
3. the Refinery closes down.

The implementation of these three scenarios would depend on both internal and external economic factors dealing with refining in the Bay Area. Impacts of each of these scenarios are described below.

<u>Continued Operation at Current Capacity - Obtaining Crude/Shipment of Product From Other Sources</u>

This scenario would entail the sharing with other marine terminals and/or the use of pipelines for both receiving crude oil and product shipment. This may entail the construction of pipelines to connect with other terminals. The capacity of the area's marine terminals is such that an increased use could occur without major disruptions to energy supplies. Careful queuing of shipments would be necessary to avoid delays in tanker deliveries and thus avoid any adverse, but nonsignificant (Class III) impacts.

Reduced Refinery Operations

This scenario would involve the reduction of the refining capacity of the Unocal Marine Terminal by approximately one-half. This will mean that the other refineries in the area will take up the shortfall. Currently, this could be accommodated, although there may be a potential adverse, but nonsignificant (Class III) impact in long-term refining capacity within the Bay Area. Although the Marine Terminal would not supply crude oil, this volume could be accommodated at other terminals. There would be potential adverse (Class III) impacts associated with the shipment of product. Some products may have to be transferred by pipeline, rail or truck to other points of distribution. This additional cost may make Unocal less price competitive.

Shutdown of Unocal Refinery

The shutdown of the Unocal Refinery would result in the loss of approximately 9 percent of refining capacity in the Bay Area. This loss coupled with the suspension of the Pacific Refining Refinery and the potential permanent closure of other small refiners, may result in a potential long-term shortfall in Bay Area refining capacity. This would be a significant (Class II) impact that may require importation of refined products.

4.13.6.2 Consolidation Alternative

Consolidation of the Pacific Refining Terminal at the Unocal Terminal would not create any significant impact to the overall energy supply. If the Pacific Refining Refinery is reactivated, there may be some indirect problems with the scheduling of tankers. This adverse but nonsignificant (Class III) queuing impact would require careful scheduling.

SECTION 5 - ALTERNATIVES TO PROPOSED PROJECT CONSIDERED AND ELIMINATED FROM DETAILED EVALUATION

A screening process was used in the selection of alternatives examined within this EIR. All alternatives were initially evaluated from a systems safety and risk perspective, and from a feasibility perspective. Several of these alternatives were eliminated from further evaluation in the document as infeasible. These are briefly presented below.

5.1 CONSOLIDATION

5.1.1 Consolidation of Unocal and Pacific Refining Terminals at Pacific Refining Terminal

The Pacific Refining Company Hercules Wharf is located approximately 1,000 feet west of the Unocal Refinery wharf. The wharf is a concrete pile and concrete-decked offshore wharf with two breasting and four mooring dolphins in line, with the face connected by catwalks and two breasting dolphins in line with the rear of the face. The face tanker berth is 1,228 feet, while the rear of the face barge berth is 258 feet. One 24-inch, one 10-inch, two 8-inch, and one 6-inch submerged pipelines extend from the wharf to storage facilities onshore. The Terminal is used for the receipt of crude oil and the shipment of petroleum products.

This alternative would involve abandonment of the Unocal Marine Terminal, with Unocal and Pacific Refining Company both using the Pacific Refining Marine Terminal. This alternative would require installation of numerous submerged pipelines extending from the Pacific Refining Terminal to the Unocal Refinery.

From a safety and risk perspective there are no advantages of consolidation at the Pacific Refining Terminal. In fact, there are several aspects that could decrease the safety and risk.

- The Pacific Refining Terminal is serviced by subsea pipelines. Subsea pipelines are more difficult to inspect and maintain.
- The construction of additional subsea pipelines creates the potential for damaging the existing pipelines.
- The addition of the Unocal vessels calling at the Pacific Refining Terminal coupled with the fact that there are fewer berths could create congestion at the Terminal and increase the potential for accidents and spills.
- Because there is no direct access to the pier (i.e. roadway to the shore), it is difficult to rapidly provide personnel and equipment to the wharf in the event of an accident.
- The pipeline spill risks from the abandonment of the Unocal Terminal would be present.

Because safety and risk were considered as primary features of the feasibility of an alternative, this alternative was eliminated from further consideration.

5.1.2 Consolidation with Pacific Refining and Wickland Oil Selby Storage Terminals

The Wickland Oil Selby Storage Terminal is located approximately 1 mile east of the Unocal Wharf and is used for receipt and storage of petroleum products. This alternative would involve consolidation of the Unocal, Pacific Refining, and Wickland Oil Selby Terminals at the Unocal Marine Terminal. The existing product pipeline that presently transfers product from the Unocal Refinery to the Wickland Oil Terminal could be used for product transfer from the other direction.

The Wickland Terminal Wharf cannot handle as many vessels as the Unocal Terminal Wharf. The Wickland Terminal handles approximately 40 tankers (Marine Exchange 1992) and 8 barges (SLC 1992) annually. It is unlikely that the Wickland Terminal could handle the 200 to 250 vessels required annually by consolidation.

From a risk and safety perspective, consolidation at the Unocal Terminal would be better than consolidation at the Wickland Terminal. There would also be a slight risk of a spill from the pipeline that would need to be constructed between Unocal and Wickland. This alternative was also eliminated from further consideration.

5.1.3 Single Facility Consolidation and Deep Water Port Consolidation

5.1.3.1 Single Facility Consolidation in Bay

The concept of consolidation of Unocal and all other Bay Area marine terminals into one large terminal within the Bay was briefly examined. The concept of a single port in the Bay has been examined as early as the 1960s when the idea a "Super Port" in deep water near Alcatraz was introduced (personal communication, Steve McAdams, BCDC, 1993). The concept would provide a major docking platform with pipeline branches to strategic terminal throughout the Bay. One of the thoughts behind this concept was to be able to provide the access for deep draft vessels to offload crude to Bay Area refineries, while at the same time attempting to minimize vessel travel through the Bay and minimize environmental risk. This plan was dropped from later BCDC plans.

The use of presently existing facilities was also examined such as consideration of use of the Standard Oil Company, Chevron U.S.A., Richmond Long Wharf. This wharf is a 2,463-foot nearshore wharf. Its configuration includes 3,065 feet of berthing space with dolphins, with other sections providing for 1,660 feet and 630 feet of berthing space. Even though it is a large facility, it would be virtually impossible to modify the wharf and to provide the pipeline infrastructure that would be required to transform this wharf into a facility that could accommodate all Bay Area tanker traffic.

Consideration was also given to the logistics that would be involved in single facility consolidation. This would involve not only procurement of agreements with all existing terminal operators, but also the planning and construction of the pipeline infrastructure system that would be required. Because of the complexity of this concept, and its feasibility with respect to its time frame for implementation (the SLC would like to implement a new lease with Unocal as soon as possible), this concept was eliminated from further consideration.

5.1.3.2 Deep Water Port Consolidation

The concept of an offshore port located outside of the Bay was also considered. This would involve development of a port several miles off the California coastline to reduce the number of tankers entering U.S. ports and cause environmental damage, and to minimize the potential for spills that would effect shorelines. One such offshore terminal, the Louisiana Offshore Oil Port (LOOP), has been constructed and is operating in deep water 18 miles offshore. This facility became operational in 1982 (U.S. Department of Interior 1990).

While such concepts appear to have the potential to reduce nearshore tanker accidents, significant questions remain as to the environmental and economic benefits of these facilities offshore. As above, because of the complexity of this concept, and its feasibility with respect to its time frame for implementation, this concept was eliminated from further consideration.

5.2 LIMITATIONS OF TERMINAL USE

Options under this scenario include limitations on Unocal Marine Terminal import or export. These include allowance for crude import only, product export only, and emergency use only. Crude import and product export both assume retention of existing capacities. All were eliminated as infeasible. It is unlikely that the Terminal would be able to operate in any type of efficient manner by limiting usage in any of these manners.

Reduced use of the Terminal would decrease the risk of the Terminal, but not necessarily proportionally to the decrease in vessel calls or throughput. The wharf and pipelines would still present a continuous potential for a pipeline spill release. In addition, the method used to replace the throughput (import or export) could shift the risk to another location.

A more realistic scenario, that of a reduction of crude intake due to no Terminal, was presented in Section 2.3.1 and carried forward in the impacts analysis. That alternative represents a combination of the reduction of crude import and product export.

5.2.1 Crude Import Only Through Marine Terminal

This alternative would involve import of crude oil only, via the Marine Terminal. As discussed in Section 2.3.1 for the No Project Alternative, if products were not able to be shipped via the Unocal Marine Terminal, then they would require shipment through pipeline to other marine terminals with some product transfer via pipeline and by increased truck and rail usage.

This alternative would decrease the risk at the Terminal to that of a crude oil spill only. Annually there are approximately 36 tanker deliveries of crude oil, approximately 25 percent of the vessels presently calling at the Terminal and representing approximately 25 percent of the risk. Approximately 12 of the vessel callings take out product as well as bring in crude. If another option using tankers were chosen to export the products, then these 12 vessel may have to call at a second terminal to load product, resulting in a sightly increased risk due to the second docking operation.

5.2.2 Product Export Only Through Marine Terminal

This alternative would involve the export of product only via the Marine Terminal. Without Alaskan Cook Inlet crude, the lube portion of the Refinery would require shutdown because alternative crude oils suitable for processing in Unocal's present lube units are unavailable. Also, the lube crude distillation unit and the downstream processing units are constrained by crude sulfur content by (permit limit) and metallurgical limitations of the equipment (corrosion control). Without a lube crude supply, 7 of 30 Refinery process units that produce lubricating oil and waxes would be shut down. The fuels producing process units would also be impacted and operate at reduced capacity. As is the case with the alternative involving crude intake from Central Valley (with the No Project Alternative in Section 2.3.1), modifications would be necessary to the Refinery to process additional Central Valley crude. The lube oil manufacturing portion of the Refinery requires a specialty crude with suitable properties to match unit design and meet product specifications. In order to accommodate an increased refining demand using Central Valley crude, modification and expansion of existing facilities would be required. Modification or expansion of these facilities would, in part, compensate for the loss of jobs from the shutdown of the lube units.

This alternative would decrease the risk at the Terminal to that of a product spill only. Product export represents about 83 percent of the vessel calls at the Terminal. The risk from the crude oil import would depend on the alternative chosen to replace import at the Terminal.

5.2.3 Emergency Use Only

Under this alternative, the Marine Terminal would be retained complete, with all equipment operational. Under emergency conditions, use of the Terminal would be restricted for use by any tanker or barge that would require unloading of its contents.

While this alternative would decrease the overall risk at the Terminal, it could quite possibly increase the risk over what it presently is, per vessel call. It would be difficult to maintain the same level of training and experience of the personnel working at the Terminal if it were only used occasionally. This was considered infeasible and eliminated from further consideration.

5.3 LEASE OPTIONS/OTHER USES

5.3.1 Short-Term Lease for Phase-Out of Terminal

This alternative would involve granting a short-term lease to Unocal. This would be granted under conditions that Unocal phase out its operation of the Marine Terminal. If the Terminal is not granted a new lease, then limitations could occur under the conditions that Unocal places on its phase-out lease. This was not considered an alternative, but rather a ramification of phase-out of the Terminal.

5.3.2 Lease of Marine Terminal by Another Marine Operator

This consideration would involve granting a lease to another marine operator, if Unocal and the SLC would be unable to come to terms of agreement on a new lease. However, problems arise with regard to ownership of the terminal pier and infrastructure, which are Unocal's. Also, the problem of logistics of transfer/transport of crude or product through the

Unocal facility from another refinery would result. This alternative would result in, at least, the same impacts as the Proposed Project with regard to tankers and barges. Additional impacts would result from construction and operation of new lines to another refinery. This alternative was eliminated from further consideration.

5.3.3 Retain Pier for Nonterminal Uses

Under this option, the pier structure would be retained for other uses, such as for fishing. Access to the pier is via the Unocal Refinery, thus the feasibility and safety regarding public access is of major concern. Public access through the Refinery would not only present safety problems, but the logistics of how to manage such access becomes impractical. This alternative has been eliminated from further detailed examination.

5.4 ALTERNATIVES FOR CRUDE SUPPLY BY PIPELINE

The Santa Barbara County Crude Oil Transportation Analysis (October 1989) gives an overview of existing pipelines for transportation of crude oil from Bakersfield to San Francisco. Unocal would not be able to connect to these pipelines because upgrades to these pipelines are not possible and because of construction limitations.

5.4.1 Chevron Pipeline

Chevron operates a 205-mile proprietary pipeline from Belridge to Richmond. This is an 18-inch unheated line with a capacity of 90 to 95 MBD. The pipeline is believed to be currently operating at full capacity, moving a SJV blend of 21-23 API crude to the San Francisco area. Deliveries can be made to this line at the Kettlemen pump station from Chevron's Elk Hills gathering system (via a 10-inch unheated line) and Shell's Kernridge gathering system (via a 6-inch line having a 17 MBD capacity). Crude is also received via the Rio Bravo to Belridge line (a 12-inch line having a 27 MBD capacity). In the San Francisco area, the pipeline is connected to the Chevron, Tosco, and Shell refineries. Based on industry input as well as previous studies, it is believed that looping and/or upgrading of this pipeline is not possible due to right of way (ROW) and construction limitations in the San Francisco area.

5.4.2 Texaco Pipeline

This 20-inch proprietary pipeline from Coalinga to San Francisco is owned and operated by Texaco and has a capacity of 215 to 220 MBD. It is currently operating at about 200 to 215 MBD. The pipeline is heated and receives SJVH crude from the Texaco and Union gathering systems in the Bakersfield area. The line supplies crude primarily to the Shell and Tosco refineries in Martinez, as well as small amounts to Exxon's Benicia refinery. Crude is delivered to Shell and Tosco through exchange agreements. Looping possibilities for this pipeline are limited. Some segments have already been looped in order to reduce pumping requirements and thus lower operating costs. The already in-place looping did not increase line throughput. Any additional looping is unlikely to significantly increase the pipeline's throughput, as there is a 17-mile segment of line (from Marsh Creek to Martinez) where looping is very unlikely. This area is highly developed and thus construction permits would be difficult to obtain. In addition, Texaco has the right of way for only a single line. Technical modifications such as adding pumping capacity would not result in a higher pipeline throughput given the size and thickness of the pipe and its geographical location (mountain region).

SECTION 6 - RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

If the proposed lease is granted, Unocal will continue to operate its Marine Terminal at Davis Point, as it has for the past 38 years. No foreseeable modifications are planned to the pier, other than maintenance and regulatory compliance, for updating elements such as air quality control (recently completed). Long-term modifications would be required only if the Terminal were to accommodate larger vessels, in which case structural modifications to the pier could be required.

Short-term use of man's environment will not change as a result of the continuation of the Marine Terminal. Over the long-term the Marine Terminal will continue to provide access to the Unocal Refinery for the production of oil and product. The Unocal Refinery represents 9.6 percent of refinery capacity in the San Francisco region. Several other refineries in the area (Chevron USA in Richmond, Exxon USA in Benicia and the Shell and Tosco Refineries in Martinez) are substantially larger.

Without the use of the Marine Terminal, the Unocal Refinery could replace its supply of Alaskan crude by a combination of import through another north Bay Area marine terminal via a pipeline connection, and/or by imported SJV crude via modification to their existing Oleum pipeline or through connection into a common carrier pipeline. This however, would not be expected to affect tankering activity. If the Unocal Marine Terminal were not able to continue operations, the vessels now serving Unocal would most likely still import crude and export product in the Bay Area through another marine terminal. This would apply especially to future conditions, as over the next 20 years, San Joaquin Valley crude supply will reduce substantially and be replaced by more tankering from other, primarily foreign sources. If the Unocal Marine Terminal is not in use, tankering to other terminals in the area will continue regardless of whether the Unocal Marine Terminal is/isn't in use. Thus, use of man's environment and long-term productivity would remain unchanged with or without the Unocal Marine Terminal.

If the Unocal Marine Terminal were to be shut down, other ramifications to the Unocal Refinery (on a worst-case) could be the viability of continuation of operation of the Refinery itself. Unocal employs nearly 500 persons. If the Refinery were to close, the socioeconomic impacts resulting from the loss of direct and indirect employment would be substantially negative to the local community, both in the short- and long-term. Refinery operation is an integral part of the economic viability of the Davis Point area. Effects of the shutdown would also be felt on a regional scale. Unocal's three West Coast refineries (Los Angeles, Santa Monica, and San Francisco) are dependent on each other for intermediate feed stocks (mainly gas oil, butane, and gasoline blending stocks). Gas oil and gasoline stocks are transferred between Los Angeles and San Francisco by tanker. Closure of the Refinery would significantly affect these other refineries.

Additionally, 45 percent of the Refinery's product output is shipped to the northwest U.S. as no product pipelines exist. Economic consequences would also result as a consequence of product shortfalls in the northwest.

SECTION 7 - SIGNIFICANT ENVIRONMENTAL IMPACTS THAT CANNOT BE MITIGATED TO INSIGNIFICANCE

Significant environmental impacts that cannot be avoided by granting a new lease by the SLC to Unocal for continuation to use the Unocal Marine Terminal at Davis Point (Proposed Project) are presented below. These impacts would remain significant and unavoidable (Class I), even after incorporation of mitigation measures.

The Proposed Project would not result in significant impacts under normal operations. The following impacts could occur in the event of an oil or product spill:

- Even though the chance of an oil spill is low, if an accidental spill occurs, unavoidable significant impacts can result. Spills at the Marine Terminal (including those from the Terminal itself or from vessels generally greater than 50 bbl cannot be mitigated to a level of nonsignificance because the ability to contain and clean up this volume is beyond the capability of Unocal's onsite equipment.

  A spill from a tanker is the responsibility of the vessel owner/operator. While each vessel is required to have an oil plan that identifies spill response measures for containment, recovery, and protection of sensitive resources, it is unlikely that it can prevent a large spill from contacting sensitive resources and the shoreline. An unavoidable significant impact can result.

  The filled state lands that are under consideration for the new lease contain a Unocal butane pressure vessel. An unconfined vapor cloud explosion (considered to be the worst type of accident event) could cause heavy damage throughout the local area with structure damage, window breakage, and potential for injury. While the probability of such an event is extremely remote, an unavoidable significant impact can result.

- Water quality impacts would result from changes in water chemistry from an accidental spill of crude oil or product in either the San Francisco Bay or within the outer coast. The severity of the impact is dependent on (1) the size of the spill, (2) composition of the oil, (3) characteristics of the spill (instantaneous versus prolonged discharge; surface versus subsurface spill, and so forth), (4) the environmental conditions and the effect of these conditions on spill properties due to weathering, and (5) the effectiveness of cleanup operations.

  At the Terminal, any size spill would violate water quality objectives and result in an unavoidable significant impact. Also, large spills in the Bay or outer coast from tankers can result in unavoidable significant impacts to water quality.

- Oil spills greater than 50 bbl are considered to be unavoidable significant impacts to biological resources. Such spills are most likely to occur during tankering. Unocal tanker spills in the Bay Area have the greatest probability of contacting waters through central and northern San Francisco and San Pablo Bays, Carquinez Strait, and Suisun Bay. Biological resources that can be affected include phytoplankton, zooplankton, rocky intertidal and shallow subtidal habitat, intertidal mudflats, dungeness crab, bay shrimp, eelgrass, longfin smelt, Pacific herring, Chinook salmon, striped bass, American shad, white sturgeon, starry flounder, and a variety of threatened/endangered/candidate species.

  Along the outer coast, the tanker routes with the greatest risk are near the Golden Gate, from Cape Mendocino north, and the area around Point Reyes. Biological resources that can be affected include phytoplankton, zooplankton, rocky intertidal and shallow subtidal habitat, double-crested cormorant, and a variety of threatened/endangered/candidate species.

- Fishing areas at highest risk from Terminal and tanker oil spills are those located in Suisun Bay, rivers and sloughs near the Unocal Terminal, eastern San Pablo Bay, and the central portion of San Francisco Bay. The most vulnerable species are shrimp, herring, salmon, sturgeon, bass, smelt, perch, and clambeds. Spills that cannot be contained have the potential to cause unavoidable significant impacts to fisheries in the Bay Area.

Along the outer coast, the most vulnerable nearshore fisheries are dungeness crab, sea urchin, and fisheries harvested from shore. Unavoidable significant impacts to fisheries from a spill can result.

- Aesthetics impacts also result from spills. In oil spill events, where medium to heavy oiling is encountered over a wide-spread area and where cleanup efforts and residual effects of oiling may be observed for periods in excess of 3 months, unavoidable significant impacts are projected.
- Unavoidable significant land use and recreational impacts can result if oil spill cleanup efforts prohibit shore use, channel access, or recreational fishing activities for a period in excess of 3 months.

SECTION 8 - ANY SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES THAT WOULD BE INVOLVED IN PROPOSED PROJECT SHOULD IT BE IMPLEMENTED

As per CEQA (Section 15126(f)), this section presents the irreversible changes related to the use of, or long-term commitment of, nonrenewable resources. Irreversible changes represent long-term environmental damages that could result from the proposed project.

- Of the impacts presented in Section 7 (Significant Environmental Impacts that Cannot be Mitigated to Insignificance), even the impacts of oil spills over a long enough time period are reversible. However, if a large oil spill was to cause enough biological damage so as to result in the elimination of a species, an irreversible impact would result.
- Nonrenewable fossil fuels would be consumed through the continued use of the Marine Terminal.
- The Marine Terminal operation indirectly acts as a stimulus for the extraction of oil reserves, adding to the eventual depletion of a limited resource.
- The Proposed Project would continue to preclude the use of the shoreline for recreational uses. This impact would be irreversible for the duration of the lease period.

SECTION 9 - GROWTH INDUCING IMPACT OF THE PROPOSED PROJECT

The Proposed Project involves the granting of a new lease so the Unocal Marine Terminal can continue to operate as it has for the past 38 years. The continuation of actions by the Terminal is not growth inducing. Even with an assumed future increase in import and export activity through the Terminal, no growth inducement would result. The Marine Terminal is capable of operating 24 hours per day; however, current deliveries and product export do not even average 8 hours per day of use of the Terminal.

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SECTION 11 - LIST OF ACRONYMS

ABAG	-	Association of Bay Area Governments
ADT	-	average daily traffic
AIChE	-	American Institute of Chemical Engineers
ANS	-	Alaskan North Slope
API	-	American Petroleum Institute
BAAQMD	-	Bay Area Air Quality Management District
Basin Plan	-	Water Quality Control Plan for the San Francisco Bay Basin
bbl	-	barrel
BCDC	-	Bay Conservation and Development Commission
BLS	-	Bureau of Labor Statistics
BPCD	-	barrels per calendar day
bpd	-	barrels per day
bph	-	barrels per hour
bpy	-	barrels per year
CAAQS	-	California Ambient Air Quality Standards
CAP	-	Clean Air Plan
CCAA	-	California Clean Air Act
CCMP	-	Comprehensive Conservation and Management Plan
CDFG	-	California Department of Fish and Game
CEQA	-	California Environmental Quality Act of 1970
CFR	-	Code of Federal Regulations
CNEL	-	Community Noise Equivalent Level
CO_2	-	carbon dioxide
Corps	-	Department of the Army, Corps of Engineers (not an acronym, but noted here)
CPFV	-	Commercial Passenger Fishing Vessel
CPL	-	Chevron Pipeline Company
dB	-	decibel
dBA	-	decibels on A-weighted scale
DOI	-	Department of Interior
DOT	-	Department of Transportation
DWT	-	dead weight tonnage
EBRPD	-	East Bay Regional Parks District
EIR	-	Environmental Impact Report
EPA	-	U.S. Environmental Protection Agency
FHA	-	Federal Highway Administration
FRA	-	Federal Railroad Administration
gal	-	gallon
GGNRA	-	Golden Gate National Recreation Area
GIS	-	Geographic Information System
gpd	-	gallons per day
hp	-	horsepower
HRA	-	Health Risk Assessment

IGS	-	inert gas system
IMO	-	International Maritime Organization
km	-	kilometer
LCP	-	Local Coastal Plan
LOS	-	level of service
LTMS	-	Long Term Management Strategy
m/sec	-	meters per second
m	-	meter
m^3/sec	-	cubic meters per second
MARL	-	maximum allowable residue level
MFID	-	Marine Facilities and Inspection Division
mg/L	-	milligrams per liter
mgd	-	million gallons per day
mi^2	-	square miles
MIS	-	median international standard
MLLW	-	mean lower low water
MMS	-	Minerals Management Service
MPA	-	Marine Preservation Association
MSIS	-	Marine Safety Information System
MSL	-	mean sea level
MSRC	-	Marine Spill Response Corporation
MTBE	-	methyl tertiary butyl ether
NAAQS	-	National Ambient Air Quality Standards
nm	-	nautical miles
NMFS	-	National Marine Fisheries Service
NOAA	-	National Oceanic and Atmospheric Administration
NOP	-	Notice of Preparation
NPDES	-	National Pollution Discharge Elimination System (permit)
NSR	-	New Source Review
NWI	-	National Wetlands Inventory
OCS	-	outer continental shelf
OPA	-	Oil Pollution Act of 1990
OSPR	-	Oil Spill Prevention and Response
OSRISK	-	computer-based oil spill model
PAHs	-	polycyclic aromatic hydrocarbon
PCB	-	polychlorinated biphenyl
PFMC	-	Pacific Fisheries Management Council
PG&E	-	Pacific Gas and Electric
ppb	-	parts per billion
PPE	-	Personnel Protective Equipment
ppt	-	parts per thousand
psi	-	pounds per square inch
psig	-	pounds per square inch gauge
PUC	-	Public Utilities Commission
ROI	-	region of influence
RWQCB	-	Regional Water Quality Control Board
SFRWQCB	-	San Francisco Regional Water Quality Control Board
SIP	-	State Implementation Program
SJV	-	San Joaquin Valley
SJVH	-	San Joaquin Valley Heavy crude oil
SLC	-	State Lands Commission

SPCC - Spill Prevention, Control, and Countermeasures

SWRCB - State Water Resources Control Board

TBT - tributyltin

TO - thermal oxidizer

TPIC - Terminal Person-In-Charge

tss - total suspended solids

TSS - Traffic Separation Scheme

UCB - University of California at Berkeley

ug/L - micrograms/liter

USCG - U.S. Coast Guard

USGS - U.S. Geological Survey

USFWS - U.S. Fish and Wildlife Service

V/C - volume to capacity (ratio)

VCS - vapor control system

VPIC - Vessel Person-In-Charge

VRS - vapor recovery system

VTS - Vessel Traffic Service

VTSS - Vessel Traffic Separation Schemes

WCSC - West Coast Shipping Company