EIR-EA

Shell OCS Beta Unit Development

December 1, 1978

Volume I

Prepared By:

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Environmental Setting

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EXECUTIVE SUMMARY

PROJECT DESCRIPTION

In December, 1975 the Department of the Interior conducted Outer Continental Shelf Lease Sale No. 35, accepting high cash bonus bids for 56 tracts in four general geographic areas off the California coast. One of these areas was San Pedro Bay where a total of 13 tracts were leased. A unit agreement for these tracts has been submitted for preliminary approval in accordance with U.S. Geological Survey regulations. The designated Beta Unit includes leases P-0296, P-0300, P-0301, P-0306, and unleased tract 255. Shell Oil Company is to be the initial operator. Other potential participants in the Beta Unit are Aminoil USA, Inc., Champlin Oil Company, Chanslor-Western Oil and Development Company, Chevron USA, Inc., Hamilton Brothers Oil Company, Occidental Petroleum Company, and Union Oil Company of California. The Beta Unit is located in federal waters approximately nine miles (14.4 km) off Huntington Beach, California.

As a result of exploration efforts, Shell and its co-lessees (Aminoil, Occidental, Hamilton Brothers and Chanslor-Western) have committed leases P-0300 and P-0301 to unitization and development. Recoverable petroleum reserves of 100 to 200 million barrels of oil are estimated to exist on these leases. Decisions regarding development of other leases in the Beta Unit have not been made by their leaseholders. Shell's initial development plans include a drilling platform (Ellen) in 265 feet (81 m) of water connected by a bridge to a nearby production platform (Elly) in 255 feet (78 m) of water. The drilling platform will have slots for 80 wells. It will be connected by pipeline to the production platform. On the production platform the oil will be treated by a process train to separate produced water and gas and then pumped ashore via a 16-inch (0.4 m) subsea pipeline to the Port of Long Beach. Produced water will be reinjected for reservoir pressure maintenance purposes and the produced gas will be used as fuel for platform power generation. No gas will be transported to shore. At the Port of Long Beach the oil will be metered and distributed to existing refinery facilities by connection into a seven company distribution system near the THUMS manifold. No refinery modifications are included as a part of this project. Other shore elements include a small materials staging yard in the Port of Long Beach, and a crew operations boat launch facility, presently planned for Huntington Harbour, where personnel will be transported by boat to the platforms.

Development plans call for a second drilling platform (Eureka) with 60 slots in about 700 feet (213 m) of water about 1.5 miles (2.4 km) south of the shallow-water platforms to develop the southerly part of the reservoir. Thus, there will be three platforms associated with the project. A complete Plan of Development covering all aspects of the project has been submitted by Shell to the U.S. Geological Survey. Oil to be produced is a viscous crude (14-16^{o} API) which is considered sour (high sulfur [3-4%] content). Peak production with two drilling platforms in operation will occur in about 1986 and will be approximately 24,000 barrels (3,800 m^3) per day. The field life is estimated at about 35 years, at which time the platforms and other offshore facilities will be removed and the wells sealed. Average production will be about 13,000 barrels (2,070 m^3) per day. As a comparison, current U.S. consumption of petroleum products is about 18.1 million barrels/day. Thus, while the total impact of the project in terms of U.S. petroleum production and foreign imports (currently about 7.9 million barrels/day) is small, it nevertheless has important economic consequences which are estimated at about $2.0 billion over the life of the project, based on current market prices.

The production platform (Elly) has sufficient space for process equipment to treat a total of 40,000 barrels (6,360 m^3) per day. Also, the pipeline is designed to handle this production rate. Thus, if Chevron or other Beta Unit leaseholders decide to proceed with development, or if Shell's production warrants, capacity will exist to treat and transport additional field production.

The location of the Shell Beta platforms is in the Separation Zone of the Gulf of Santa Catalina Traffic Separation Scheme. This scheme provides a method of separating inbound and outbound shipping proceeding to or from the Ports of Long Beach and Los Angeles from the Gulf of Santa Catalina. Presently these lanes are used by approximately nine ships per day. Because of concern about collision risks with shipping, the platforms have been situated at a distance greater than 500 meters from the adjacent traffic lanes.

ENVIRONMENTAL REPORT

The project as described involves federal, state, and local actions. The offshore platform sites and a portion of the off-shore pipeline route are in federal OCS waters for which the U.S. Geological Survey serves as the permitting agency. The National Environmental Policy Act (NEPA) covers these actions. A portion of the offshore pipeline will cross State of California lands for which a right-of-way will be required. The

California State Lands Commission is a co-lead agency for this action. The pipeline has its landfall in the Port of Long Beach. Also, onshore distribution and staging facilities are located in the Port and will be subject to Port lease actions. The Port of Long Beach is, therefore, a co-lead agency with the State Lands Commission for actions required under the California Environmental Quality Act (CEQA).

This report serves as both an Environmental Assessment (EA) for NEPA associated reviews and an Environmental Impact Report (EIR) for CEQA mandated actions.

ENVIRONMENTAL IMPACT/MITIGATION

The major environmental effects of this project are in the following categories:

1. Air Quality
2. Oil Spills and Associated Impacts
3. Marine Traffic
4. Energy Supply/Demand and Economics
5. Oceanographic/Water Quality
6. Geotechnical Factors
7. Marine Biology
8. Cultural Resources
9. Other

Each significant impact and proposed mitigation measures are discussed.

1. Air Quality

a. Construction Offshore

The construction and installation of the offshore platform will cause temporary intermittent air quality impacts. These impacts will be insignificant due to the relatively small quantities of emissions and the intermittency of the activity. The major pollutant will be NO_x. However, the increase will amount to only 0.01 percent over current Los Angeles County emissions and this is considered regionally insignificant.

b. Construction Onshore

Fugitive dust emissions from excavation of the onshore site will slightly increase dust levels. In this instance, the impacts will be minimal and will be mitigated by the usual dust control method (a water spray).

Exhaust from the workers' automobiles will be the prime source of carbon monoxide, nitrogen oxides and hydrocarbons. The short-term nature of this activity and its limited impact precludes significant effects and no mitigation is required.

c. Operational Phase

The key pollutants of NO_2, SO_2, and particulate (TSP) to be emitted by the Beta Project during operation were modeled as inert pollutants using computerized air quality dispersion models. These concentrations were determined using the Texas Air Control Board's Texas Episodic Model (TEM) and the Environmental Protection Agency's (EPA) Air Quality Dispersant Model (AQDM). The Texas Model is used for calculating short-term impacts (one to twenty-four hour) and the AQDM was used for the annual average calculations. These models are both recommended for air quality impact analyses in EPA's guideline document on air quality modeling. Both models assume a steady-state Gaussian plume formula.

- Nitrogen Dioxide

Nitrogen oxide exhaust from the turbines and diesel engines will be the major source of emissions from the platform equipment and drilling rigs. The annual average and short-term models were utilized to calculate the NO_2 impacts at the shoreline and at the three-mile state boundary. Maximum concentrations of NO_2 will occur well out to sea. Onshore and three-mile limit impacts were predicted to be minimal. The worst-case one-hour concentration at the shoreline was $8 \mu g/m^3$, well under the state standard of $470 \mu g/m^3$. The EPA annual significance level of $1 \mu g/m^3$ was also not approached, with shoreline levels estimated at $0.03 \mu g/m^3$.

- Sulfur Dioxide

Equipment on the production platform and the crew/supply boats are the major sources of SO_2. The emissions were reviewed under a number of meteorological conditions and averaging times. In summary, regardless of the standard applied, the maximum increase in concentration will be significantly below allowable levels of increase. The annual EPA level of significance is 1.0 $\mu g/m^3$ and project increases are estimated at 0.01 $\mu g/m^3$. The California standard for one hour of 1310 $\mu g/m^3$ is far above the one hour 2.0 $\mu g/m^3$ concentration levels predicted for the project. Thus, no adverse impact is projected.

- Particulates, Carbon Monoxide, and Hydrocarbons

Modeling of the particulate emissions with short-term and annual Gaussian dispersion equations yielded negligible ground level concentrations at the shoreline. Carbon monoxide impacts at the shoreline were also insignificant. The EPA one hour significance level is 2 $\mu g/m^3$ for CO and the predicted concentration at the shoreline will be 0.002 $\mu g/m^3$.

The hydrocarbons emitted by the turbines and diesel engines are expected to have little or no impact. The South Coast Air Quality Management District (SCAQMD) requires a new source review to be conducted if the project emits 25 pounds per hour or 250 pounds per day. At maximum loading, the offshore operations will generate only 200 pounds per day of hydrocarbons. Likewise, emissions from the onshore surge tank will be below 250 pounds per day. The maximum combined project hydrocarbon emissions are estimated to be 293 pounds per day.

d. Mitigation

Ultimately, resolution of jurisdictional uncertainties and the attainment or non-attainment status of the project area will determine the required level of mitigation. If it is found that the project is in a non-attainment area, then it is likely that Rule 213 of the SCAQMD will be applied. Under Rule 213 the project would be required to be subjected to an air quality impact analysis because NO_x, SO_x, and hydrocarbon emissions all exceed the limit of 250 pounds per day (2,602, 389 and 293 pounds respectively). The project would also likely be required to provide pollutant offsets. Although offsets for the project are available within the basin from third party sources, Shell and its co-lessees have sufficient internal offsets within the basin and/or in Ventura County to satisfy any necessary reductions.

If the project is within an attainment area and subject to EPA or Department of the Interior jurisdiction, then the project will not require mitigation because the Prevention of Significant Deterioration (PSD) levels will not be exceeded. However, regardless of the jurisdictional issues, Shell proposes to install Best Available Control Technology (BACT) to reduce major pollutants such as either a hydrocarbon vapor recovery system or a double seal floating roof on the onshore surge tank. Further, Shell is pursuing the installation of innovative technology in the form of water injection for the offshore turbines which could reduce NO_x emissions by as much as 65 percent according to the turbine manufacturer. Shell has requested the turbine manufacturer to develop this technology and plans to adopt it for this project when available.

2. Oil Spills and Associated Impacts

The possibility of a significant oil spill associated with the offshore platforms and the pipeline exists even though the probability is low. The causes of a spill might be any number of reasons including well blowout, equipment failure, ship collision, operator error, pipeline failure or damage, and others. To assess the impact of a spill several scenarios were developed and analyzed. These included:

- A 5000-bbl (785 m^3) platform spill
- A 50-bbl (8 m^3) pipeline spill
- A 50-bbl (8 m^3) Long Beach Harbor spill
- A catastrophic 80,000-bbl (12,720 m^3) platform spill

Prevailing oceanographic and meteorological conditions are such in San Pedro Bay that the likelihood of a sizeable spill reaching shore somewhere between San Pedro and Dana Point is high if spill containment and clean up are not highly effective. A series of trajectories were run indicating the path of dispersion and shore contact.

The impacts of a spill are very dependent on the spill volume, prevailing weather and oceanographic conditions, and spill location. The impacts would include:

a. Water Quality - Short-term degraded water quality conditions.

b. Marine Biology - Effects on intertidal, benthic, plankton, fish, marine mammal and bird communities, and marshland resources;

c. Air Quality - Short term hydrocarbon emissions;

d. Recreation - Disruption of coastal zone and coastal related tourist activities with attendant economic consequences.

The primary means to mitigate oil spills is to ensure that they do not occur, through strict enforcement of Shell's operational procedures and USGS OCS Orders. Applicable Pacific Area Orders include:

Pacific Area OCS Order No. 2

This Order requires the operators to file an application for drilling which includes information on the drilling platforms or vessel, casing program, blowout prevention equipment, well-control training and safety training of operator's person nel, and a list or description of critical drilling operations.

Pacific Area OCS Order No. 3

This Order regulates the plugging and abandonment of wells which have been drilled for oil and gas.

Pacific Area OCS Order No. 5

This Order sets regulations for the installation, design, testing, operation, and removal of subsurface safety devices.

Pacific Area OCS Order No. 6

This Order pertains to procedures for completion of oil and gas wells.

Pacific Area OCS Order No. 7

This Order concerns the control of pollution to the marine environment and provides regulations for the disposal of waste materials generated as a result of offshore operations.

Pacific Area OCS Order No. 8

This Order requires that platforms, fixed structures and artificial islands be designed with consideration for geological, geographical, environmental and operational conditions.

Pacific Area OCS Order No. 9

This Order provides approval procedures for oil and gas pipelines in the OCS.

Additionally, other federal agencies are responsible for monitoring and regulatory actions related to spill prevention.

The second method is to ensure prompt action by Shell in the event a spill does occur. In this respect Shell has prepared a Spill Contingency Plan for the Beta Project.

This plan, developed in 1976, will be updated by Shell in 1979 prior to commencement of Beta operations, and submitted to the USGS for approval. Recommendations to enhance the present plan include:

a. Update time-dependent factors such as personnel responsibilities and equipment inventories (USGS will require periodic updating once approved);

b. Consider incorporating additional specific commitments from commercial clean-up firms for support services in the event of a major spill;

c. Provide more detail procedures by personnel assignment for spill handling including use of dispersants;

d. Consider locating another VIKOMA seapack containment boom on the Beta platforms to provide up to 3000 feet (900m) for immediate deployment;

e. Incorporate pipeline leak location and routine surveillance procedures; and

f. Incorporate appropriate references to and measures for protection of sensitive bays and estuaries including location of spillbooms and agencies responsible for their deployment.

3. Marine Traffic

The location of the platforms in the separation area of the Gulf of Santa Catalina Traffic Separation Scheme (TSS) creates concern regarding conflicts with shipping and the potential for collision. Approximately nine ships per day use the TSS and this might increase to as many as 11 ships by the year 2000. The annual risk of a collision between a large ship (greater than 500 gross tons) and any of the Beta platforms is assessed at 0.0046 (or put another way one collision every 217 years). The project life is 35 years. This risk is based on historical data from oil platform collisions in the Gulf of Mexico where traffic and weather conditions create a comparable risk situation. Detail risk estimates for all types of collisions were calculated.

Several findings related to a review of historical collision data in the Gulf of Mexico are worthy of note and have implications on mitigation approaches for the Beta Project. First, the use of charted traffic lanes, designated clear of fixed objects, can reduce the possibility of a ramming. Second, evidence from the Gulf of Mexico indicates that mariners will not always adhere to designated traffic lanes when the opportunity for economic savings exist (i.e., via a short cut). Third, a major factor in large-ship collisions with platforms has been an inability to visually identify the structure both after dark and during conditions of reduced visibility due to inclement weather.

Despite the low probability of a large-ship collision with any of these platforms, measures to reduce this risk should be taken. These include:

a. Approved Navigation Aids. The Coast Guard has approved Shell's plan for platform navigation aids. At a future date, if additional platforms are built in

San Pedro Bay, it may be necessary to augment these aids with a radar identification type system such as RACON.

b. Visual Identification. The platforms should be distinctive in marking and color to ensure earliest possible recognition by ships under all types of conditions.

c. Notification of Marine Interests. Notices to Mariners, Coast Pilot, charts, and other navigation documents and notices should incorporate platform installation and placement data in a timely manner.

d. Safety Zones. In accordance with Inter-Governmental Maritime Consultative Organization (IMCO) Resolution A.379(X) a 500 meter safety zone around each platform should be considered. As presently situated, all Shell Beta platforms are further than 500 meters from the Gulf of Santa Catalina traffic lanes. Hence, no adjustment in either the lanes or the platform locations is necessary to maintain a 500 meter separation.

The pipeline may need to be buried to a depth greater than four feet (1.2 m) in the harbor area to minimize conflicts with harbor activities. Appropriate notices and chart modifications will be required to notify marine interests of the subsea pipeline and to prevent conflicts, particularly with anchoring activities.

4. Energy Supply/Demand and Economics

Prior studies have projected crude oil "best case" demand estimates within California at 2,265,000 barrels (360,000 m^3) per day in 1980, and 2,455,000 (390,000 m^3) in 1985. When compared with existing 1975 refinery capacities in the State, as augmented by firm, planned additions to these capacities, it has been concluded that the 1980 refining requirements can be met, but that by 1985 an additional refinery capacity of 190,000 barrels (30,000 m^3) per day will be required in California. If refinery capacity is limited, the output of the Shell Beta unit, projected at 24,000 barrels (3,816 m^3) per day by 1986, might serve to aggravate this situation.

On the other hand, using different sources of information, and certain assumptions, a recent survey of West Coast refineries would imply that sufficient refinery capacity exists within the Los Angeles basin to more than meet the processing needs for the caliber of oil produced by the Shell Beta unit (high sulfur, heavy crude), for both 1980 and 1985. Extrapolation of this survey indicates that the current capacity of Los Angeles area refineries to process high sulfur heavy crude oil is approximately 237,000 barrels (38.000 m^3) per day, as contrasted with a projected 1980 production of 181,000 barrels (29,000 m^3) per day, and 1985 production of 188,700 barrels (30,000 m^3).

During 1978, the United States imported roughly 10,000 (1,600 m^3) barrels per day of high sulfur, heavy crude oil. Thus, an additional effect of the expected Shell Beta production of 24,000 (3,816 m^3) barrels per day would be to more than satisfy this demand, thereby reducing the nation's dependence, albeit to a small degree, on foreign imports.

Another factor is the expected rapid increase in oil from the North Slope of Alaska. Unless measures are taken to divert this somewhat higher quality oil[1] elsewhere, estimates of a West Coast surplus range from 320,000 to 980,000 barrels (51,000-156,000 m^3) per day by 1980 and from 750,000 to 1,800,000 (120,000-286,000 m^3) by 1985. Additional production from the Shell Beta Unit would, of course, contribute further to the surplus.

One final effect involves the possiblity that production from the Beta Unit will contribute to what appears to be an existing marketing problem on the West Coast for high sulfur, heavy crude oil. Inasmuch as the Shell Beta production will be similar in quality to that currently being produced onshore, concern has been expressed that its introduction to the market would aggravate this condition and result in a surplus of high sulfur, heavy crude in the area. While this potential may exist, it is anticipated that the 1978 amendments to the Department of Energey Entitlement Regulations will alleviate this condition, to the extent that by the time the Beta Unit becomes fully operational, this potential effect will have been essentially eliminated.

The installation and operation of the Shell Beta facilities will serve to increase regional job opportunities over the expected 35 year life of the project. In

[1] Less than one percent sulfur by weight versus 3-4 percent for Shell Beta oil.

addition, it will generate increased personal income through direct wages as well as through secondary, multiplier effects on the economy. Furthermore, it will generate royalties to the federal government. While these largely beneficial effects are acknowledged, when compared with the very large baseline figures existing in each of these categories within the Los Angeles-Orange County region, the impact of the Beta Unit is considered negligible.

5. <u>Oceanographic/Water Quality</u>

The platforms and pipeline should have no significant effects on oceanographic conditions. The oceanographic criteria to which the platforms are being designed are considered adequate and conservative based on local conditions and published data.

Water quality and oceanographic conditions at the platform sites and along the pipeline route were verified as corresponding to previously published data for San Pedro Bay by a short-term sampling program conducted for this project. This gives further confidence to the design criteria.

Some short-term water quality impacts may occur as a result of pipeline trenching and burial in Long Beach Harbor, however, if conditions imposed by the pending Corps of Engineers pipeline permit are followed these impacts should be minimized and no long-term significantly adverse effects should result.

Discharge of drill cuttings and muds, as well as waste discharges from the platforms, will cause some highly localized water quality effects near the platforms, but no concentration standards should be exceeded. Contaminated drill cuttings and muds will be disposed at approved shore sites in accordance with Pacific Area OCS Order No. 7.

Thermal discharges from platform cooling systems may result in a maximum temperature change (ΔT) between receiving waters and the discharge water temperature of as much as 21.6 F (12.0C) during winter months. The EPA policy is that 20F (11.1C) is the maximum ΔT for this type discharge. Recognizing that Shell's discharge will only very slightly exceed the maximum ΔT by 1.6F (0.9C), if EPA enforces this criterion, provisions may need to be made to draw cooling water from deeper depths, to provide additional volume, or to diffuse the discharge into the receiving waters. This should be determined as an element of the EPA wastewater discharge permit (NPDES).

6. Geotechnical Factors

The impacts of platform and pipeline activities were assessed from a geotech nical standpoint. No geotechnical surveys or new site specific analyses were performed for the environmental report; rather, surveys and baseline research conducted for Shell and others in the project area were used to evaluate impacts. Also, published literature was used as the basis for the seismicity evaluation.

The possiblity of well blowout and resulting oil spill due to a failure of the blowout prevention system is low if Pacific Area OCS Orders are followed. Shell's planned reservoir pressure maintenance program using water injection, if properly implemented, should minimize any possibility of induced displacements along existing fractures, ground subsidence, or induced seismic events. The thickness of the capping strata, generally low reservoir pressure, and the well casing program planned for the Beta Project, coupled with revised rules and more stringent regulation of drilling operations, make the possibility of loss of control of a drill well remote.

The likelihood of gravity-induced slumping or surficial soils creep at the platform sites, where seafloor gradients are less than four degrees, is remote.

The design criteria for the shallow-water platforms (Ellen and Elly) as pertains to ground and structural instability due to gravity, seismic and ocean-wave loading, appear conservative and based on state-of-the-art techniques. No adverse impacts are predicted. Moreover, the USGS will conduct a detailed design review of the project before approval. Additional geotechnical evaluations and soil borings are required for the deep-water platform (Eureka) before its design is finalized. No judgment could be made regarding its adequacy. However, if design procedures similar to the shallow-water platforms are used, no adverse impacts are anticipated. The USGS will also review and approve this design.

The platform to shore pipeline design was also reviewed. No adverse impacts are predicted to the pipeline due to subsidence, ground movement (not earthquake associated), gravity loading, or structural integrity along the pipeline route. The potential consequences of earthquake associated fault movements, seismic-induced liquefaction, and ocean wave-induced liquefaction and scour are still being evaluated by the applicant at the present time and results will be available for the Final EIR/EA. Should any mitigation be required it would consist of pipeline realignment or design alteration. Also additional geotechnically-related studies will be required to finalize the deep-water to shallow-water platform pipeline design.

7. Marine Biology

Biological impacts from oil spills are potentially significant depending on the size and duration of a spill. Large-scale spills of greater than 5000 barrels (795 m^3) could impact sensitive habitats along the coastline. Species which are the least mobile, such as those found in the intertidal and benthic communities, will be adversely affected, as well as those species which live or feed on the surface of the ocean, such as marine birds. The degree of impact will be related to the efficiency of the Shell Spill Contingency Plan. While these habitat impacts are felt to be adverse, the literature indicates that spill impacts on marine organisms and wildlife tend to be short-term in duration. Over a period of one to two years, most habitats will regenerate themselves.

Trenching for the pipeline in Long Beach Harbor and discharge of drill cuttings from the platforms will result in short-term, adverse biological effects, primarily on the benthic, but also on other marine communities in the immediate impact area. Proper pipeline trenching and burial procedures, and strict control of contaminated drill cuttings should mitigate these effects. The areas impacted are very small.

The platforms themselves will act as artifical reefs and will significantly enhance many elements of the marine biological community. This is a long-term benefit which will include improved recreational fishing in the nearby waters.

8. Cultural Resources

No archaeological/historical resources are known to exist at the platform sites, along the pipeline route, or at shore facility locations. Because of the potential for historic marine or pre-historic human cultural resources along the pipeline route, the applicant's pipeline route remote sensing survey was augmented with a five transect magnetometer and side scan sonar survey. With the exception of magnetometer disturbances, the results of the other instrument recordings were essentially negative. Seven magnetic disturbances which could not be identified and which are considered potentially significant were recorded along the route. Six of these are considered possibly to be of cultural value; the remaining anomaly is not felt to be a cultural resource, but should be investigated prior to laying the pipeline. While it is likely that these anomalies are modern debris, it is recommended that the six anomalies be investigated with a mobile video unit, if seawater visibility conditions permit. If any cultural resources are identified, they should be evaluated by a qualified marine archaeologist or the pipeline route should be adjusted to avoid the resource location.

9. Other Impacts

There will be some aesthetic impacts associated with the project, primarily with the offshore platforms. Because the platforms are nine miles (14.4 km) offshore, they will be neither dominant nor particularly offensive to onshore viewers. Moreover, at this distance some of the visibility is restricted because of the curvature of the earth.

No mitigation is recommended for visual enhancement of the platforms since their identification by shipping in the TSS is considered an overriding mitigation requirement.

Some relatively minor onshore impacts will result such as construction noise, traffic, and dust. These are short-term in nature and should be handled through local ordinance and permit processes. A potential for parking overload and circulation impacts at the Huntington Harbour Crew Launch facility exists during project construction and may need to be mitigated through acquisition of temporary offsite parking, pooling/bussing arrangements during the construction stage, or utilization of an alternate launch facility.

The project as proposed is consistent with Coastal Zone Policy and the Port of Long Beach Master Plan. Potential construction activity conflicts in the Port with proposed SOHIO and marina development activities can be avoided by appropriate scheduling.

ALTERNATIVES

Several alternatives to the project including the "no project" alternative were evaluated.

By virtue of the fact that the federal government has leased these tracts for oil and gas development, the no project alternative was already evaluated and rejected during the federal OCS Lease EIS process. State and local agencies could deny the project as proposed with the result that some impacts on their jurisdictions could be avoided. In all likelihood such an approach would result in barging of the oil from the platforms to various ports, an inherently more risky process from an environmental standpoint according to Department of Interior studies. The no project alternative, while eliminating environmental impacts, would not allow valuable petroleum resources estimated at 100-200 million barrels to be recovered.

Other alternatives evaluated included alternative pipeline routes to shore and barging of the product. All viable approaches appear more environmentally penalizing, particularly in terms of Coastal Zone conflicts.

Originally, subsea completion systems were considered for the project to avoid marine traffic conflicts in the TSS. The nature of the oil in the Beta Unit is such that it must be artificially lifted (pumped) from the wells. This requires frequent well servicing and would obviate any benefits to marine traffic because of the need for constant rig vessel services in the same area, and at variable locations.

Other alternatives examined included different numbers of platforms or platform locations. So long as the platforms remain at least 500 meters outside the traffic lanes, no major impact on marine traffic is predicted. The scheme that Shell has proposed for this project allows efficient handling of the oil treatment requirements; other treatment approaches offer no overriding environmental benefits.

The shore facilities are relatively small in area and could be sited at alternative locations, but no particular environmental benefits are foreseen with the exception of the crew launch facility. Location at a more industrialized area might reduce parking and circulation impacts at a congested coastal location. In this respect, a number of sites might be available in the Port of Long Beach or Los Angeles.

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SECTION 1.0
INTRODUCTION

Shell Oil Company and its co-lessees in this project are proposing to develop a portion of the Beta Unit oil field in an area of the Outer Continental Shelf (OCS) located approximately nine miles (14.5 km) offshore of Huntington Beach, California. The proposed Beta Unit consists of five tracts in San Pedro Bay where Shell *et al.* are proposing to install on two of the tracts' three offshore platforms (two drilling, one production) for the purpose of developing, extracting, and processing crude oil resources in the field. Once processed onboard the production platform, the crude oil will be pumped via a pipeline to shore in the Port of Long Beach from whence it will be distributed to existing regional refinery facilities. A complete project description is provided in Section 2.0 of this document. The two tracts covered by this project were leased as part of OCS Lease Sale No. 35 in 1975.

The leasing and potential development of tracts of OCS Lease Sale No. 35 including the Beta Unit were covered by an Environmental Impact Statement (EIS) prepared by the U.S. Department of the Interior, Bureau of Land Management (BLM, 1975). That document covered the overall environmental impacts associated with exploration and development of crude oil and gas resources within San Pedro Bay and the other OCS Lease Sale No. 35 areas. Specific lease developments will be subject to individual environmental review as projects are proposed. It is important to understand that the cumulative and overall effects of OCS Lease Sale No. 35 development (and others such as OCS Lease Sale No. 48) are covered in the Lease Sale EIS, not in individual project environmental reports.

The purpose of this document is to cover the specific environmental impacts associated with the proposed Shell *et al.* development of two leaseholds in the Beta Unit. This document is a combined Environmental Impact Report (EIR) and Environmental Assessment (EA) reflecting its dual function under the California Environmental Quality Act of 1970 (CEQA), with amendments of March 4, 1978, and the National Environmental Policy Act of 1969 (NEPA). In this case, the California State Lands Commission (SLC) and the Port of Long Beach (Port) are joint lead agencies under a Memorandum of Understanding (MOU) dated September 6, 1978. The reason for this relationship is that the pipeline bringing crude oil onshore from the Shell offshore platforms will require a right-of-way across offshore state lands prior to entering the Port of Long Beach. A lease for the right-of-way from the SLC will be required. The Port will be the point of landfall for the pipeline and the location of onshore crude oil handling and distribution facilities tying into the existing regional refinery system, hence the joint lead agency relationship. Further, the U.S. Geological Survey (USGS), which is also a party to the MOU, has lead agency responsibility for areas under federal jurisdiction. Their areas of responsibility include the platform sites and a portion of the offshore pipeline route. Under Department of Interior and USGS guidelines for implementing NEPA, this document is intended to serve as an EA.

In accordance with current amendments to CEQA stressing a focused environmental report, this document identifies the key environmental issues of the project and makes use of the extensive environmental baseline existing for the project areas. Prior to initiating this study, the three lead agencies developed a joint report outline and identified key issues (SLC, 1978). As a result of this and the subsequent analysis, this EIR/EA is focused on the following major issues:

- Air Quality
- Geotechnical Factors
- Marine Safety
- Oil Spills
- Oceanography/Water Quality

Other issues which also receive significant analysis and are addressed in depth include:

- Marine Biology
- Socioeconomics
- Cultural Resources
- Energy Supply/Demand

To eliminate repetition of baseline data, this document draws heavily on certain master documents. The baseline data in these documents have been incorporated into this document by: (1) reference; (2) brief summarization; or, where necessary, (3) complete quotation. These documents include:

(1) United States, Department of the Interior, 1975. Final Environmental Impact Statement, 1975, Outer Continental Shelf Oil and Gas General Lease Sale (No. 35). Volumes 1-5.

(2) United States Department of the Interior, 1978. Preliminary Draft Environmental Impact Statement, 1978, Outer Continental Shelf Oil and Gas General Lease Sale (No. 48), Volumes 1-2.

(3) Southern California Ocean Studies Consortium, 1974. A summary of knowledge of the Southern California Coastal Zone and Offshore Areas. Volumes 1-3.

(4) Dames and Moore, for Shell Oil Company, 1978. Regional Baseline Environmental Data, Shell Beta Unit Project.

(5) Port of Long Beach, 1977. The Final Environmental Impact Report on the Proposed General Plan, Volumes 1-2 of EIR plus Finalizing Addendum.

(6) Port of Long Beach, 1976. Draft Environmental Impact Report on the SOHIO West to Mid-Continent Pipeline Project, Volumes 1-3 and Executive Summary.

(7) Port of Long Beach, 1976. Master Environmental Setting, Volumes 1-2.

(8) Port of Long Beach, 1976. Environmental and Geotechnical Program Study, Volumes 1-3.

This document is supported by technical data, memoranda, and correspondence in a separate appendix.

Persons reviewing this document should keep in mind that the material provided herein is informational in nature. It is intended to enable appropriate public agencies and the public to evaluate the environmental impacts associated with the project as proposed. The responsible public agencies are obligated to balance possible adverse effects against other public objectives, including economic and social benefits, to determine whether the project receives necessary permits and approvals. Moreover, these agencies also are required to evaluate possible alternatives and mitigating measures where adverse impacts are identified.

This environmental report is not intended to be used as an engineering design document. Likewise, it does not relieve the responsible agencies or the applicant of their responsibilities to insure that engineering documents or permit applications otherwise required for this project are prepared and submitted.

Because certain terminology is particular to the oil production and offshore industries, a glossary of terms is provided as part of the Introduction to provide references for the lay reader who may not be familiar with these terms.

GLOSSARY

ANOMALY. In magnetometry, an unusual waveform on analog data, characteristic of disruption to normal background values. Can be manmade (i.e., iron object) or natural (i.e., geologic ore body).

ANTICLINE. An arched fold of stratified rock with the rock strata sloping downward in opposite directions from the central axis of the arch.

ANNULAR BLOWOUT PREVENTER: A large valve, usually installed above the ram preventers, that forms a seal in the annular space between the pipe and wellbore or on the wellbore itself if no pipe is present; often called a Hydril after one of the manufacturers of such units.

API. American Petroleum Institute, a trade association for American oil and gas companies.

API GRAVITY. An arbitrary scale expressing the gravity or density of liquid petroleum products. The measuring scale is calibrated in terms of degrees API. It may be calculated in terms of the following formula:

$$°API = \frac{141.5}{\text{Specific Gravity at 60F}} - 131.5$$

ASSOCIATED GAS. Free natural gas in immediate contact, but not in solution, with crude oil in the reservoir (see DISSOLVED GAS).

ATMOSPHERIC BOTTOMS. The first stage in refinery processing is normally distillation of the crude oil at atmospheric pressure into its natural boiling point components. The bottoms product from this distillation is referred to as "atmospheric bottoms," and normally has an initial boiling point of approximately 650F. This product is usually suitable for residual fuel oil blending or can be a feed stock to subsequent processes for conversion into lighter fractions.

BALLASTING. The taking on by tankers of water to replace off-loaded oil and thereby improve stability.

BARREL. A common unit of measurement of liquids in the petroleum industry; it equals 42 U.S. standard gallons.

BENTHIC FAUNA. Animals whose habitat is in deep water or on the sea bottom.

BLOWOUT. An uncontrolled flow of gas, oil, and other well fluids from a well to the atmosphere. A well blows out when formation pressure exceeds the pressure being applied to it by the column of drilling fluid.

BOREHOLE. The wellbore; the hole made by drilling or boring a well.

BRITISH THERMAL UNIT (BTU). A unit of heat energy equal to the heat needed to raise the temperature of 1 pound of air-free water 1F (from 60F to 61F).

CASING. The steel lining of a well, the main purposes of which are to prevent caving of the sides of the well, to exclude water or gas from the well, and to provide means for the control of well pressures and oil production.

CENTIPOISE (CP). One-hundredth of a poise.

CHRISTMAS TREE. The assembly of pipes, valves, and fittings at the top of the casing which is used to control the flow of oil and gas from a producing well.

COMMERCIAL FIND. An oil or natural gas discovery large enough to warrant the financial investment necessary to develop the resources.

COMMON CARRIER TRANSMISSION LINE. Pipelines which may be used by more than one producer and are regulated by the Federal Power Commission or the Interstate Commerce Commission.

COMPLIANT TOWERS. The term compliant towers refers to bottom-founded, surface-piercing structures that sway slightly in response to wave forces, rather than trying to resist those forces as is the case with a fixed platform. There are two basic types of compliant towers -- the buoyant tower and the guyed tower. Compliant towers are used in lieu of fixed production platforms for areas of extreme water depth.

CONDENSER. Ordinarily, a water-cooled heat exchanger used for cooling and liquefying oil vapors. Where the cooling medium used is air, the condenser is called an air condenser.

CRACKING. A phenomenon by which large oil molecules are decomposed into smaller, lower-boiling molecules; at the same time, certain of these molecules, which are reactive, combine with one another to give even larger molecules than those in the original stock. The more stable molecules leave the system as cracked gasoline, but the reactive ones polymerize, forming tar and even coke.

CROSSOVER. A connection between two channels or passages. Crossovers are used in packers, in piping, and in other special devices in flow systems.

CRUDE OIL. Hydrocarbons, in liquid form, of such a variety of mixtures that no two are the same. The two major categories are sour, with one percent or more sulfur, and sweet, with less sulfur.

DEAD WEIGHT (DWT). The difference, expressed in tons, between a ship's displacement at load draft and at light draft. It comprises cargo, bunkers, stores, fresh water, etc.

CRUDE RUNS. The amount of crude oil processed through crude oil distillation; usually presented on a per day basis.

CUT. A fraction obtained by a separation process.

DEDICATED RESERVES. Reserves which have been designated to specific users.

DEEP-WATER PORT (DWP). Any fixed or floating man-made structure other than a vessel, or any group of such structures, located beyond the territorial sea and off the coast, to be used or intended for use as a port or terminal for the loading or unloading and further handling of oil for transportation in land area. The term includes all associated components and equipment, including pipelines, pumping stations, service platforms, mooring buoys, and similar appurtenances to the extent they are located seaward of the high water mark.

DESULFURIZATION. The removal of sulfur or sulfur compounds from a charge stock.

DEVELOPMENT WELL. A well drilled in a proven field for the purpose of completing the desired pattern of production. Sometimes called an exploitation well.

DIRECTIONAL DRILLING. Controlled drilling deviation from a vertical plane for the purpose of reaching subsurface points laterally remote from the point at which the bit enters the earth.

DISSOLVED GAS. Natural gas in solution with crude oil in the reservoir (see ASSOCIATED GAS).

DISTILLATE. That portion of a liquid which is removed as a vapor and condensed during a distillation process.

DISTILLATION. Vaporization of a liquid and its subsequent condensation in a different chamber. The separation of one group of petroleum constituents from another by means of volatilization in some form of closed apparatus, such as a still, by the aid of heat.

DRAINAGE TRACT. A tract adjacent to one from which oil and gas are being produced. As production continues, oil and gas may be drained from formations in the drainage tract.

DRY GAS. A gas which does not contain fractions that may easily condense under normal atmospheric conditions.

EMULSION. A dispersion of fine particles of one liquid in another. The tendency to do this is called "emulsibility."

EXPLORATORY WELL. A well drilled in unknown territory to find and define oil and gas deposits. If territory is completely unknown, the well is called a wildcat.

FIELD. An area which, consisting of a single or multiple reservoirs, encompasses a group of oil and gas wells.

FLARING GAS. The process of burning off natural gas at the offshore platform when there is not sufficient quantity to warrant piping the gas to shore.

FLUE GAS. Gas from the combustion of fuel, the heating value of which has been substantially spent and which is, therefore, discarded to the flue or stack.

FREE-WATER KNOCKOUT. A tank for separating water from oil.

FUEL LEAN. Fuel/air mixture containing more than stochiometric oxygen; i.e., oxygen rich.

FUEL RICH. Fuel/air mixture containing less than stochiometric oxygen; i.e., oxygen lean.

GAS LIFT. Process by which crude oil is forced to the surface by injecting gas through the production tubing.

GAS/OIL RATIO (GOR). The quantity of gas produced with the oil, expressed as cubic feet per barrel of oil.

GATHERING LINES. Flow lines which run from several wells to a single tank battery.

GRADIENT. Taken here for purposes of magnetic survey to be the background intensity of the earth's magnetic field and local variations within it. In southern California, about 49,000-50,000 gammas.

GRAVITY. The ratio of the weight of a volume of any liquid to the weight of an equal volume of distilled water at 60F.

HYDRIL. See Annular Blowout Preventer.

HYDROCARBONS. Compounds composed of carbon and hydrogen.

JACKET. The legs which support a development/production platform.

JACK-UP RIG. A mobile drilling platform with extendible legs for support.

LANDFALL. The location where a pipeline comes out of the water and onto land.

LAY BARGE. A barge used to lay underwater pipelines.

LEASE STIPULATIONS. Conditions under which the offshore tracts must be developed.

LIGHTERING. A method of offloading tankers at sea or outside of ports, usually from large tankers to smaller ones which, in turn, continue into a discharge port. Lightering is a common practice at entrances to certain ports which cannot handle the deep drafts of large tankers.

LOAD FACTORS. A measure of utilization of electric generating system capacity, reflecting the percentage of time the electric generating facilities are being used to design capacity.

MAGNETOMETER. For purposes of marine archaeological and geological hazards surveys, the magnetometer is a total field measuring instrument, utilizing the precession of spinning protons or hydrogen nuclei after release from orientation by electrical charge. The sensor is towed on the end of a cable behind the vessel, and is called the "towfish."

MANIFOLD. An accessory system of pipeline to a main pipeline system (or other conductors) that serves to divide a flow into several parts, to combine several flows into one, or to reroute a flow to any one of several possible destinations.

MARINE RISER. A sectional pipe running from a floating drilling rig to the ocean floor used to direct the drill stem and carry mud.

MARINE TERMINAL. A facility which receives or ships out petroleum products. In addition to pipelines from the terminal to shore, marine terminals require onshore pumping stations and surge tanks.

MUD. The liquid that is circulated through the wellbore during rotary drilling and workover operations. In addition to its function of bringing cuttings to the surface, drilling mud also cools and lubricates the bit and drill stem, protects against blowouts by holding back subsurface pressures, and deposits a mud cake on the wall of the borehole to prevent loss of fluids to the formations. Although it originally was a suspension of earth solids (especially clays) in water, the mud used in modern drilling operations is a more complex, three-phase mixture of liquids, reactive solids, and inert solids. The liquid phase may be fresh water, brine, diesel oil, or crude oil, and may contain one or more conditioners.

MUD SCREEN. A shale shaker (i.e., the vibrating screen used to remove cuttings from the mud as it returns to the surface from the bottom of the well).

NATURAL YIELDS. The amount of a specific product or products obtained from crude oil in the crude distillation process, expressed as a percentage of the crude oil input.

NECKING. The tendency of a metal bar or pipe to taper down to a reduced diameter at some point when subjected to excessive longitudinal stress.

POISE (P). The viscosity of a liquid in which a force of 1 dyne (a unit of measurement of small amounts of force) exerted tangentially on a surface of 1 cm^2 of either of two parallel planes 1 cm apart will move one plane at the rate of 1 cm per second in reference to the other plane with the space between the two planes being filled with the liquid.

POUR POINT. A temperature 5F above that temperature at which an oil is solid. It represents the lowest temperature at which the oil will flow.

PRESSURE-RELIEF VALVE. A valve that opens at a preset pressure to relieve excessive pressures within a vessel or line; also called a relief valve, safety valve, or pop valve.

PROCESSING PLANT. Facility used to separate water and mineral impurities from the oil and gas pumped out of the well. These facilities may be located either on the platform offshore or onshore.

PRIMARY OIL RECOVERY. Mechanical means for recovering oil which depend on only natural forces to cause oil and gas to flow from the reservoir rock into oil producing wells. There are three processing mechanisms which are classified as forms of primary recovery: (1) dissolved gas drive; (2) gas cap drive; and (3) water drive.

PRODUCED WATER. Water which is intermixed with the crude product when it is brought to the surface. The crude is run through a free water knockout system and the result is produced water and "dry crude."

RESIDUE. Heavy oil or bottoms left in the still after gasoline and other relatively low-boiling constituents have been distilled off, or the remaining fraction from crude oil after distilling off all the heaviest components.

SACRIFICIAL ANODE SYSTEM. Corrosion protection for below water portion of the platform.

SCRAPER TRAP. Sometimes called a pig trap. Located at the end of the pipeline to allow removal of a serapen which is sent through the pipeline to keep the pipe walls clean.

SEA STATE. A system of indicating the relative intensity of conditions at sea. SS1 signifies "Smooth sea: ripples, no foam. Wind: light to gentle breeze, 1-4 knots."

SECONDARY OIL RECOVERY. Mechanical means for recovering oil which utilizes gas or water injection to augment the recovery efficiency provided by primary oil recovery. Both gas and water injection serve to maintain reservoir pressures and function as supplements to the primary gas and water production mechanisms.

SEGREGATED BALLAST. A term describing the provision of separate tanks for ballast water only, thus eliminating the need to carry ballast in cargo oil tanks. Tankers must carry about one-third or more of their total capacity in ballast when on an empty leg of a voyage to improve stability and control the draft of the ship. Usually sea water is used for ballast.

SHOT POINT. A navigational "fix" taken by a positioning system to precisely locate the data relative to the survey area. A survey line will consist of a number of these fixes along a linear course.

SIDE SCAN SONAR. A sonar device using an acoustic signal and recording its return as a reflection from objects within its range. Side scan sonar "looks" in both slightly less than horizontal directions from its sensor head (i.e., from below itself) to the horizon of its "view."

SKIM TANK. Used to remove oil from water by gravity separation.

SOUR CRUDE. Crude oil containing a large amount of sulfur compounds.

SOURCE WATER. Water, other than produced water, used in the reinjection process to maintain field pressure. In this case, sea water will be used as source water.

STAGING. A term applicable to compressors, pumps, cooling systems, treating systems, etc., that indicates that the unit or element (which is complete in itself) is placed in series with another unit or units of like design so as to improve operating efficiency and results.

STRUCTURAL TRAP. An oil reservoir that occurs where the strata have been folded or faulted, such that an upper portion of the structure is bounded by an impermeable layer of rock, which arrests the upward migration of oil.

SURGE TANK. A tank or vessel through which liquids or gases are passed to steady their flow and eliminate pressure surges.

SWEET CRUDE. Crude oil containing relatively little sulfur.

TERTIARY OIL RECOVERY. Chemical and thermal means for recovering oil which enhances the mechanical means discussed under primary and secondary recovery processes. Thermal recovery techniques include in-situ combustion, steam flooding, and steam cycling; the chemical means include injection of polymers and other materials. Both types of tertiary recovery are used to maximize recovery efficiency.

TRACT. 5,760 acres (2,332.8 ha) per tract (9 $mi.^2$ or 23 km^2).

UNIT. A combination of leases by agreement to permit the handling of the lessees' interests as if such interests were covered by a single lease.

UTILIZATION FACTOR. The relationship of actual crude runs to total installed crude distillation capacity during a specified time period.

VISCOSITY. That property of a fluid which determines its rate of flow. As the temperature of a fluid is increased, its viscosity decreases, and it therefore flows more readily.

WET GAS. A gas containing a relatively high proportion of hydrocarbons which are recoverable as liquids.

YIELD. The amount of a specific product or products obtained in a given process, expressed as a percentage of the feedstock. There are many yields, each of which should be specifically defined when used.

SECTION 2.0
PROJECT DESCRIPTION

2.1 PROJECT OBJECTIVES

2.1.1 Federal Objectives

National policy is directed toward achieving a reduction in foreign oil imports to this country; in part, this will be accomplished through development of energy resources within the United States. These energy resources include fossil fuels such as coal, oil, and gas, as well as other energy sources, including so-called "alternative energies" such as solar, geothermal, wind, and others. In addition, conservation is a prime mechanism in reducing dependency on foreign oil imports. At the present time the U.S. consumes approximately 18.1 million barrels (bbl) of oil per day, of which approximately 7.9 million bbl or 44 percent is imported from foreign suppliers. For both balance of payments equalization and reduction of the possibility of disruption of oil supplies in future periods of uncertainty, it is important to achieve these national energy objectives.

Consistent with the national policy, the U.S. government plans to continue to lease federal lands for development of oil and gas resources. It is federal policy that such resources be developed in an environmentally sensitive manner. As readily developable petroleum resources are discovered and produced, prospecting moves to areas more difficult to exploit. Included in these areas are federal lands in the OCS. The Department of the Interior, BLM, is responsible for the lease of OCS areas for such development. Under BLM, certain areas off the California coast have been opened to lease nomination and bidding. The history of the particular lease area which includes the Beta Unit project location is discussed in Section 2.1.2.

In addition to developing oil and gas resources on federal lands for the reasons cited, royalties from the sale of such resources are important sources of revenue to the U.S. government.

2.1.2 Development of Lease Sale No. 35

In January 1974, the Department of Interior requested the petroleum industry to nominate, by tract, areas they wished to be offered for lease, with eventual development of any discovered oil and gas resources. The nominated areas, totalling some 6.8 million acres (2,720,000 ha), were evaluated by BLM and USGS in terms of interest shown, geology and potential reserves, and environmental considerations. During this initial review, the proposed lease area was reduced to approximately 1.5 million acres (600,000 ha) and was designated as OCS Lease Sale No. 35.

The BLM prepared an EIS for OCS Lease Sale No. 35. The EIS addressed exploration, development, and production in considering impacts of the sale. This document is a major reference in developing any site-specific environmental assessments in the sale area.

Lease Sale No. 35 took place on December 11, 1975, with the Department of the Interior accepting bids for 56 of the 231 tracts finally offered. The Department of the Interior rejected the bids on 14 tracts. Prior to this, tracts in Santa Monica Bay, areas south of San Miguel Island, and areas offshore of Palos Verdes, Long Beach, and Orange County were withdrawn from consideration.

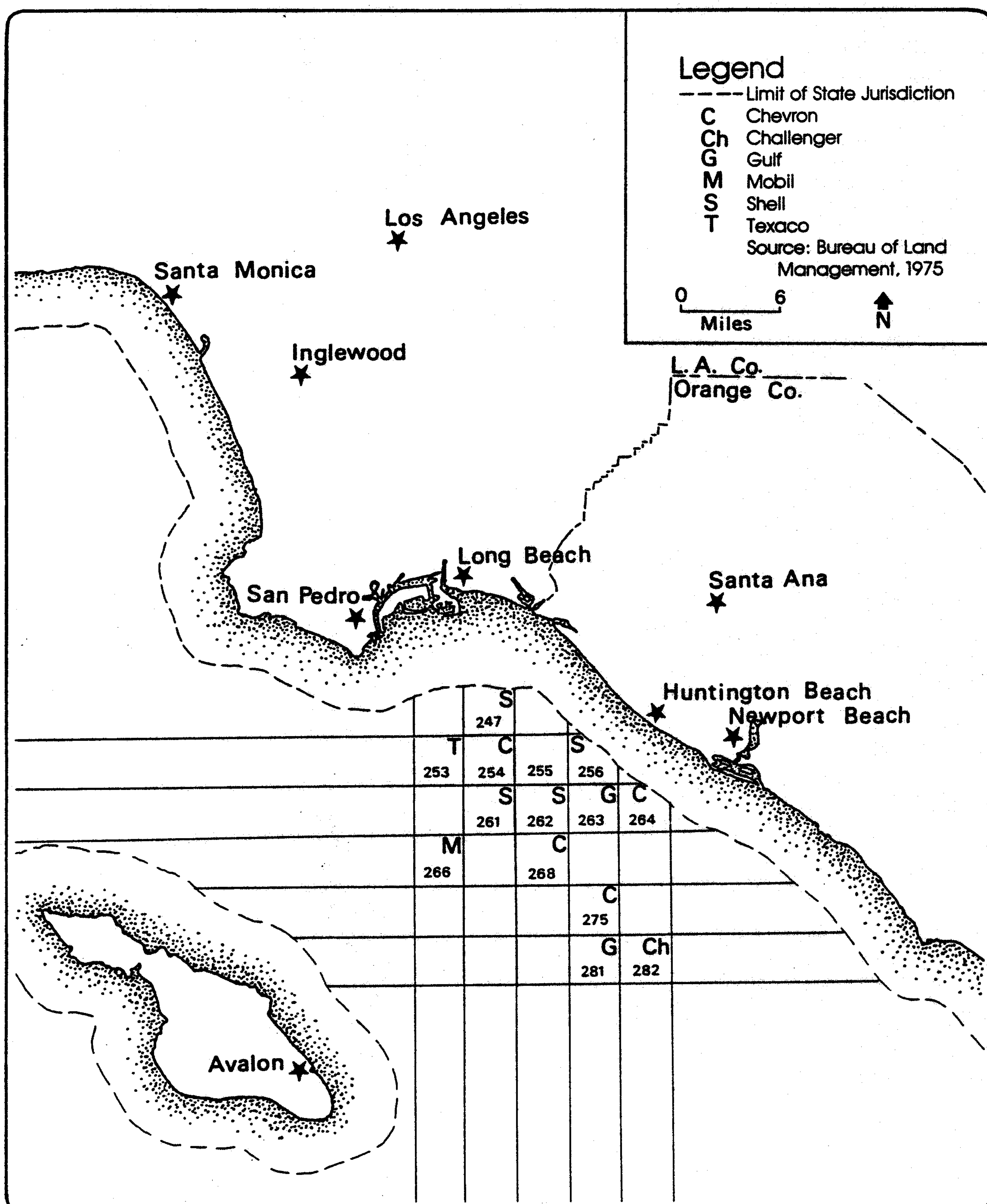
Four general geographic areas were included within Lease Sale No. 35: 1) Santa Rosa North area; 2) Santa Barbara Island area; 3) the Tanner-Cortes Bank area; and 4) San Pedro Bay area. A total of 13 tracts were leased in the San Pedro Bay area, with potential lease operators including Chevron USA, Shell, Gulf, Texaco, Mobil, and Challenger. These tracts are shown in Figure 2.1-1 along with their corresponding lease numbers. A royalty burden of 33-1/3 percent of production and unitization requirements were placed on parcels 254, 261, and 262 prior to the lease sale. The remainder of the San Pedro Bay tracts carry a royalty of 16-2/3 percent.

A number of core holes were drilled on OCS Tract 254 and one on Tract 261 prior to the December 1975 lease sale. Several of the wells had heavy oil (tar) shows in thinly bedded Pliocene sands. Most did not penetrate the Miocene sands, however, and provided little geological information.

Subsequent to the lease sale, a total of 21 exploratory wells have been drilled on the three tracts (eight by Shell on Tracts 261 and 262, and 13 by Chevron on Tract 254). Chevron and Shell have shared information on most of these wells. Chevron has not yet determined if development of Tract 254 is justified. Additionally, wells have been drilled on Tracts 247, 253, 256, 263, and 266, with drilling planned on 282. Thus, nine of the thirteen San Pedro Bay tracts have been or soon will be tested.

2.1.3 Applicant Objectives

The Shell Oil Company (Shell) is a major producer of petroleum products in the U.S. Among other producing areas, the company has been extensively involved in offshore production activities, particularly in the Gulf of Mexico. Through exploratory drilling discussed previously, Shell and its co-lessees have estimated that recoverable petroleum reserves in the range of 100 to 200 million barrels of oil exist in their portions of the OCS lease area covered by this project. The lessees' objective is to recover, process, refine, and market these resources within the framework of their existing product distribution systems and supply/demand functions. These factors will be addressed in this report. Through the sale of such petroleum products the lessees expect to derive economic benefit in terms of return on investment.



San Pedro Bay Lease Tracts

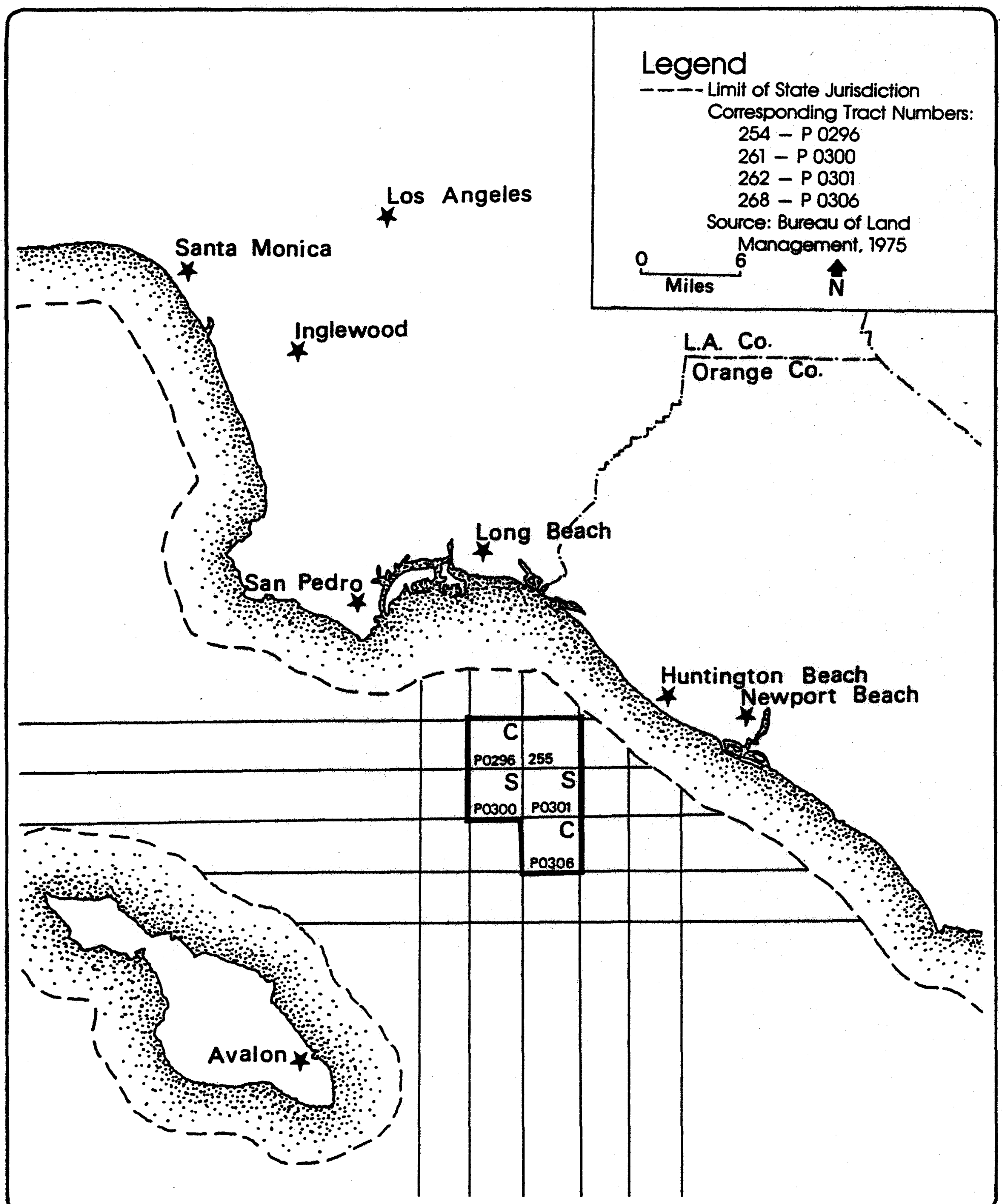
Figure 2.1-1

2.2 PROJECT LOCATION

The area of possible development covers approximately 28,800 surface acres (11,660 ha) on five tracts (leases P-0296, P-0300, P-0301, P-0306, and unleased Tract 255) and is denoted as the proposed Beta Unit as shown in Figure 2.2-1. Shell Oil Company is to be the initial operator for the proposed Beta Unit. Other potential participants are: Aminoil USA, Inc.; Champlin Oil Company; Chanslor-Western Oil and Development Company; Chevron USA, Inc.; Hamilton Brothers Oil Company; Occidental Petroleum Company; and Union Oil Company of California. The Unit is located in federal waters in the San Pedro Bay about nine miles (14.5 km) offshore of Huntington Beach, California. Planned development of leases P-0300 and P-0301 include a drilling platform (Ellen) in 265 feet (81 m) of water, connected by a 200-foot (61 m) bridge to a production platform (Elly) in 255 feet (78 m) of water, and a 16-inch (0.4 m) diameter subsea oil pipeline to shore at Long Beach, California, with a design capacity of 40,000 barrels (6,360 m^3) of oil per day. The proposed platform locations and pipeline route are shown in Figure 2.2-2. In the Port of Long Beach connection is to be made to existing onshore distribution facilities for ultimate disposal at Los Angeles basin refineries. The development plan also provides for a deep-water drilling platform (Eureka) in approximately 700 feet (213 m) of water 1.5 miles (2.4 km) southerly of the shallow-water platform complex. This deep-water drilling facility will be interconnected with the Ellen/Elly complex with three or four interconnecting pipelines, one or two 12-inch (0.3 m) crude lines, a 4-inch (0.1 m) gas line, a 6- or 8-inch (0.15-0.2 m) injection water line, and a power cable.

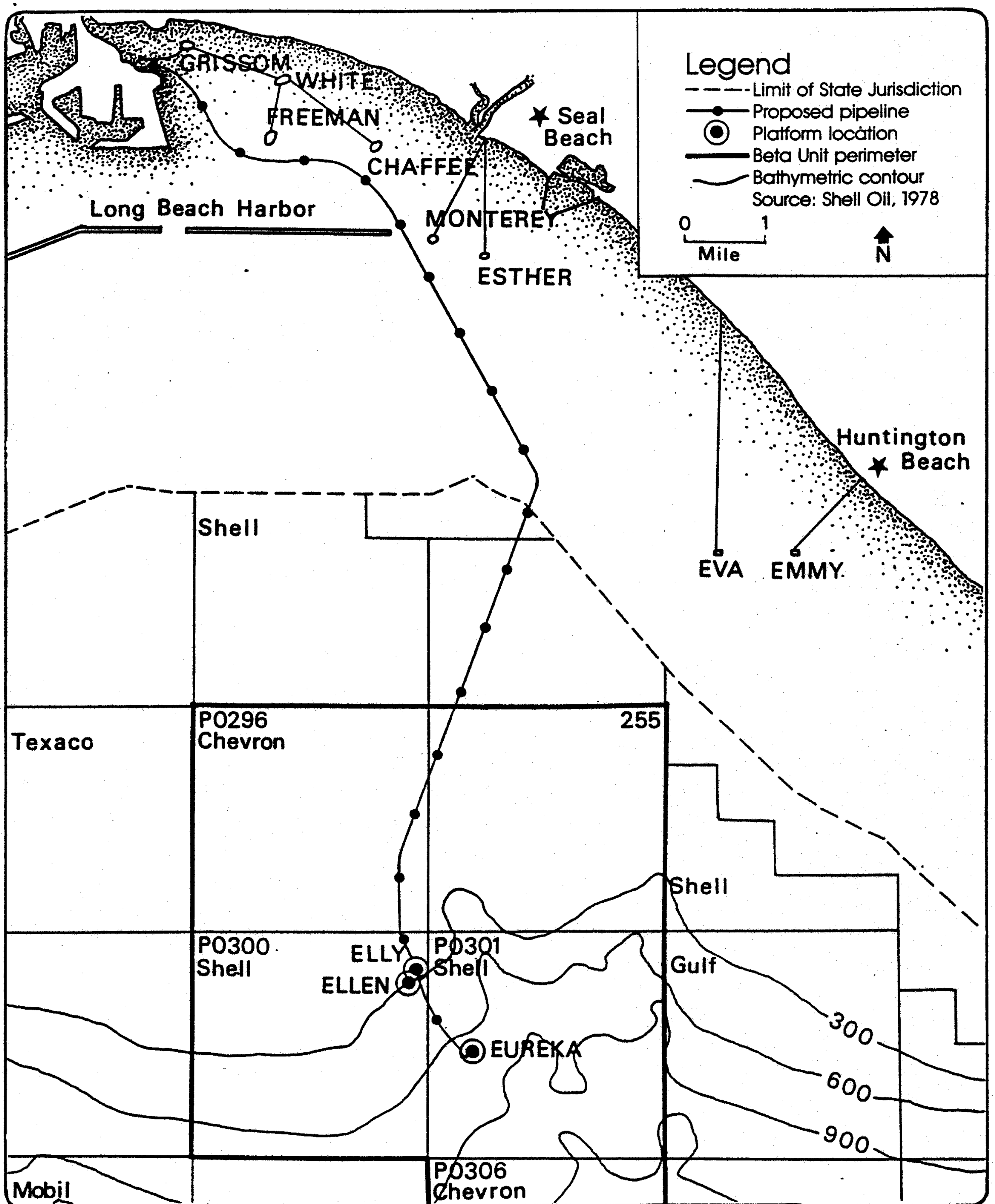
The location of the Shell Beta Unit platforms and pipeline in relation to the Port of Long Beach and coastal communities is shown in a regional aerial photograph on Figure 2.2-3. The proposed development would be located within the separation zone of the maritime Traffic Separation Scheme (TSS) leading from the Gulf of Santa Catalina through San Pedro Bay. Figure 2.2-4 shows the location of the platforms in relation to the traffic lanes. Based on navigation maps, a distance is indicated of 3,900 feet (1,190 m) from production Platform Elly to the northbound traffic lane and 4,250 feet (1,296 m) from drilling Platform Ellen to the northbound traffic lane. The U.S. Army Corps of Engineers evaluated the establishment of a safety fairway in the Gulf of Santa Catalina TSS. Such a fairway would include the traffic lane and a 500-meter buffer zone to each side of the traffic lane. The Corps has no current plans to implement such a fairway. Deep-water Platform Eureka is located approximately 2,600 feet (800 m) from the northbound traffic lane. Distances of the platforms to the southbound lanes of the TSS are much greater.

The project's onshore facilities would receive clean crude oil from the aforementioned pipeline whose nearshore route would generally parallel the existing THUMS Clean Oil Line (Figure 2.2-5). The onshore facilities would consist primarily of distribution and surge capacity elements tying into the existing refinery and



Beta Unit Regional Map

2.2 - 1
Figure

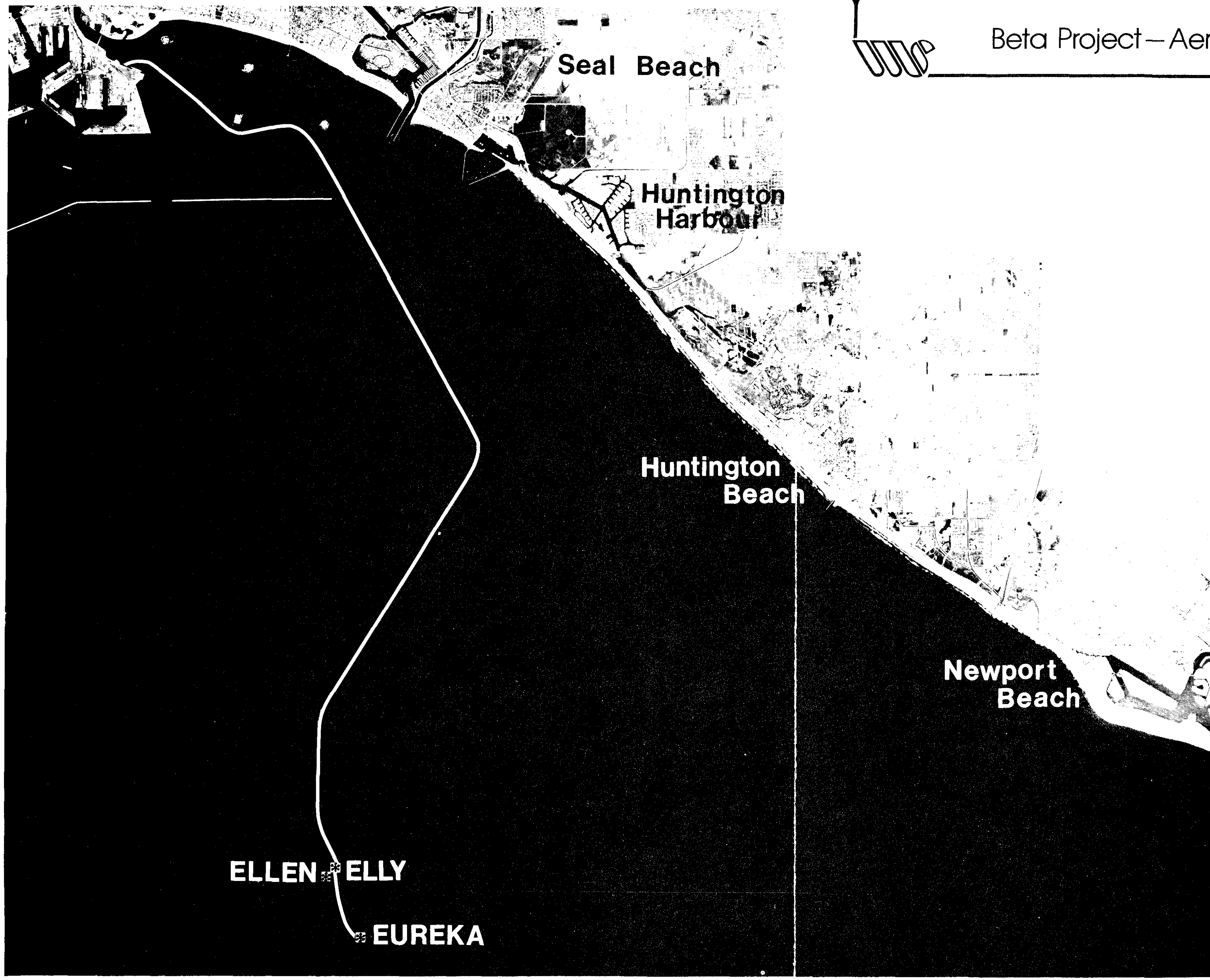


Beta Unit Vicinity Map

Figure 2.2-2

Beta Project—Aerial Map

Figure 2.2-3



Legend
* Platform location
Source: Shell Oil, 1978
Note: Platform positioning accurate, symbols not to scale

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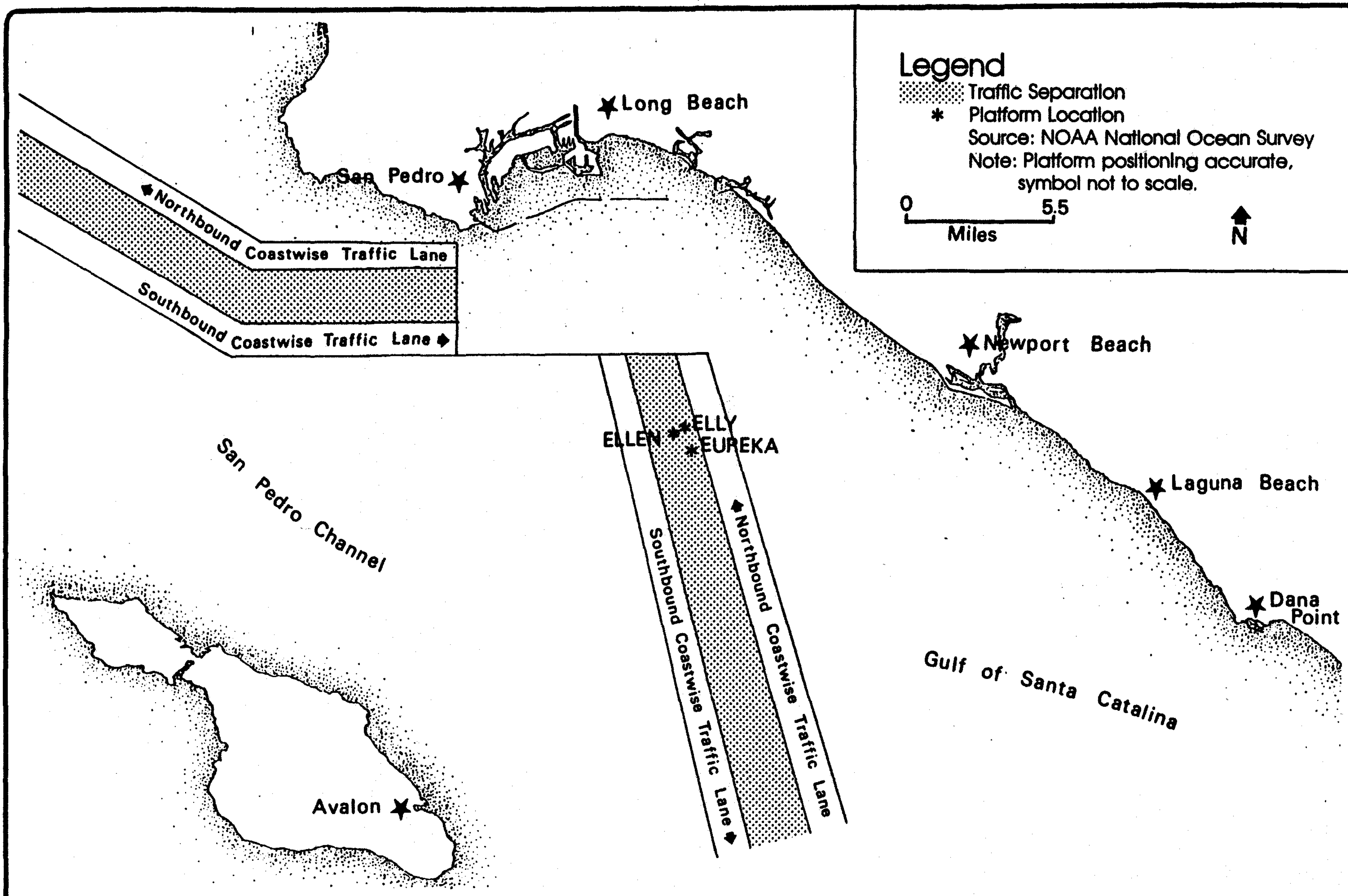
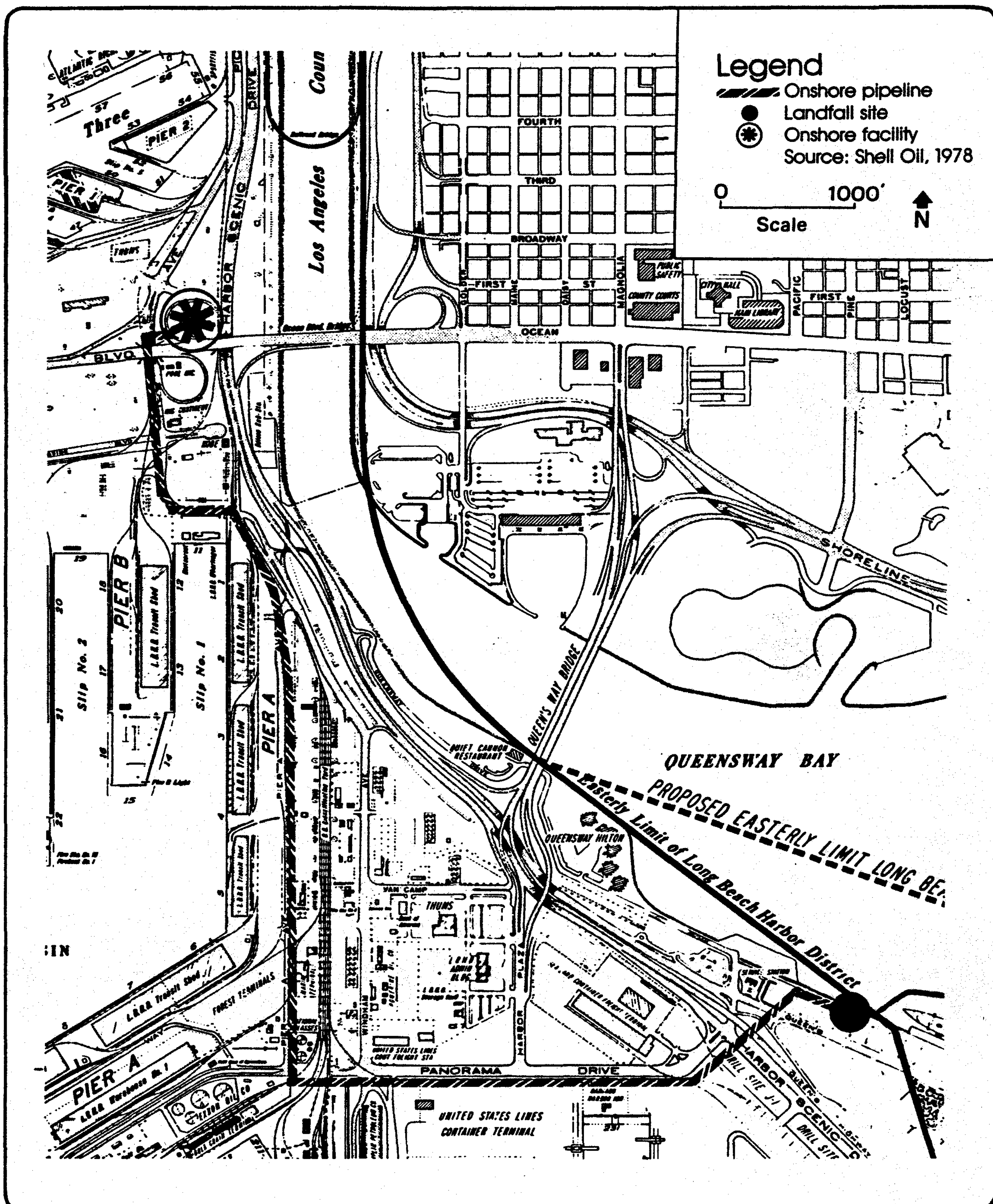


Traffic Separation Schemes

2.2-4
Figure



Onshore Pipeline Alignment

2.2-5
Figure

refinery distribution systems. The onshore facilities are proposed to be located on a one-acre (0.4 ha) site near the THUMS distribution facility just south of Pier 1 in the Port of Long Beach. In addition, two other small support sites would be required in the harbor area or nearby communities. These are discussed in the Project Description.

2.3 SUMMARY OF DEVELOPMENT TO DATE

During July through October of 1976, Shell drilled an exploratory well on Lease P-0301 to a total depth of 8,305 feet (2,531 m), penetrating the entire Miocene section on the east side of the Palos Verdes fault. The well encountered a net oil column of 520 feet (158 m) at the top of the Miocene sands. Chevron initiated their exploratory drilling on Lease P-0296 in late July 1976. This drilling encountered a net oil column of 250 feet (76 m). Shell and Chevron have drilled a total of 21 exploratory wells to date to evaluate the prospect. Based on these efforts, Shell Oil and its co-lessees have, in accordance with Title 30, Code of Federal Regulation 250.34 and the then proposed OCS Order Number 15, Pacific Region, prepared a Plan of Development (POD) for the Beta Unit. The Beta Unit POD was submitted to the USGS Conservation Division on November 7, 1977. The POD includes the following: the geologic setting; field history and reservoir evaluation; platforms; drilling plans and facilities; production plans and facilities; pipelines and shore facilities; and an appendix including oil spill contingency plans. In addition, Shell Oil has made application to the California SLC for pipeline right-of-way and to the Port of Long Beach for a right-of-way and a site for onshore distribution facilities. The POD was also submitted by the USGS to the Governor of the State of California for review and comment by appropriate state agencies.

Chevron USA, and its co-lessees, holders of leases P-0296 and P-0306 in the proposed Beta Unit, have not made a decision as to whether to proceed with development of their leases. The Chevron lease development is, therefore, not covered by this environmental report.

2.4 PROJECT DESCRIPTION

2.4.1 Overview

The proposed program for development of the Shell Beta Unit includes five general phases:

(1) Fabrication and installation of a drilling platform jacket (support structure) and decks in 265 feet (81 m) of water (Platform Ellen).

(2) Fabrication and installation of the companion production platform jacket and decks in 255 feet (78 m) of

water (Platform Elly), and installation of a 200 foot (61 m) bridge connecting Ellen and Elly.

(3) Fabrication and installation on Platform Elly of process facilities necessary to: (a) test, collect, separate, heat, treat, dehydrate, measure, and transport the produced resources; (b) clean, treat, pressurize, and inject via Platform Ellen both the produced water and source water (from either seawater or shallow non-potable aquifers) for secondary oil recovery and reservoir pressure maintenance operations; and (c) generate the necessary power (via the produced natural gas or diesel fuel) for lifting the oil from the reservoir, injection, compression, and transportation.

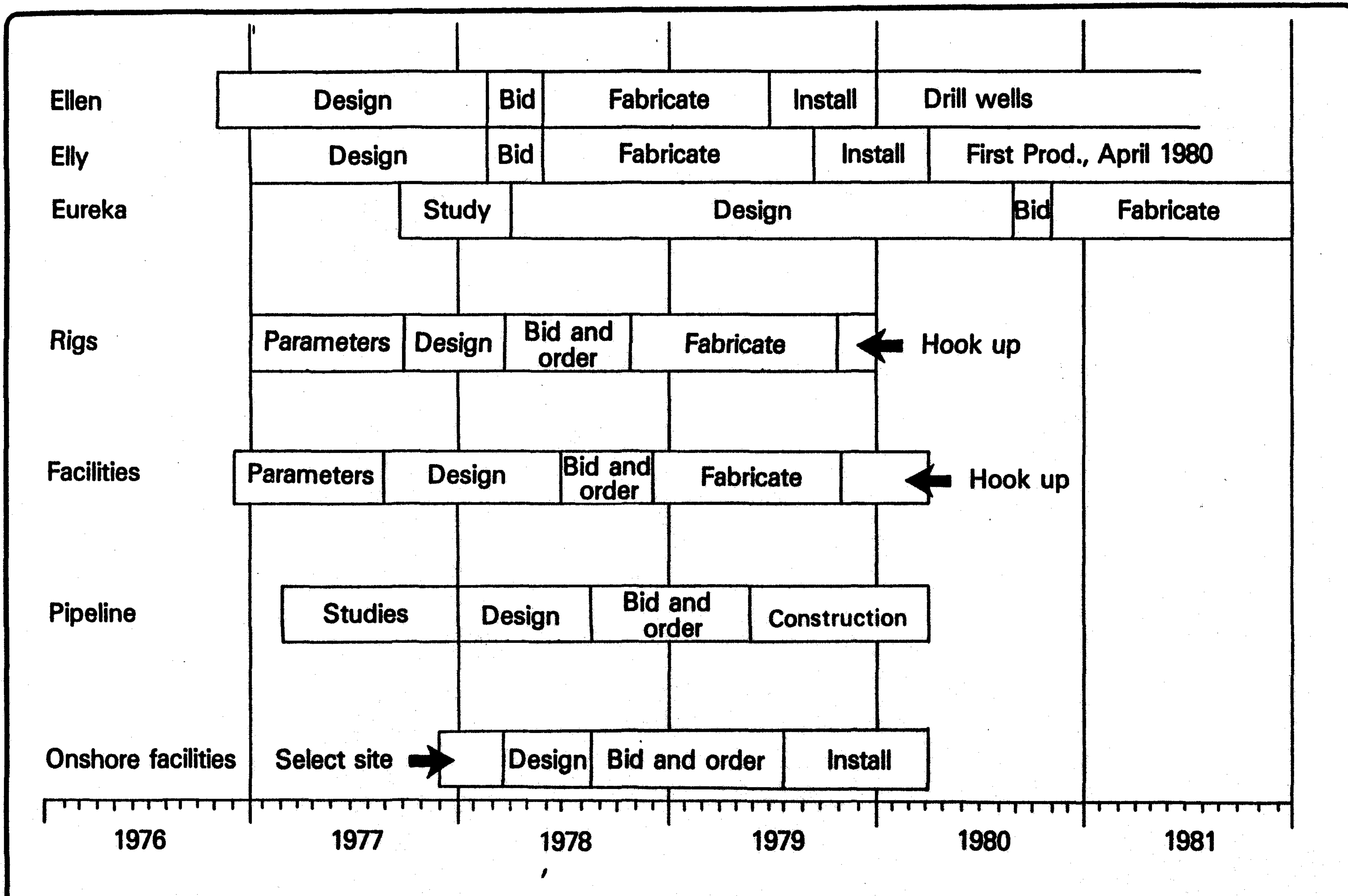
(4) Construction and installation of two American Petroleum Institute (API) type drilling rigs on Platform Ellen.

(5) Installation of approximately 17 miles (27 km) of clean oil 16-inch (0.4 m) pipeline to the Port of Long Beach and the construction of onshore facilities to meter and distribute the oil to local refineries. The pipeline capacity will be sufficient for handling the production not only from Shell platforms in the Beta Unit, but also from other San Pedro Bay OCS leases which might be developed in the future. The nearshore pipeline route will generally parallel the existing THUMS pipelines in Long Beach Harbor, with the landfall in the Port of Long Beach on Pier J, near the Queen Mary (Figures 2.2-2 and 2.2-5). Connection would be made near the THUMS seven-company distribution manifold two miles (3.2 km) inland. Other facilities at the distribution manifold site include a pipeline scraper trap, meters, a surge tank, and pumps. These are discussed further in the description of onshore facilities in Section 2.2.4.

The overall schedule for the Shell Beta Unit development is shown in Figure 2.4-1.

The Shell development plan includes a second drilling platform (Eureka) in approximately 700 feet (213 m) of water to more fully develop the Beta Unit oil and gas reserves. The production platform (Elly) will be designed with sufficient capacity to process production from Platform Eureka. From Platform Ellen, Shell will have the capacity to drill up to 80 wells, including service and waterflood injectors, at angles up to 70° from the vertical.

The Shell exploration program has indicated that the reservoir contains oil in seven separate producing intervals, known as zones A through G. Gas-oil ratios range from 160 to 230 cubic feet per barrel (28.5 to 40.9 m^3/m^3). Oil gravities extend from



Beta Field Development Schedule

2.4-1
Figure

10-12° API in the A and G zones to 20-22° API in the upper D zone. Oil production from Platform Ellen is expected to peak at a rate of approximately 16,000 barrels (2,540 m^3) per day (b/d) about two years after the first well is drilled (1983), with the estimated peak field production rate of 24,000 b/d (3,816 m^3) of 14-16° API oil from both Platforms Ellen and Eureka occurring some three years later (1986). Figures 2.4-2 and 2.4-3 show the production/injection forecast and the Beta reservoir, respectively.

2.4.1.1 Development Region

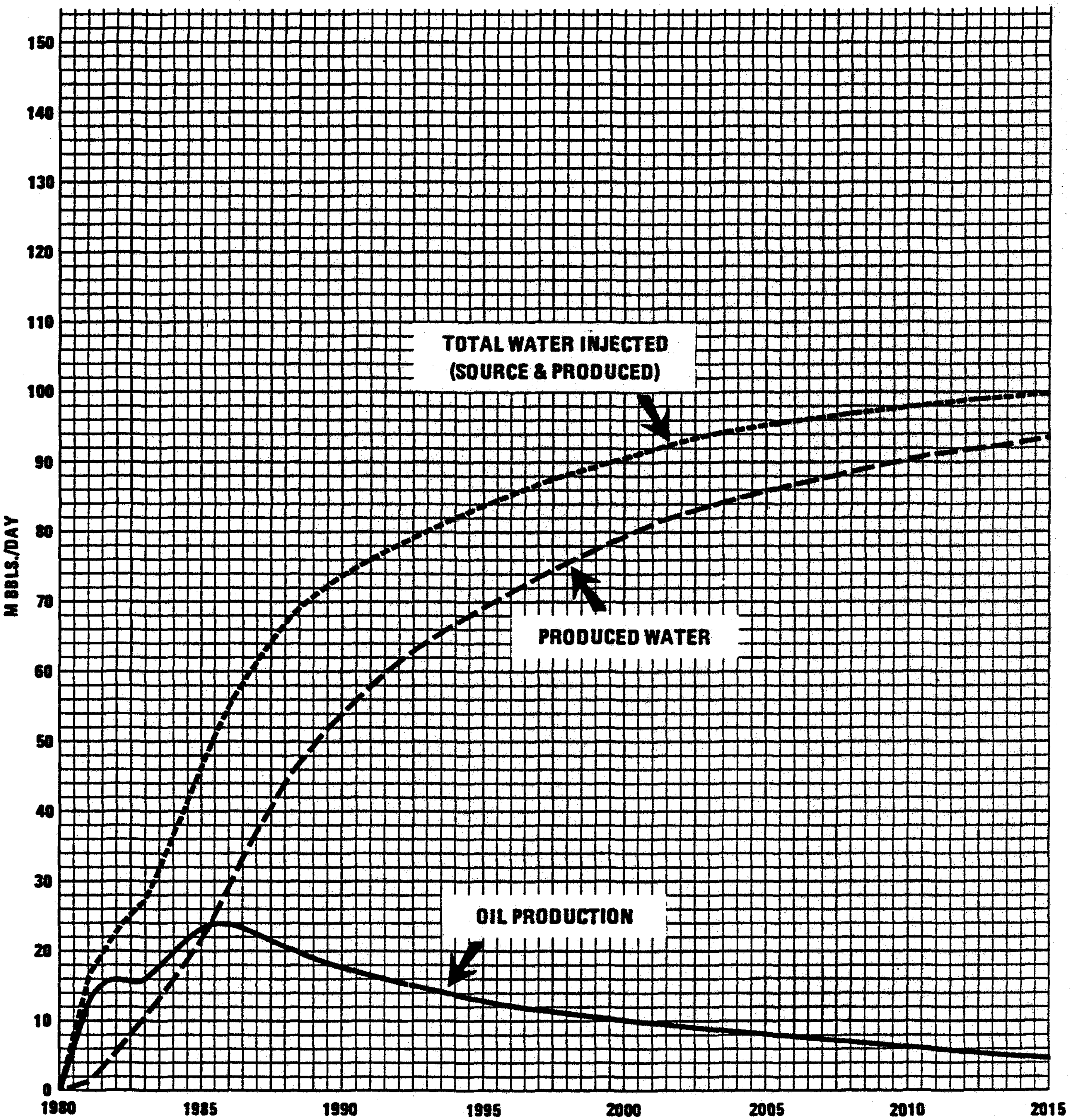
The area of planned development is located on the shelf and slope of the San Pedro Basin, in the offshore portion of the Peninsular Ranges Province (Figure 2.4-4). Major structural features in the vicinity of the area include the northwest trending Palos Verdes and Newport-Inglewood fault zones. These zones consist of strike-slip faults with components of vertical offset and numerous secondary faults and folds that are typical of the geologic structure of the region.

Oil is currently produced from accumulations in structures associated with the Palos Verdes and Newport-Inglewood fault zones both onshore and offshore in San Pedro Bay. The project will develop a similar oil accumulation in the offshore area along the Palos Verdes fault zone. The shallow-water platform sites (Elly and Ellen) are to be located near the shelf edge in an area between the Palos Verdes fault zone and the San Gabriel submarine valley. Presently the nearest oil production is from an offshore extension of the Huntington Beach oil field, about six miles (10 km) to the northeast.

2.4.2 Platforms

2.4.2.1 General Description

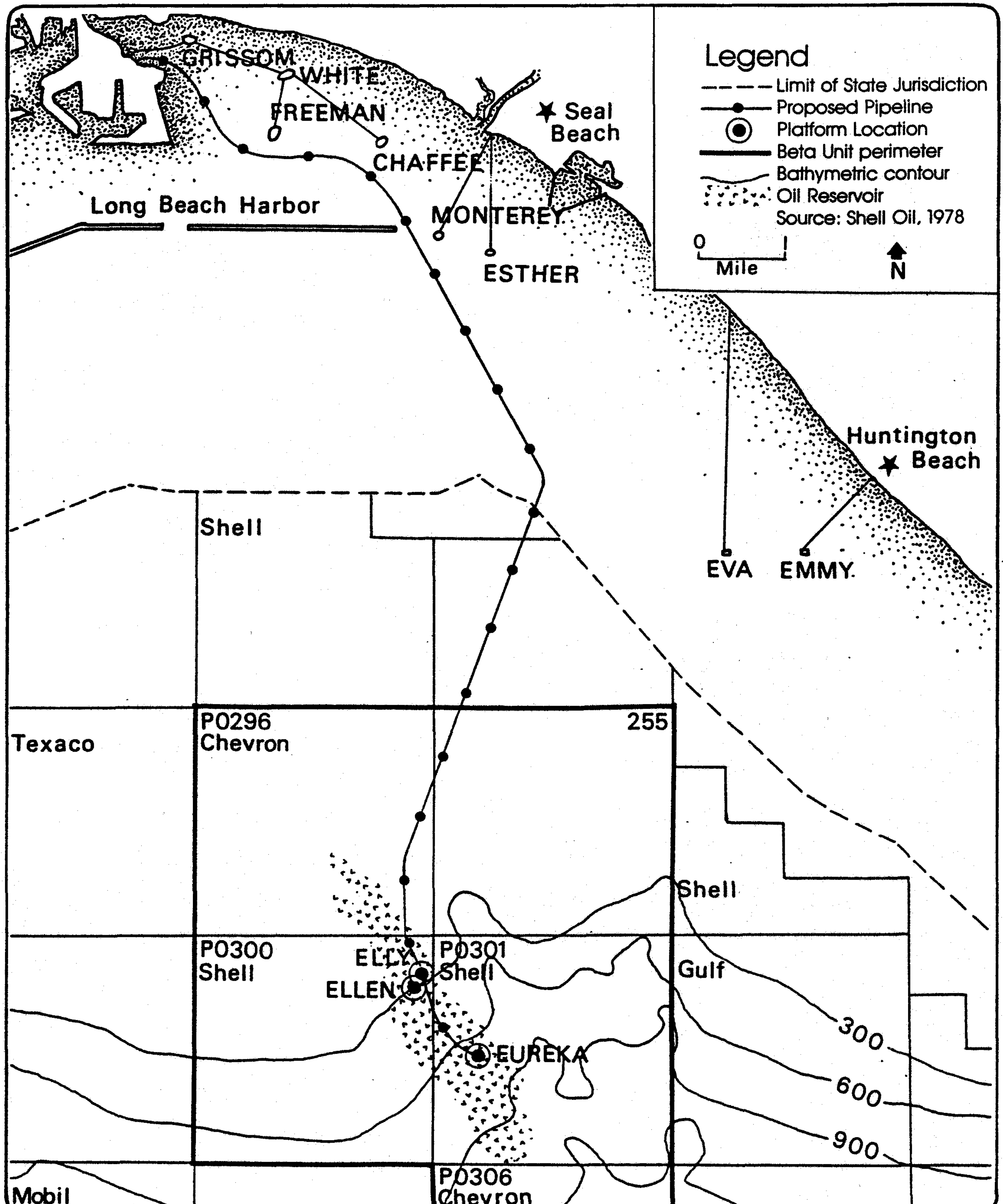
Initially, the Beta Field will be developed with a drilling platform (Ellen) and a companion production platform (Elly). The drilling platform, as shown in Figure 2.4-5, will be a standard eight-leg jacket. The platform will have two deck levels, each about 108 feet (33 m) by 175 feet (53 m), with space for 80 wells and two drilling rigs. Initially only 60 wells will be drilled by Shell to develop the portion of the field on their leaseholds. The remaining 20 slots are reserved for additional drilling which may be required in this or adjoining leaseholds. The production platform, also shown in Figure 2.4-5, will be a 12-leg jacket. Two deck levels on the production platform, each about 210 feet (64 m) by 150 feet (46 m), will accommodate process equipment for all anticipated production at the Beta Unit. A personnel and pipeline bridge about 200 feet (61 m) long will link the two platforms. The overall dimensional extent of the Ellen-Elly Platform complex is estimated to be approximately 680 feet (207 m) by 240 feet (73 m), or 3.7



Source: Shell Oil, 1978

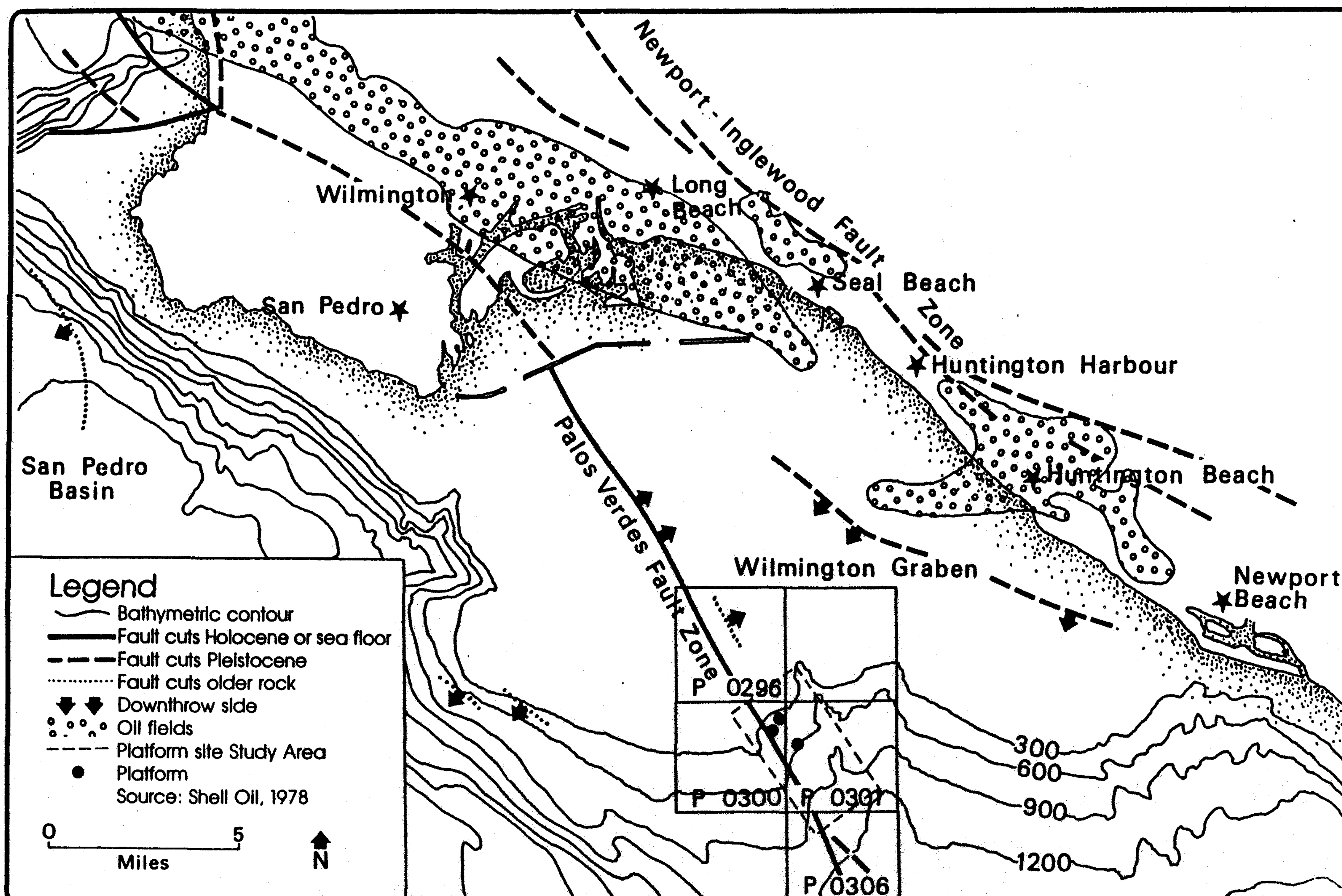
Beta Production/Injection Forecast

2.4 - 2
Figure



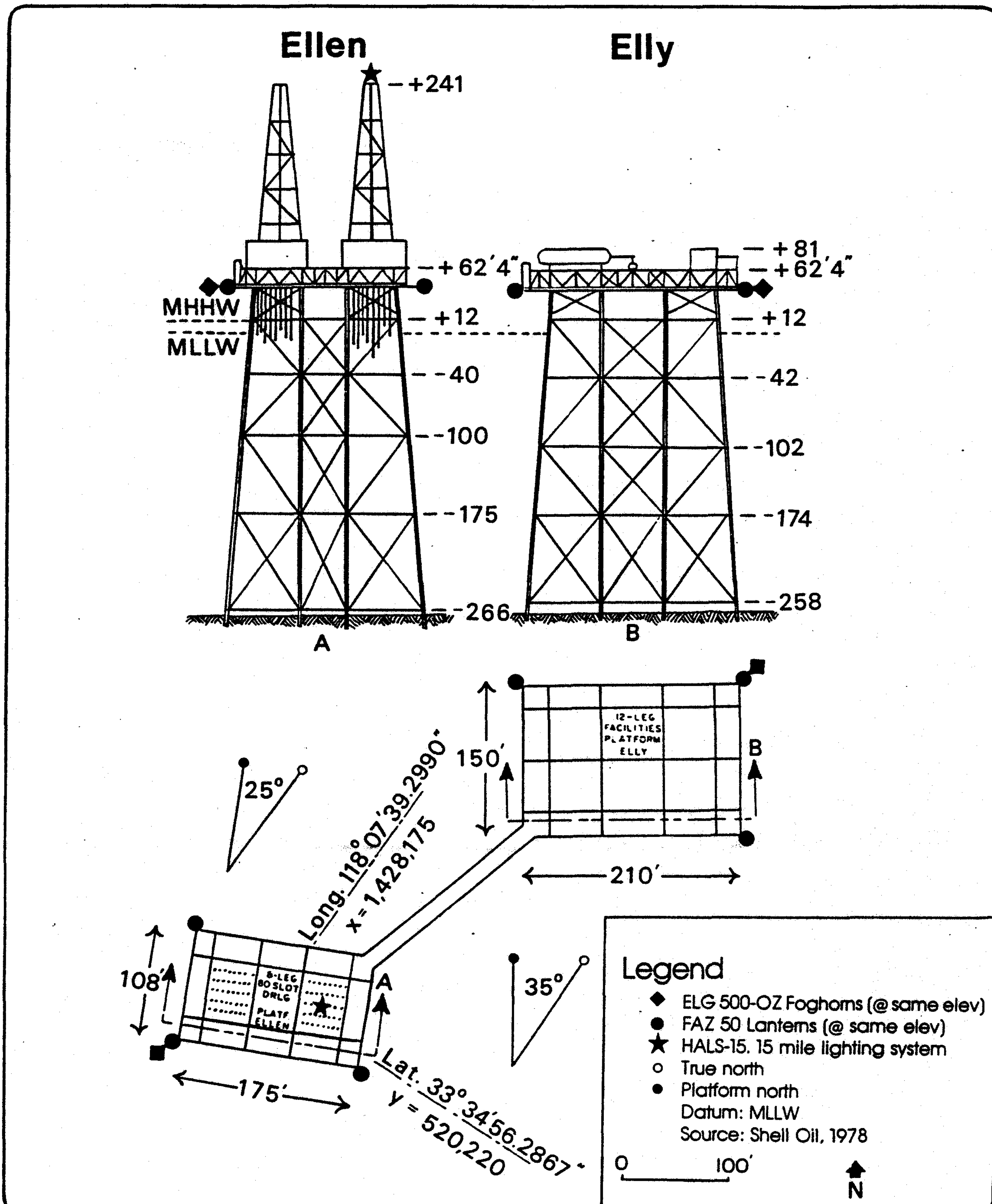
Beta Reservoir

2.4-3
Figure



Structural and Geologic Features of San Pedro Bay and Vicinity

Figure 2.4-4



Beta Unit Platform Schematics

2.4-5
Figure

acres (1.5 ha). Figure 2.4-6 is a photograph of models of these platforms. The Eureka facility has not been completely designed, however it will be of the same general configuration and design as Platform Ellen. It will be designed for 60 wells.

2.4.2.2 Platform Design Criteria

The platforms are being designed in accordance with the latest drafts of USGS OCS Order No. 8 and API RP 2A to withstand dynamic loads caused by severe storm waves, earthquakes, and stress/strain during launching and installation. The platforms' main legs are framed with diagonal and horizontal bracing which provides a level of redundancy and adds to the structural integrity. The structures will be secured to the ocean bottom with steel piles driven through and welded to the legs of the jackets. Because the platforms will be near the Palos Verdes and Newport-Inglewood faults and close to the San Pedro shelf edge, particular emphasis has been directed toward the seismic design criteria and soil stability analysis (Shell, 1977). Further data on these topics, oceanographic criteria, platform analyses, fabrication, and installation are summarized below.

(1) Oceanographic/Meteorologic Criteria

The platforms have been designed for severe storms having less than a one percent chance of exceedance in a given year. The design wave, wind, current, and tide criteria for the site are as follows:

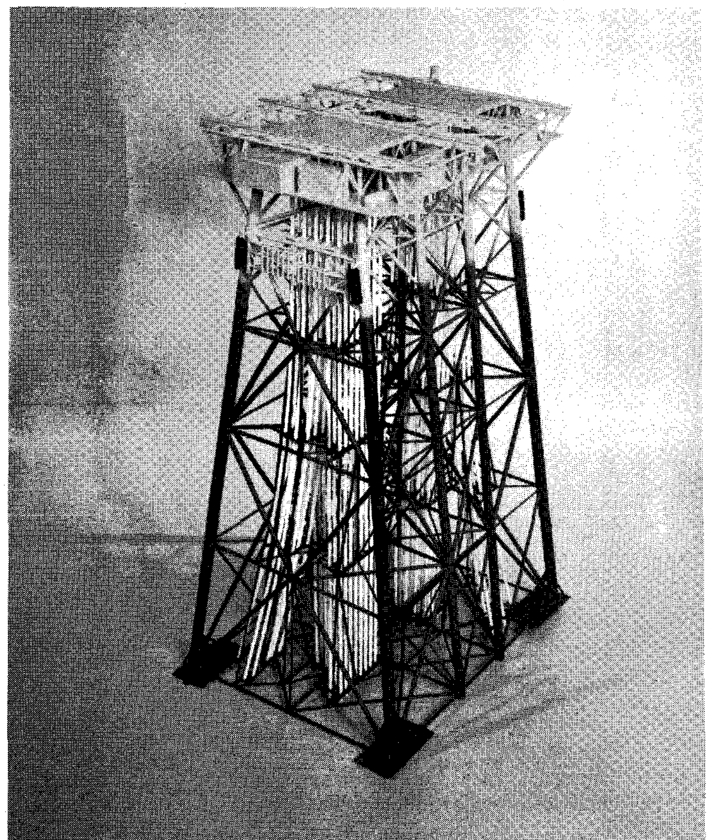
• Wave	
Maximum Height (Crest-Trough)	45 feet (13.7 m)
Period of Maximum Wave	9 to 15 seconds
• Wind (5-second average; assumed in the wave direction; measured at +30 feet (9.1 m) elevation)	64 knots (119 km/hr)
• Current (assumed in the wave direction)	
Surface	2.8 fps (85 cm/sec)
Mid-depth	1.6 fps (49 cm/sec)
Bottom	0.6 fps (18 cm/sec)
• Tide (including storm surge)	6.0 feet (1.8 m) (above MLLW)

These oceanographic design criteria were derived from a study by Evans Hamilton, Inc. (1976).

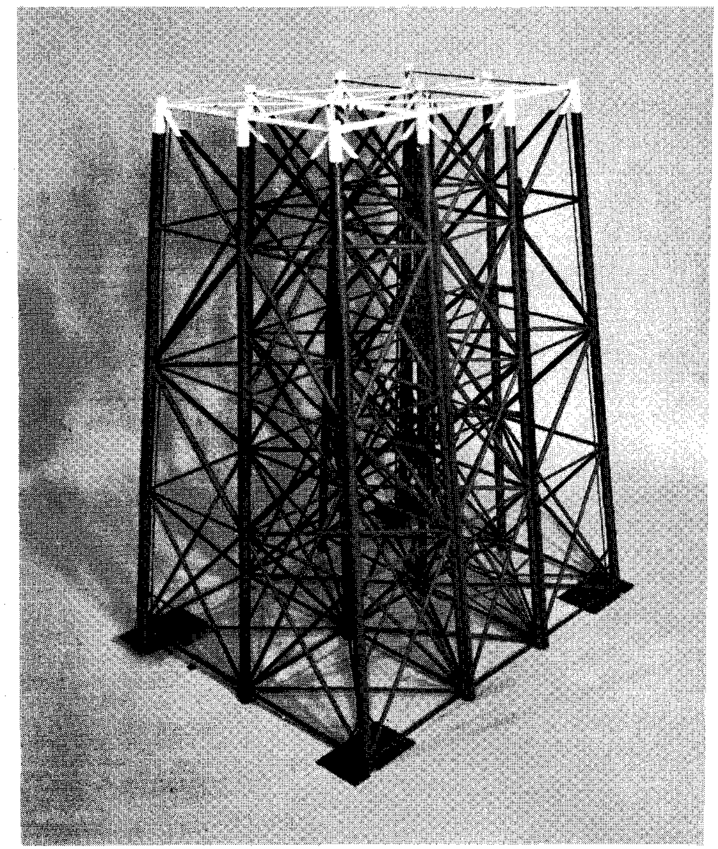
(2) Seismic Criteria

The location of the Beta Field within an area of recognized seismicity requires that all structures be designed for

Ellen



Elly



Source: Shell Oil, 1978

Proposed Jacket Configurations Shell Beta Unit

2.4 - 6
Figure

an earthquake environment. The platforms have been designed by Shell for a two-level design requirement as outlined in API RP 2A. For the first-level earthquake criteria, Shell's design specification is that the platforms resist shaking, without damage. In this case, they have selected a peak horizontal acceleration of 0.25 g. Shell's analysis is that the probability that the platform locations will experience this earthquake activity is about 0.005 per year - a 200-year recurrence interval.

For the second-level earthquake criteria, associated with a rare, intense earthquake, Shell's design specification is the platforms withstand the acceleration without collapse. In this case, the design ground motions selected by Shell are twice those of the first-level criteria (0.5g). At the Beta Field, Shell's analysis is that the probability of an earthquake exceeding this criteria is less than 0.001 per year - a recurrence interval greater than 1,000 years (Shell, 1977).

An analysis of these criteria is provided in the geotechnical factors assessment, Section 4.1.

(3) Corrosion Criteria

The platform will be protected from corrosion by coatings in the wave-splash zone and above, and by cathodic protection below mean water level. Two types of protective coatings developed and applied in the Gulf of Mexico will be used:

(a) Galvanizing applied to grating, ladders, cages, and other difficult-to-paint hardware.

(b) Multi-coated painting of the exterior surfaces of the structures will be from the minus eight-foot (2.4 m) elevation to the top of the structure.

A sacrificial anode system will provide the corrosion protection for the below-water portion of the platforms. Aluminum anodes will be uniformly located throughout the structures. This is further detailed in the Impact Analysis.

2.4.2.3 Operations

(1) Construction Procedures

The principal components of this type of platform are the deck, the jacket, and the piling. A contractor(s) will fabricate and assemble these components, and barge them to the offshore site for the installation. All major offshore components will be fabricated outside California, and will be barged to the site. Each jacket, after being transported to the site on a launch barge, will be launched and then lowered to the ocean floor by a derrick barge assisted by controlled jacket flooding. After the jacket is secured by piling driven through and welded to the top of the jacket legs, the deck sections and equipment will be set in place on the jacket. The open deck elevations will be approximately 65 feet (20 m) above mean high water. The entire structure from ocean floor to the top of the deck will be the equivalent height of a 33-story building. The anticipated commencement date of platform installation is mid-1979, as shown in the project schedule, Figure 2.4-1.

There will be a need for an onshore staging area of up to three acres (1.2 ha) to provide support for the installation and drilling processes. A preferred location for the staging area has been identified in the Port of Long Beach. Onshore facilities are discussed in Section 2.4.4.

(2) Drilling Operations

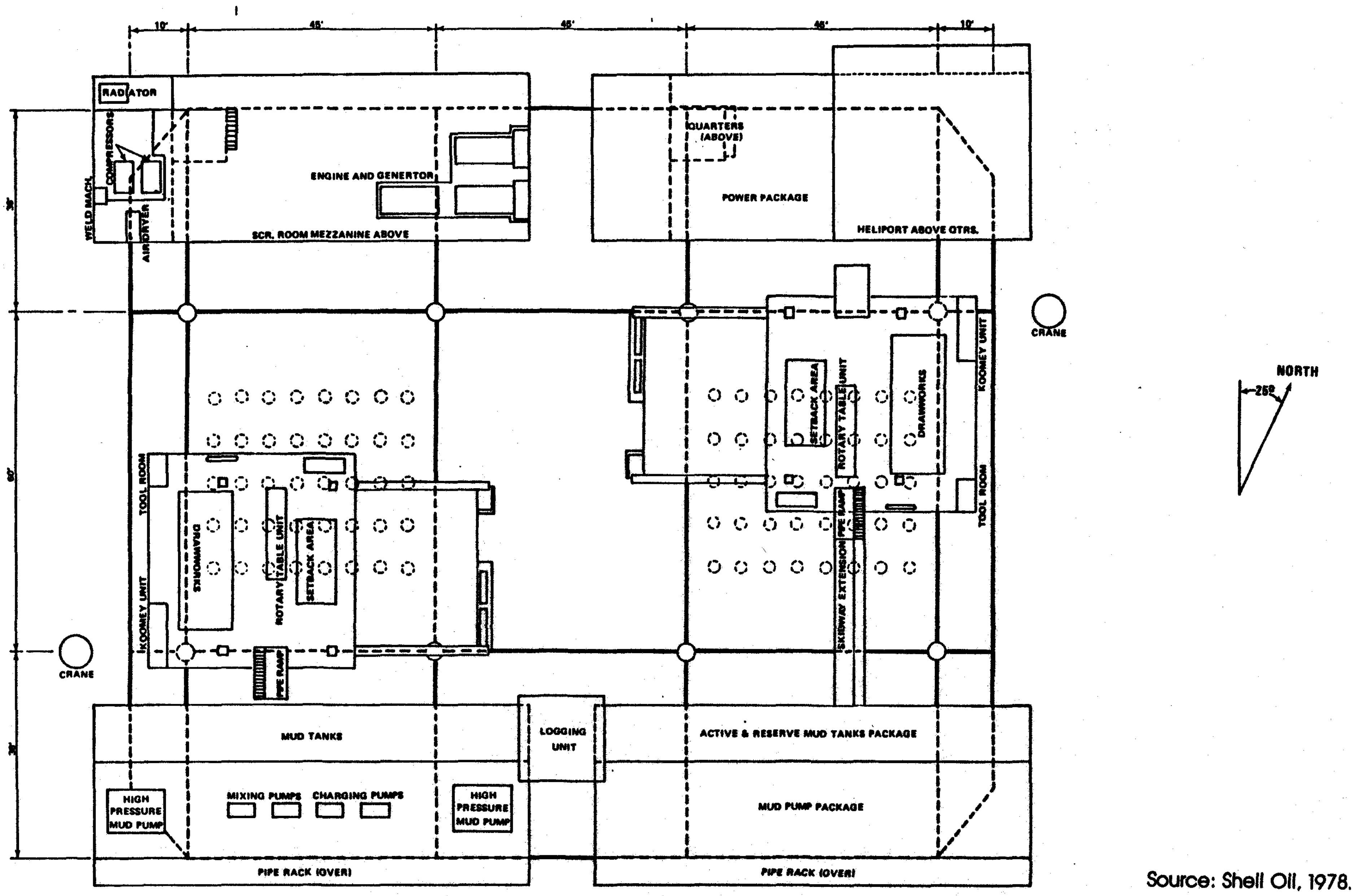
Platform Ellen will have conductor slots for 80 wells. Two drilling rigs will drill and complete the wells at an approximate rate of one well per month per rig. Figures 2.4-7 and 2.4-8 show the drilling equipment locations. Figure 2.4-9 provides a cross-section of Platform Ellen.

The major components of the drilling rigs will be located on the upper deck. These components include the pump package, power package, skid base, substructure, and derrick. The living quarters, with bunks, dining facilities, offices, and heliport, will be located above the power package. The pump package will also act as the pipe rack and support the rig cranes. Cementing units, gravel-packing equipment, and storage of liquid and dry material will be located on the lower deck.

After the initial drilling phase is completed, one rig will be moved to Platform Eureka, where two drilling rigs are planned. These will operate in a similar manner as on Ellen. The rig left on Platform Ellen will be designed to move from one well bay to the other as required for well servicing, workovers, and redrills. The primary drilling platform components are:

(a) Drilling Components

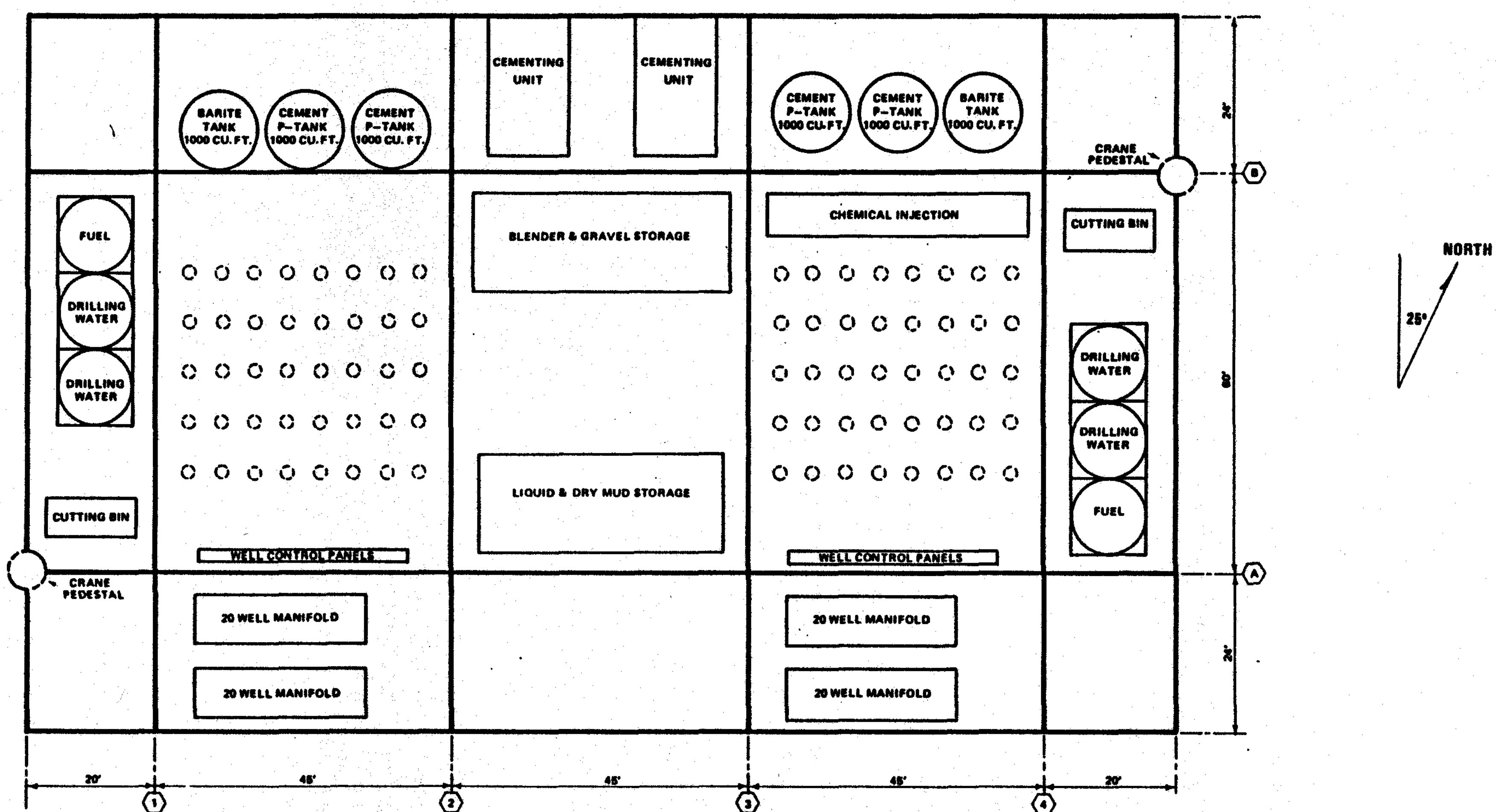
- Two 1,400,000-pound (636,000 kg) gross-nominal-capacity derricks, 30 feet (9 m) by 30 feet (9 m), 147 feet (45 m) high. The derricks will be designed in accordance with API standards.
- Drawworks - 1000 h.p. electrically powered.
- Rotary Table - electrically powered.
- The hook, traveling block, and crown block will be of 350+ ton (318+ metric ton) load-rated capacity to match the derrick.



Source: Shell Oil, 1978.

Equipment Arrangement, Upper Deck Platform Ellen

2.4-7
Figure



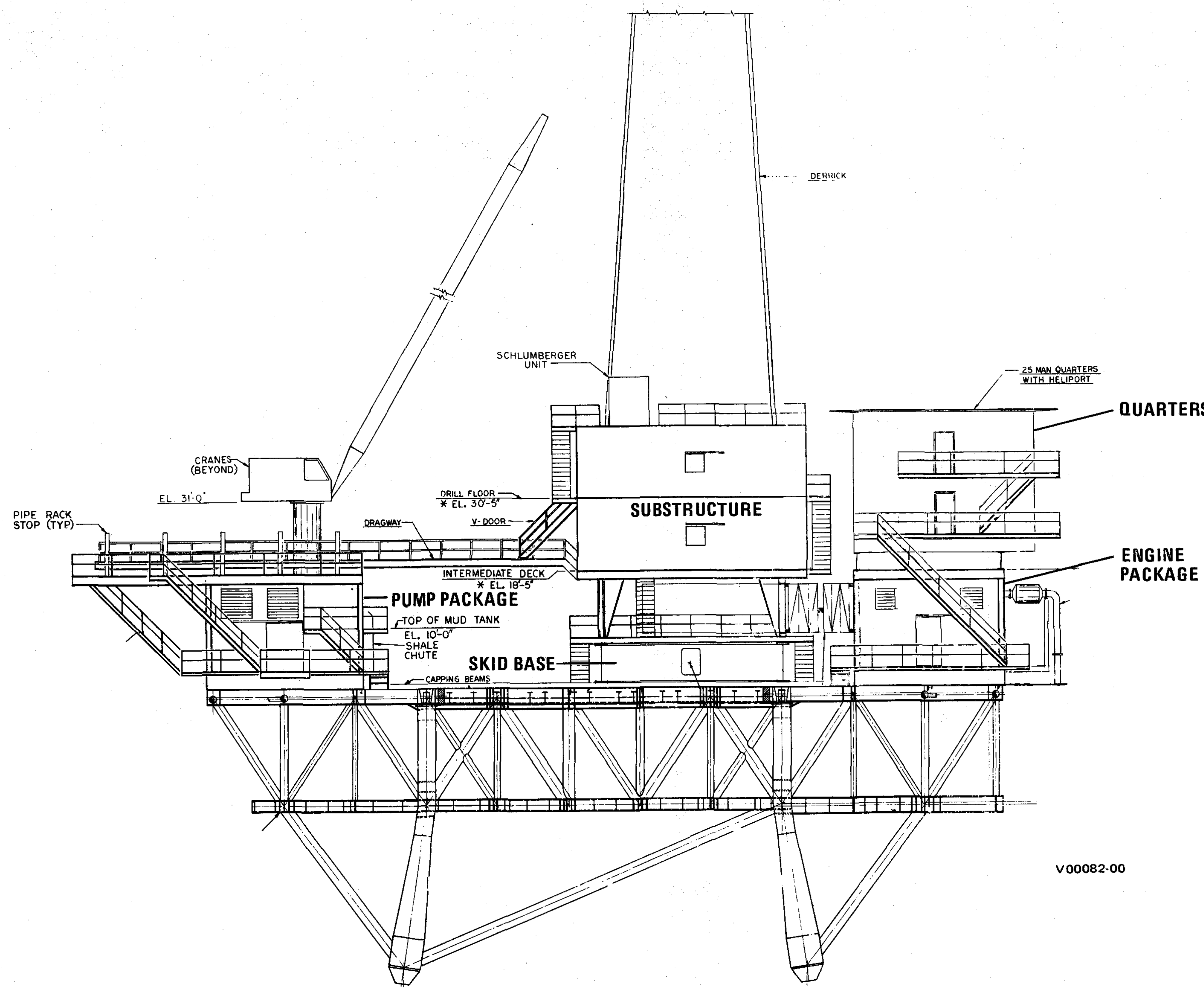
Source: Shell Oil, 1978.

Equipment Arrangement, Lower Deck Platform Ellen

2.4-8
Figure

Drilling Rig Ellen

Figure 2.4-9



- The drill string will be 5-inch (0.11 m), Grade G drill pipe.

(b) Substructures

The substructure will provide support for the derrick, drawworks, and connecting stairways. Each substructure will be supported on a skid-base, which will rest on two deck skidbeams. The skidbase will be equipped with a hydraulic jacking system to facilitate movement along the well rows. Mechanical restraint equipment will be installed to prevent substructure movement.

(c) Drilling Fluid System

A separate fluid (mud) system will be provided for each drilling rig in the pump package. Each rig will be equipped with two mud pumps (800 h.p. each), a mud-slugging tank (75 bbl) (12 m^3), a circulation tank (300 bbl) (48 m^3), and a reserve mud tank (350 bbl)(56 m^3). In addition, a 1200-bbl (191 m^3) completion fluid system will be shared by the rigs. The completion fluid will be used for underreaming, perforating through the pay interval, and for gravel packing operations.

(d) Cementing Unit

A diesel-powered dual cementing unit and four 1000-cubic-foot (28 m^3) bulk storage tanks will be provided for well-cementing operations. In addition, a single cementing unit, in combination with a blender, will be used for completion work.

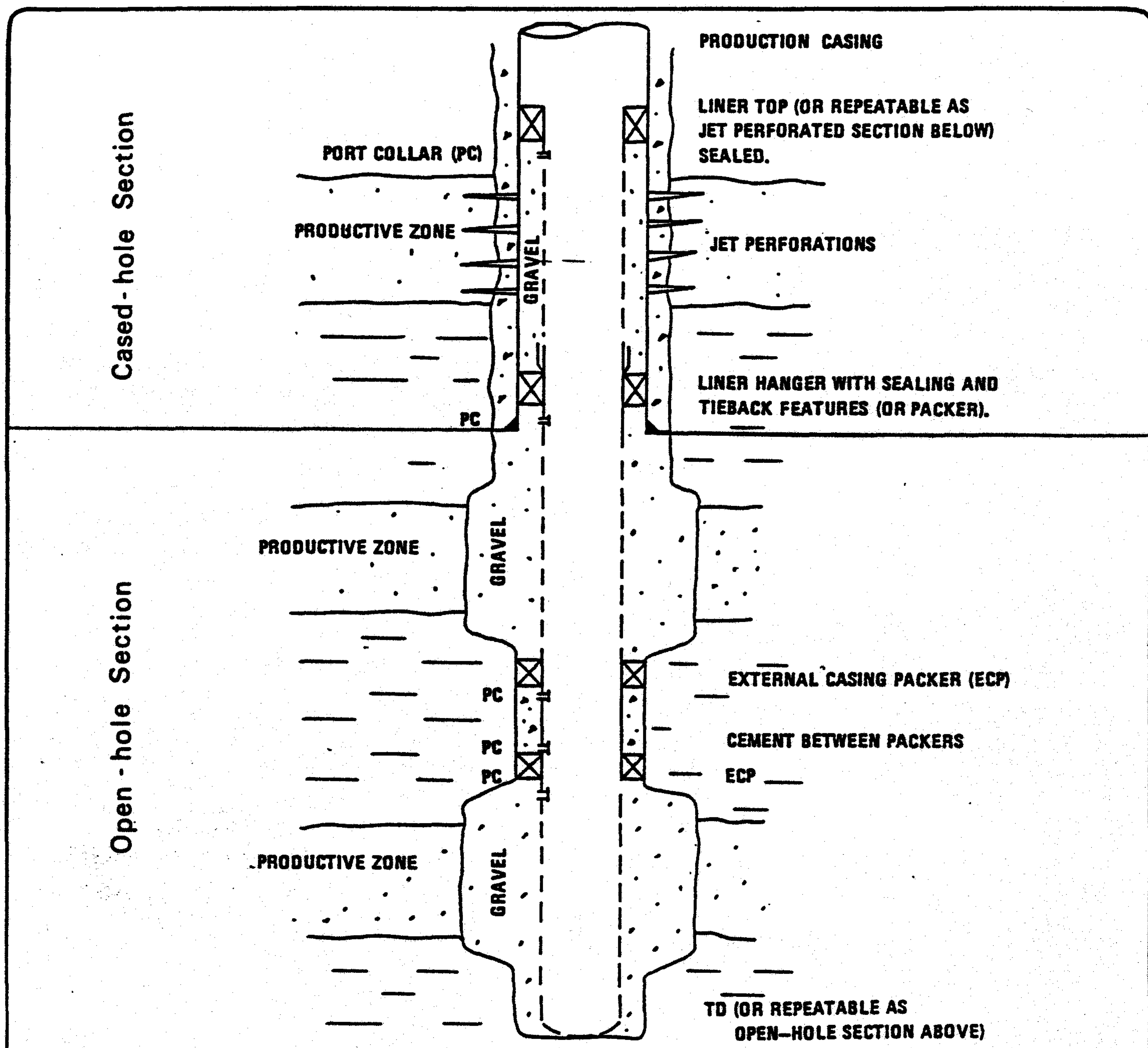
(e) Casing

Casing setting depths and cementing will be in accordance with the USGS Pacific Area OCS Order No. 2 or the USGS approved field rules.

Based on data they have collected, Shell is proposing as field rules the following casing and drilling program (refer to Figure 2.4-10 for a profile of the well casing):

- 24-inch (0.6 m) conductor pipe be set 200+ feet (61+m) below mud line.

- The 16-inch (0.4 m) casing string will be eliminated.



SIMPLIFIED PROCEDURE FOR OPEN-HOLE SECTION

1. SET PRODUCTION CASING.
2. DRILL THROUGH PRODUCTIVE INTERVAL-LOG.
3. OPEN HOLE THROUGH PRODUCTIVE ZONES-RUN LINER, SET OPEN HOLE PACKERS.
4. GRAVEL PACK PRODUCTIVE ZONES (FROM BOTTOM UP) THROUGH PORT COLLARS.
5. CEMENT BETWEEN ZONES (FROM BOTTOM UP) THROUGH PORT COLLARS.
6. WASH AND REPACK AS REQUIRED.

Source: Shell Oil, 1978.

SIMPLIFIED PROCEDURE FOR CASED-HOLE SECTION

1. DRILL THROUGH PRODUCTIVE INTERVAL-RUN LOGS.
2. RUN AND CEMENT CASINGS.
3. JET PERFORMANCE COMPLETION ZONES-WASH PERFORATIONS.
4. RUN LOWER LINER AND GRAVEL PACK.
5. RUN OPEN LINER (S) AND GRAVEL PACK (ALTERNATIVE TO STEPS 4 & 5 - RUN ENTIRE LINER, SET PACKERS-GRAVEL PACK THROUGH PORT COLLARS FROM BOTTOM UP.)
6. WASH AND REPACK AS REQUIRED.

Schematic of Combination Type Well Casing Completion

Figure 2.4-10

- The surface casing will be set from 1200 to 1500 feet (366-472 m) below the mud line.
- An additional casing string will be set on top of the pay or at total depth. The exact setting depth of this string will be determined by the well completion program.

A more complete description of the casing program is provided in Shell's Plan of Development. This program will be finalized in accordance with USGS approved field rules.

(f) Well Completions

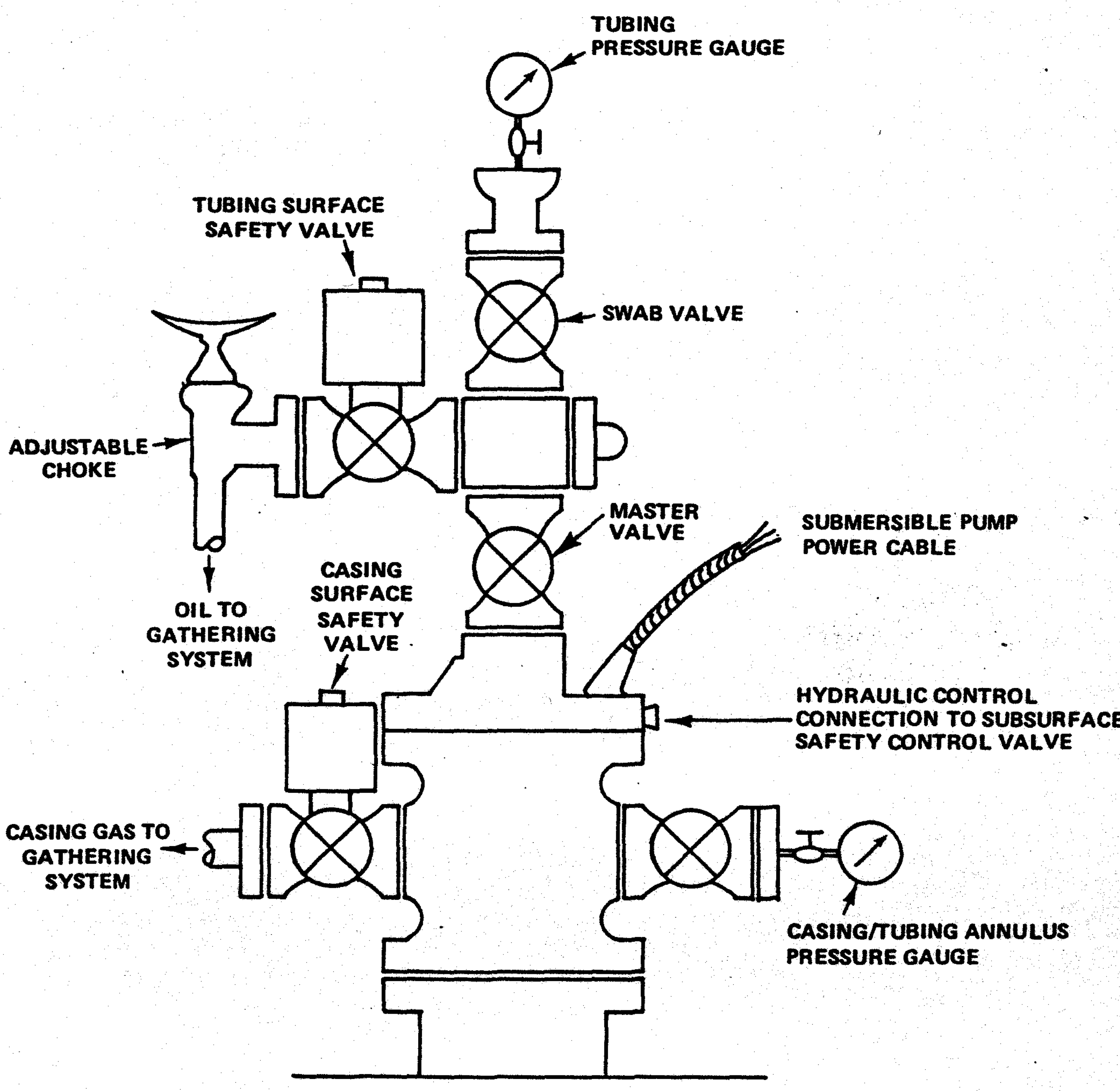
The reservoir consists of an assemblage of sands, shales, and silts. The thicker shales divide the reservoir into seven zones. Sand control will be achieved by gravel packing a slotted liner (or screen) inside cemented, perforated casing or in open hole.

(g) Wellheads and Slots

A typical wellhead configuration is shown in Figure 2.4-11. On Ellen, the 80 well slots are divided into two groups of 40. Each group of 40 slots consists of five rows of eight slots each. Initially, 60 well conductors will be installed with the remaining 20 well slots reserved for future use. Initially, all wells will be equipped with downhole hydraulically controlled safety valves in accordance with OCS Order No. 5. Flowlines for the 60 wells will connect to a manifold system on Ellen.

(3) Production Operations

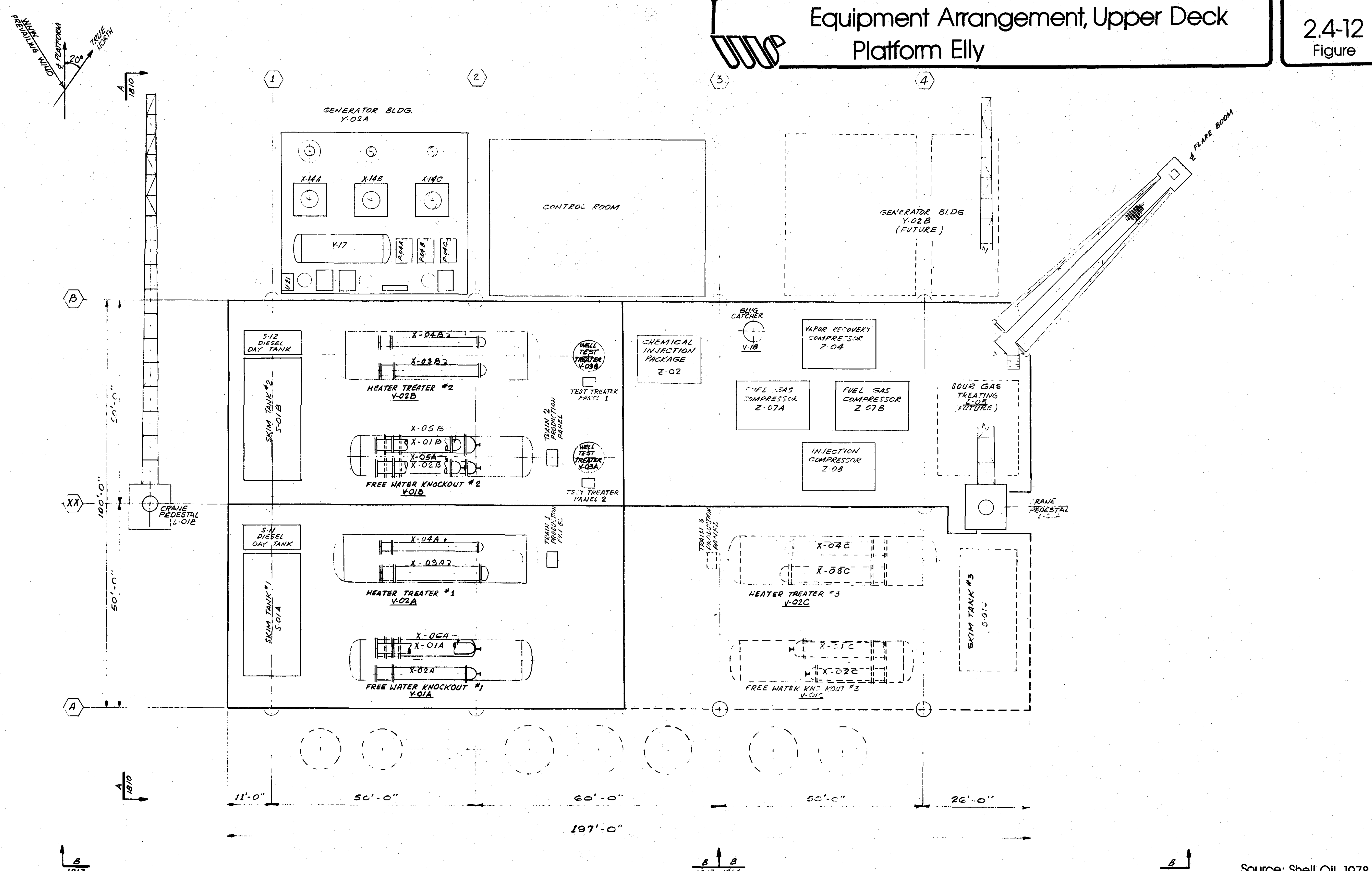
The production platform (Elly) will be located adjacent to Platform Ellen. Platform Elly will contain the treating facilities associated with development of the Beta project. These facilities will include process equipment for treating oil and water. Platform Elly will also house systems for gas handling, electricity generation, utility systems, and emergency support facilities. The platform facilities are intended to make the field operation as self-sufficient as possible. The incorporation of process equipment on a larger separate facilities platform eliminates the need for similar processing facilities on other platforms such as the planned deep-water Platform Eureka and/or a possible Chevron platform to the northwest. The proposed layout of deck facilities on Platform Elly is shown in Figures 2.4-12 and 2.4-13. Figure 2.4-14 is a photograph of a model of Platform Elly.



Source: Shell Oil, 1978.

Wellhead Schematic

2.4-11
Figure



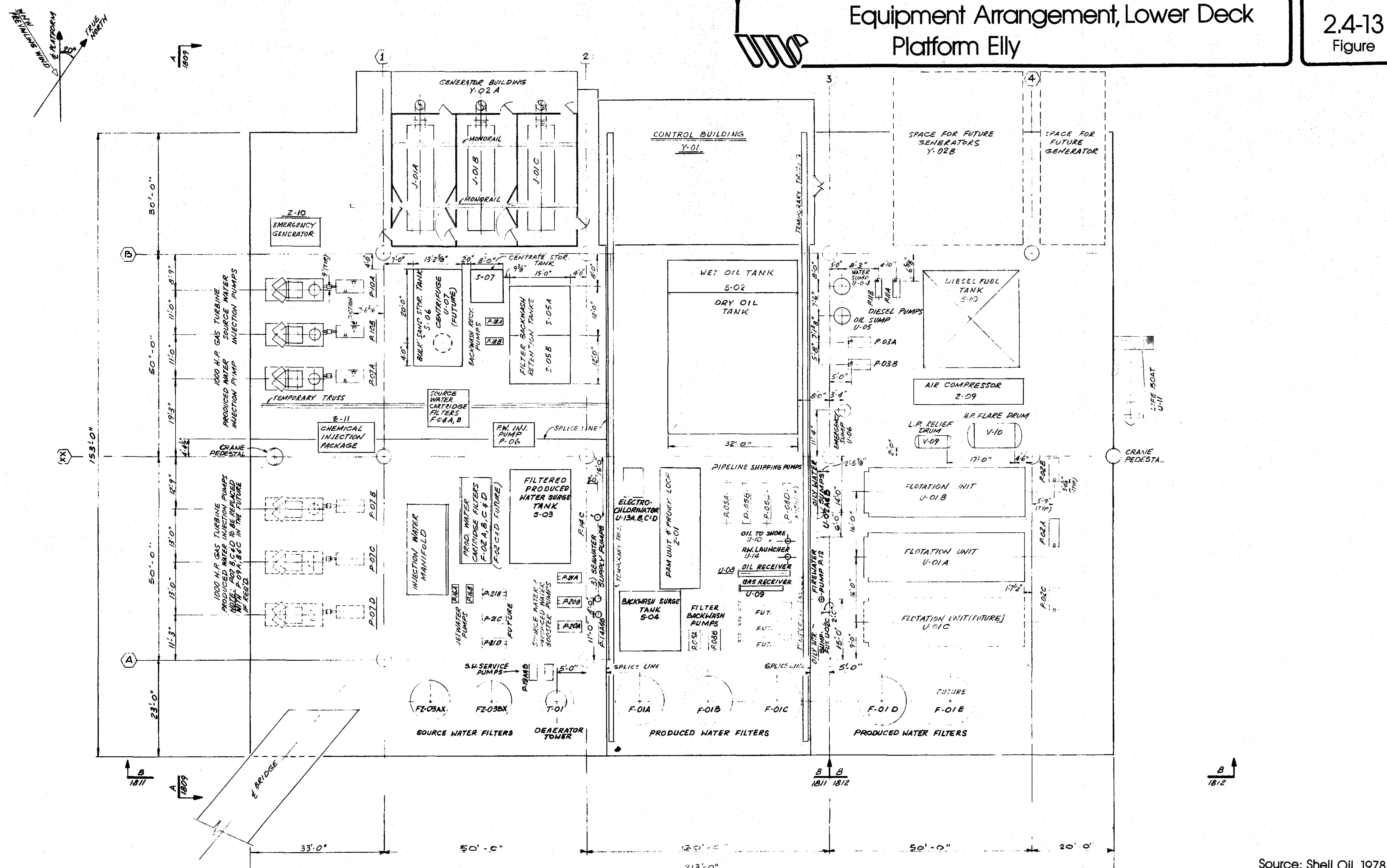
Equipment Arrangement, Upper Deck Platform Elly

Figure 2.4-12

Source: Shell Oil, 1978.

Equipment Arrangement, Lower Deck Platform Elly

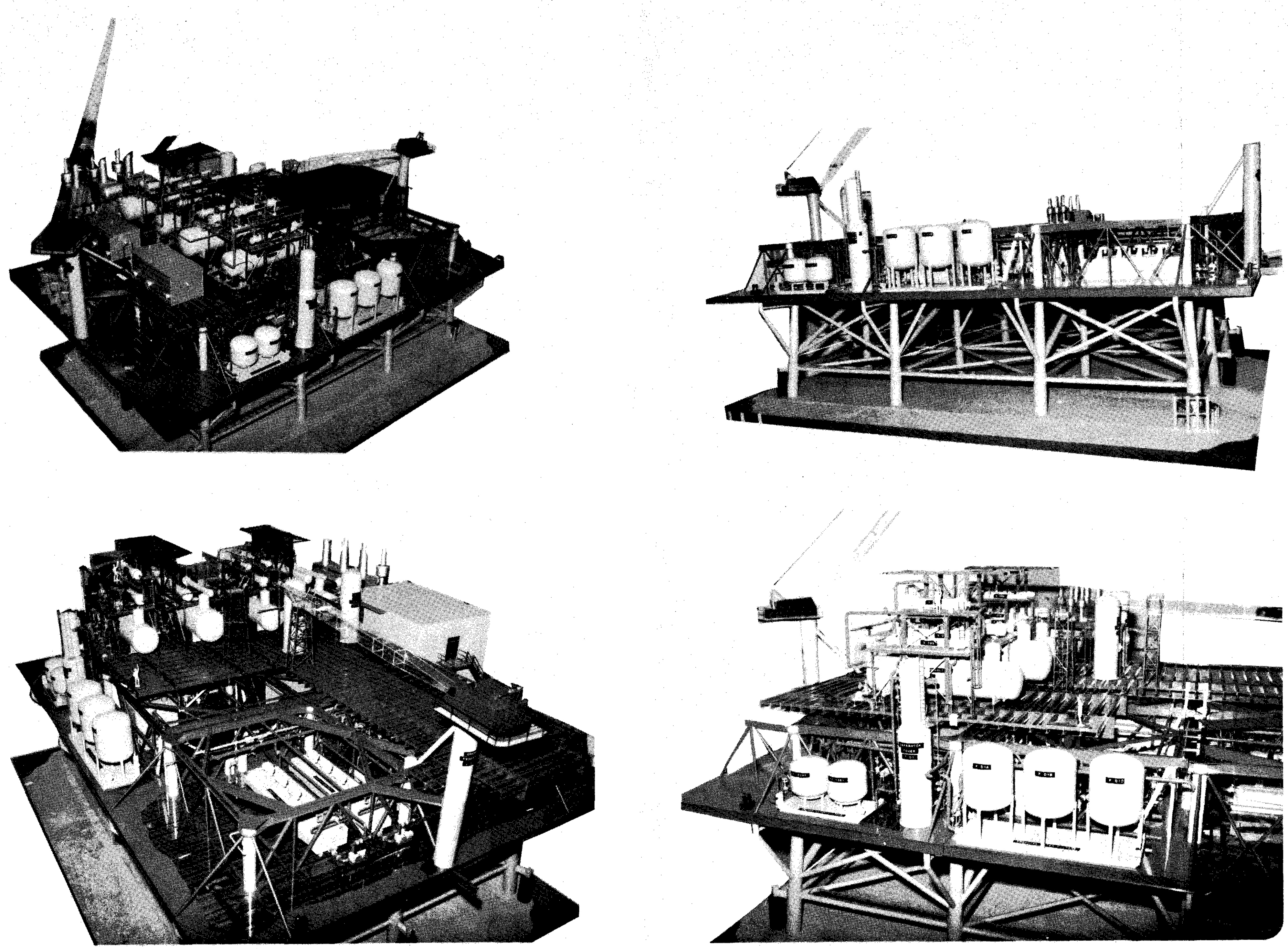
2.4-13 Figure



Source: Shell Oil, 1978.

Production Platform Elly

2.4-14
Figure



Source: Shell Oil, 1978.

(a) Process Flow

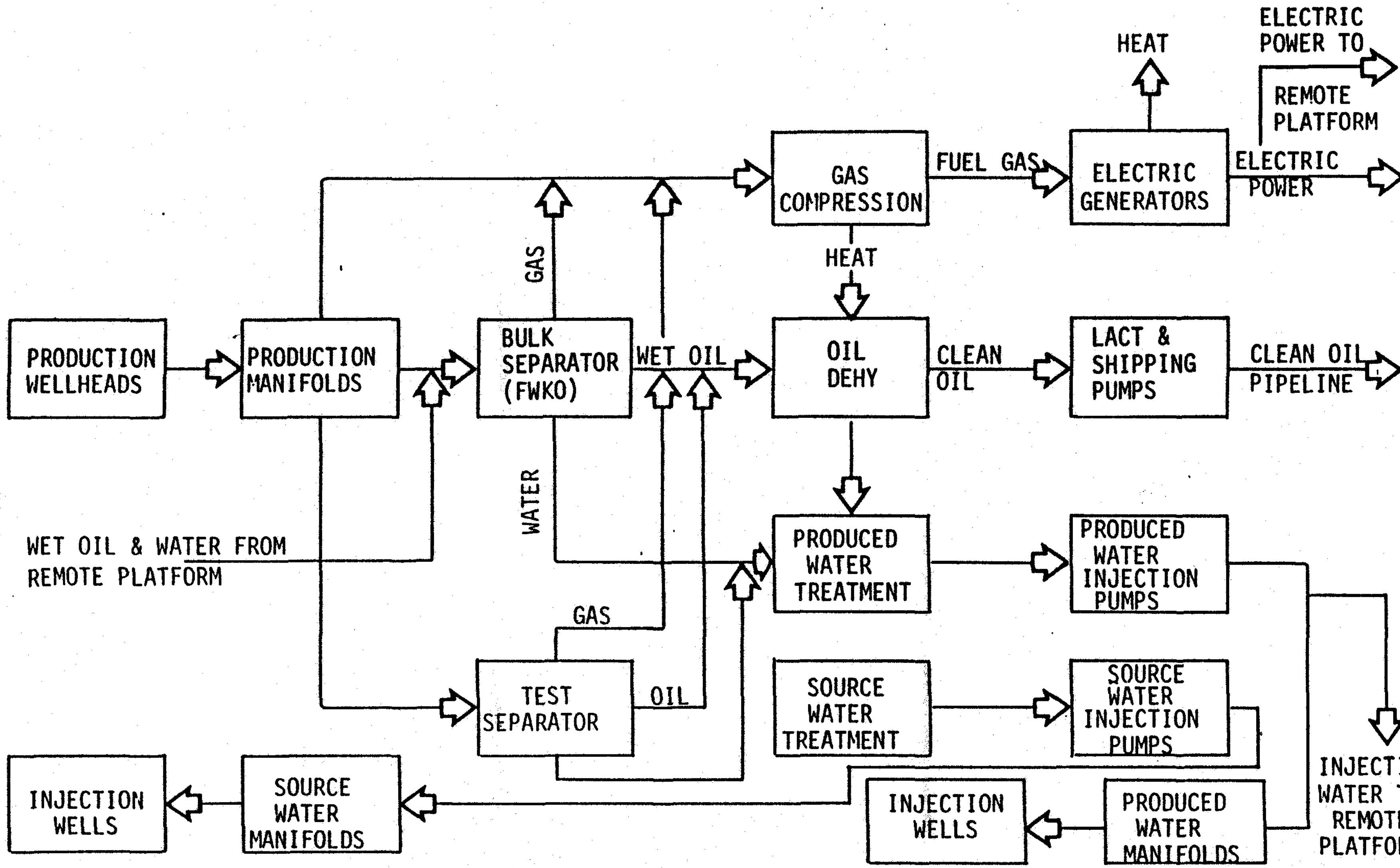
The following summarizes the oil treatment process flow through Platform Elly. Figure 2.4-15 is a simplified flow diagram of this process.

- The well production of wet oil is brought to Platform Elly from wells on Platform Ellen and eventually Platform Eureka. This wet oil enters various portions of the system through production manifolds.
- The small amount of gas and most of the water are removed in the free water knockout vessels.
- The gas is fed to compressors which compress it for use as gas turbine fuel. Any surplus gas not used by the gas turbines will be injected into a formation for subsequent use as fuel.
- The wet oil travels to a dehydration unit where, using waste heat from the turbines, the remainder of the water is removed. The clean or dry oil then enters the shipping pumps and is transported via pipeline to Shell's onshore facility.
- Water separated from the oil is sent to water treatment facilities for oil removal.
- Treated produced water and treated source water (sea water) are injected into the producing formations to maintain formation pressure and increase ultimate production.

(b) Production Equipment - Design Criteria

The type and quantities of equipment are based on the following Shell design criteria derived from the drilling of eight exploratory wells:

- Maximum bottomhole pressure - 2200 psig (156 kg/cm^2)
- Bottomhole temperature - 140F - 160F (68C-78C)
- Oil Gravity - 12° API to 20° API (specific gravity 0.98-0.93)
- Gas/Oil Ratio (GOR) - 160-185 cf/bbl (28.5 -33 m^3/m^3)



Source: Shell Oil, 1978.

Simplified Process Flow

2.4-15
Figure

- Maximum Water Injection Pressure at surface - 2000 psig (142 kg/cm^2)

- Maximum shut-in wellhead tubing pressure 2000 psig (142 kg/cm^2) (with pump)

(c) Oil Distribution

Produced oil and water will be routed to a bulk production header or one of two test headers on Elly. It is anticipated that artificial lift (pumping) will be required for all wells initially or soon after completion; therefore, provisions for submersible electric pumping will be provided.

(d) Oil Processing and Shipping

Space for three separate trains of oil dehydration equipment is provided on Elly. Two of the trains will be installed initially; the third will be added if it is needed. The produced crude is directed through one of the parallel trains. The stream is first heated to about 140F (68C) in two heat exchangers for three-phase separation in the free water knockout vessel. This vessel operates at 65 psig (5.8 kg/cm^2). The gas from this vessel is sent into the gas compression system and the oil/water emulsion phase is sent to the treater for the final step of oil dehydration. Water from this vessel is sent to the produced water treating system.

The emulsion is heated in two heat exchangers to approximately 220F (105C) before entering the treater where the remaining water is removed; the clean oil then flows to the clean oil storage tank. From this tank, the oil is metered and pumped into the pipeline to shore facilities where custody metering and distribution occurs.

(e) Produced Water Cleanup and Injection

Prior to injection of the produced water, it must be treated to remove suspended solids and oil. Treatment consists of a skim tank for removal of oil and solids by gravity separation. The water is then passed through a Wemco gas flotation cell in which the gas is continuously recycled. The third stage of treatment consists of filtration through sand filters. Next, the filtered water is accumulated in a surge tank, and then pumped through cartridge-type polishing filters. Gas turbine driven injection pumps then boost the water to the required injection pressure.

(f) Gas Handling and Compression

Gas is collected from various points in the production handling system. The primary source of gas is from the casing-tubing annulus. A casing-gas gathering system is provided in order to minimize the backpressure on the producing formation. Additional gas separation occurs in the free water knockout, in the treater, and in the stock tank. Provisions are included for collecting all of these gases and compressing them for use as fuel gas for the gas turbines on the platform, or, for injection to the formation for the short period during which produced gas exceeds fuel gas requirements.

The expected gas production from the field is expected to peak at 4.32 million scf/day in 1986, and to average about 2.16 million scf/day over project life. During periods where there are upsets in the system caused by equipment malfunctions or other conditions, the produced gas will be automatically flared via the vent gas flare shown in Figure 2.4-12.

(g) Source Water Treatment and Injection

Sea water is used as a supplemental source of injection water. Treatment consists of filtration to remove suspended solids and deaeration to remove oxygen. As in the case of the produced water, gas turbine driven pumps boost this water to the pressure required for injection.

(h) Relief and Vent Systems

Overpressure protection for pressure vessels is provided by appropriately sized pressure relief valves. These valves discharge into a collection system which routes the vapor through a "Vent Scrubber" to prevent liquid carryover prior to venting. Two separate collection systems and scrubbers are provided. One provides protection for the low-pressure vessels (less than 5 psig (1.4 kg/cm^2)) and the second provides protection for all other pressure vessels. The vent collection system routes the vapors to the flare, when required, for combustion.

(i) Utility Systems

Platform operations are designed to be as self-sufficient as possible. The following utility systems are provided:

- Electric Power Generation. Deck space is provided for up to six 2500-kw generators. The generators will be driven by gas turbines which can utilize either natural gas or diesel oil as fuel. A discussion of diesel fuel handling is provided below. These generators will provide power for artificial lift and for process and production needs on the platforms. When Platform Eureka is installed, these generators will supply power to it via a submarine electric cable.

- Emergency Power Generation. Three separate emergency diesel-driven generators of about 400-kw capacity each will provide backup power to certain critical loads such as lighting, navigation aids, instrument air compressors, and personnel quarters.

- Process Heating System. Process heat requirements are met by a closed circulating system utilizing pressurized hot water as the heat transfer media. The source of the heat will be the turbine generation exhaust which will pass through heat recovery units. Utilization of this heat enables a heat utilization factor for the plant of about 50 percent of available heat energy.

- Potable Water/Sewage Treatment. Provisions are made for producing potable water from distilling units using waste turbine heat and for supplying water from shore by supply boat if needed. Provision will be made for storing required potable water on the platform. Sewage will be treated through a packaged sewage treatment unit.

- Personnel Quarters. Personnel quarters will accommodate those persons who are routinely quartered on the platform. Sleeping accommodations, kitchen and dining areas, locker room, and restroom-washroom facilities will be provided.

- Diesel Fuel Handling. Diesel oil will be used as fuel for the electric power generation turbines starting in about 1993 when natural gas production drops off. Initially, about 140 barrels (22 m^3) per day will be consumed, and this will rise to about 570 barrels (90 m^3) per day in 2000. The platform supply boats will transport diesel oil to the platforms in about 200-barrel (318 m^3) quantities from a marine terminal, probably Shell's terminal in San Pedro. Supply deliveries will vary from about one every 14 days in 1993 to one every 4 days in 2000. The initial diesel oil storage capacity of 1000 barrels (159 m^3) for emergency power generation will be increased when electric power generation is switched to diesel oil.

2.4.2.4 Pollution Control and Safety Features

The pollution control and safety systems include the following:

(1) Fire Suppression System. The fire suppression system consists of:

(a) Fire detection and alarm:

- Gas detectors
- Ionization (smoke) detectors
- Ultra Violet (U.V.) detectors
- Heat rise detectors
- Fusible plugs

(b) Fire extinguishment:

- A looped fire-water system with a total of three fire-water pumps (two located on one platform and one on the other to preclude damage to all by one incident). Primary and alternate electric power sources are provided for these pumps;

- Combination water/foam (aqueous film forming) hose reel stations are provided at designated locations throughout the platforms;

- A fixed water spray system on the oil storage and shipping pumps on Platform Elly;

- Manual water monitors at designated locations on Platform Elly;

- Stationary dry chemical (350-pound - 159 kg) units at designated locations throughout the platforms;

- DuPont Halon 1301 gaseous fire extinguishment systems in several confined machinery spaces on Platform Elly; and

- Portable dry chemical and carbon dioxide extinguishing units at designated locations throughout the platforms.

As a result of the extensive exploration drilling program to date there is no indication of H_2S in the produced gas. Since the gas is sweet, no hydrogen gas safety system has been included in Shell's initial development plans. If the development drilling program encounters sour gas, provisions will be made to install such a system.

(2) Navigation Aids. Navigation aids for Platforms Ellen and Elly are designed in accordance with U.S. Coast Guard Class 1 criteria. The system includes the following components:

Quantity	Description
2	CG-1000 Fog Signal inverter with remote control switch and two ELG-500/02 emitters. Blast characteristic is 2 sec ON and 18 sec OFF; 120/240 VAC 60Hz power source required.
1	SF-4000 Light Controller and Monitor with photocell; 120 VAC, 60Hz power source required.
8	Dual Ventilated FA-250 Lanterns with 120 volt AC, 500 watt lamp with mounting stand to operate as a master and standby system. Flash characteristic is 0.04 sec ON, 0.6 sec OFF, 7000 effective candelas; 120 VAC, 60Hz power source required.

Quantity	Description
1	HALS 15, 15 Mile Derrick Light. Dual ventilated FA-250 lantern with mounting stand and both lanterns operating simultaneously, 15,000 effective candelas. Flash characteristic 1.0 sec ON, 2.0 sec OFF; 220 VAC, 60Hz, power source required.

The location of these components on Ellen/Elly is shown in Figure 2.4-5. The fog signals have a two-mile minimum range and are directional and synchronized. All lights will flash in unison. The system is manufactured by Automatic Power, Inc. All navigational components are connected to the emergency standby generator buss. A similar system will be installed on Eureka when it is constructed.

Shell's application for navigational aids for this project has been approved by the U.S. Coast Guard. The application and approvals are provided in the Technical Appendix. As noted, the Coast Guard has approved only the navigational aids and not the platforms or the platform sites at this juncture.

2.4.2.5 Emergency Shutdown System (ESD) and Automatic Shut-in of Wells

All wells will be equipped initially with surface-controlled (platform) subsurface safety devices. These devices will be installed in the well below the mudline and are held open by hydraulic and pneumatic pressure from platform systems. Any accidental or deliberate bleeding off of the pressure will cause these devices to shut and thereby stop any flow from either the tubing or the casing annulus in the well. The wells are also equipped with surface safety valves similarly actuated.

The pneumatic system holding open the hydraulically-operated subsurface safety devices and other safety shut-in devices on the platform equipment is located throughout the platform. Automatic monitors of critical functions and manual bleed-off valves at ESD stations will cause the system pressure to bleed off if an abnormal condition is detected. Accidental breaking of ESD system piping will also cause the system to bleed off and shut-in the wells.

2.4.2.6 Safety and Escape Equipment

Escape systems including survival capsules, life rafts, and life jackets will be provided on each of the shallow water platforms. The crew quarters building on Ellen will be located near the bridge to Elly to provide a means of egress from the drilling platform if required.

2.4.2.7 Deck Drainage/Sump System

In order to prevent spills of oil or other pollutants from reaching the ocean, both Ellen and Elly will be equipped with drainage collection systems in all areas where spills are likely to occur. These "drip pans" will collect the spill and route it to a separator from which oil is pumped back into the oil-handling system and water is either discharged to the skim pile or pumped back into the produced water cleanup system. Under normal operations (i.e. routine cleanup and washdown of spills less than 400 gallons [1.5 m^3)], no discharge of either oil or water into the ocean should occur.

Should the capacity of the pumping system be exceeded (e.g., during a heavy rainstorm or when fire water is being used), the excess water which cannot be pumped back into the produced water system will discharge into a skim pile of 220-bbl (35 m^3) capacity from which the oil will be recovered and returned to the oil handling system.

2.4.2.8 Oil Spill Handling

Oil spill procedures are generally outlined in Shell's *Spill Contingency Plan* dated October 1977. This document spells out containment procedures, emergency management infrastructure, and equipment inventories. The plan is designed to respond to two levels of spill. Small spills (< 50 barrels - 8 m^3) will be dealt with by the platform personnel using equipment from the Southern California Petroleum Contingency Organization (SC-PCO). Larger spills or moderate spills in adverse weather conditions will be turned over to SC-PCO for manpower coordination. In the case of either sized spill, the manpower is provided by either Shell (small spill) or from all members of the consortium (large spill). At present, there are twelve (12) participating companies in the consortium.

Once a spill has been detected and the source located, the field supervisor on the platform will initiate the level of response required and establish appropriate contact with SC-PCO, Shell management and appropriate regulatory agencies such as the Coast Guard, and Fish and Wildlife Service. Then, from locations within the Los Angeles/Long Beach harbor, boats will bring appropriate equipment and personnel to the site to begin containment and removal procedures.[1]

The five prime categories of effort planned include:

- Deployment of Work Boats - used for deploying booms, dispensing chemicals, and moving personnel.

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[1] Estimated response time to obtain equipment and personnel from various companies is 2-3 hours.

- Containment Booms - used primarily to surround the leeward and lateral edges of a spill to corral oil and permit recovery of oil under reasonably controlled conditions. The booms move windward with the oil slick, reducing the rate of travel of the slick. Booms are available in various sizes up to 4,100 feet (1,250 m) in length and are both plastic and rubber.

- Chemical Collecting Agent - a surface tension modifier used to minimize the spreading tendency of an oil slick on the surface of the water. This chemical is used in conjunction with containment booms. Shell Oil Herder[R] is an example of this type chemical.

- Skimmers - used in conjunction with booms, this equipment is designed to selectively recover oil from the surface of the water. Shell has proposed to use the Komara Miniskimmer; however, SC-PCO has additional types available.

- Chemical Dispersants - a chemical emulsifier which disperses the oil into the water phase in the form of an oil-in-water or "water-wet" emulsion, with low mixing required to effect the dispersion. Chemical dispersants planned for use include agents such as BP 1100WD and Corexit 9527.

In addition, equipment is available for the absorption of oil on shore. Also available are shovels, pitchforks, pans for wildlife treatment, and miscellaneous communications support gear. A listing of equipment, agency contacts, and chain-of-command contacts can be found in the Containment Plan.

2.4.3 Crude Oil Pipeline

A 16-inch (0.4 m) pipeline will transport clean crude from Platform Elly to shore. Installation is planned in late 1979 as shown in the project schedule, Figure 2.4-1. The pipeline capacity will be 40,000 b/d (6,360 m^3/d), which will be sufficient to handle Shell's maximum projected Beta Unit production (24,000 b/d - 3,816 m^3/d), plus any additional production which might result from development of nearby leases. Since all gas produced at the Beta Unit will be used as gas turbine fuel, gas transportation facilities to shore are not required.

The pipeline will be laid on the bottom from Platform Elly to the Long Beach Harbor breakwater. At the breakwater, the pipeline will be buried in a dredged trench with at least four feet (1.2 m) of cover to protect it against damage from ship activities in the harbor. This is further discussed under construction techniques, below. An application to install the pipeline and dredge within the harbor has been submitted to the U.S. Army Corps of Engineers. Approvals have not been received. Additionally, application has been made to the SLC for lease of right-of-way for the pipeline on lands within state waters. This lease application cannot be acted upon until such time as the environmental report has been certified.

2.4.3.1 Pipeline Route

The pipeline route is shown in Figures 2.2-2 and 2.2-5. The subsea portion of the route to Long Beach is about 17 miles (27 km), with landfall on Pier J north of the Queen Mary in the Port of Long Beach. The nearshore route would parallel the THUMS lines to a seven-company distribution manifold about two miles (3.2 km) inland. A route profile and cross section of the pipe is shown in accompanying Figure 2.4-16.

In addition to the preferred alignment, there are alternative routes which were considered by Shell and are analyzed in this study. These routes include: (1) Alternative 1 - a pipeline route to Huntington Beach or Huntington Harbour; (2) Alternative 2 - a pipeline route to Seal Beach. From each of these landfalls a shore pipeline would be required to connect into the existing refinery system. These alternatives are evaluated in this report. The design criteria and characteristics of the alternate subsea routes would generally be the same as for the preferred route, as discussed in the following section.

2.4.3.2 Pipeline Design Criteria

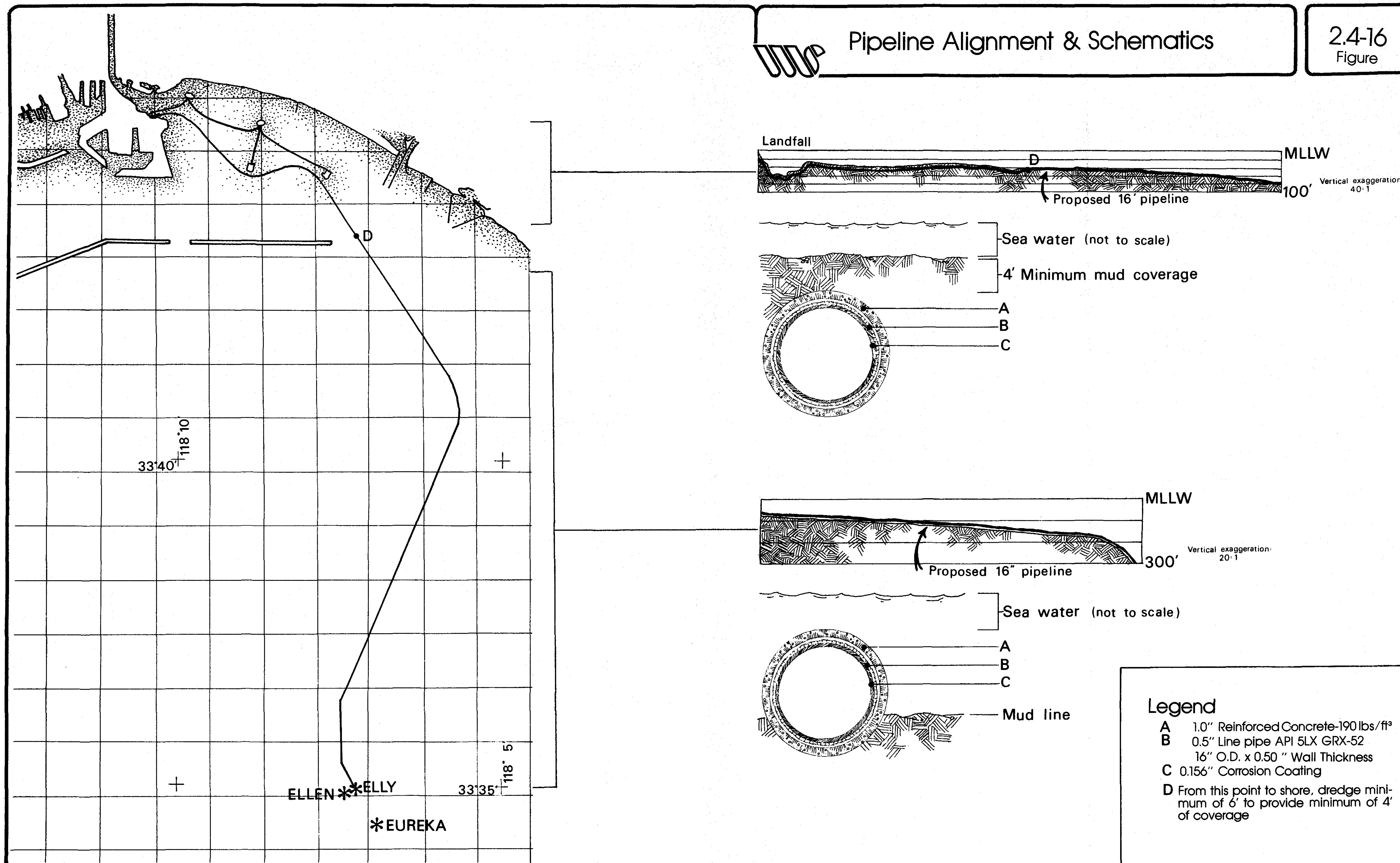
The pipeline will be constructed of 16-inch (0.4 m) O.D. seamless or double submerged arc-welded steel pipe with a 0.500-inch (1.25 cm) wall thickness, 82.77 lbs/ft (124.16 kg/m). Pipe joints will be welded. Concrete weight coating, consisting of a one-inch (2.5 cm) thickness of 190 lbs/ft^3 (3,040 kg/m^3) concrete will be applied, resulting in a submerged weight in sea water of about 46 lbs/ft (69 kg/m) empty and 118 lbs/ft (177 kg/m) full of 0.94 specific gravity crude oil. Protective coating will be by "double enamel coat" system of coal tar enamel, reinforcing glass wrap, and outer felt wrap. In addition to enamel coating, the line will be protected with sacrificial zinc anodes. The zinc anodes will weigh approximately 315 lbs (143 kg) each and will be installed at intervals of 1,000 feet (305 m). Internal corrosion in the pipeline is not expected. However, the use of inhibitors is planned. Testing and monitoring for internal corrosion will dictate the extent of the program.

The offshore portions of the pipeline will be designed to resist movement because of on-bottom currents predicted to occur during the design 100-year storm. Stability will be achieved by the weight of the submerged pipeline.

Maximum design operating pressure of the line will be 1420 psi (99 kg/cm^2), whereas the normal operating pressure will be 1000 psig (70 kg/cm^2). The pipeline will be designed to withstand external loads, including hydrostatic pressures with the pipeline void and with its absolute internal pressure equal to normal atmospheric pressure. The pipeline will be designed in accordance with Pacific Area OSC Order No. 9, DOT Regulation 49 Part 195 as amended August 18, 1976 and applicable state regulations to withstand

Pipeline Alignment & Schematics

2.4-16 Figure



Legend

- **A** 1.0″ Reinforced Concrete-190 lbs/ft³
- **B** 0.5″ Line pipe API 5LX GRX-52 16″ O.D. x 0.50 ″ Wall Thickness
- **C** 0.156″ Corrosion Coating
- **D** From this point to shore, dredge minimum of 6′ to provide minimum of 4′ of coverage

stresses which result from installation, thermal and fluid expansion effects, earthquake and other dynamic effects, dead loads, and surges.

2.4.3.3 Construction

The pipeline will be trenched to provide a minimum cover of four feet (1.2 m) within the extension of the Long Beach breakwater. Trenching will be by dipper dredge, casting aside the spoil for subsequent backfill. Pipelines which have been installed in offshore California have not required burial for stability and no movement of these lines has been observed. It is Shell's intention to install this line without burial within State waters outside the Long Beach breakwater. Based on results of bidding, pipe installation will be either by the lay barge or pull methods. During construction, inspection will be accomplished with full-time qualified inspectors. Girth welds will be radiographically inspected in accordance with 49CFR 195.234(EX1). Prior to construction, the bare pipe will be inspected for defects. Upon completion, the pipeline system will be pressure tested with sea water to 2160 psig (151 kg/cm^2) for 24 hours. After testing, the pipeline will remain full of seawater until oil production is initiated. The seawater contents will then be clarified and disposed of in accordance with applicable discharge requirements.

2.4.3.4 Pipeline Operation

At Platform Elly, the pipeline will be protected from over-pressure by means of a pressure switch set to shut down the pumps when a predetermined pressure is exceeded.

The oil pipeline to shore is monitored in two ways to detect leaks and limit the amount of oil spilled in the event of a leak. Very large leaks (i.e., pipeline rupture) will be detected by a high/low pressure sensor on the pipeline exit from the platform. In the event that this sensor detects an abnormally low pressure caused by a pipeline break, all oil shipping pumps will be automatically stopped. The time elapsed between detection and pump shutdown will be less than five seconds.

A volumetric leak detection system is intended to detect leaks smaller than a rupture. This system repeatedly scans a group of measurement devices at each end of the pipeline. After each scan, it calculates the volume of oil which has entered the line since the last scan, the change in oil volume in the shore surge tank due to level changes since the last scan, the volume of oil shipped to purchasers since the last scan, and the change in oil volume in the pipeline due to pressure and temperature changes since the last scan. A net volume imbalance for the bounded system is then calculated. Under normal conditions, the net imbalance at each scan should be either plus or minus and the cumulative imbalance will drift about zero. If a leak occurs, the cumulative imbalance will grow steadily in a positive direction. When an alarm limit is exceeded (25-50 barrels or 3.98-7.95 m^3), a leak is assumed.

When a leak is detected, an alarm will be sounded, a report summarizing pipeline conditions printed, and a cumulative imbalance versus time trend plot generated for the last 200 scans. By reviewing the report and plot, the operator can make a judgment as to the validity of the alarm. If warranted, the operator may also perform pressure dropoff tests by closing the onshore pipeline shutdown valves. The operator can shut down the pipeline if a leak is believed to exist. The sensitivity of this system, and hence the maximum amount of oil that could leak before an alarm was sounded, is about 25 to 50 barrels (3.98 to 7.95 m^3) of oil.

During operations, safety devices will be checked periodically in accordance with Department of Transportation regulations. Cathodic protection surveys will be performed annually to determine adequacy of protection.

2.4.4 Shore Facilities

2.4.4.1 Port of Long Beach

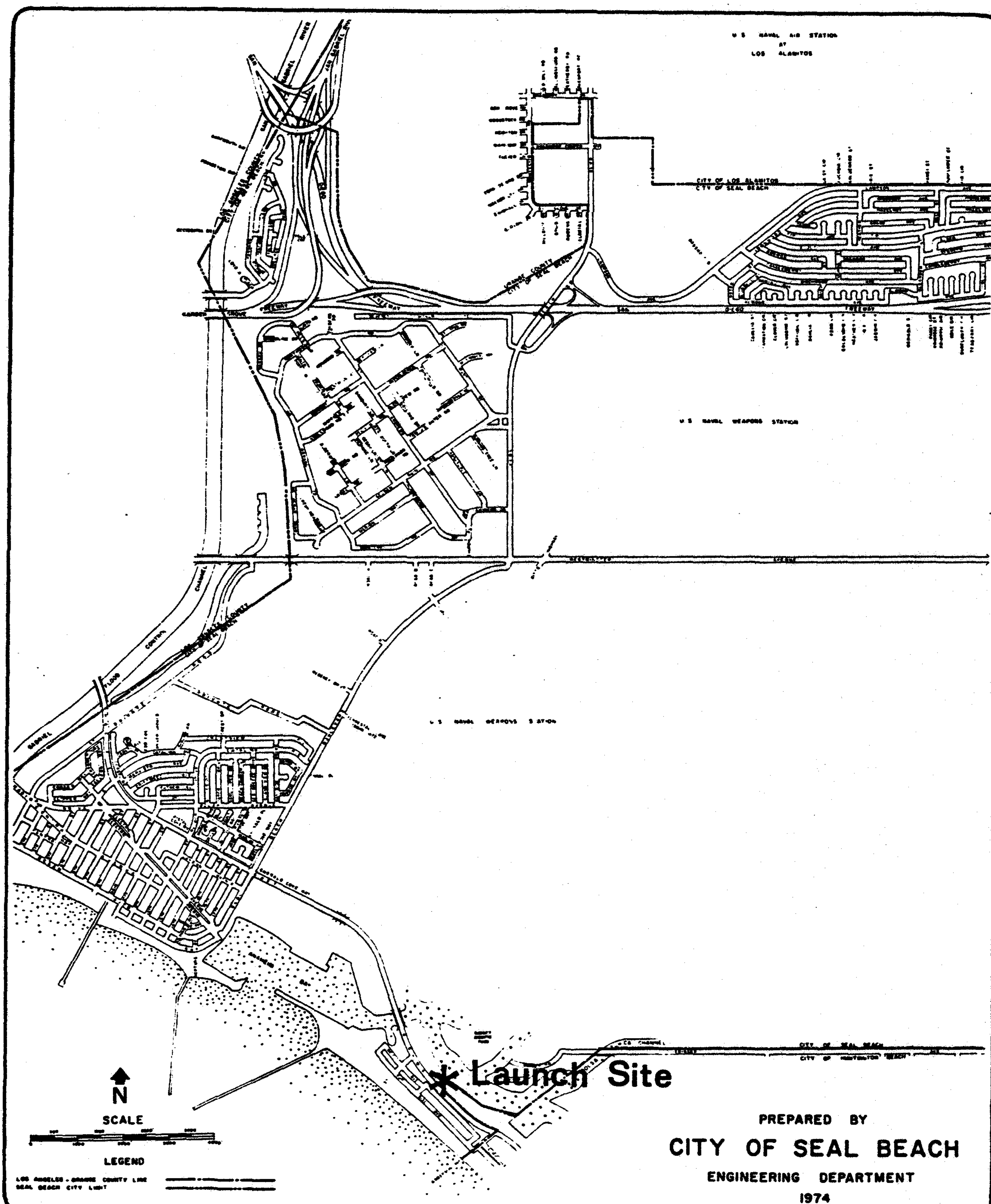
Onshore facilities in the Port of Long Beach will consist of: (1) a pipeline right-of-way; (2) a marine supply and equipment storage yard; and (3) a one-acre (0.4 ha) crude oil distribution site. The proposed onshore section of the pipeline will surface north of the Queen Mary and then parallel the THUMS lines to an area near the THUMS seven company distribution manifold about two miles (3.2 km) inland (as shown in Figure 2.2-5).

The distribution facility located on approximately one acre (0.4 ha) will consist of a scraper trap, custody transfer meters, a 10,000-bbl (1,600 m^3) tank (equipped for vapor recovery or double-seal floating roof), four electrically powered pumps, and manifolds. This facility will be diked to contain any spills, and will have either an oil and water separator or a sump pump to prevent oil from reaching harbor waters. The distribution manifold will tie into the seven-company distribution system near the THUMS manifold, however, it will be separate from the THUMS manifold.

The marine supply and equipment storage yard will be a waterfront facility where the supply boat will dock and take on supplies (pipe, drilling equipment, etc.) destined for the oil platforms. It will be located on three acres (1.2 ha) just south of Seventh Street and Pier Avenue. This site has good railroad access.

2.4.4.2 Huntington Harbour Crew Launch

An additional support facility is presently planned to be located in the far western portion of Huntington Harbour (Figure 2.4-17). It will be used to stage work crews from the mainland out to the oil platforms. The facility will consist of slips for the crew boat and a controlled access parking lot containing 30 to 40



Vicinity Map of Crew Launch Site

2.4-17
Figure

parking spaces. The facility will use an existing Shell marina facility for this purpose. It is proposed that the existing gas station be removed to allow for the necessary parking.

The crew boat for the proposed project will load personnel at the launch site and proceed into Sunset Bay, pass under the Pacific Coast Highway bridge, and into Anaheim Bay. It then will follow a prescribed course for recreational and commercial vessels, avoiding naval property and waters, into the open sea and out to the platforms.

2.5 FIELD RESTORATION

At the end of the project life (estimated at 35 years), the field will be restored in accordance with applicable OCS Orders. This will include well sealing and capping, platform removal, and pipeline retrieval. Inasmuch as technology and restoration requirements will change significantly in the interim, no detailed evaluation of such procedures in terms of environmental impact is performed, nor considered warranted at this time.

2.6 PROJECT AIR QUALITY EMISSIONS OFFSETS

Shell Oil Company proposes as part of this project to voluntarily offset major air pollutant emissions from offshore and onshore operations at a level which provides a net air quality benefit in the Basin. They propose to accomplish this by reducing emissions from sources internal to Shell Oil. Included in this consideration will be existing operations in Yorba Linda and Ventura, California. Shell's Yorba Linda reduction program involves collecting casing gas from various producing wells, condensing the hydrocarbons, separating the hydrocarbon liquids from the water, and salvaging the hydrocarbons. In Ventura, Shell proposes to convert some gas-fueled compressors and engines to purchased electricity with a resultant reduction in air emissions, particularly NOx.

SECTION 3.0
ENVIRONMENTAL SETTING

3.1 GEOTECHNICAL SETTING

3.1.1 Geology

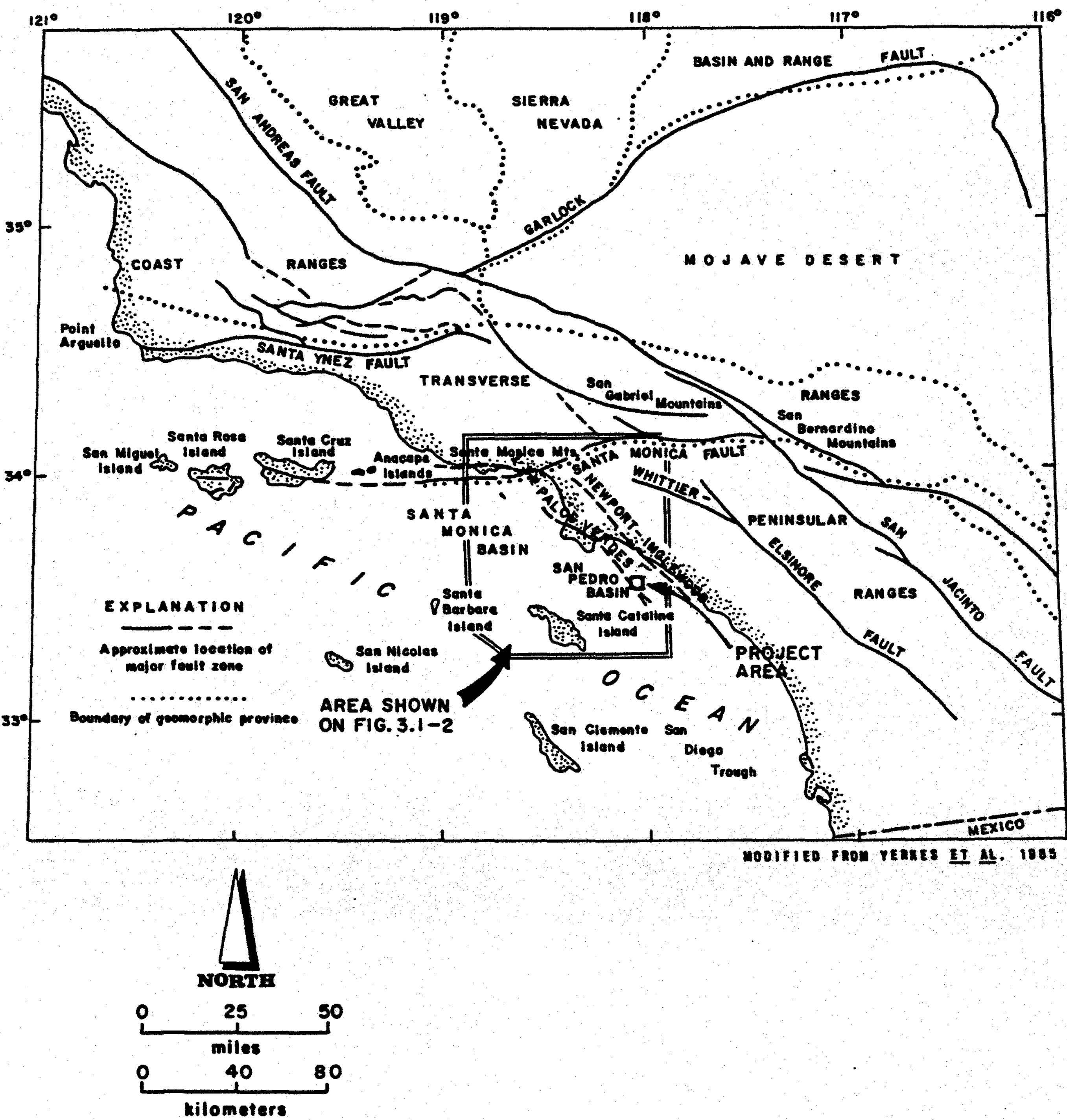
The geotechnical section of this report is based on a compendium of the existing literature. Included in the review were documents submitted by Shell Oil Company on their design parameters and by Dames and Moore on regional baseline. This information has been augmented and substantiated by Fugro, Inc. using the literature base and their knowledge of the project area from previous studies. There has not been any field work conducted as part of this study.

3.1.1.1 Physiography

Lease P-0300 and P-0301 platform sites and associated facilities are located on the San Pedro shelf, a submergent part of the Peninsular Ranges province of southern California (Figure 3.1-1). Both the submerged and exposed parts of this province are characterized by elongate northwest trending ridges separated by sediment-filled structural basins. The onshore portions of the Peninsular Ranges province adjacent to the project area contain subdued topography of the Los Angeles Basin. Northwesterly of the project area the Palos Verdes Hills, which rise to about an elevation of 1,400 feet (425 m), form a prominent topographic feature within this basin.

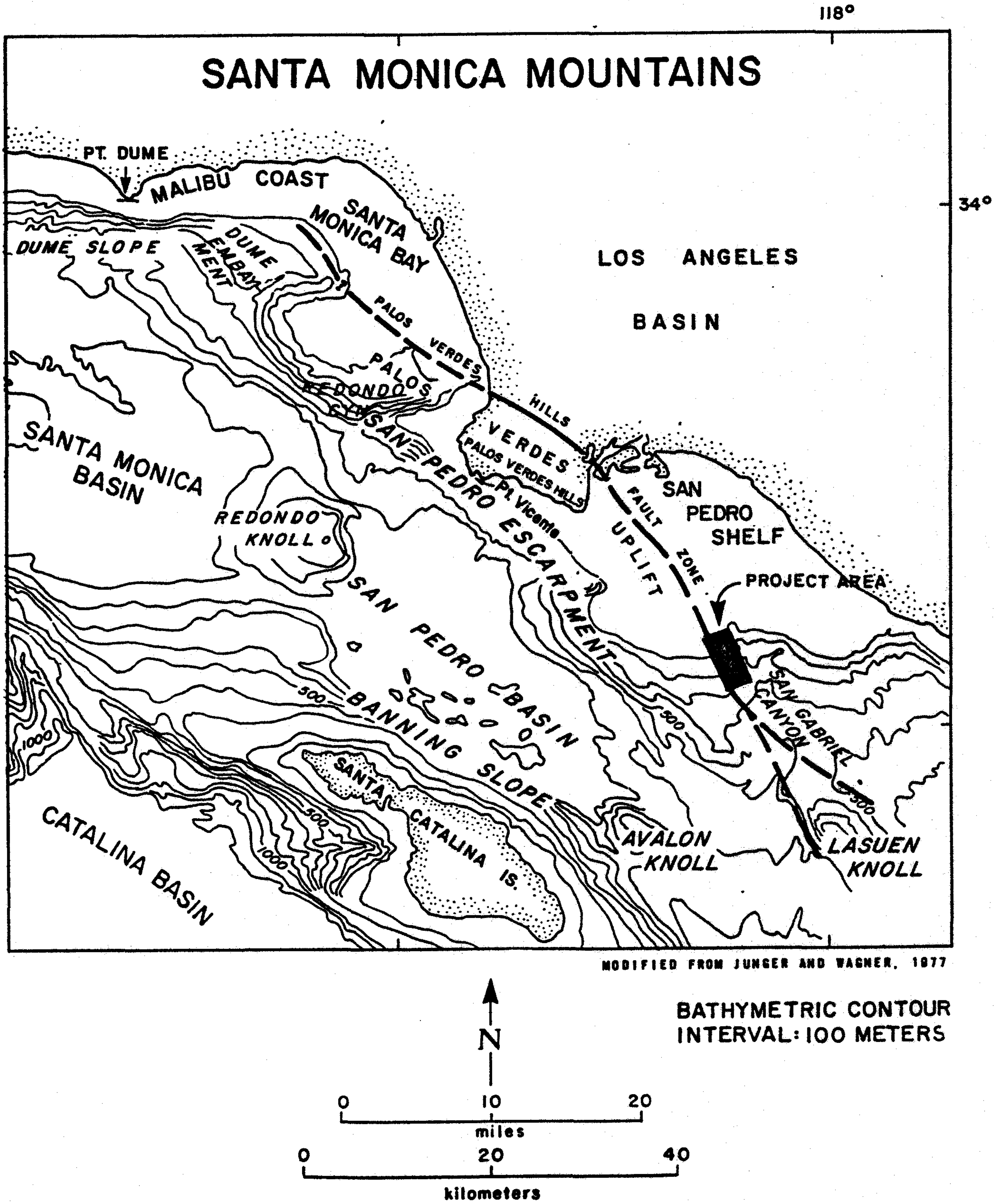
The submerged portion of the province, termed the "continental borderland" is characterized by highly irregular bathymetry (Figure 3.1-2). A complex of basins, banks and islands, and canyons occurs between the shallow, nearly flat-lying San Pedro shelf, on which the proposed development is located, and the Catalina Basin to the south. Submarine ridges in this area of the continental borderland rise above the sea-floor to form broad, shallow banks and islands with elevations as high as 2,100 feet (640 m), such as Santa Catalina Island. In contrast, the San Pedro shelf forms a relatively flat featureless platform from the coastline to water depths of about 200 feet (60 m). The shelf is bounded by slopes of the arcuate San Pedro escarpment. Several submarine canyons along this escarpment dissect the outer edge of the platform. The most significant canyon is the San Gabriel submarine canyon immediately east of the platform sites. Present relief of the walls within this canyon ranges from 150 to nearly 200 feet (45-60 m); slope angles average 15° (Mesa[2], 1977).

Development of the Ports of Los Angeles and Long Beach has resulted in extensive modification of the natural bathymetry within



Geomorphic Provinces and Major Fault Zones

Figure 3.1-1



Bathymetry and Major Structural Features in the Offshore Site Region

Figure 3.1-2

near-shore portions of the San Pedro shelf (Dames and Moore, 1977b). Modifications have included breakwater construction, landfill projects, navigation channel dredging, and the construction of several artificial islands for oil production activities within the area of the Los Angeles and Long Beach harbors.

3.1.1.2 Regional Geology (Offshore and Coastal)

(1) Geologic History

The Los Angeles Basin, which includes the coastal plain and the project area, has been described as having evolved through five major geological phases to become the eroded, low-relief surface that it is today (Yerkes, *et al.*; 1965). These phases are: (1) predepositional phase - basement rocks; (2) prebasin phase of deposition - upper Cretaceous to lower Miocene rocks; (3) basin inception phase - middle Miocene rocks; (4) principal phase of subsidence and deposition - upper Miocene to lower Pleistocene rocks; and (5) basin disruption phase - upper Pleistocene to Holocene strata (see Table 3.1-1, Geologic Time Scale, for definition of rock ages).

Basement rocks have been divided into two physically separate and genetically distinct groups, the eastern basement complex of metamorphosed sedimentary and volcanic rocks, partly intruded by plutonic rocks, and the western basement complex of Catalina Schist (Yerkes *et al.*, 1965), which includes the project area. These basement rocks are of pre-late Cretaceous age.

The upper Cretaceous to lower Miocene rocks were deposited over a broad area during three cycles of marine transgression and regression. This sequence of rocks is only present in the areas underlain by the eastern basement complex. These rocks include as much as 5,900 feet (1800 m) of chiefly marine sedimentary deposits of late Cretaceous age and as much as 11,000 feet (3350 m) of shallow marine and non-marine clastic sedimentary deposits of Paleocene to early Miocene age. The site area underlain by the western basement complex is not known to contain pre-middle Miocene sedimentary rocks; whether their absence is due to non-deposition or erosion is conjectural (Yerkes, *et al.*, 1965).

Middle Miocene was the beginning of a significant episode of emergence and erosion. Emergence varied considerably in duration and degree from one part of the basin to another. During much of the middle Miocene,, a northwest-trending marine embayment covered the site of the Los Angeles Basin. Following deposition into this embayment during middle Miocene, the sea withdrew from parts of the embayment and exposed extensive areas to erosion. As a result, some areas were stripped of middle Miocene deposits.

The present form and structural relief of the Los Angeles Basin can be attributed to a long phase of subsidence and

TABLE 3.1-1

GEOLOGIC TIME SCALE

Subdivision in use by the U.S. Geological Survey			Age estimates commonly used for boundaries (in m.y.)	
Era or Erathem	System or Period	Series (Epoch)	Geological Society of London (1964, p. 260-262)	Berggren (1972, p. 195-215)
	Quaternary	Holocene (Holocene)		
		Pleistocene (Pleistocene)		
				1.8
		Pliocene (Pliocene)		
				5.0
		Miocene (Miocene)		
				22.5
Cenozoic	Tertiary	Oligocene (Oligocene)		
				37.5
		Eocene (Eocene)		
				53.5
		Paleocene (Paleocene)		
			65	65
	Cretaceous	Upper (Late)		
		Lower (Early)		
			136	
		Upper (Late)		
Mesozoic	Jurassic	Middle (Middle)		
		Lower (Early)		
			190-195	
		Upper (Late)		
	Triassic	Middle (Middle)		
		Lower (Early)		
			225	

SOURCE: Modified from Bishop, Eckel, and others, 1976 deposition that began in late Miocene time and continued, without interruption, through early Pleistocene time. The embayment that resulted from the renewed subsidence covered most of the area of the middle Miocene embayment.

As in the middle Miocene, not all parts of the basin were submerged simultaneously during the late Miocene to early Pleistocene, nor were the rates of sedimentation everywhere equal. There were periods of tectonic activity along the Palos Verdes fault zone near and within the site area which led to the uplifting of the Palos Verdes Hills area in Pliocene time. There was renewed subsidence in early Pleistocene, and marine deposition resumed in the site area and the Basin area.

The central part of the Los Angeles Basin continued to subside and receive sediment throughout late Pleistocene and Holocene time. The middle to late Pleistocene history of the Palos Verdes Hills is markedly different from that of the central part of the basin. At the end of early Pleistocene time, the project site and adjacent areas were slightly below sea level and were blanketed by 300 to 1,000 feet (90-300 m) of marine lower Pleistocene strata. Submarine canyons formed in the site area in early Pleistocene, and funneled turbidite deposits into the San Pedro basin. This process has continued to the present.

After a history of subsidence and deformation, renewed activity along the Palos Verdes fault zone in late Pleistocene uplifted a large island area. Thirteen individual wave-cut terraces have been identified due to this period of activity. Faulting continued into Holocene and historic time in the San Pedro bay area, indicated locally by offsets of the seafloor and recorded seismic activity.

(2) Structural Features

Evidence currently suggests that seismicity and tectonism in southern California are due to the relative northwestward motion of the Pacific plate with respect to the North American plate (Crowell, 1968; Atwater, 1970, Allen, 1975). The San Andreas fault system represents the surface expression of this zone of plate interaction and is the dominant seismotectonic element of California. Crustal (strike-slip) failure along this zone of plate interaction is occurring across a broad region of southern California.

Dominant structural elements which account for an estimated six centimeters per year (cm/yr) of northwestward movement of the Pacific plate with respect to the continent (Brune, 1968; Atwater, 1970) include the San Andreas, San Jacinto, Whittier-Elsinore, Newport-Inglewood, and possibly the Palos Verdes faults within the Peninsular Ranges (Figure 3.1-1). Historically, the San Jacinto fault has been the most active of these elements, with nine moderate earthquakes ($6 \leq M \leq 7$) recorded along its 250-km (155 mi) length since 1890 (Sharp, 1967; Thatcher *et al.*, 1975).

In the Peninsular Ranges, the series of subparallel northwest-trending faults separate large elongate blocks that stand at different structural elevations (Yerkes *et al.*, 1965). Recent activity along this system of faults is reflected in historic seismicity, geomorphic features indicative of youthful faulting, and offsets of young geologic units.

The San Andreas fault (Figure 3.1-1) forms the master controlling tectonic feature in the system, extending a distance of over 1,100 km (684 mi)(Jennings, 1975). The San Jacinto fault branches off from the San Andreas fault, whereas other faults within the system (i.e., Newport-Inglewood) either die out in a series of smaller splay faults or are terminated on the north by east-west-trending structures along the southern front of the Transverse Ranges.

The most significant onshore northwest-trending fault zone near the proposed development is the Newport-Inglewood fault. The Newport-Inglewood fault zone, or structural zone, trends northwesterly along the western side of the Los Angeles Basin (Figure 3.1-3). The northern extent of the fault zone is terminated at the Santa Monica Mountains frontal fault system, and the southeastern portion can be inferred to extend to Laguna Beach on the basis of epicenter locations (Barrows, 1974), for a distance of about 50 mi (80 km). Southeast of Laguna Beach, the Newport-Inglewood Fault zone aligns with an offshore zone of faults that can be traced for about 35 mi (56 km) to Oceanside (Barrows, 1974), for a total fault length of about 85 mi (137 km). The fault zone contains a number of *en echelon* uplifts which provide large traps for oil and gas. The pattern of uplifts and other subsurface evidence as well as first-motion studies of earthquakes support the concept of right-lateral fault movements (Barrows, 1974). The fault zone is seismically active, although no surface faulting has been observed resulting from historic earthquakes. The largest and most destructive historic earthquake along the Newport-Inglewood fault zone was the Long Beach earthquake of March 10, 1933, of magnitude 6.3.

Offshore, the project region contains structural highs and depositional basins separated by northwest-trending linear submarine escarpments and fault zones (Figure 3.1-2). Structural highs include the submarine ridge forming Santa Catalina Island and the Palos Verdes uplift of the site area. The Palos Verdes uplift represents a 45-mile (72 km) long topographic and structural feature extending northwest-southeast from the Palos Verdes Hills (Junger and Wagner, 1977).

The offshore fault zones are northwest-trending, parallel with the mainland faults. The most continuous offshore faults in proximity to the site area (Figure 3.1-3) are the Palos Verdes Hills fault zone, the San Pedro basin fault zone, and several short unnamed faults just west of the coastline (Junger and Wagner, 1977).

The Palos Verdes Hills fault zone (subsequently termed the 'Palos Verdes fault,' for descriptive convenience) has recently been studied by numerous investigators (Yerkes *et al.*, 1965; Vedder *et al.*, 1974; Ziony *et al.*, 1974; Greene *et al.*, 1975; Junger and Wagner, 1977; Mesa[2], 1977). The fault actually forms a zone of sub-parallel and *en echelon* traces which is known to extend from the northern part of Santa Monica Bay southeasterly to Lasuen Knoll, a total distance of about 55 miles (88.5 km)(Figure 3.1-2). The northwestern portion of the fault north of Redondo Canyon in the Santa Monica Bay forms a zone several miles wide of scattered faults with Pleistocene displacements (Greene *et al.*, 1965; Junger and Wagner, 1977). No single continuous active trace has been found. The segmented nature of fault traces in near-surface strata within the Palos Verdes fault zone is also documented by interpretation of a dense network of high-resolution seismic lines at the platform site area. Mesa[2] (1977) reports that no one individual fault trace may be mapped with confidence over the entire 4.5 mile (7.2 km) length of the site area surveyed.

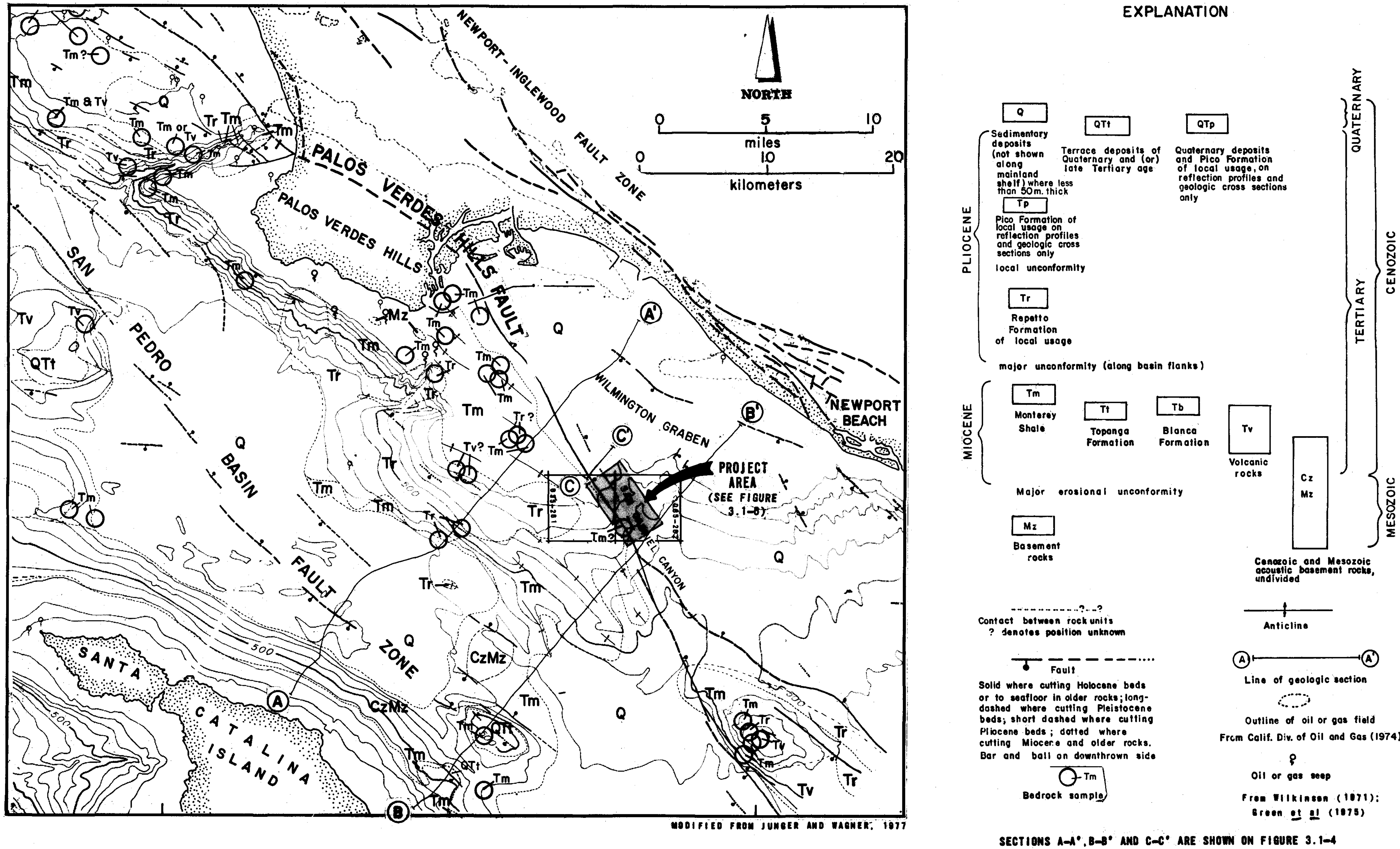
Offshore, southeast of the Palos Verdes Hills, the fault consists of a zone of disturbance about one to two miles (1 to 3 km) wide. The fault bifurcates at a point 20 miles (32 km) south of the harbor breakwater, with a branch on either side of Lasuen Knoll. The possible extension of the fault zone southeast of Lasuen Knoll has been suggested by the U.S. Geological Survey (Greene - personal communication), but such an extension is not yet demonstrated. The dip of the fault is nearly vertical with several investigators reporting traces dipping steeply to both the northeast and southwest. The predominant sense of displacement is right-lateral. However, high-angle reverse movements are implied in the Palos Verdes Hills by vertical separation of the basement rocks by over 3,300 feet (1,000 m)(Yerkes *et al.*, 1965). Both onshore and offshore vertical separation of as much as 6,000 feet (1800 m) is reported by Greene *et al.*, (1975). Significant components of strike-slip movement, based on differences of rock characteristics across the fault, also occurred (Yerkes *et al.*, 1965). High resolution subbottom profiles across the fault traces in San Pedro Bay show offset Holocene deposits (Ziony *et al.*, 1974; Greene *et al.*, 1975) and show evidence of disruptions of the seafloor (Figure 3.1-4) (Junger and Wagner, 1977; Greene *et al.*, 1975).

The San Pedro basin fault zone, as described by Junger and Wagner (1977), consists of several *en echelon* fault traces across the San Pedro basin, unassociated with a basin flank (Figure 3.1-3). The fault shows about 600 feet (180 m) of vertical displacement of Pliocene age strata. Lower Pleistocene deposits are evidently offset across this fault in the San Pedro basin (Junger and Wagner, 1977).

A discontinuous series of relatively short faults is present near-shore along the San Pedro shelf (Junger and Wagner, 1977). These faults appear to form the mainland boundary of the Wilmington Graben (Figure 3.1-3, 4). Although unclear on some seismic profiles, these faults probably terminate at the top of lower Pliocene (Repetto) strata (Junger and Wagner, 1977). Greene *et al.* (1975) indicates these discontinuous faults offset the base of the Holocene section.

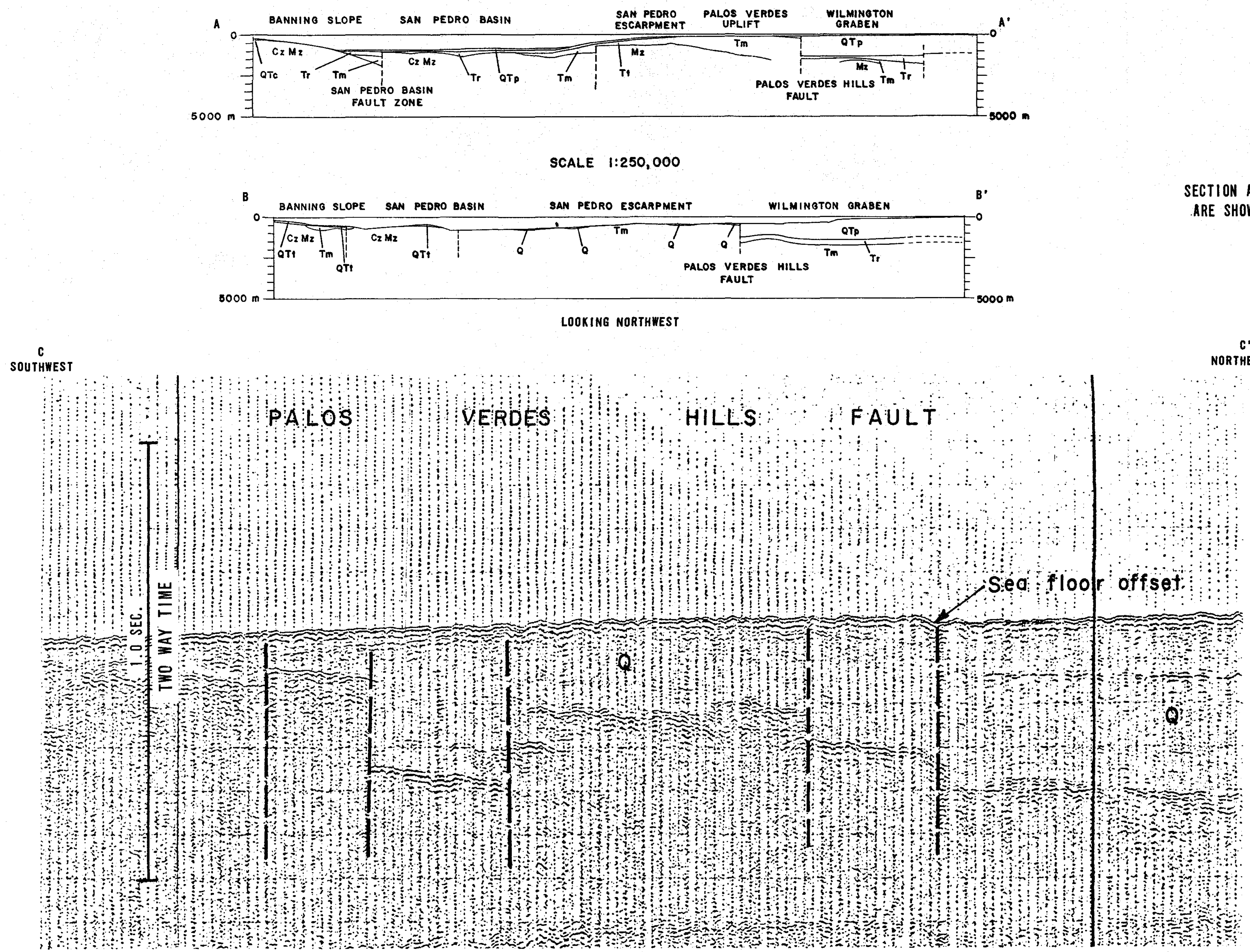
Surface Geologic Map of the San Pedro Basin

Figure 3.1-3



Geologic Sections and Subbottom Acoustic Reflection Profile across San Pedro Basin

3.1-4
Figure



SECTION AND PROFILE LOCATIONS ARE SHOWN ON FIGURE 3.1-3

(SECTIONS AND PROFILE MODIFIED FROM JUNGER AND WAGNER, 1977)

(3) Stratigraphy

The stratigraphy of the area surrounding San Pedro basin has been described in detail by Junger and Wagner (1977), and Vedder *et al.*, (1974). Most of the information presented in the following section has been directly abstracted from these references.

The basinward projection of the mainland geology and scattered seafloor sediment samples has formed the basis for describing the stratigraphy of the San Pedro basin and vicinity. The subsea distribution of the principal rock units is shown on the geologic map, Figure 3.1-3. Regional stratigraphic correlation columns from the San Pedro basin area are shown on Figure 3.1-5. Both the Wilmington and Long Beach oil field stratigraphic columns represent the section lying between the Palos Verdes and Newport-Inglewood fault zones.

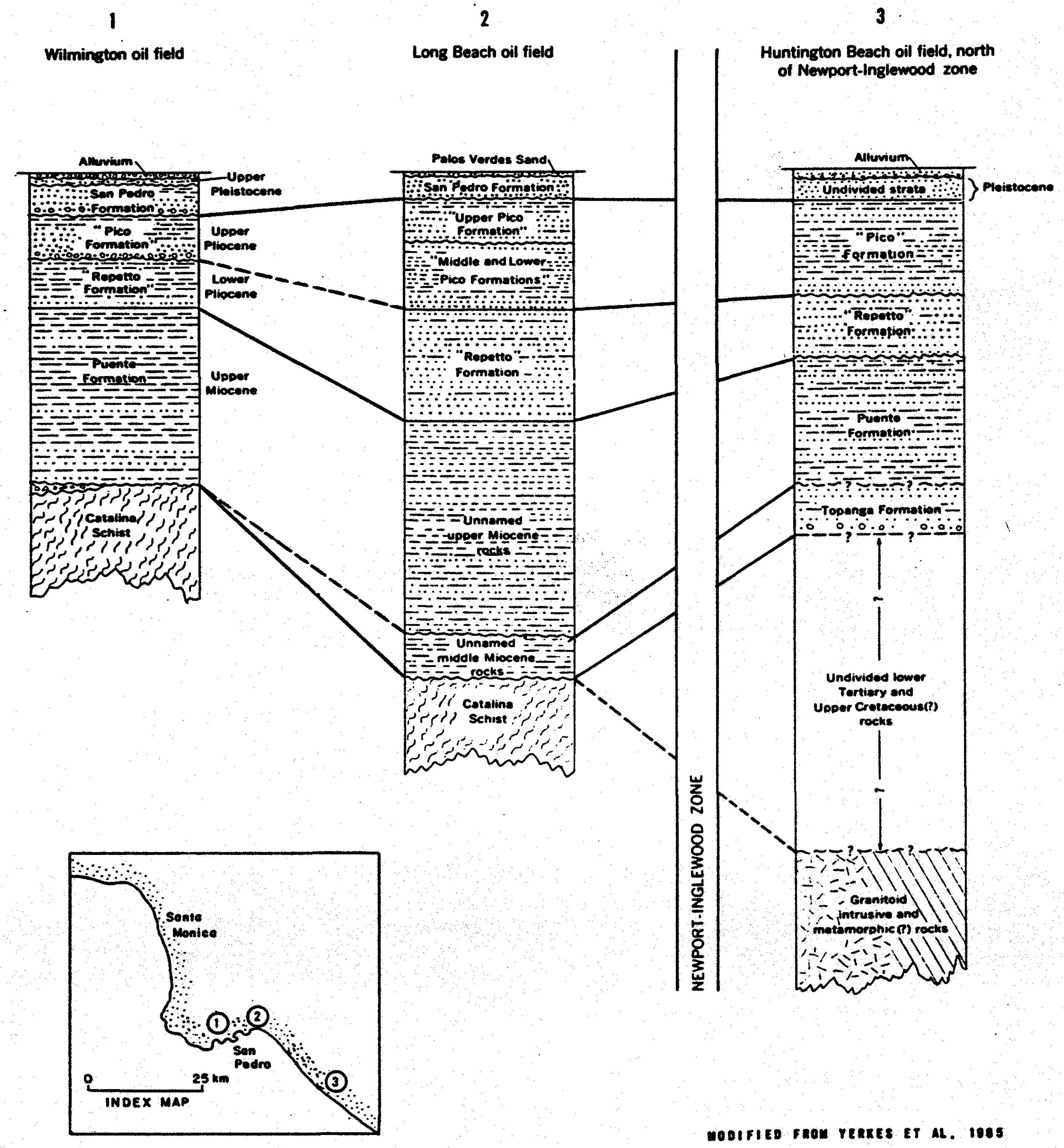
San Pedro Bay lies within a belt of clastic strata which extends along the southern California coast from San Diego to Los Angeles. The width of the belt increases several fold in the Los Angeles basin area where the strata thicken abruptly to a maximum of about 32,000 feet (9700 m)(Yerkes *et al.*, 1965).

In the offshore part of the Peninsular Range province, submarine outcrops of basement rocks are confined to a few known exposures on and adjacent to Catalina Island and scattered ridges. Distinctive metamorphic rocks, represented by Catalina Schist, have been penetrated by several oil wells and are believed to underlie large portions of the offshore region west of the Newport-Inglewood fault zone (Vedder *et al.*, 1974). Seismic reflections interpreted to come from the top of the Catalina Schist are present in profiles run southeast of the Palos Verdes Hills, in San Pedro Bay (Junger and Wagner, 1977).

Pre-Miocene subsea sediments have not been described in the vicinity of San Pedro Bay (Figure 3.1-5). Miocene rocks, including both volcanic and sedimentary types, form most of the high-standing topography of the submerged part of the continental borderland. Seafloor exposures of both rock types are widely distributed along ridges and on knolls, but commonly are covered by a thin veneer of Quaternary sediments. The Miocene sedimentary section is estimated to be 3,000 feet (900 m) thick (Vedder *et al.*, 1974). Locally, the Miocene stratigraphic successions, even though thick, appear to be interrupted by unconformities.

Seafloor samples indicate that, lithologically, submerged Miocene rocks are as varied as their mainland counterparts. Siliceous shale and mudstone as well as sandstone and siltstone of middle and late Miocene age have been sampled on the crest of the Palos Verdes uplift, and along the San Pedro escarpment.

Pliocene sediments have accumulated on many of the lower slopes and in all of the basins of the borderland (Vedder *et al.*, 1974). Pliocene strata, consisting of Repetto and Pico



MODIFIED FROM YERKES ET AL. 1965

Selected Stratigraphic Columns from the San Pedro Basin Area

3.1-5
Figure

formations in the central part of the San Pedro Basin, are estimated to have a maximum thickness of 7,000 feet (2100 m) (Vedder *et al.*, 1974).

The basin sediments of Pliocene age cannot be directly correlated to known occurrences of Pliocene strata on the mainland. The Pliocene stratigraphic sequence has been established largely by correlation of unconformities observed in the offshore basins with those described in the Los Angeles Basin (Junger and Wagner, 1977).

Three major divisions of the basin sediments are defined by two marked unconformities in Pliocene rocks, associated with accelerated subsidence and sedimentation of the basins. The upper unconformity is correlated with the unconformity at the top of the Repetto onshore (Figure 3.1-5), largely on the observation that the majority of the faults in the basins terminate at this horizon. The lower unconformity is correlated with an intra-Repetto unconformity in the Huntington Beach and Sunset Beach oil fields.

Unconsolidated sand and mud of Pliocene and Holocene age form relatively thick deposits which cover near shore shelves and slopes. Vedder *et al.* (1974) report as much as 1,100 feet (335 m) of Quaternary deposits in the San Pedro Basin. This thickness may be an underestimation, since late Pleistocene sediments alone within the Wilmington Graben are reported to be between 1,000 and 1,200 feet (300 to 365 m) thick (Mesa[2], 1977), half of which were penetrated by site boreholes.

Flat-lying marine Holocene deposits range in thickness from 0 to 90 feet (27 m) on the San Pedro shelf west of the Palos Verdes fault zone. East of the fault, in San Pedro Bay, Holocene sediments are between about 25 and 45 feet (7-14 m) thick (Greene *et al.*, 1975). About 30 to 55 feet (9-16 m) of Holocene deposits were encountered in the platform siting areas (Mesa[2], 1977). A detailed description of these and other units are presented below under Site Geology.

3.1.1.3 Site Geology - Platforms

(1) Geologic Setting and Bathymetry

The Platform sites are located on the southern margin of the San Pedro shelf in water depths of 250 to 270 feet (76 to 82 m) and on the mid-basinal slope at a water depth of about 700 feet (213 m)(Figure 3.1-6). At the shallow water sites, the seafloor is featureless and slopes at less than one degree southeasterly, whereas at the deep water site the basin slopes uniformly at three to four degrees to the southeast. Both areas are bounded on the east by the San Gabriel submarine canyon, cut during late Pleistocene-early Holocene time, but now inactive and filling with sediments (Mesa[2], 1977).

A broad topographic bulge, or unwarp, and shallow seafloor gullies, apparently associated with the Palos Verdes fault zone, are present about 2,500 feet (760 m) southwesterly of the shallow water sites (Figure 3.1-6). The deep-water site is located topographically below and about 500 feet (150 m) east of the topographic bulge.

The near surface stratigraphy and structure were interpreted and presented in a report by Mesa[2] (1977). Geologic interpretation was based on a detailed geologic and geophysical survey of the site area and three soil borings. The surveyed data, collected in 1976-1977, covered 8.4 square miles (21.7 km^2), and profiling consisted of precision bathymetry, high resolution seismic profiling (SONIA), mini-sparker (UNIBOOM), sparker, side-scanning sonar, and magnetics. Borings 261-1 and 261-2 were drilled about 400 feet (122 m) easterly of the production platform site. Borehole 262-1 was located at a water depth of 542 feet (165 m), about 3,500 feet (1060 m) northerly of the deep-water platform site. Subsequently, five additional soil borings (261-3 through 261-7) were drilled in the immediate area of the shallow-water platform sites (Woodward-Clyde Consultants, 1978). Borehole locations and depths drilled below mudline are shown on Figure 3.1-6.

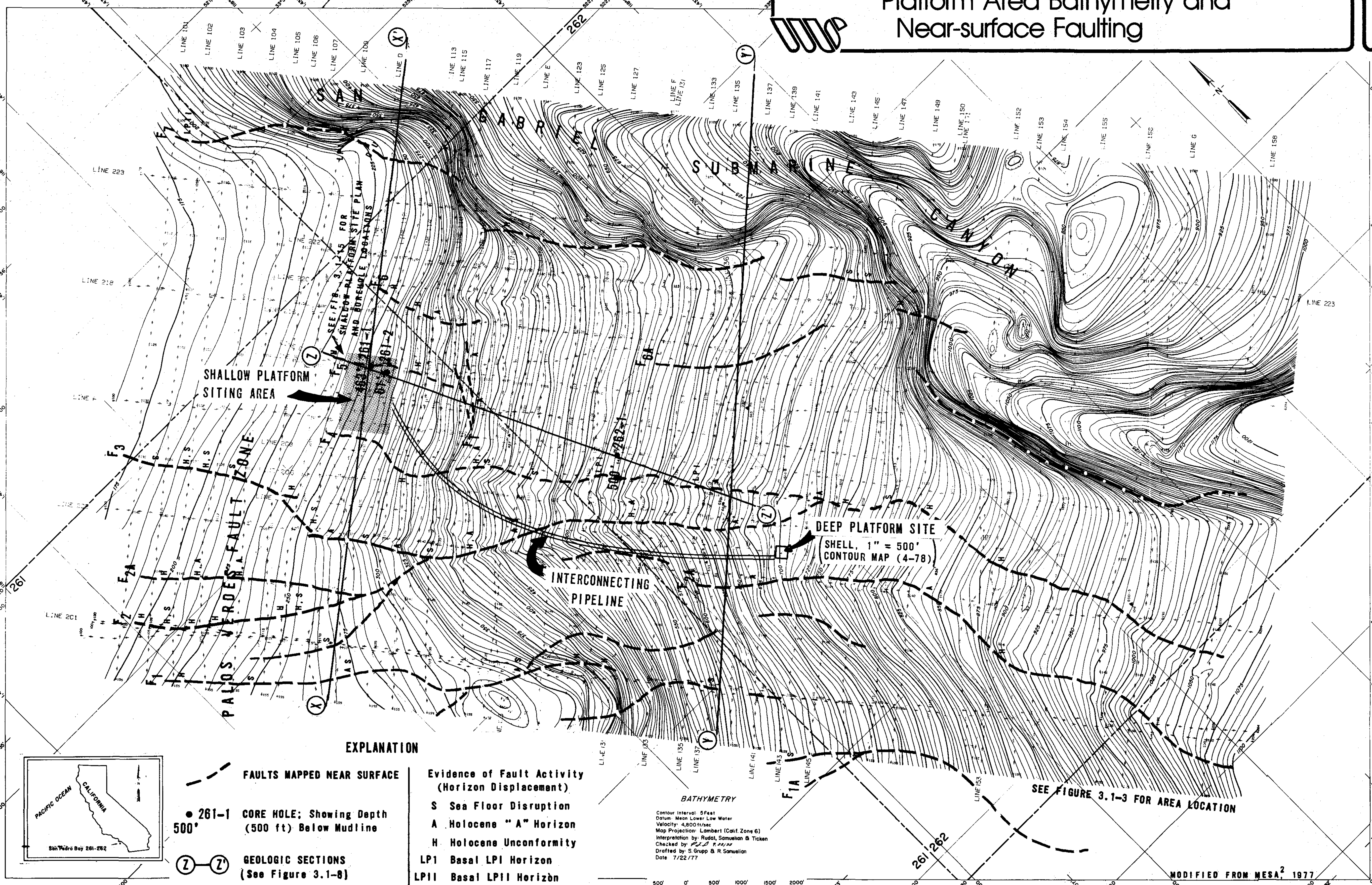
(2) <u>Structural Features</u>

Upper Miocene and Pliocene strata at the margin of the Wilmington Graben are upwarped along the Palos Verdes fault zone to form structural closure for oil and gas accumulations (Figure 3.1-7) (Shell, 1977). A main branch of the fault zone truncates the anticline on the southwest, and other secondary faults with small displacements divide the fold into several blocks. The two deep faults shown on Figure 3.1-7, interpreted from geophysical data, appear to correlate with near surface faults identified on shallow high-resolution seismic profiles (Figure 3.1-6). The detailed site area studies (Mesa[2], 1977) identify a series of northwest-trending *en echelon* to braided fault traces spaced about 500 to 2,000 feet (150-600 m) apart. These faults are designated F_1 through F_7 (Figure 3.1-6). The fault traces west of and including F_4 form the Palos Verdes fault zone, which extends beyond the detailed surveyed area. These fault traces show evidence of high angle reverse displacements (west block up) of up to 75 feet (22 m). The *en echelon* surface pattern suggests a component of strike slip movement as well.

Recent Holocene displacements are indicated on high resolution shallow profiles across each fault in the Palos Verdes fault zone (Figure 3.1-8). Faults in this zone also show evidence of seafloor disruption, and F_{2A}, F_3 and F_4 surface traces closely follow seafloor gullies. In addition, recent tectonic movements are suggested by a broad bowing of the seafloor west of Faults F_3 and F_{2A} (Figure 3.1-6). Boring and geophysical correlations interpreted by Mesa[2] (1977) show that near-surface, late Pleistocene strata east of Faults F_3 and F_4 dip uniformly to the southeast. West of Faults F_4 and F_{2A}, the strata appear discontinuous and folded.

Platform Area Bathymetry and Near-surface Faulting

Figure 3.1-6



Easterly of the platform sites, a significant fault zone (F_7) follows portions of the westerly rim of the San Gabriel submarine canyon (Figure 3.1-6). Vertical displacements across the faults (east block up) are on the order of 40 to 50 feet (12 to 15 m) at the top of the Pliocene section. Greene *et al.* (1975) indicates these fault traces offset the base of the Holocene sequence. Faults F_5 and F_6 represent relatively minor displacements. Fault F_5 shows a maximum of five feet (1.5 m) of displacement across late Pliocene strata, with evidence suggesting disruption at the base of the Holocene.

(3) Stratigraphy

Exploratory oil wells in the platform site areas penetrated upper Miocene through Holocene sediments (Figure 3.1-7). Upper Miocene sands form the reservoir rocks at depths of 2,700 to 4,700 feet (about 813-1433 m) subsea (Shell, 1977). The Miocene section is overlain by a Pliocene sequence that thickens from about 1,000 feet (300 m) beneath the platform sites to over 2,000 feet (600 m) to the east. Pleistocene rocks are represented predominantly by marine late Pleistocene clastic sediments reported to be 1,000 to 1,200 feet (300 to 365 m) thick (Vedder *et al.*, 1974). About half of this section was penetrated by the site core holes (Figure 3.1-8). The site core holes encountered from 30 to 55 feet (9 to 17 m) of nearly flat-lying, marine Holocene sediments which unconformably overly the late Pleistocene deposits.

A generalized, late Quaternary stratigraphic section has been established for the sites based on siting area core holes shown on Figure 3.1-6 and interpretations of seismic reflection data (Mesa[2], 1977). The generalized late Pleistocene (LP) and Holocene units are shown in profile on Figure 3.1-8 and are described in Table 3.1-2. The major late Pleistocene units are defined by unconformities and are designated LP-IV to I, from oldest to most recent. A tentative time scale for the stratigraphic divisions, constructed using microfossils and paleobathymetry (Mesa[2], 1977), is also shown on Table 3.1-2.

The shallow stratigraphy of the shelf platform and shelf slope differ somewhat. As shown diagrammatically on Figure 3.1-8, Unit LP-I was not encountered beneath the shallow-water sites, but is present in borehole 262-1 along the lower slope. The Holocene LP-I interval is continuous along the shelf slope, but on the shelf, Holocene materials unconformably overlie late Pleistocene (LP-I) channel deposits (Mesa[2], 1977). Each of the shallow-water site boreholes encountered sand and gravel deposits which do not continue downslope to boreholes 262-1 (Figure 3.1-8). Interpretation of seismic profiles indicates that the sand and conglomerates are channel-fill deposits. These relatively coarse-grained subunits occur within the LP-III Unit and the base and top of the LP-II interval.

Five additional boreholes (262-3 through 261-7) were drilled by Woodward-Clyde (1977) at the shallow platform sites.

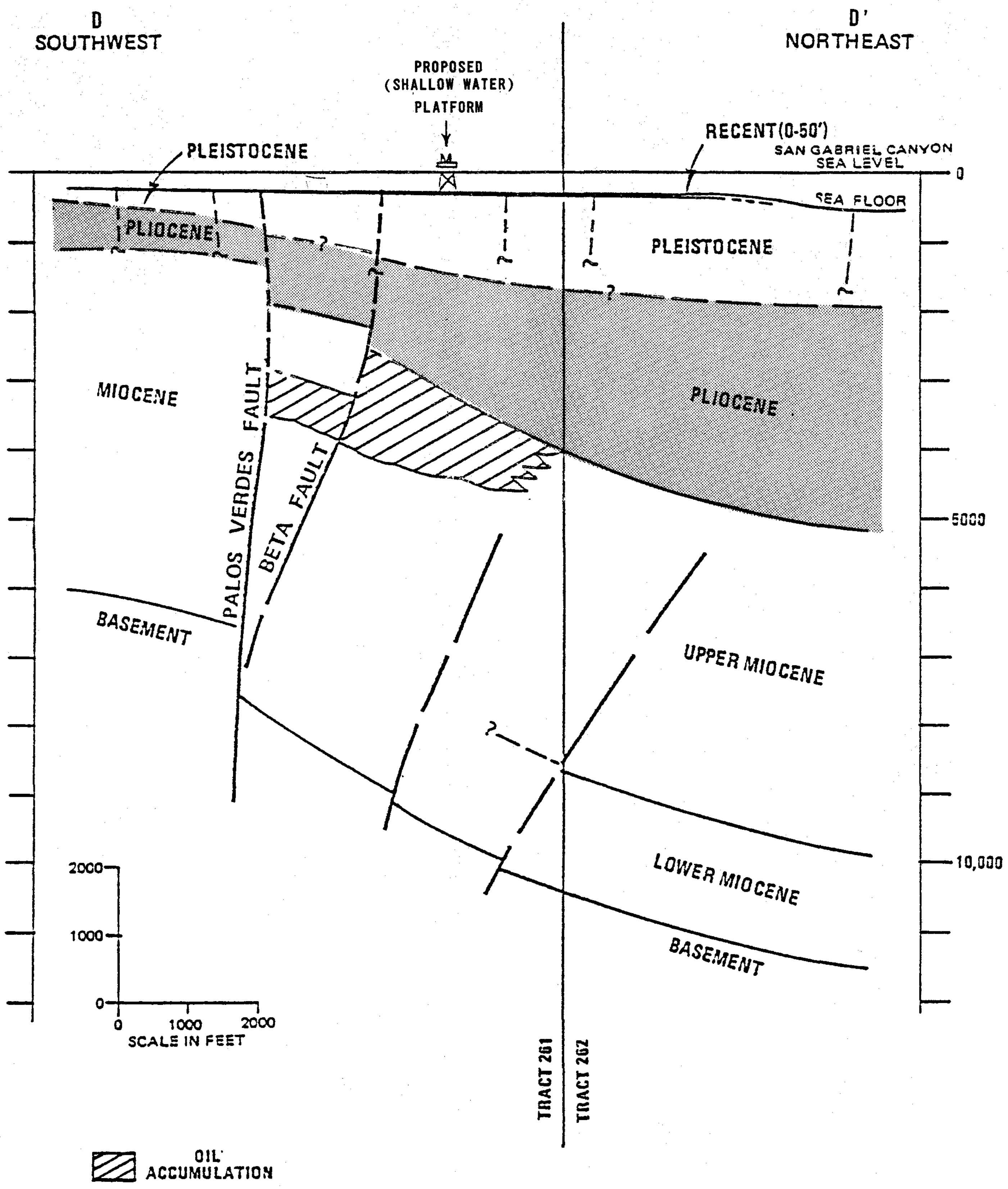
TABLE 3.1-2

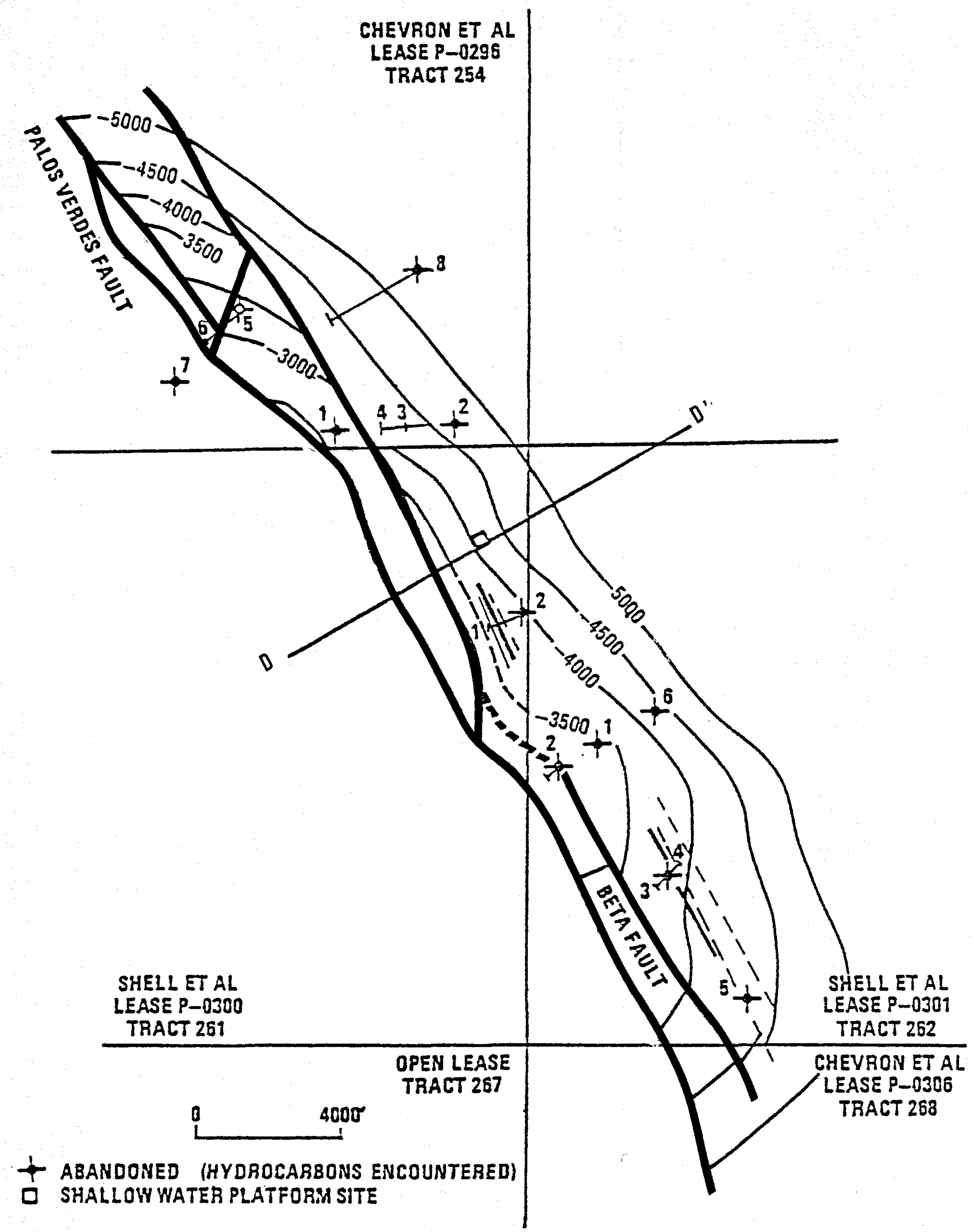
GENERALIZED QUATERNARY STRATIGRAPHIC SECTION, PLATFORM SITING AREA (MODIFIED FROM WOODWARD CLYDE CONSULTANTS, 1977)

Stratum Designation	Depth Below Seafloor ft (m)	Generalized Quaternary Unit (Mesa[2] 1977)	Soil Description
A	0-12 (0-3.5)	Holocene	Loose SANDY SILT to CLAYEY SILT (ML)
B	12-30 (3.5-9)		Medium-stiff SILTY CLAY (CL)
C_1	30-50 (9-15)		Dense SILTY SAND and SAND (SP-SM)
C_2	50-70 (15-21)	Late Pleistocene II	Dense GRAVELLY SAND to SANDY GRAVEL (SP,SM,GP)
C_3	70-100 (21-30)		Dense SILTY SAND (SM)
D_1	100-210 (30-64)		Stiff-to-very-stiff SILTY CLAY to CLAYEY SILT (CL-ML); SANDY below 170 ft in some areas
D_2	210-250 (64-75)	Late Pleistocene III	Dense SILTY SAND, SANDY SILT to CLAYEY SILT, and some GRAVELLY SAND (ML,SM,GP)
D_3	250-400+ (75-120)		Stiff-to-very-stiff SILTY CLAY to CLAYEY SILT (CL-ML) with CLAY (CH) layers.

Platform Area Structure Contours (Upper Miocene Layer) and Deep Geologic Section

Figure 3.1-7

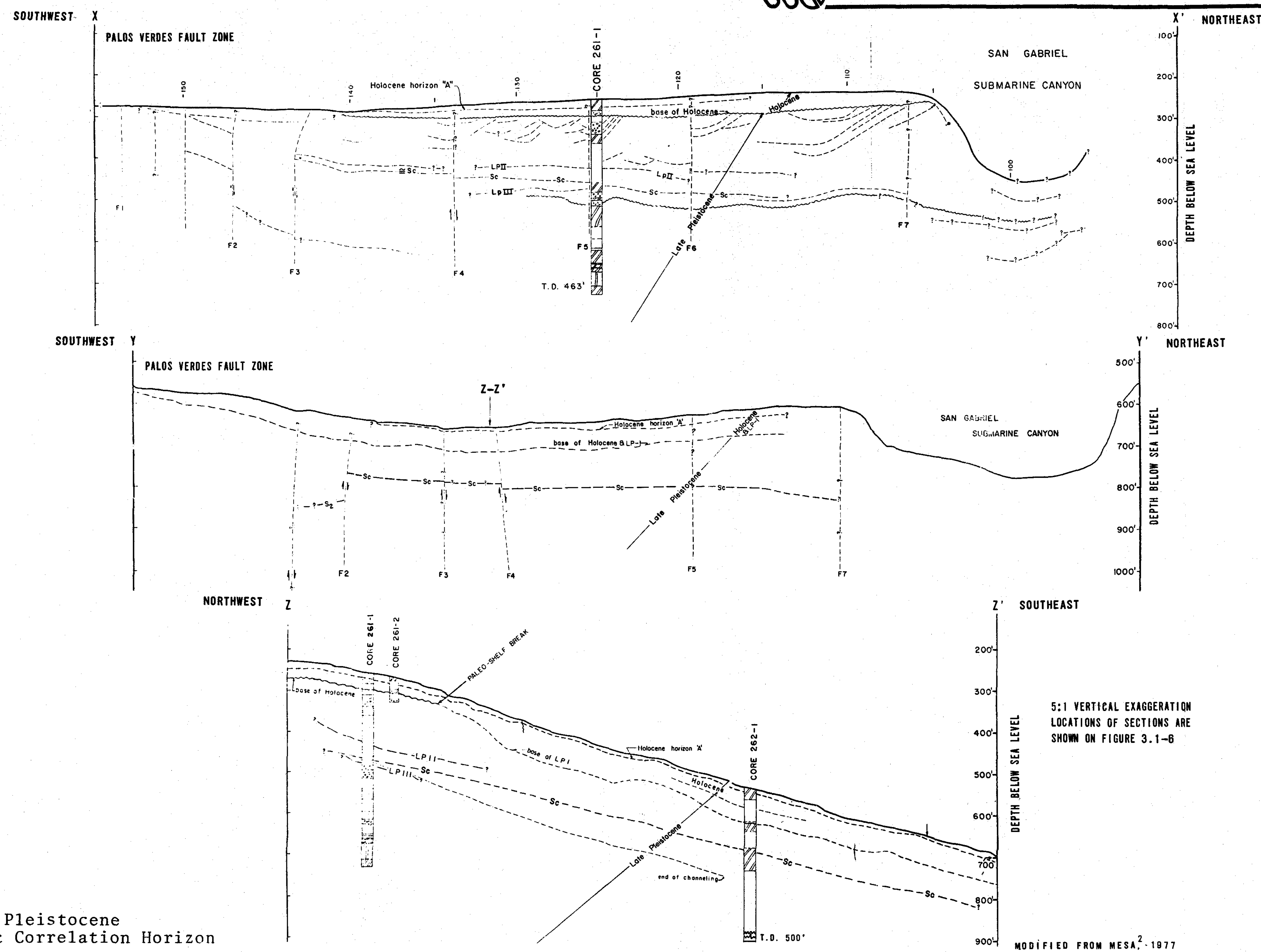




MODIFIED FROM SHELL, 1977

Platform Area Shallow Geologic Sections

Figure 3.1-8



L.P. = Late Pleistocene
Sc = Seismic Correlation Horizon

Their location relative to the proposed platforms are shown on Figure 3.1-9. The soil types encountered in these boreholes generally agree with the Quaternary stratigraphic section developed by Mesa[2] (1977) (Table 3.1-2), based on boreholes 261-1, 261-2, and 262-1.

(4) <u>Surficial Features</u>

The delineation of microtopography and surficial features in the platform siting areas was performed by Mesa[2] (1977) by interpretation of side-scan sonar, shallow high resolution (SONIA), and UNIBOOM profiling. Anomalous, shallow subbottom features and topographic irregularities are shown in Figure 3.1-9. These features are discussed, from west to east. Anomalous seafloor features occur west of Fault F_4 within the Palos Verdes fault zone. Most of the surface traces of Faults F_4, F_3 and F_{2A} are coincident with seafloor gullies. A broad bowing of the seafloor occurs west of Faults F_3 and F_2A. In addition, several irregular surface patterns and near-surface anomalies were identified within the fault zone.

The most extensive irregular topographic pattern within the fault zone trends northwestward along the western margin of the siting area (Figure 3.1-9). These seafloor irregularities, in part, reflect bedrock exposures or the presence of near-surface hard rock. Several discontinuous linear trends were also noted within this area.

An elongate area between 300 and 475 feet (91-145 m) water depth along Fault F_3 was identified as a disturbed area. It probably contains submarine sliding and fault disruptions.

East of the Palos Verdes fault zone and Fault F_4, several anomalous seafloor features were identified. The most significant feature in proximity to the shallow water platform sites (approximately 1000 ft - 300 m) is a disturbed area with topographic expression between the 300 and 425 feet (91-130 m) isobaths (Figure 3.1-9). Seismic profiles indicate disrupted Holocene and latest Pleistocene reflectors. This disturbed area is believed to contain Holocene deposits which are unstable due to creep, minor slumping, and possibly transverse faulting (Mesa[2], 1977).

A detailed review of portions of the San Gabriel submarine canyon was performed by Mesa[2] (1977) to assess slope stability. A shallow slump block was identified in the canyon; however, no unequivocal evidence of slumping or sliding was found.

(5) <u>Oil and Gas Seeps</u>

Hydrocarbon seeps are numerous along the Santa Barbara Channel and the Santa Monica shelf northwesterly of the Palos Verdes Peninsula. Oil and gas seeps in southern Santa Monica

Bay occur along the probable northerly extension of the Palos Verdes fault (OTC, 1977), and offshore of Palos Verdes Peninsula (Wilkinson, 1972; Greene *et al.*, 1975). These seeps have been estimated to produce 12 to 15 barrels of oil per day and an undetermined amount of gas (Wilkinson, 1972).

In the San Pedro shelf area, two oil seeps and one gas seep were reported by Wilkinson (1972) between Point Vicente and Point Fermin. Green *et al.* (1975) show several additional areas of possible oil and gas seeps, interpreted from seismic relfection profiles, in the same area. One gas seep is known along Huntington Beach (Wilkinson, 1972). All of these reported occurrences are shown on Figure 3.1-3.

Hydrocarbon seeps in the platform siting area were identified using fathometer, water column bubble detector, side-scan sonar records, and high-resolution profiles (Mesa[2], 1977). Based on the relative strength of this supportive data, seeps were classified by Mesa[2] (1977) as definite, probable, and questionable, according to the following criteria:

Rank	Criteria
1	Seep definite or highly probable as based upon at least two separate types of records (e.g., sonography plume-like signals and high-resolution profile data);
2	Seep probable - typical signal response on at least one record, in many cases with less definite signal response from a second system; and
3	Seep questionable - extremely doubtful - generally single data source with atypical seep signal.

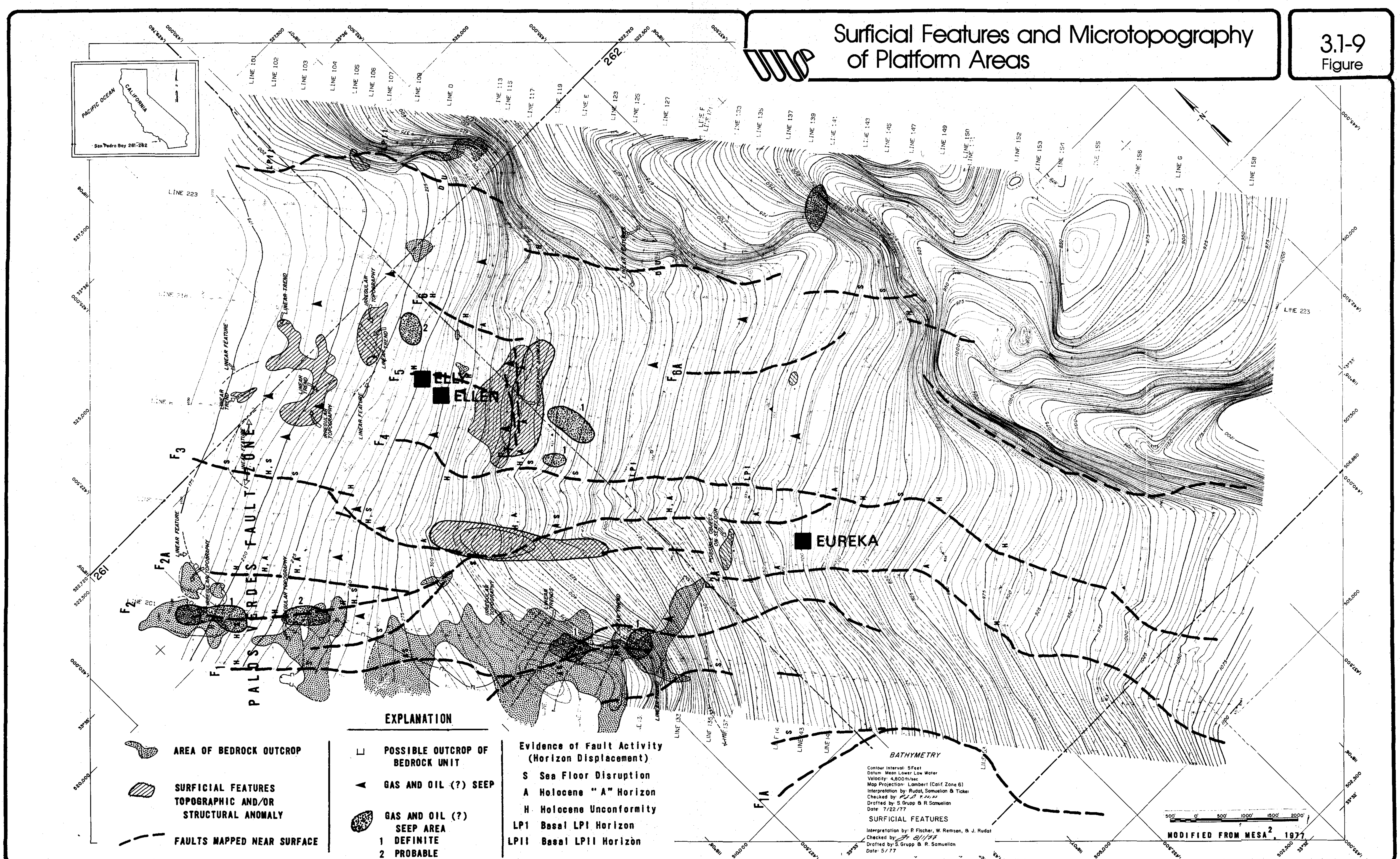
The seep locations identified by this study by Mesa[2] (1977) are shown plotted on Figure 3.1-9.

3.1.1.4 Geology of Pipeline Routes

(1) Long Beach Route - Offshore Geology

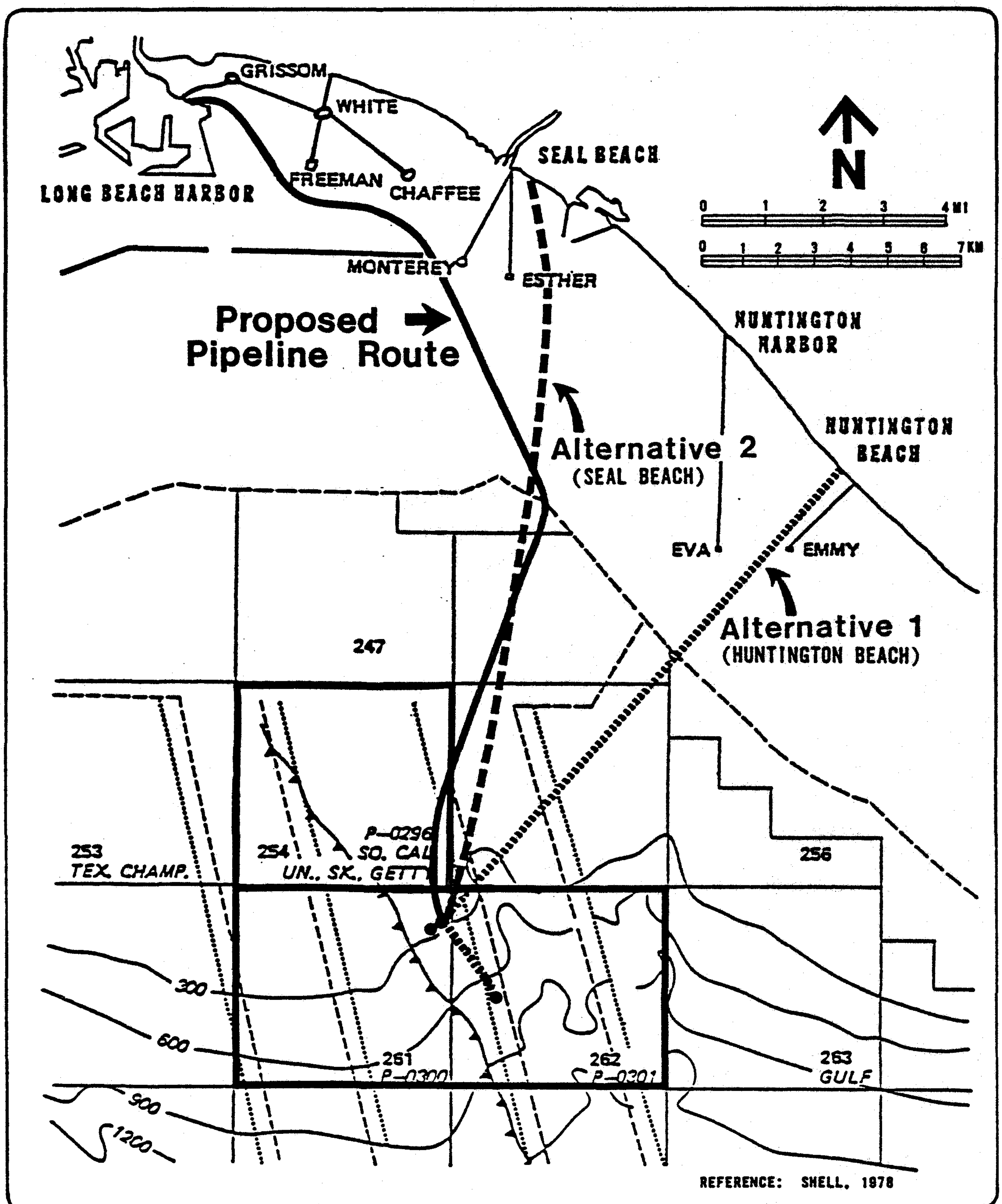
- Geologic Setting and Bathymetry

The subsea portion of the pipeline route to Long Beach is approximately 17 miles (27 km) long, and extends from the shallow-water platforms at the San Pedro slope, across the San Pedro Shelf, to the upper edge of the San Pedro slope (Figure 3.1-10). Landfall is planned on Pier J near the Queen Mary. Water depths



Surficial Features and Microtopography of Platform Areas

Figure 3.1-9



Alternative Pipeline Routes

Figure 3.1-10

range from 18 to 270 feet (5.5 to 82 m). The overall slope of the seafloor within the pipeline corridor is southerly with slopes ranging from 0.15 degrees to 3 degrees. The seafloor is relatively featureless, with some depressions noted in the Long Beach Harbor (Dames and Moore, 1977b).

Mesa[2] (1977) interpreted detailed survey data on the shallow structure and stratigraphy of the Palos Verdes fault zone in the vicinity of the pipeline route, and two geophysical surveys were performed along the pipeline routes by Dames and Moore (1977a, b). The major structural geologic features along the pipeline route are the Palos Verdes fault zone, the Wilmington Graben, the "unnamed fault zone" (Junger and Wagner, 1977), and the Wilmington Anticline (Figure 3.1-11).

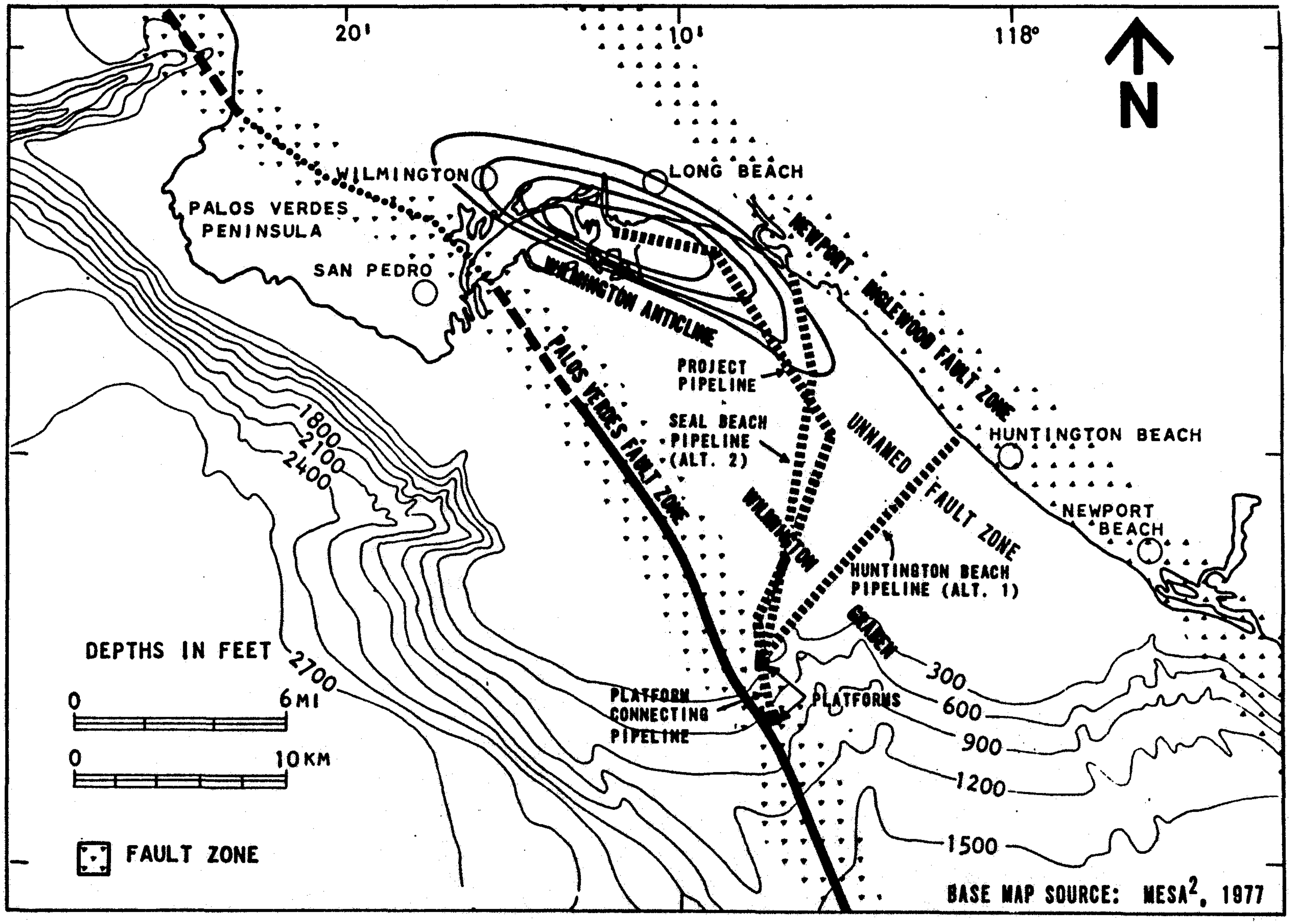
- <u>Structure and Stratigraphy</u>

Several shallow structural geologic features occur along the Long Beach pipeline route (Figures 3.1-12 and 3.1-13). One feature noted near the center of the Long Beach outer harbor (F_C), although indistinct, may be related to faulting and the underlying Wilmington Anticline. Deeply incised channels and two distinct fault displacements with possible Holocene offsets (F_A and F_B) were also encountered and are shown on Figure 3.1-12.

The most significant structural feature which crosses this pipeline route is the "unnamed fault zone," which has Holocene displacement as described by Junger and Wagner (1977) (Figure 3.1-11). Faults F_A and F_B may represent features within this zone (Figure 3.1-12). Although faults within this zone reportedly offset the base of the Holocene section (Greene *et al.*, 1975), no evidence of seafloor disruption was reported where faults F_A and F_B cross the pipeline alignment, or at any other location along the route.

Other faults with probable Holocene offsets are present near the pipeline route but do not appear to cross it. Four of the faults reported by Mesa[2] (1977), (Faults F_4, F_5, F_6, and F_7) closely parallel or project towards the pipeline route near the platform sites in the vicinity of Turn 1 (Figure 3.1-12).

Exploratory oil well data and foundation investigations indicate the stratigraphy beneath the pipeline route is similar to that below the platform site areas (Figure 3.1-4 and 3.1-5). Overlying Jurassic(?) basement rock are the upper Miocene Puente Formation, lower Pliocene Repetto Formation, and upper Pliocene Pico Formation. These formations contain an average of about 7,000 feet (2100 m) of porous sand with thin interbeds of siltstone and shale. Overlying the Pico Formation are the lower Pleistocene San Pedro Formation and upper Pleistocene Palos Verdes Sand units (Figure 3.1-7). The San Pedro Formation is about 450 feet (135 m) thick and consists chiefly of poorly bedded, brown, silty sand and gravel deposits. The Palos Verdes sand is approximately 250 feet (75 m) thick and consists mainly of non-marine



Major Geologic Features Along Pipeline

3.1-11
Figure

clastic deposits. The overlying Holocene sediments are shallow water deposits with percentages of gravel and channel deposits increasing oceanward. Inside the harbor, dredge fill has been placed or removed in several areas along the pipeline alignment.

- Surficial Features and Hydrocarbon Seeps/ Accumulations

The delineation of microtopography and surficial features along the pipeline route was performed by interpretation of side-scan sonar, fathometer and shallow high-resolution UNIBOOM profiling (Dames and Moore, 1977b). Anomalous, shallow subbottom features and topographic irregularities are shown in Figures 3.1-12 and 3.1-13.

A number of small-scale features were observed on the seafloor along the pipeline route. These features include sand ripples, apparent anchor drag marks, possible buried pipelines, and various small-scale irregularities.

Areas of sand ripples were observed within the survey route from a point off the east end of the Long Beach breakwater southeasterly for about 20,000 feet (6100 m)(Figure 3.1-13). The ripples are oriented (axis of crest) approximately northwest-southeast, and have approximate amplitudes and wave lengths of less than 1 and 3 feet (30 and 90 centimeters), respectively. The soil sampling survey (Dames and Moore, 1977a) revealed a basic substrata of organic clayey or sandy silt in the area. These data, plus the patchy nature of the ripples, suggest they may represent mobile areas of sand on top of a less erodible, more cohesive soil unit, rather than the rippled surface of a large sandy deposit.

Apparent anchor drag marks were visible on the seafloor in several areas. Numerous drag marks observed at the seaward end of the route near Turn 1 (Figure 3.1-13) are probably due to anchors of drilling equipment recently used on the site. Other small drag marks around Island Chaffee in Long Beach Harbor are probably due to anchoring vessels.

Linear features, showing evidences of subsurface excavations, were observed in the area of Island Chaffee and other man-made islands in the Long Beach Harbor. These features correspond to designated pipelines connecting the islands in the harbor.

Several areas of small-scale, irregular, seafloor anomalies were observed. These disturbed bottom areas or unidentifiable bottom targets appear to be due, at least in part, to recent human activities. Each of these targets represents objects on the seafloor which seem incongruous with the surrounding sedimentary and bathymetric environment. These include unidentifiable seafloor debris, isolated magnetic anomalies, and possible water column gas plumes. These disturbed bottom areas and unidentifiable targets are delineated on Figure 3.1-12 and 3.1-13.

Surficial Features — Long Beach Offshore Pipeline Route - A

Figure 3.1-12

EXPLANATION

PIPELINE ROUTE HARBOR "A" AS SELECTED BY SHELL OIL CO. 3/31/78
PIPELINE ROUTE HARBOR "B" AS PROPOSED BY THE CALIFORNIA STATE LANDS COMMISSION

EXISTING THUMS PIPELINES

F_B NEAR SURFACE FAULTING (FAULTS F_A AND F_B MAY REPRESENT THE UNNAMED FAULT ZONE OF JUNGER AND WAGNER, 1977)

U290 / D320 POSSIBLE FAULTING–INDICATED ON ONLY ONE SURVEY LINE ORIENTATION OF FAULT PLANE NOT DETERMINED. FAULT SEGMENT PLOTTED NORMAL TO TRACK LINES NUMBERS ARE DEPTHS IN FEET BELOW THE SEAFLOOR DISPLACEMENT AS INDICATED U-UP, D-DOWN.

80 / 60 SHALLOW BURIED CHANNEL: APPROXIMATE LIMITS CHANNEL DEPTHS AS INDICATED (TIC MARKS POINT TOWARDS CHANNEL AXIS)

DEEP BURIED CHANNEL: APPROXIMATE LIMITS

—18→ CHANNEL BURIED AXIS: AXIAL DEPTH AS INDICATED, ARROW INDICATES FLOW DIRECTION ALONG CHANNEL AXIS

AREA OF SHALLOW ACOUSTIC REFLECTION DISRUPTION -POSSIBLY DUE TO GAS ACCUMULATION

ZONE OF DEEP ACOUSTICAL REFLECTOR DISRUPTION -POSSIBLY DUE TO GAS ACCUMULATION

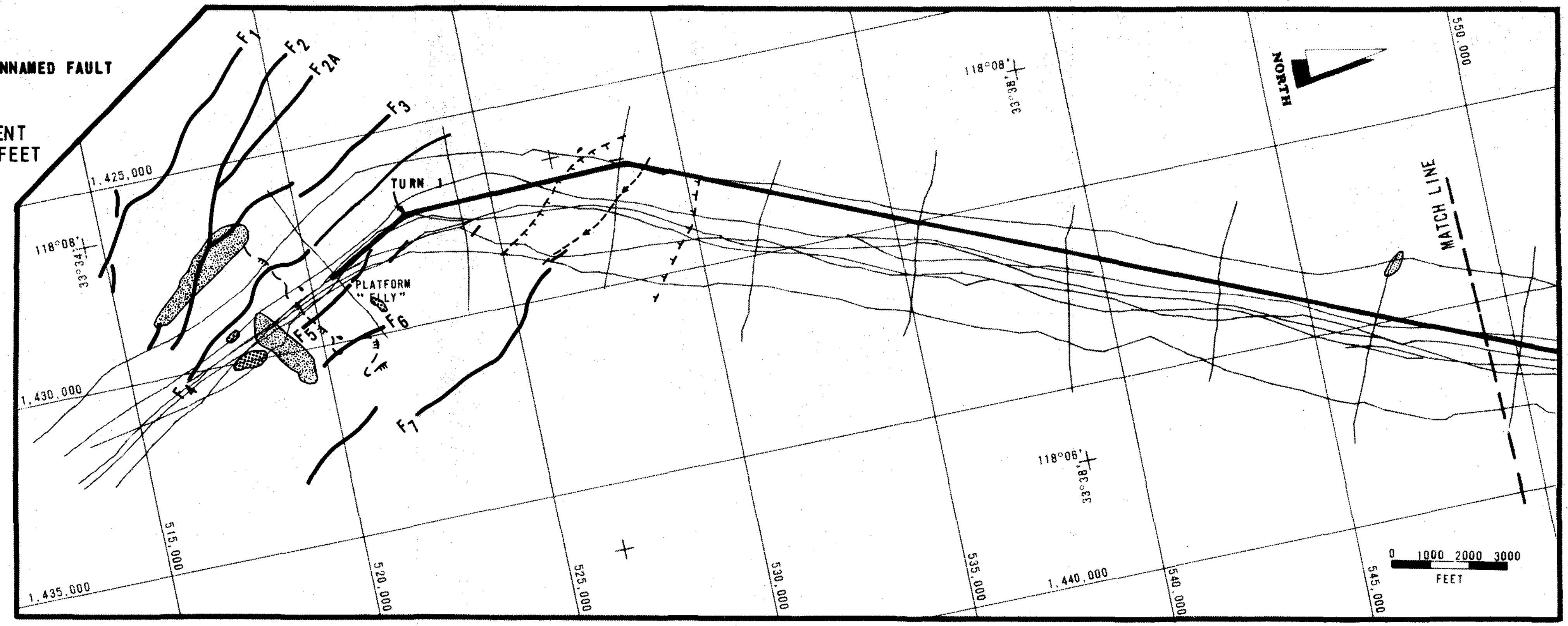
GAS PLUME–FROM SIDE SCAN SONAR

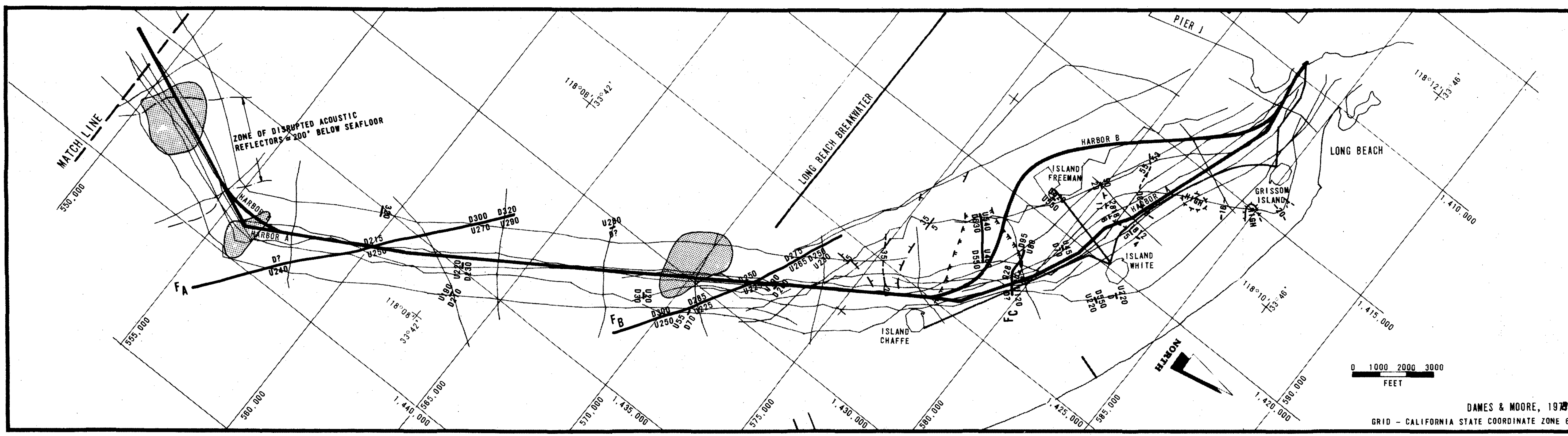
PALEO-SHELF BREAK

DISTURBED STRATA

GAS SEEP LOCATION

NOTES: FAULTS F_1 TO F_7 FROM MESA[2], 1977. FAULTS F_1 TO F_4 ARE CONSIDERED TO BE SPLAYS OF PALOS VERDES FAULT ZONE





Surficial Features — Long Beach Offshore Pipeline Route - B

3.1-13
Figure

EXPLANATION

PIPELINE ROUTE HARBOR " A" AS SELECTED BY SHELL OIL CO. 3/31/78
PIPELINE ROUTE HARBOR " B" AS PROPOSED BY THE CALIFORNIA STATE LANDS COMMISSION

EXISTING THUMS PIPELINES

SIDE SCAN SONAR

POSSIBLE GAS PLUME

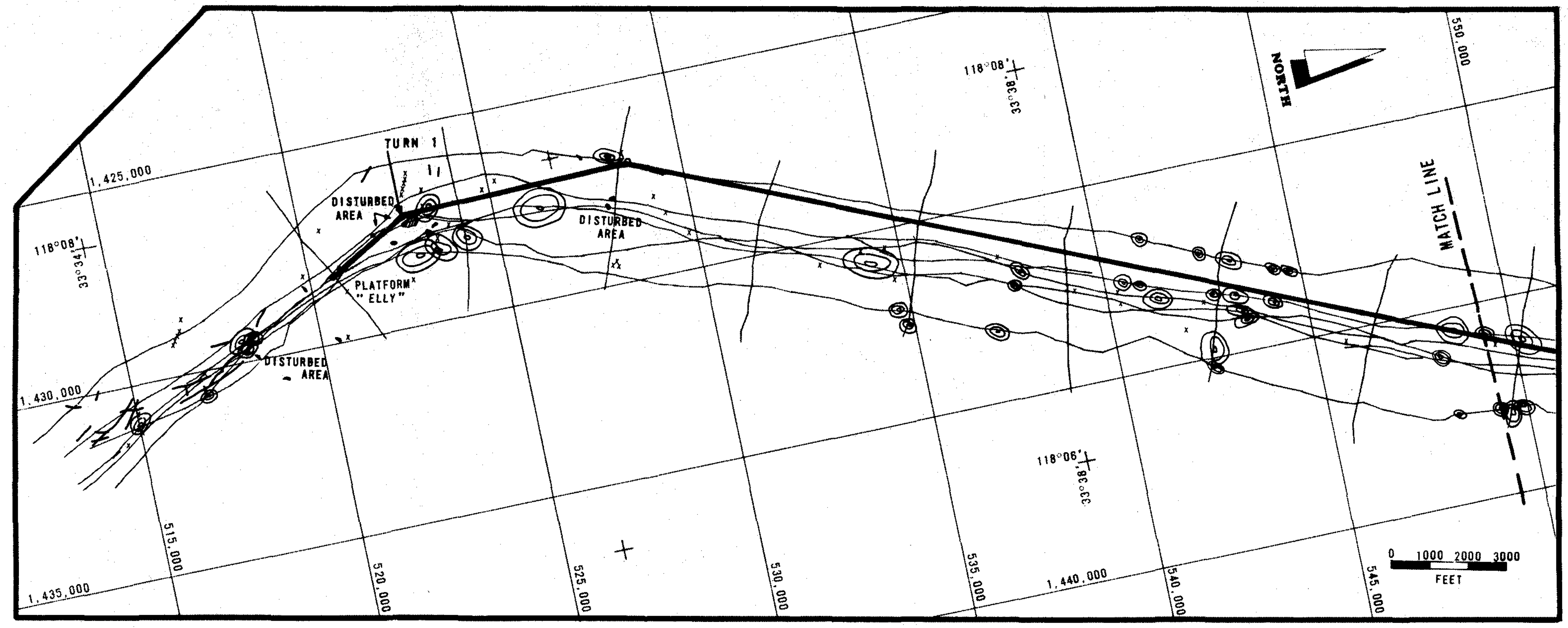
UNIDENTIFIED TARGET

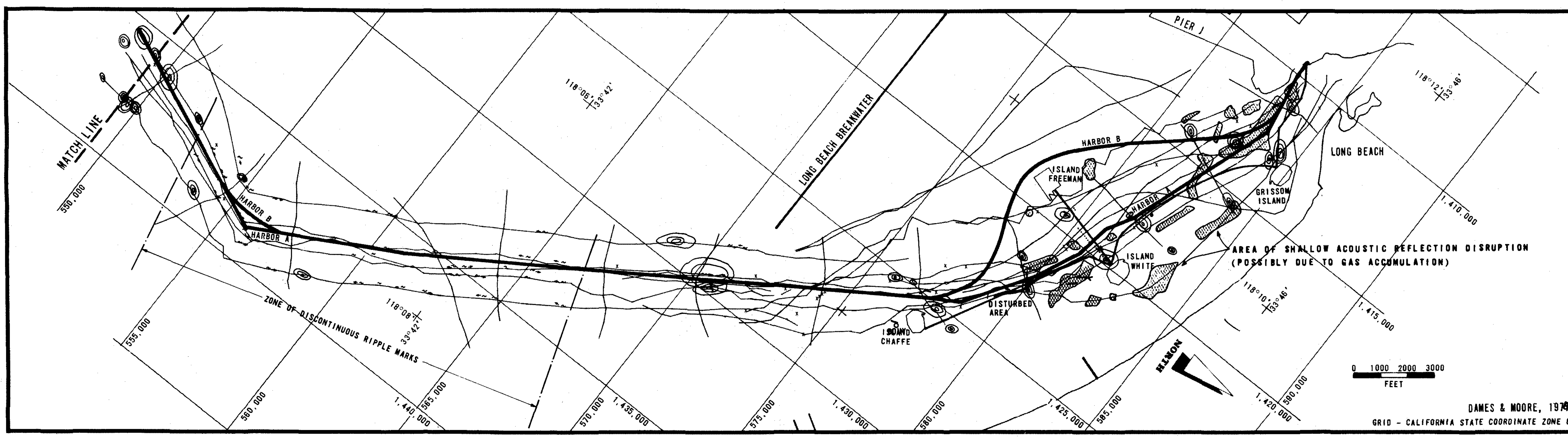
RIPPLE MARKS DISCONTINUOUS, OCCUR ALONG SURVEY LINES BETWEEN ARROWS (→)

DRAG MARKS

MAGNETOMETER

MAGNETIC ANOMALY (ONE CONTOUR = 10 MILLIGAMMAS)





Evidence for gas-charged sediments was examined by Dames and Moore (1977b). The recognition of possible gas in the subsurface was based upon:

a. apparent depression or disruption of subsurface reflectors (due to local, reduced acoustic velocity related to the presence of gas in the sediments);

b. acoustically-opaque zones adjacent to otherwise reflective subsurfaces (due to total signal attenuation by gas); and

c. water column gas plumes.

At several locations near the seaward end of the survey corridor, possible water column gas plumes were observed (Figure 3.1-13). With the exception of obvious water column gas plumes, the above are not definitive evidence of gas. However, in combination, and where correlatable with known structure, they may be indicative of gas in the subsurface. The gas plumes identified cannot be associated with any specific fault.

Areas of disrupted reflectors, which could indicate subsurface gas occur at about the midpoint of the route and within the harbor area (Figures 3.1-12 and 3.1-13). The deeper-water area lies in the vicinity of the eastern edge of the Wilmington Graben of Junger and Wagner (1977). However, no gas plumes were observed in this area.

(2) Long Beach Route (Project) - Onshore

- Geologic Setting

The onshore portion of the Long Beach pipeline route starts at Pier J near the Queen Mary and parallels the THUMS lines to the THUMS distribution manifold about two miles (3.2 km) inland (Figure 3.1-14). The route is essentially flat, with an average elevation of 20± feet (6± m). The offshore and onshore pipeline route is near the Wilmington anticline and is bounded by the Palos Verdes fault zone on the west and the Newport-Inglewood fault zone to the east (Figure 3.1-11).

No major faulting or structures are indicated along the onshore route, however minor faulting may be present at depth. Stratigraphy of the onshore pipeline route is similar to the offshore portion (see Section 3.1.1.4 (1)) with the upper ±50 feet (±15 m) recent dredge fill.

- Surficial Features and Hydrocarbon Seeps

Surficial features (roads, buildings, etc.) are shown on Figure 3.1-14. No oil or gas seeps have been reported along the onshore portion of the pipeline route.

(3) Huntington Beach Route (Alternative 1) - Offshore

- Geologic Setting and Bathymetry

The alternative pipeline route to Huntington Beach is approximately nine miles (14.5 km) long and is the shortest distance to shore (Figure 3.1-10). Landfall will be near the foot of the bluff immediately west of Huntington Beach city limits. The offshore portion of the pipeline extends from the shoreline in Huntington Beach, across the San Pedro Shelf, to the upper edge of the San Pedro slope (Figure 3.1-11). Water depths range from 0 to 270 feet (0 to 82 m). The overall slope is southerly, from 1 to 2 degrees. The seafloor is relatively featureless with some isolated outcrops, debris, and buried channels.

The major structural features crossed by the pipeline alignment are the Wilmington Graben and the "unnamed fault zone" (Junger and Wagner, 1977) (Figure 3.1-11). These structures are described in the Long Beach Route (Section 3.1.1.4 (1)). The route is bounded by the Palos Verdes fault on the west and the Newport-Inglewood fault zone on the east.

- Structure and Stratigraphy

The Huntington Beach pipeline route crosses Fault F_7 indicated by Mesa[2], (1977)(Figure 3.1-6) and possible extensions of faults found near turn 1 (Figure 3.1-12) in the Long Beach pipeline route survey. The pipeline route crosses the Wilmington Graben and the "unnamed fault zone" (Figure 3.1-11). The stratigraphy is essentially the same as that along the Long Beach route (Section 3.1.1.4(1)) except recent dredge fill is absent.

- Surficial Features and Hydrocarbon Seeps

Huntington Beach route surface features are schematically shown on Figure 3.1-15. Along the route several ridges and possible bedrock outcrops are indicated. Several small channels, trash, and debris are also delineated. Gas seeps are not shown along this survey route.

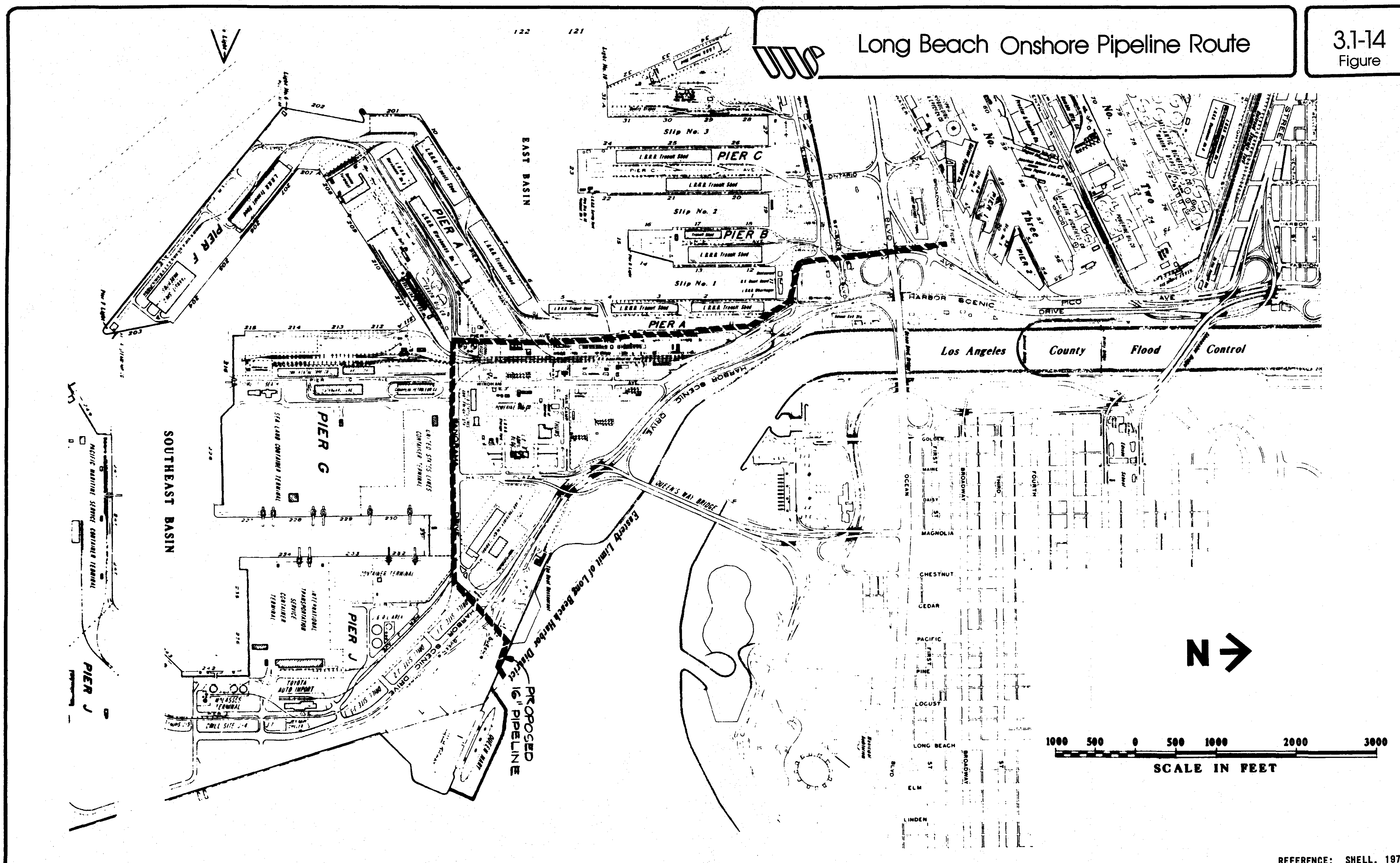
More detailed survey work is necessary to determine the presence or absence of oil and gas seeps along this route, if it is selected, as well as to more accurately locate all surficial features.

(4) Huntington Beach Route (Alternative 1) - Onshore

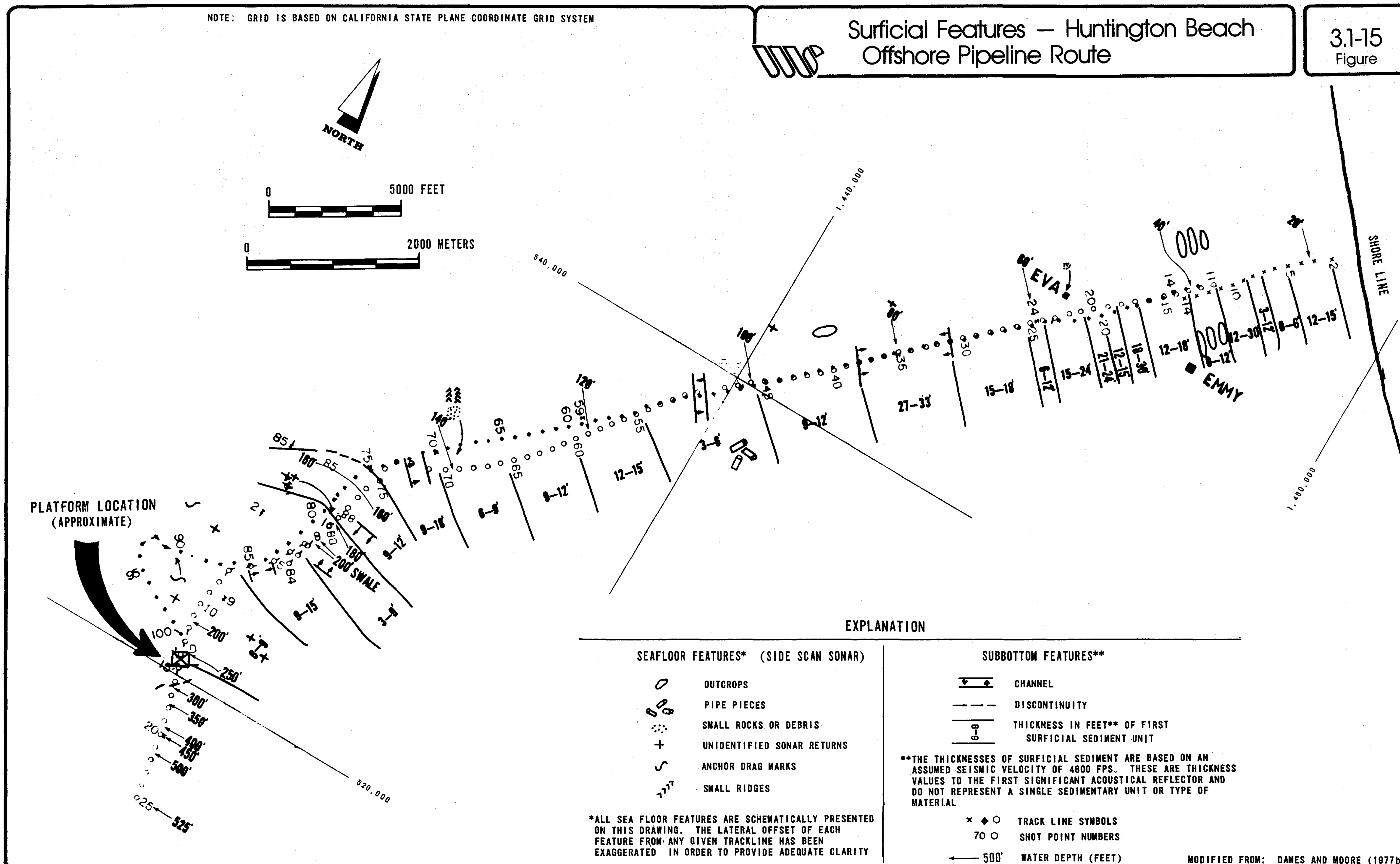
The onshore route is not known at this time.

Figure 3.1-14

Long Beach Onshore Pipeline Route



REFERENCE: SHELL, 1978



Surficial Features — Huntington Beach Offshore Pipeline Route

Figure 3.1-15

(5) Seal Beach Route (Alternative 2) - Offshore

- Geologic Setting and Bathymetry

The subsea portion of the Seal Beach pipeline route is slightly more than 11 miles (17.7 km) long (Figure 3.1-10). The Seal Beach route roughly follows the Long Beach route from the platforms to within about 2.5 miles (4 km) from shore, and makes landfall near Seal Beach (Figure 3.1-11). Water depths range from 0 to 260 feet (0-79 m). No geophysical or bathymetric work has been performed specifically for this proposed alternate route. The geologic setting and bathymetry are believed to be generally similar to the Long Beach Route (Section 3.1.1.4(1)). The Newport-Inglewood fault zone is 0.5 miles (0.8 km) easterly of landfall at Seal Beach (Figure 3.1-11).

- Structure and Stratigraphy

Geologic structure and stratigraphy along the Seal Beach route are expected to be similar to that encountered along the Long Beach route (Section 3.1.1.4(1)). Although no significant geologic structures are anticipated along the route segment that extends to Seal Beach (Figure 3.1-11), no specific studies have been performed to date to delineate structures and stratigraphy.

- Surficial Features and Hydrocarbon Seeps

To date, no geophysical work has been performed specifically along this route to delineate surficial features and hydrocarbon seeps.

(6) Seal Beach Pipeline Route (Alternative 2) - Onshore

The onshore route of the Seal Beach Pipeline is not known at this time.

(7) Platform-Connecting Route

- Geologic Setting and Bathymetry

The platform-connecting route extends between the deep-water (700 feet or 213 m) drilling platform and the shallow-water production platform (Figure 3.1-6). Water depths for the pipeline vary from 700 to 260 feet (213 to 79 m). The pipeline will follow slightly irregular topography with several small channels (Figure 3.1-6). The deep geologic structural and stratigraphic setting for the pipeline is the same as described for the areas of the shallow- and deep-water platforms (Section 3.1.1.3).

- Surficial Features and Hydrocarbon Seeps

The platform-connecting pipeline units, from the shallow-water production platform site to the 700 feet (213 m) depth, crosses faults F_4, F_3, and closely parallels a short undesignated fault between about 500 to 560 feet (152 to 170 m) water depth (Figure 3.1-6). The area survey between the platform sites indicated an unidentified object on the seafloor between a water depth of 600 to 625 feet (183 to 190 m). No hydrocarbon seeps have been identified along this pipeline route.

3.1.1.5 Soils

(1) Platform Sites

Soil conditions at the platform sites were investigated by drilling eight boreholes to depths of 264 to 560 feet (80 to 170 m) below the seafloor (Figure 3.1-15). The borehole locations were selected by Shell and drilling and testing was performed by Woodward-Clyde Consultants (1978). The water depth in the area varies between about 250 and 270 feet (76-82 m) below mean sea level. Samples indicate that soils vary from gravels and sands to silts and clays.

Three generalized soil profiles (Woodward-Clyde, 1978) were established on the basis of the boring program results. From these profiles an idealized soil profile for the site was developed. The depth below seafloor in this profile is based on an average water depth of 260 feet (79 m) (MLLW) over the site area. The idealized profile is:

Depth Below Seafloor Ft	(m)	Soil Description
0-12	(0-3.6)	Loose SANDY SILT to CLAYEY SILT (ML)
12-30	(3.6-9)	Medium-stiff SILTY CLAY (CL)
30-50	(9-15)	Dense SILTY SAND and SAND (SP-SM)
50-70	(15-21)	Dense GRAVELLY SAND to SANDY GRAVEL (SP, SM, GP)
70-100	(21-30)	Dense SILTY SAND (SM)
100-210	(30-64)	Stiff-to-very-stiff SILTY CLAY to CLAYEY SILT (CL-ML); SANDY below 170 ft in some areas
210-250	(64-76)	Dense SILTY SAND, SANDY SILT to CLAYEY SILT, and some GRAVELLY SAND (ML, SM, GP)
250-400+	(76-122+)	Stiff-to-very-stiff SILTY CLAY to CLAYEY SILT (CL-ML) with CLAY (CH) layers

The idealized soil profiles suggest that the soils beneath the site are predominantly low-to-medium plasticity silty clays and clayey silts. Two major strata of granular materials varying from silty sands and sandy silts to sandy gravels are present: one between depths of about 30 to 100 feet (9-30 m) and a second between about 210 to 250 feet (64-76 m) below the seafloor. The silts, sands, and gravels appear to have been deposited in ancient channels crossing the site.

Based on an evaluation of Boreholes 261-6 and 261-3, and 261-4 and 261-5, the general dip of soils at the site appears to follow the seafloor at generally less than three percent to the southeast.

(2) Pipelines Offshore

- Long Beach Route (Project)

Soil conditions along the entire Long Beach pipeline route were investigated by a surficial sediment sampling program (Dames and Moore, 1977b). These data, along with information from the platform drilling programs and foundation studies within the harbor, comprise the soil information for this pipeline route. The upper 20 feet (6 m) of soil along the pipeline route outside the harbor can be generalized as about 0 to 10 feet (0-3 m) of loose sandy to clayey silt (ML), and 10 to 30 feet (3-9 m) of medium stiff silty clay (CL). Sediment sampling and coring for previous pipelines within the Long Beach Harbor have indicated a general soil profile consisting of 0 to 4 feet (0-1.2 m) of black silty sand to silty clay with decayed organic matter (OL), and 4 to 20 feet (1.2-6 m) of green and gray-green silty sand to clayey silt. Dredged fill may exist in the area of the Queen Mary and Pier J.

- Huntington Beach Route (Alternate 1)

A gravity sampling program was performed along the Huntington Beach pipeline route by Dames and Moore (1977b). Eight samples were obtained along the entire route. Each sample was similar at each location. The upper 12 inches (30 cm) generally consists of dark gray-green fine sandy silt with some mica and organics. No other boring or sampling has been done along the route. Subsurface materials can be expected to be similar to those encountered in the platform area.

- Seal Beach Route (Alternate 2)

No sampling or borings have been done along this route. As the route closely parallels the Long Beach Route, similar conditions should be expected.

- Platform Connecting Route

No sampling or borings were done along this route. Soils along the route should be approximately the same as encountered in the borings for the platform sites.

(3) Pipelines Onshore

- Long Beach Route (Project)

The entire onshore portion of the pipeline will be emplaced on dredged hydraulic fill which ranges in thickness from 20 to 50 feet (6-15 m). Most of the fill material came from the bay and harbor area and consists of a heterogeneous mixture of sands, silts, clays, some organic materials, and rubble fill.

- Huntington Beach Route (Alternate 1)

The onshore route is not known at this time.

- Seal Beach Route (Alternate 2)

The onshore route is not known at this time.

3.1.2 Seismicity

The San Pedro Bay region is within the continental borderlands of southern California. These borderlands comprise an extensive series of northwest-trending faults along which the rock units have been offset in a right-lateral sense and have been uplifted or downdropped to form numerous submarine basins and linear escarpments. This tectonic activity appears to have reached a maximum during Quaternary time, and it is continuing today. The major northwest trending faults are approximately parallel to the San Andreas fault system and are intimately related to it. Seismicity and tectonism of these areas are attributed ultimately to the effects of the Pacific Plate of the earth's crust moving northwestward with respect to the North American Plate (Atwater, 1970). The San Andreas fault system represents the present zone of interaction between these two plates and is the master seismotectonic element in southern California. Faulting and folding associated with the plate boundary have occurred across a broad region of southern California, including the site area, the nearby Los Angeles Basin, and Peninsular Ranges.

The occurrence of earthquakes is one of the manifestations of tectonic activity in southern California. Knowledge of seismic activity is derived from the records of seismograph stations maintained since the early 1930's and historical records for earlier shocks dating back as far as 1769. San Pedro Bay, for example, is believed to be the site of the "Rio de Los Temblores" after the Spanish explorers experienced four strong shocks on the afternoon of July 28, 1769 (Wood, 1916).

In the ideal case, any earthquake can be related to a causative fault, and details of tectonic activity clarified.

However, there are unavoidable uncertainties in the instrumental determinations of earthquake epicenters and the historical earthquake records are usually imprecise. As a result, the correlations between seismicity and faulting must be described in general terms, except in the case of some of the larger and more clearly understood earthquakes. The following sections describe the existing seismicity data base, the distribution of earthquakes, and the major faults near the proposed project site.

3.1.2.1 Data Base

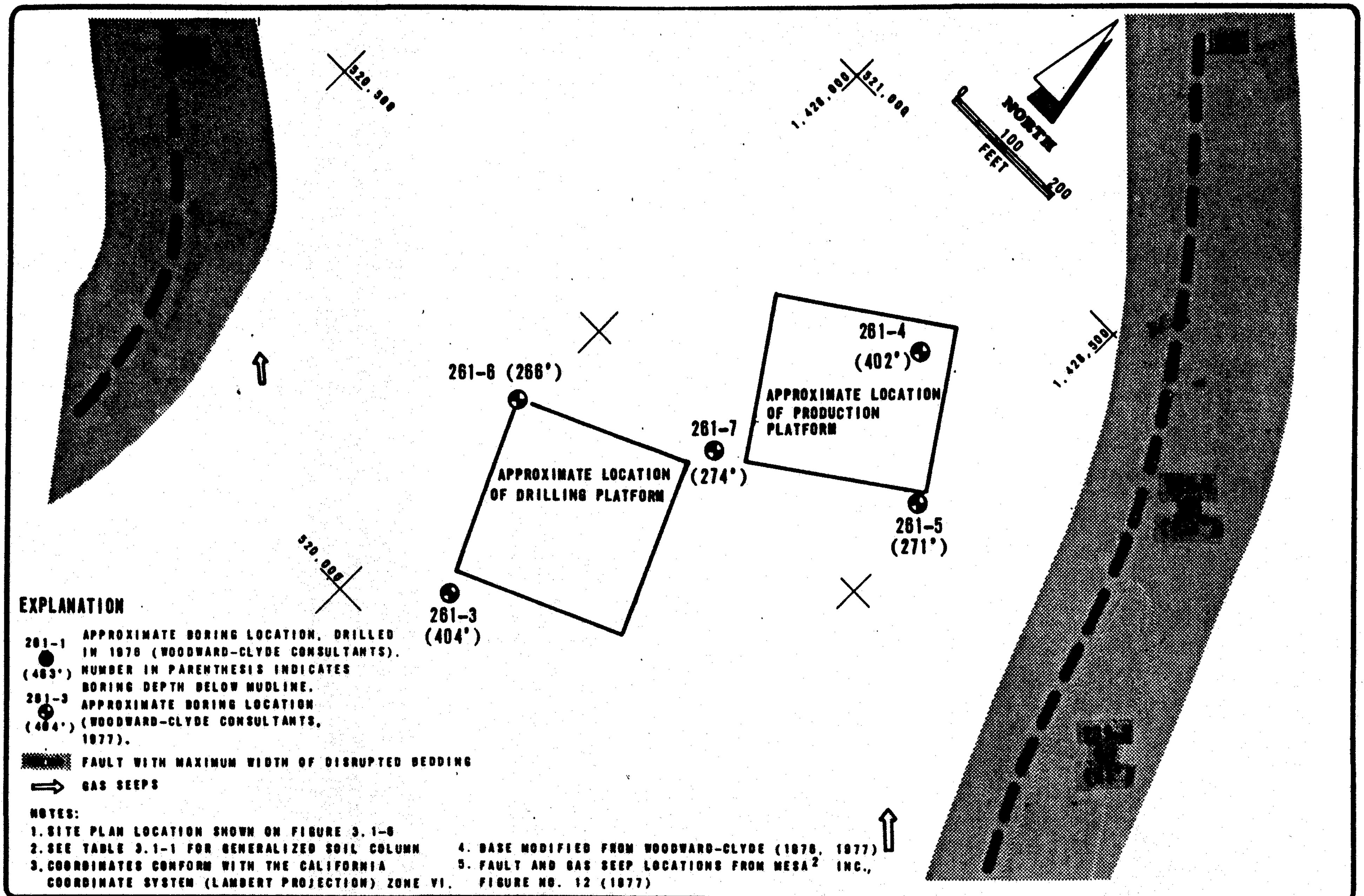
Routine determination of earthquake epicenters using instrumental readings began in about 1932 in southern California. The first seismographs were installed by the Carnegie Institution and California Institute of Technology in 1927, but several years passed before there were a sufficient number of seismographic stations to begin routine record compilations. The first stations closest to the San Pedro area were Pasadena, Riverside, Santa Barbara, and La Jolla; later, in 1939, a station at Palomar was added. Estimates of earthquake epicenters are greatly improved if the epicenter is more or less surrounded by recording stations. Not until 1957 were seismographs installed permanently on any of the Channel Islands. Thus, recent epicenter locations may be correct to as close as a few kilometers, but earlier results may be uncertain by about five km or more. Catalogues of all southern California earthquakes since 1932 have been published by the California Institute of Technology (Hileman *et al.*, 1973; Friedman *et al.*, 1976).

In other areas, detailed studies of small earthquakes have identified active faults and accurately characterized their movement. Such studies involve the installation of a densely spaced network of seismographs and precise determination of earthquake hypocenters. The results can show clear associations between mapped faults and earthquake distribution. However, the method is limited in that a lack of earthquakes does not prove faults to be incapable of producing shocks; therefore, geologic studies are used to supplement the seismic record.

No densely spaced seismic network exists in the site area, although there are many seismic stations in the nearby, landward portions of the Los Angeles basin. The currently available data permit definition of only general zones of earthquake activity. Better resolution would require installation of a suitable network of densely spaced seismographs in the site vicinity.

3.1.2.2 Distribution of Earthquakes

The distribution of larger earthquake shocks, magnitude 4.0 and above, is shown for the southern California region in Figure 3.1-16. The figure also shows the region's major faults, the San Andreas being the longest northwest-trending fault in the area. Only a few points concerning the regional seismicity are appropriate



Site Test Boring Locations

3.1-16
Figure

here; a complete discussion of the relation between the geology and the seismicity is given in Allen *et al.* (1965).

Much of the regional seismicity can be correlated with zones of faulting (Figure 3.1-17). In some cases, the epicenters can be associated with particular faults. There is a noticeable concentration of events in the vicinity of the Newport-Inglewood fault (Figures 3.1-17 and 3.1-18). Most of these epicenters are aftershocks of the 1933 Long Beach earthquake (M=6.3). The locations represent shocks along the Newport-Inglewood fault itself as well as shocks induced on nearby faults by the main earthquake.

Another point demonstrated by the seismicity distribution shown in Figures 3.1-17 and 3.1-18 is that the San Pedro Bay site is rather typical of most of the southern California region. Moderate earthquakes, with magnitudes less than about 5.0, have occurred in the site vicinity, but the area is not unique in the sense of having experienced unusually high or low levels of seismicity.

Figure 3.1-18 shows four epicenters in the site area. These occurred on January 20, 1934 (M=4.5); January 15, 1937 (M=4.0); November 1, 1940 (M=4.0); and March 22, 1941 (M=4.0). Each of these shocks has a location uncertainty of about 5 km, thus their correlation with the Palos Verdes fault is not conclusive. Other maps of this area which include small earthquakes with magnitudes less than 4.0 show an apparently random distribution of epicenters in the channel between Catalina Island and the mainland. This randomness may, however, be caused by inaccuracies in epicenter determinations.

3.1.2.3 Significant Faults

The principal faults within southern California are, from east to west, the San Andreas, San Jacinto, Whittier-Elsinore, Newport-Inglewood, and Palos Verdes (Figure 3.1-1). Of these, the San Jacinto fault has had the highest historic seismicity, although all are considered capable of generating large-magnitude earthquakes. The relationship between major faults and earthquakes of Magnitude 4.0 and greater is shown on Figure 3.1-18.

Faults considered to be of greatest significance along the borderland are the Newport-Inglewood and Palos Verdes faults, located ten miles (16 km) and less than one mile (1.6 km) from the platform sites, respectively. Other offshore faults in the immediate area appear relatively short and discontinuous. Both the Newport-Inglewood and Palos Verdes fault zones are associated with large horizontal and vertical displacements, and have long histories of seismic activity that are apparently continuing. The Newport-Inglewood fault zone was responsible for the magnitude 6.3 Long Beach earthquake of March 10, 1933 (Barrows, 1974). The Palos Verdes fault zone reportedly offsets Holocene age sediments (less than 11,000 years old) several places within San Pedro bay, and shows convincing geophysical evidence of disrupting the modern seafloor (Figure 3.1-4) (Dames and Moore, 1977a). The structural and seismic characteristics of these two faults are discussed in the following paragraphs.

(1) Palos Verdes Fault

The Palos Verdes fault, due to evidence for Holocene activity and its presence within the siting area, is of particular significance to the project with respect to potential groundshaking and ground rupture. The offshore portions of the Palos Verdes fault consist of a series of discontinuous, braided to *en echelon* traces which form a fault zone one to two miles (1.6-3.2 km) wide. Northwest of the Palos Verdes Peninsula, the fault extends across Santa Monica Bay where it is characterized by small dislocations on scattered faults within a broad zone, at least to Redondo Canyon, beyond which evidence for its continuation as one trace is ambiguous. The southeastward extent of the fault is generally considered to be at least to Lasuen Knoll (Figure 3.1-3). The total known length of the Palos Verdes fault between Redondo Canyon and Lasuen Knoll is on the order of 45 miles (72 km) long (Dames and Moore, 1977a).

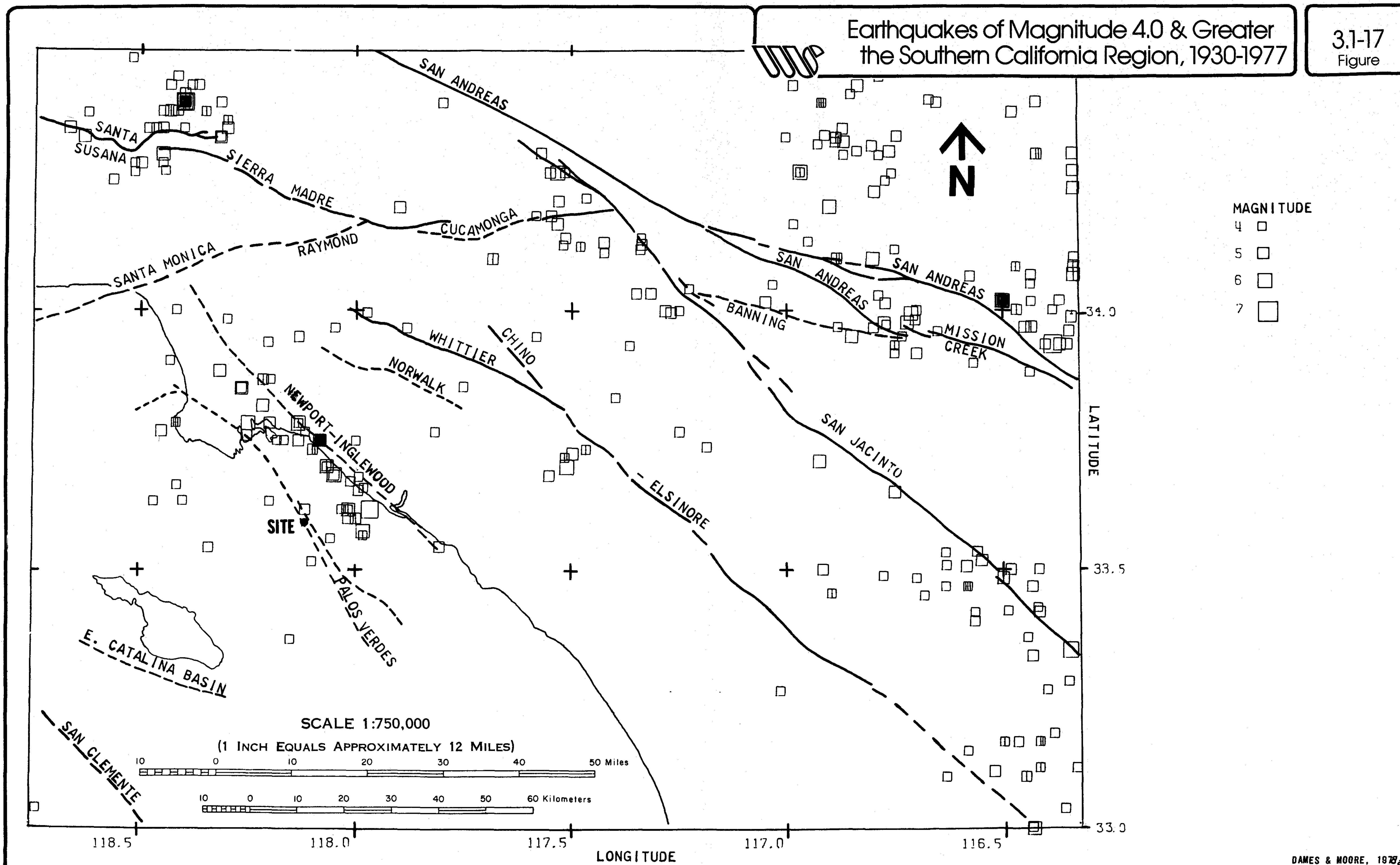
The sense of displacement varies along the fault. Right lateral strike-slip displacement, typical of the northwest-trending San Andreas system, appears dominant. However, a vertical, reverse component of displacement is also evident, particularly along the northwest end of the fault (Dames and Moore, 1977a).

Seismicity of the San Pedro Shelf has been reported by Hileman *et al.* (1973), and Friedman *et al.* (1976). Epicenter data, provided for the period between 1932 and 1977 (Figure 3.1-17), shows numerous earthquakes in San Pedro Bay, some of which appear to align with the Palos Verdes fault, although a direct association has not been documented. The results of studies by Teng and Henyey (1975) indicate that some earthquakes smaller than Magnitude 4 may have occurred on the Palos Verdes fault zone. However, several of these events occurred very near the proposed intersection of the Redondo Canyon and Palos Verdes faults. Thus, they may have occurred on the Redondo Canyon fault or some other fault not associated with either of these (Dames and Moore, 1977a).

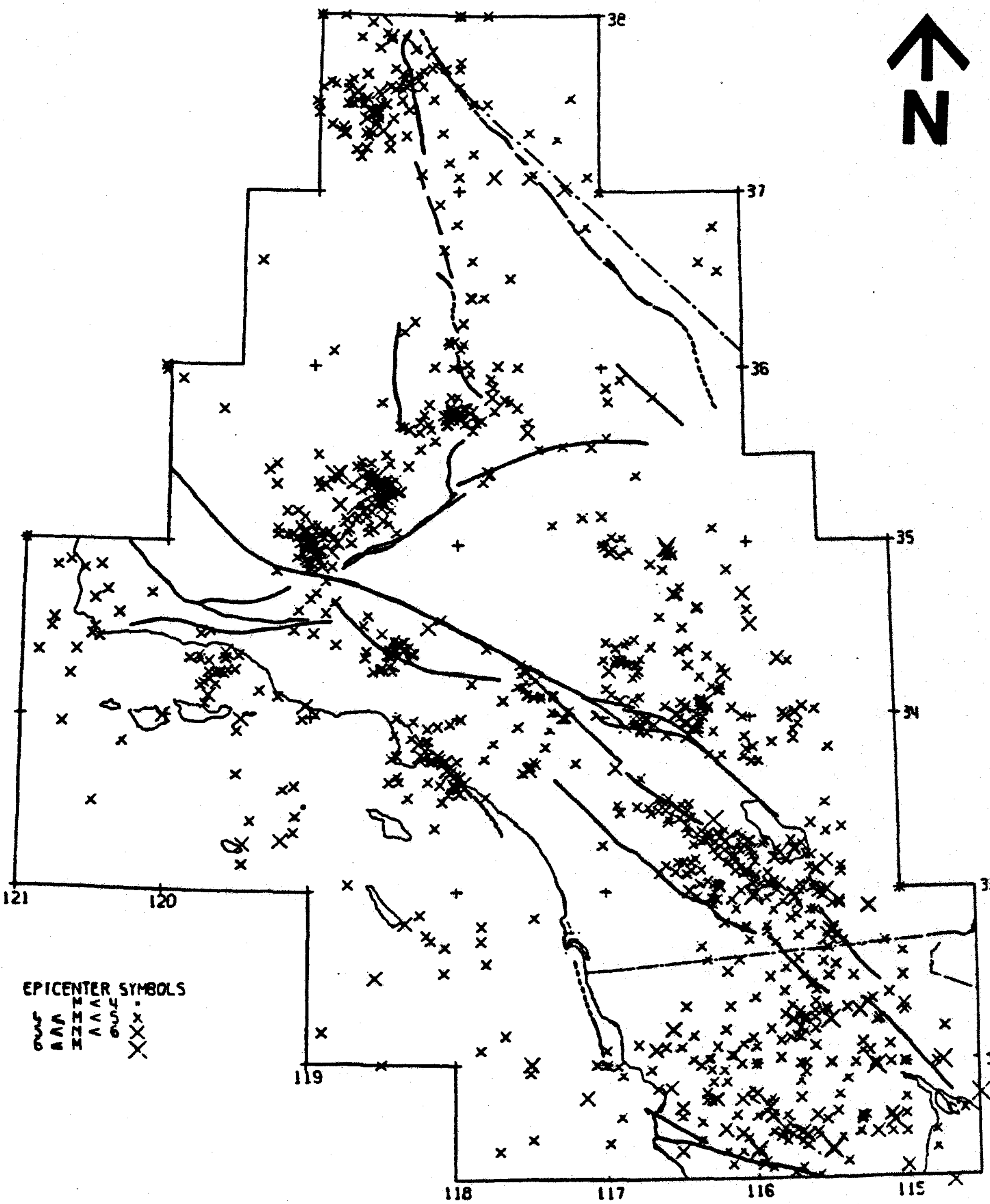
The discontinuous nature of faults in the Santa Monica Bay suggests that in the recent past this portion of the fault zone has not participated in a single, throughgoing rupture. Therefore, the appropriate length for estimating the maximum earthquake on the fault segment adjacent to the platform sites is 40 miles (64 km) from Redondo Canyon to south of Lasuan Knoll.

(2) Newport-Inglewood Fault

The Newport-Inglewood fault is located 9.5 miles (15 km) northeast of the platform sites and represents a potential source of seismic activity. The Newport-Inglewood fault is described as a seismically active structural zone (Barrows, 1974) that



Earthquakes of Magnitude 4.0 & Greater
the Southern California Region, 1930-1977
3.1-17
Figure
SAN ANDREAS
SANTA SUSANA
SIERRA MADRE
CUCAMONGA
RAYMOND
SANTA MONICA
BANNING
MISSION CREEK
WHITTIER
CHINO
NORWALK
NEWPORT-INGLEWOOD
ELSINORE
SAN JACINTO
SITE
PALOS VERDES
E. CATALINA BASIN
SAN CLEMENTE
N
MAGNITUDE
4
5
6
7
SCALE 1:750,000
(1 INCH EQUALS APPROXIMATELY 12 MILES)
50 Miles
60 Kilometers
118.5
118.0
117.5
117.0
116.5
LONGITUDE
34.0
33.5
33.0
LATITUDE
DAMES & MOORE, 1978a



SEISMICITY OF THE SOUTHERN CALIFORNIA REGION
1932 THROUGH 1974
MAGNITUDE 4 AND GREATER

AFTER FRIEDMAN AND OTHERS, 1976

Generalized Fault Map and Historic Seismicity

3.1-18
Figure

trends northwesterly for about 40 miles (64 km) from Newport Mesa to the Cheviot Hills,, where it apparently terminates against the Santa Monica Bay fault (Yeats, 1973; Barrows, 1974). Some investigators (Emery, 1960; King, 1969) suggest the fault may be extended to include the Rose Canyon fault near San Diego. On the other hand, other investigators (Jahns *et al.*, 1971), using more-site-specific data, argue that the fault cannot be extended to the southeast beyond Laguna Beach due to the absence of a throughgoing fault in rocks younger than Miocene age. However, based on its offshore alignment with a fault zone southeast of Laguna Beach, it is reasonable to extend the Newport-Inglewood fault as far southeast as Oceanside (Barrows, 1974). This produces a total fault length on the order of 85 miles (129 km). However, similar to some other northwest trending fault zones in the region, the segmented discontinuous traces which characterize the Newport-Inglewood zone of deformation show no evidence of single throughgoing displacements. On that basis, the appropriate length for estimating maximum fault rupture is taken at 40 miles (64 km).

Holocene activity is illustrated by numerous historic seismic events. Most notable of these are the Magnitude 6.3 Long Beach earthquake of 1933 and the Magnitude 4.9 Inglewood earthquake of 1920.

No surface faulting has been observed along known faults resulting from historic earthquakes along the Newport-Ingelwood fault zone (including the Magnitude 6.3 Long Beach earthquake). During the 1940's, several dozen earthquakes were reported which had epicenters along the Newport-Inglewood fault zone. Within the past 25 years, a yearly average of between two and three local earthquakes in the Magnitude 3 to 4.5 range have been recorded at various localities along this zone.

3.1.2.4 Potential for Maximum Earthquake Ground Motion at Site

The previous sections indicate that the potential for significant earthquake ground shaking at the site is high. The most severe motions would be generated from large earthquakes on the Palos Verdes or Newport-Inglewood faults. Based on the lengths of these faults documented in previous sections and correlations of fault rupture length and earthquake magnitude (Patwardhan and others, 1975; Albee and Smith, 1966; Housner, 1970), reasonable estimates of the maximum earthquake magnitudes for these two faults would be between 6.5 and 7. The maximum magnitudes assigned to the Palos Verdes (6.75) and Newport-Inglewood (7) faults by Dames and Moore (1978) lie within this range and are similar to the maximum magnitudes estimated by Greensfelder (1974). Severe ground motions produced by the San Andreas fault are also of concern because of its potential to produce a great earthquake (Magnitude ≥ 8), which could result in large, long-period motions at the site.

Levels of shaking expected at a site are typically referred to in terms of peak accelerations relative to bedrock or firm ground conditions. Such accelerations are derived basically from attenuation relationships which predict maximum ground accelerations for given earthquake magnitudes and source-site distances. For strong ground shaking (i.e., accelerations greater than about 0.1 g), accelerations experienced at the ground surface have been estimated to be lower at a deep alluvial site than at bedrock sites (Seed and others, 1975). For the seismic design of structures, design spectra anchored to an appropriate acceleration level are usually recommended.

In general, the characteristics of earthquake ground motion at a site depend on the site soil conditions, distance from the source to the site, size and type of fault rupture, regional geology, and travel paths of the seismic waves. Even with a consideration of these factors, actual acceleration levels predicted for a site generally vary depending on the attenuation relation used. Based on available literature (Seed and others, 1975; Schnabel and Seed, 1973; Donovan, 1973), data of the geologic and seismologic aspects of Beta site (Dames & Moore, 1977a; Shell, 1977), and Fugro's knowledge of existing strong motion data and the dynamic response characteristics of soils, the following table is presented, showing the range of maximum levels of shaking that can be reasonably expected at the site for the three maximum earthquakes discussed above.

Fault	Maximum Earthquake Magnitude	Closest Approach of Fault to Site (km)	Maximum Accelerations (g)	
			Rock	Mudline
Palos Verdes	6.5-7.0	0.7	0.5-0.7	0.25-0.4
Newport-Inglewood	6.5-7.0	15.0	0.2-0.5	0.15-0.3
San Andreas	8.5+	71.5	0.10	0.10

3.2 HYDROLOGY

3.2.1 Port of Long Beach

3.2.1.1 Groundwater

Three distinct bodies of groundwater exist in the Port of Long Beach area. In downward succession these are: (1) an upper alluvial saline groundwater zone essentially continuous with the ocean, occurring at approximately 15 feet (4.5 m) below the surface; (2) a lower alluvial groundwater deposit which is the principal freshwater aquifer; and (3) a body (or bodies) of saline water that underlies the principal freshwater body throughout the Downey Basin area. The quality of groundwater within the Port is considered to be poor (MES, 1976).

3.2.1.2 Surface Water

The Port of Long Beach is within the southern portion of the Los Angeles River drainage basin. The principal feature of this basin is the Los Angeles River, which empties adjacent to the eastern boundary of the Port of Long Beach.

The primary site within the Port proposed for the temporary construction equipment storage and transfer terminal is drained by the Port's storm drain system into harbor waters. This site is paved, or covered by structures, rendering it impervious to water percolation. Hence, all water resulting from rain or any other source either runs off into the harbor or evaporates.

The site within the Port proposed for the oil storage tank, pumps, and manifold system is also drained by the Port's storm drain system. However, it is not paved, therefore allowing some surface water to percolate into the groundwater table. The balance of the surface runoff which does not percolate is deposited into the harbor.

3.2.2 Huntington Harbour Crew Boat Launch

3.2.2.1 Groundwater

The upper level of groundwater in the area is found at a level of 3 feet (1 m) below the surface. The water is saline, and of poor quality. It is not considered a valuable resource.

3.2.2.2 Surface Water

Surface water resulting from rain or other sources in the proposed project's Huntington Harbour crew staging area presently runs directly into the channel between Huntington Harbour and the Seal Beach National Wildlife Refuge. The site is presently paved and developed with structures and, therefore, is impervious to water. During an average rainfall, approximately 1.5 cfs (42.5 dm^3/sec) of runoff occurs. Only a few drainage improvements have been made in the Surfside/Sunset Beach area within which the proposed site is located. These improvements consist of a few catch basins along Pacific Coast Highway, which collect runoff from the street gutters and empty into the western portion of Huntington Harbour. The closest extension of Orange County's storm drain system (Line C02) terminates at the western end of Edinger Avenue in Huntington Beach.

The Sunset Beach/Surfside area has been historically affected by high ocean tides. When unusually high tides occur, portions of Sunset Beach and Surfside are flooded. The flooding often reaches the first floor level of the dwellings in the area, causing minor damage and inconvenience. Streets can also be flooded by large waves generated by winter storms. When unusually high tides occur, surface water cannot drain by gravity alone because the elevation differential between street level and sea level is not sufficient to allow water to flow to the outlets in the harbor. If a rain of sufficient magnitude occurs at the same time as an unusually high tide, flooding is significant. For more information concerning hydrology in this area, refer to EIR No. 255 General Environmental Assessment for Sunset Beach, Environmental Management Agency of Orange County, November 1977 (Orange County, 1977).

3.3 AIR QUALITY

3.3.1 Climatology and Meteorology

3.3.1.1 Regional Climatology

The primary year-round factor governing weather patterns in southern California is the location of the semi-permanent Eastern Pacific High pressure cell. The central pressure of this cell, the pressure along the coast, and the pressure in the deserts to the southeast also participate in determining the large scale weather patterns throughout most of the year. Other meteorological features which can affect southern California's weather are: (1) Santa Anas, (2) fronts and storms, (3) upper air troughs and ridges, and (4) Catalina Eddies.

Large-scale circulation and winds along the southern California coast are largely affected by the strength of the pressure gradient between the Pacific High pressure cell located to the west and the relative positions of the thermal low to the east. During the summer months, the thermal low is well developed, and the Pacific High, although farther west than in winter, is at its strongest. This results in a larger pressure difference between the thermal low and the Pacific High. The position and strength of the high cell in summer effectively steer storms to the north and weaken them. The strength of the Pacific High determines the degree of subsidence and results in creating subsidence inversions at about 2,000 feet (600 m) above sea level. The relatively cold water that flows southward along the coast allows the formation of coastal fogs and low clouds during the night and early morning hours.

Due to terrain effects, land-sea temperature differences, and the location of the Pacific High, small-scale circulations can differ significantly from regional patterns. Areas near the coast are subject to a varied diurnal reversal which features daytime onshore and nighttime offshore winds. This sea-land circulation is often relatively shallow, resulting in funneling of winds through coastal valleys and canyons.

The typical shallowness of the marine layer near the coast is caused, in large part, by temperature inversions which are present in all seasons, but are stronger and more common in summer and fall. Three basic types of inversions occur in southern California: (1) marine inversion, caused by cooling of low-level air passing over the cool ocean surface; (2) radiation inversion, caused by nighttime cooling during generally cloudless conditions; and (3) subsidence inversion, a result of the large-scale descent of air in the Pacific High.

During inversion conditions, vertical air movement is inhibited, resulting in confinement of low-level parcels to valleys and coastal plains. Severe or persistent inversions, combined with light winds, can result in heavy buildups of atmospheric pollutants in southern California.

Upper troughs and ridges play a significant role in determining the height and intensity of the persistent subsidence temperature inversion and thus play a dominant role in determining the vertical extent through which pollutants can be dispersed.

When the upper-level circulation is anti-cyclonic (i.e., a high pressure ridge) the subsidence inversion is low and vertical motions are limited. Conversely, with the approach of an upper trough, the height of the inversion increases and the depth through which pollutants are mixed increases.

Additional synoptic regimes which can exert significant effects upon the study area are Santa Ana conditions and so-called Catalina Eddies. Santa Anas occur when there is a surface high with a cold core over the Great Basin, and lower pressures along the coast. These conditions result in strong downslope northeasterly winds over most of southern California. Santa Ana conditions are most common during the fall and winter months, often preceding the passage of a mid-latitude frontal system.

As the name implies, the Catalina Eddy forms in the vicinity of Catalina Island during the warm season. The predominant flow over the ocean is cyclonic (counterclockwise). These small scale cyclonic circulations are caused by orographic effects on the coastal mountain range in the vicinity of Point Conception. At Point Conception the coastline and mountain range turn sharply and become oriented on an east-west axis. A northwesterly flow is recurved in the lee of the mountains. The recurvature causes southwesterly to southerly winds locally instead of northwesterly, as would normally occur. The eddy has its greatest effects on air flow over the water; the extent of its effectiveness depends on the size of the eddy, and the direction and speed of its flow. Occasionally the eddy is very intense and covers a large area. When this occurs, the marine layer deepens rapidly, forcing the inversion upward and permitting greater vertical mixing.

Precipitation in the study region falls chiefly in the winter months. The major portion occurs between November and April, and is usually associated with mid-latitude cyclonic storms. Summer thunderstorms form from moisture advected to the area from either the Gulf of Mexico or the waters off lower California. These storms rarely track over the coastal waters. Tropical storms in the warm part of the year may, on very rare occasions, provide extensive rainfall.

3.3.1.2 Prevailing Winds

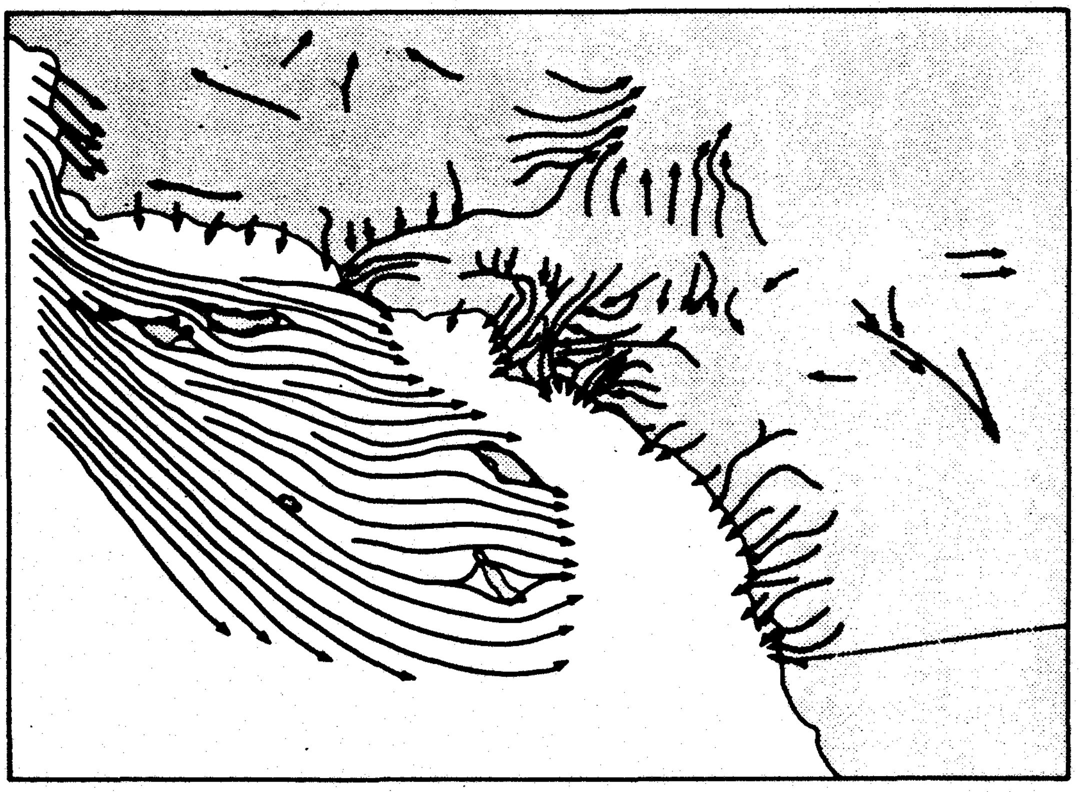
Winds in the vicinity of the Shell Beta platforms result from the large-scale atmospheric circulations associated with the semi-permanent pressure patterns and complex flow patterns created by the variability of topography along the coastal areas and offshore islands. In general, the sea breeze blows toward the land during the day, while the land breeze blows offshore during the late night and early morning hours.

Figures 3.3-1 and 3.3-2 show the prevailing airflows during the nighttime hours for the months April, July, October, and January. The flow around Point Conception is relatively strong, and indicates a primary northerly component. The area west of San Nicolas Island shows prevailing northwesterly flow. The offshore drainage flow on the land goes from areas of higher ground (i.e., mountains, hills) into the valleys and eventually offshore. The area between offshore and ocean westerlies is dependent on the strength of either flow on a given day.

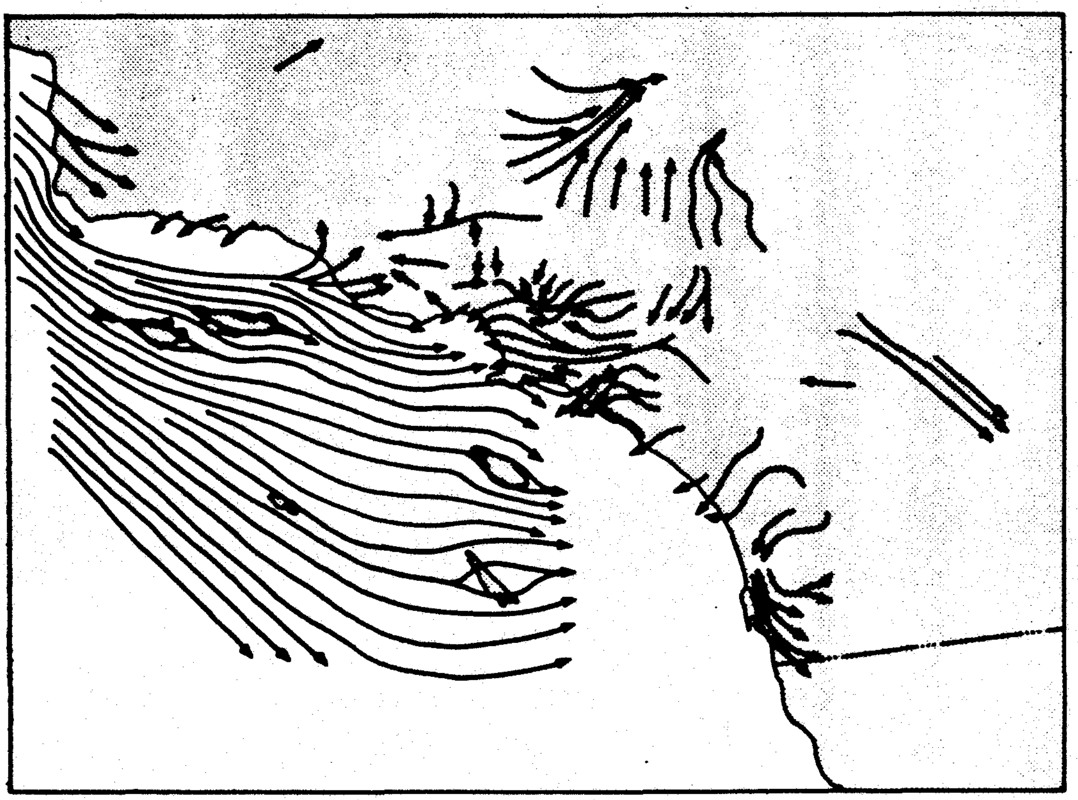
Figures 3.3-3 and 3.3-4 show the prevailing daytime flow for each of the mid-season months. The surface flow lines bend toward the coastal areas rounding Point Conception. This situation is strongest in summer and weakest in winter. The streamlines around the coastal islands are typical of flow around obstructions. The strength and penetration of the onshore air flow is dependent upon inland heating and the strength and position of the Pacific High cell.

There are no long-term wind data in the immediate vicinity of the proposed platforms. Some wind data were collected on a drilling ship (CUSS I); however, the data were only measured at four-hour intervals during the hours 0800-2400. While these data are of value in determining daytime flow patterns in the study area, they may be too sporadic to be of climatological value. Surface wind observations recorded on San Nicolas and Santa Catalina Islands, the South Coast Air Quality Management District (SCAQMD) monitoring station at Costa Mesa, and the Southern California Edison's Huntington Beach Generating Station are presented in Figures 3.3-5, 3.3-6, 3.3-7, 3.3-8 and Tables 3.3-1. 3.3-2. and 3.3-3. The relative frequency distributions are based on at least one year of data for all stations except Catalina Island. The Catalina Island data are presented for the period June 1943 to February 1944. The wind regimes at these stations are assumed to be reasonably representative of the project site's wind regimes with some modification due to the topography of the coastline and frictional effects.

It is seen from the figures that on an annual basis the most frequent winds at all four stations are westerly through northwesterly. The strong northwesterly component is particularly evident at the San Nicolas Island station which showed approximately 40 percent northwesterly wind directions. The drainage offshore flow, characteristic of most coastal stations, and Santa Ana conditions are shown to occur much less frequently at San Nicolas Island than



April, 0000-0600, PST

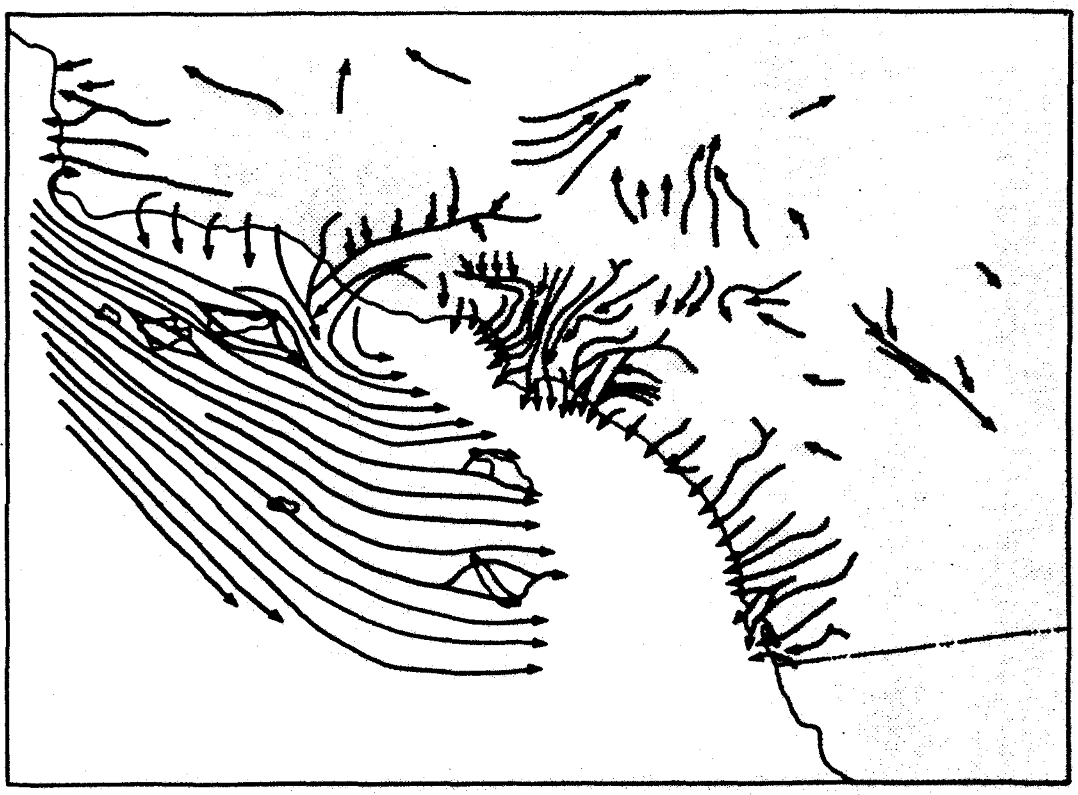


July, 0000-0600, PST

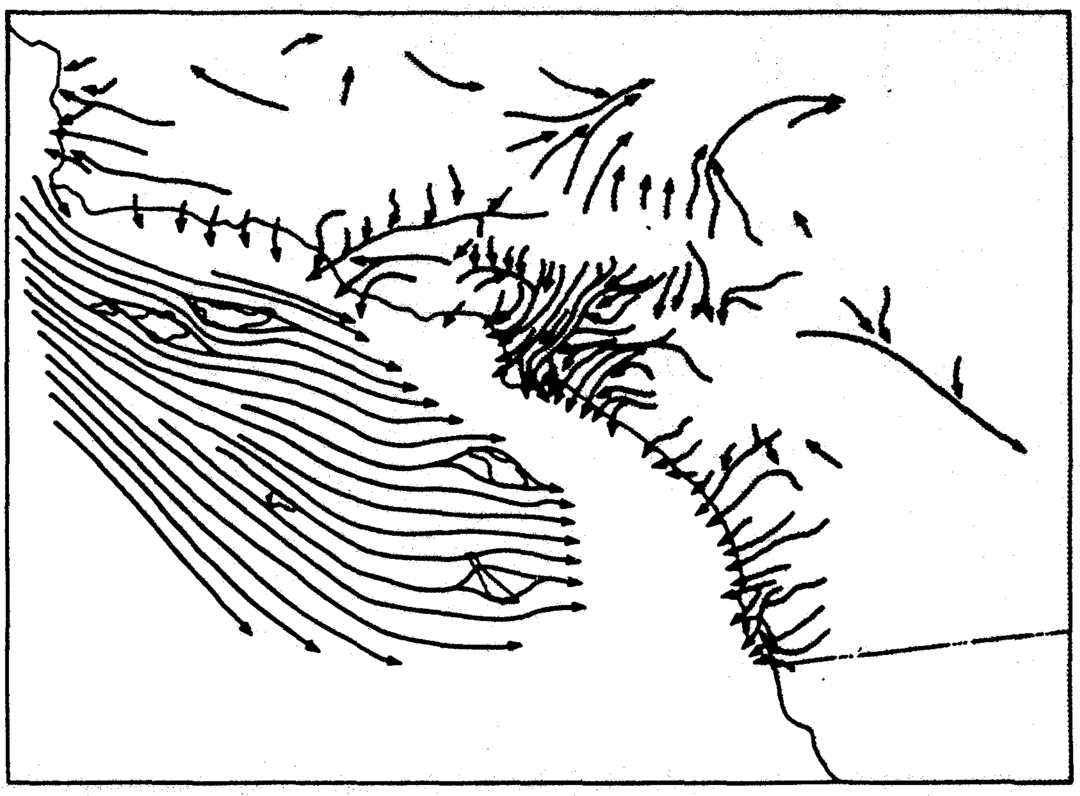
SOURCE: DeMarrais, 1965.

Streamline Charts

3.3-1
Figure



October 0000-0700, PST

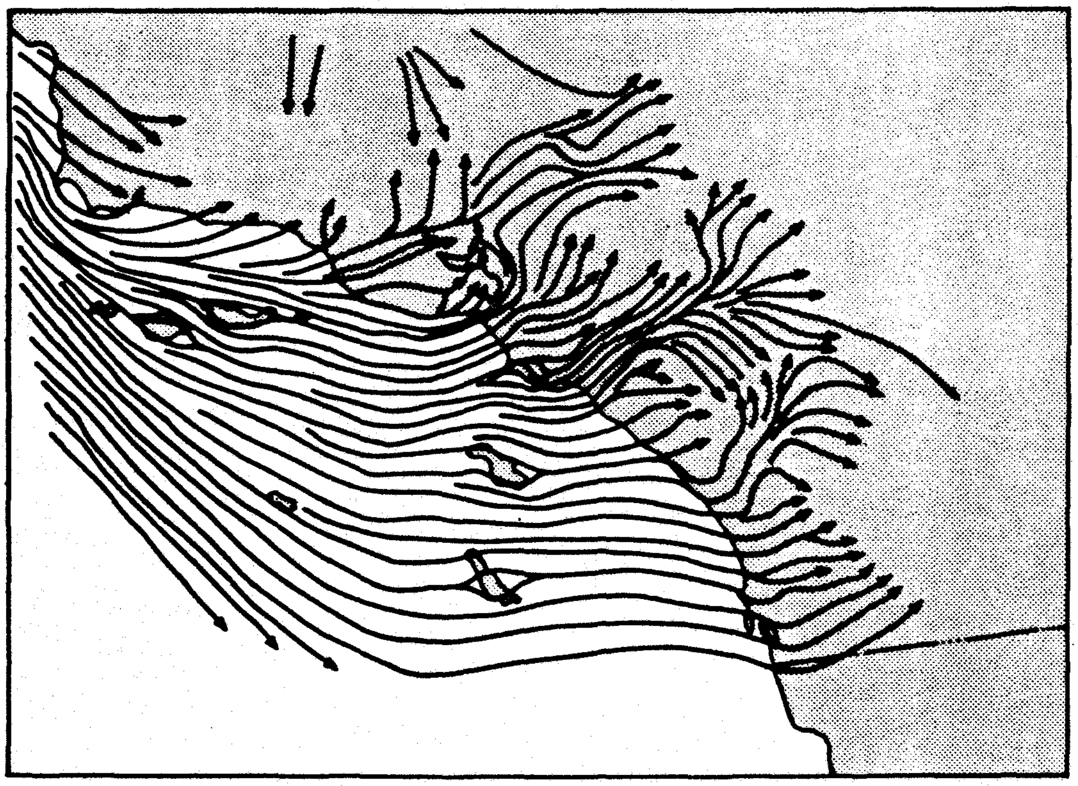


January, 0000-0700, PST

SOURCE: DeMarrais, 1965.

Streamline Charts

3.3-2
Figure



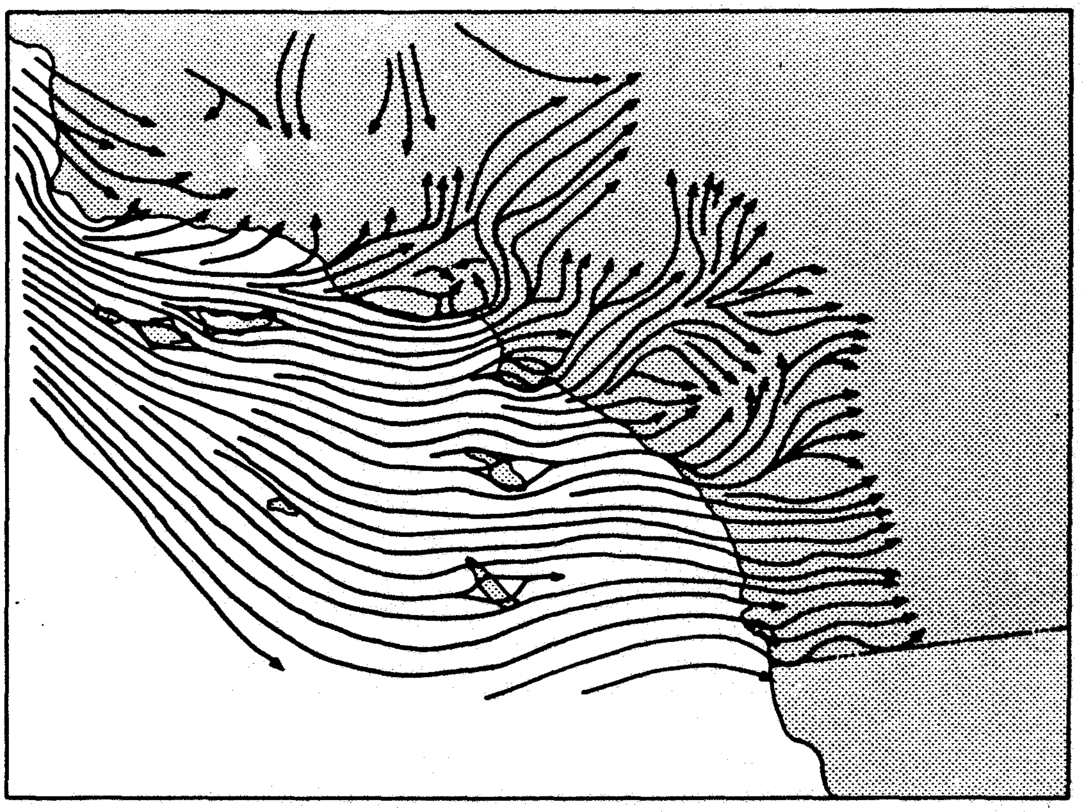
April, 1200-1700, PST

July, 1200-1800, PST

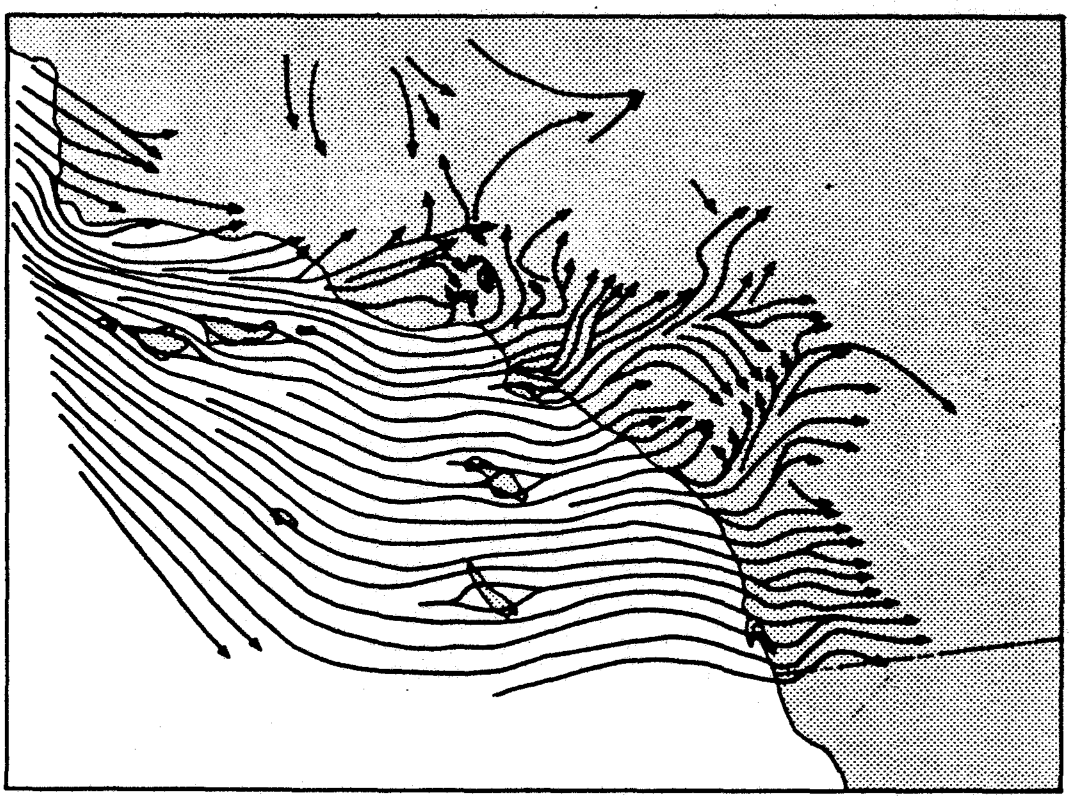
SOURCE: DeMarrais, 1965.

Streamline Charts

3.3-3
Figure



October, 1200-1800, PST

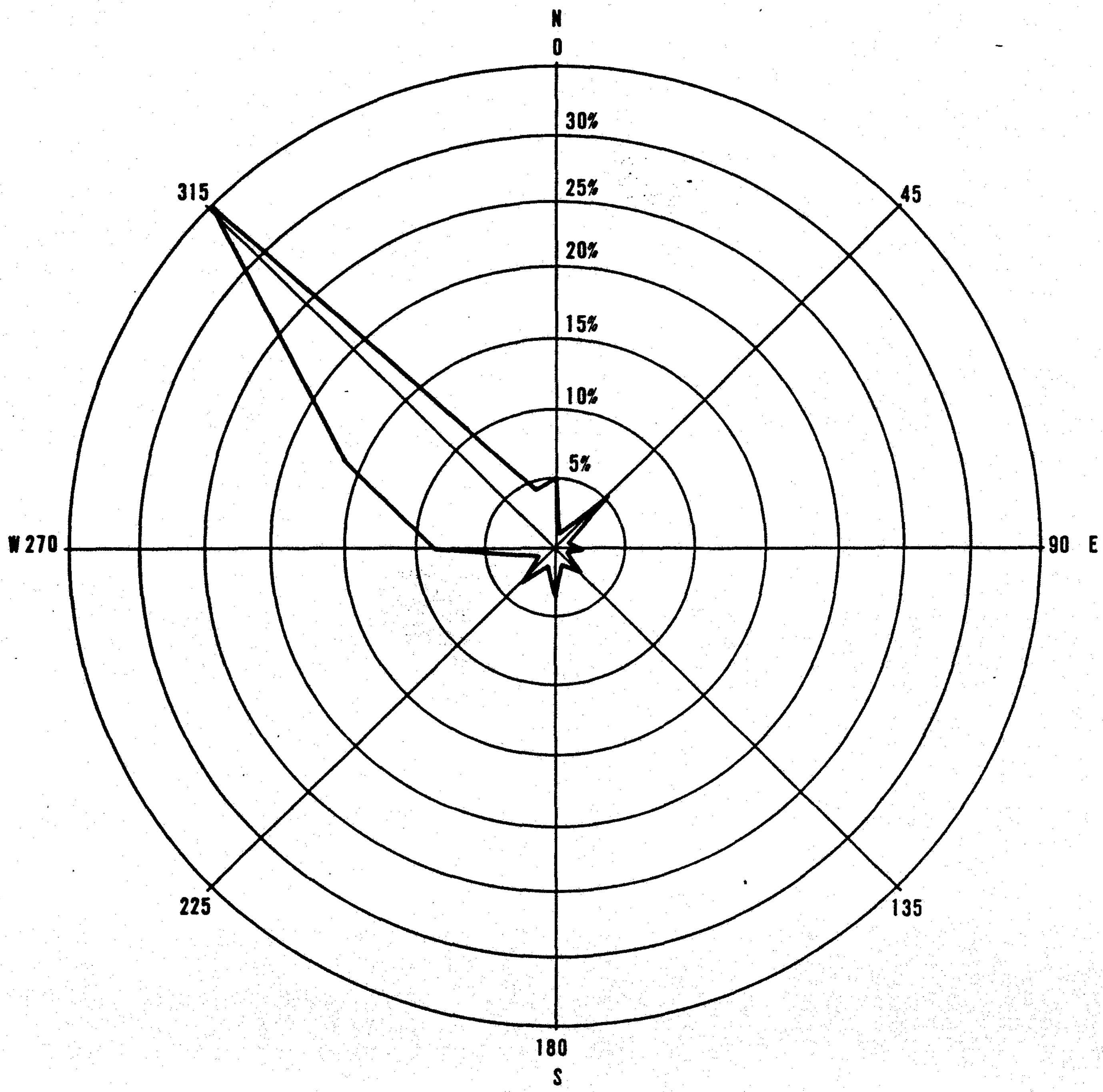


January, 1200-1700, PST

SOURCE: DeMarrais, 1965.

Streamline Charts

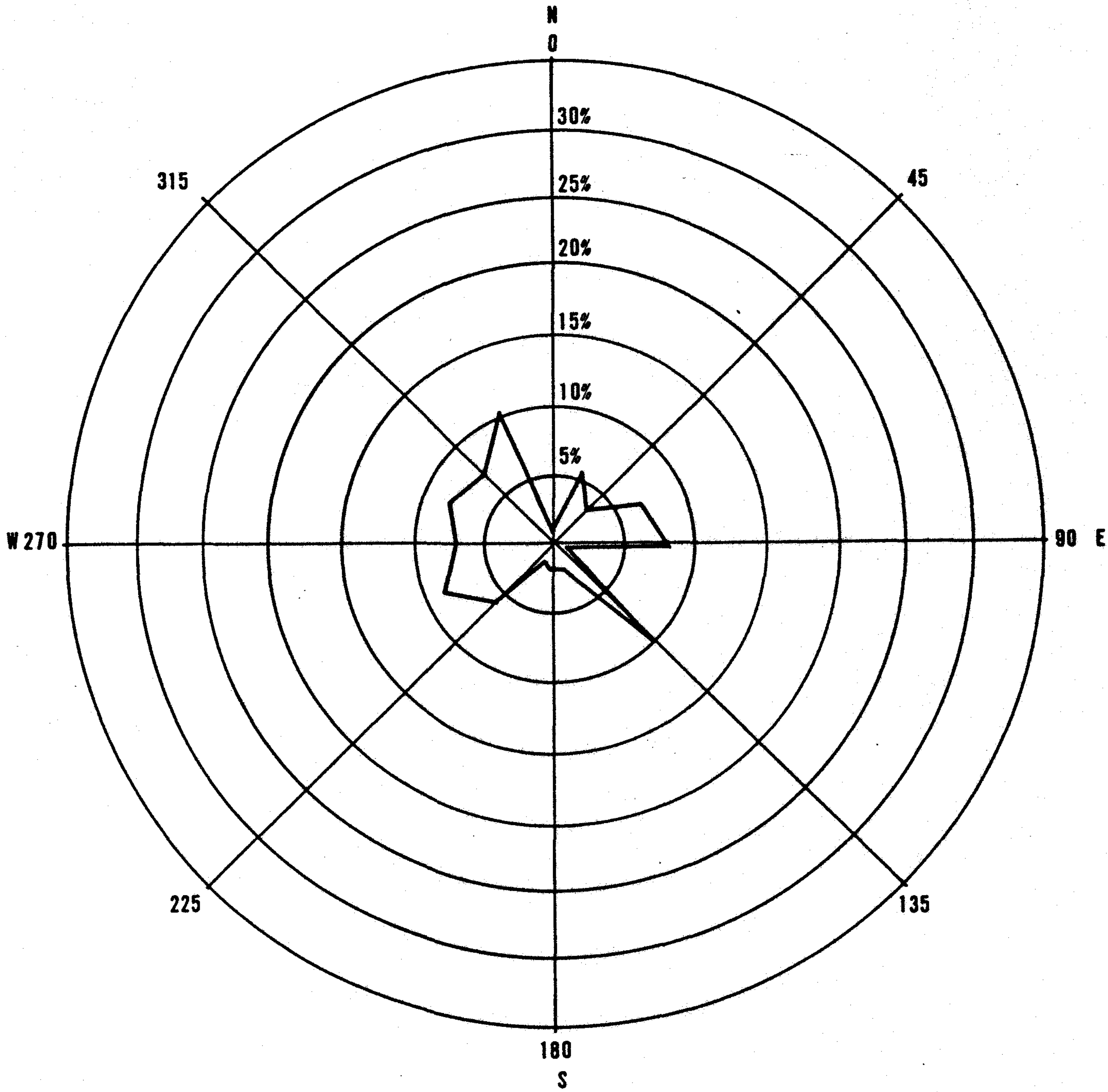
3.3-4
Figure



San Nicolas Island

Annual Wind Rose

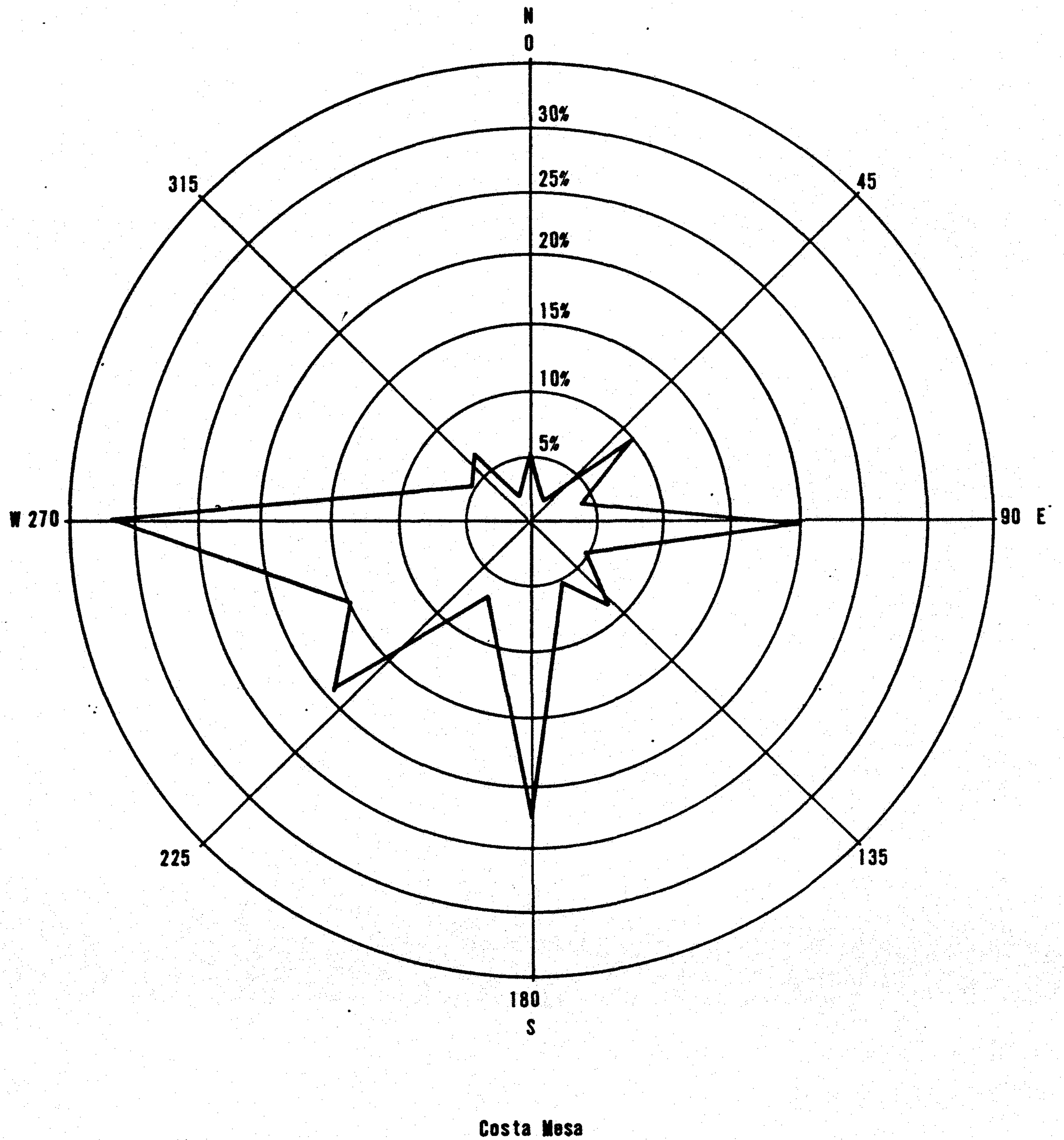
3.3-5
Figure



Santa Catalina Island
(June 1943 - February 1944)

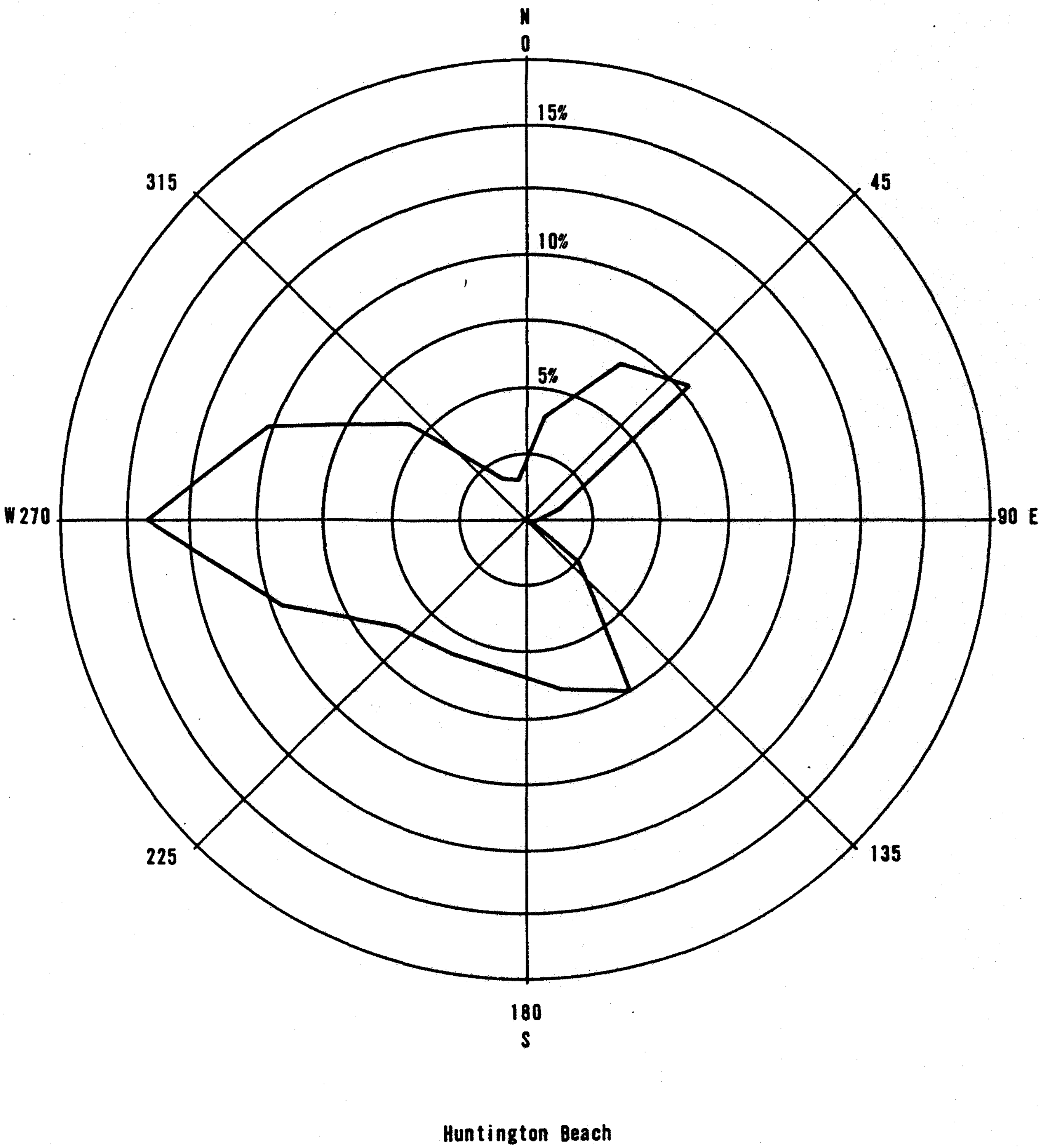
Wind Rose

3.3-6
Figure



Annual Wind Rose

3.3-7
Figure



Annual Wind Rose

3.3-8
Figure

TABLE 3.3-1

ANNUAL RELATIVE FREQUENCY OF OCCURRENCE OF
WIND DIRECTIONS (PERCENT)
SAN NICOLAS ISLAND, CALIFORNIA

Speed / Dir.	1-3 M.P.H.	4-12 M.P.H.	13-24 M.P.H.	25-31 M.P.H.	32-46 M.P.H.	47 M.P.H. and Over	Total No. of Observations %		Mean Wind Speed M.P.H.	
N	.6	3.8	.5				5	0	7	7
NNE	.1	.9	.1				1	2	7	7
NE	1.2	3.7	.3				5	2	6	1
ENE		.7	.2				1	0	8	3
E	.4	1.2	.3				2	0	7	9
ESE		.4	.1					7	10	4
SE	.3	1.1	.2				1	7	7	0
SSE	.1	.8	.2				1	2	10	2
S	.7	2.2	.5				3	5	8	1
SSW	.1	1.1	.2				1	5	8	1
SW	.5	2.5	.4				3	4	7	9
WSW		1.1	.2				1	3	8	5
W	.7	6.2	1.9				8	9	10	0
WNW		5.2	8.6	1.7	.6		16	3	16	7
NW	.8	20.0	15.6	2.4	.9		39	9	14	2
NNW	.1	3.1	1.0				4	3	10	8
CALM							2	9		
Totals	6.4	54.7	30.2	4.6	1.6		100	0	11	9

Source: U.S. Weather Bureau

TABLE 3.3-2

RELATIVE FREQUENCY OF OCCURRENCE OF WIND DIRECTIONS (PERCENT)
SANTA CATALINA ISLAND, CALIFORNIA

Speed / Dir.	1-3 M.P.H.	4-12 M.P.H.	13-24 M.P.H.	25-31 M.P.H.	32-46 M.P.H.	47 M.P.H. and Over	Total No. of Observations %		Mean Wind Speed M.P.H.	
N	.3	.7					1	1	6	9
NNE	1.5	3.6	.3	.1			5	5	6	5
NE	1.2	2.0	.1				3	3	5	0
ENE	9.0	5.6	.3				6	7	7	0
E	1.1	6.8	.3				8	2	6	9
ESE		.7						9	9	5
SE	1.7	6.9	.8	.2	.2	.1	10	0	8	8
SSE	.4	1.4	.3	.1			2	4	10	3
S	.4	1.6	.1	.1			2	2	7	7
SSW	.4	1.3	.1				1	9	7	0
SW	1.4	4.1	.3				5	9	6	3
WSW	.7	7.2	.8				8	7	7	8
W	1.3	4.6	1.1	.2			7	2	8	5
WNW	1.3	5.9	.8				8	0	7	3
NW	1.0	5.5	.5				7	0	6	9
NNW	2.1	7.5	.4		.1		10	2	6	5
CALM							10	8		
Totals	15.5	65.4	6.5	1.1	.5	.2	100	0	6	5

Source: U.S. Weather Bureau

TABLE 3.3-3

FREQUENCY DISTRIBUTION
OF WIND DIRECTIONS (PERCENT)
COSTA MESA, CALIFORNIA

Direction	Percent Frequency of Occurrence	Mean Wind Speed MPH
N	3.5	1.3
NNE	0.6	2.1
NE	5.0	2.6
ENE	2.6	2.4
E	13.0	1.5
ESE	1.8	1.8
SE	4.6	1.9
SSE	2.8	3.3
S	14.0	3.6
SSW	4.0	3.8
SW	13.3	3.8
WSW	9.1	3.8
W	19.9	3.2
WNW	1.5	2.6
NW	3.5	1.9
NNW	0.8	2.1

Source: South Coast Air Quality Management District at Santa Catalina, Costa Mesa, or Huntington Beach. The data indicated little penetration of the nighttime land breeze beyond San Nicolas Island. In particular, the frequency of offshore winds at Huntington Beach and Costa Mesa (defined as northeast through southeast) was approximately 30 percent. Similarly, the Catalina Island wind rose showed offshore flow approximately 30 percent of the time. In addition, the effects of the curvature of the streamlines around Point Conception are evident at Costa Mesa and Catalina by the larger percentages of westerly and southwesterly flow than recorded at San Nicolas Island.

The wind frequency distributions previously presented for the island and coastal stations, near the project area, were used to estimate, on an annual basis, the percentage of wind directions that blow toward the South Coast Air Basin (SCAB). In turn, it is assumed by the regulatory agencies, that such wind directions carry air contaminants emitted over the coastal waters into the South Coast Air Basin. Discussion of the impacts of these emissions is presented in Section 4.3.

Utilizing the Platform Elly site as a reference, wind directions measured clockwise from 123 degrees through 292 degrees (SE through WNW) blow toward the SCAB (see Figure 3.3-9). Conversely, wind directions measured clockwise from the NW through ESE will miss the Basin. For discussion purposes, onshore winds are defined as flow toward the SCAB, and offshore winds as flow away from the SCAB. An analysis of the existing wind data showed the following:

(1) The CUSS I data measurements for the hours 0800 to 2400 showed 35 percent of the observations offshore or away from the SCAB, and 65 percent of the observations onshore or toward the SCAB.

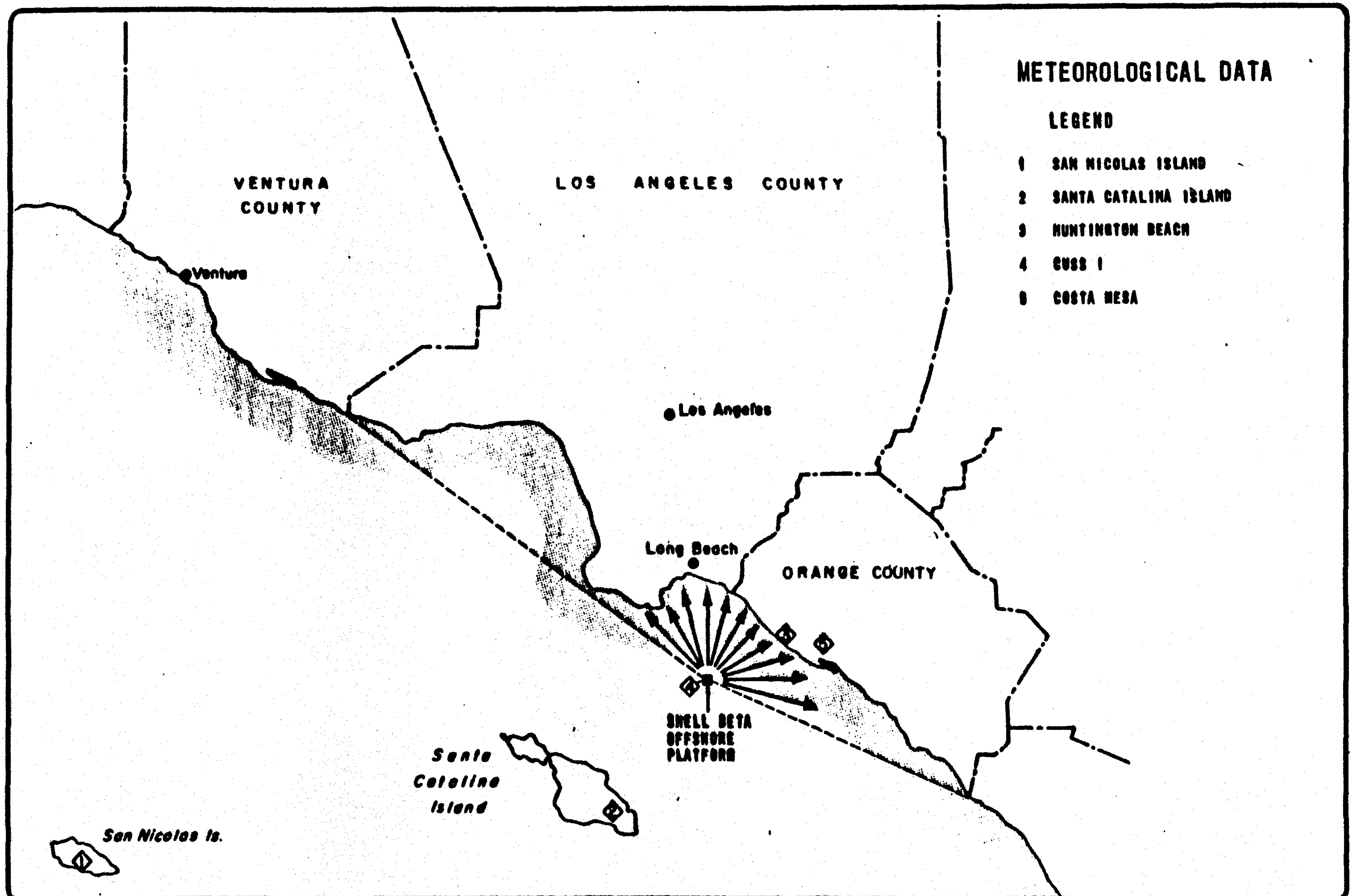
(2) The annual SCAQMD Costa Mesa frequency distribution showed 31 percent of the observations offshore and 69 percent onshore.

(3) At the Huntington Beach Generating Station, annually, the winds blow offshore 35 percent and onshore 65 percent.

(4) The nine months of summarized data at Catalina Island indicated 48 percent offshore flow and 52 percent onshore.

For the purposes of this analysis, percent of winds that were recorded as calm at the four stations were distributed on a percentage basis between onshore and offshore wind directions.

It may be concluded, based on the meteorological information presented, that annually 65 percent of the winds in the vicinity of the platform blow toward directions in the South Coast Air Basin. The data from Huntington Beach and Costa Mesa, as well as the limited CUSS I observations for the hours 0800 to 2400, support these



Transport Winds into SCAB

Figure 3.3-9

conclusions. The Catalina Island data tend to support a more offshore circulation; however, these data are probably biased, due to the location of the instrument and the topographical features of the island.

3.3.1.3 Temperatures

Along the coastal area, temperature fluctuations are small due to the influence of the marine climate. On certain occasions, offshore continental air flow can bring extremes in temperature. Freezing or near freezing temperatures have been recorded at all of the coastal and offshore locations in southern California. The synoptic weather patterns associated with these cold temperatures showed a low pressure system over the southwestern United States pumping cold arctic air directly into the area.

The platform area is more subject to marine airmass controls than the onshore facility locations, and thus would experience smaller diurnal and annual variations in temperature. The highest temperature measured at Catalina Island (Avalon Pier) was 100F (38C) and the lowest was 32F (0C). As mentioned, temperature extremes such as a maximum temperature above 90F (32C) or below 32F (0C) are infrequent. Similarly, other coastal islands such as San Nicolas Island have reported maximum temperatures above 100F (38C) and below 35F (2C). Table 3.3-4 presents maximum and minimum temperatures recorded at selected stations throughout the study area.

3.3.1.4 Precipitation

Precipitation amounts in the study area vary according to site location and local topography. Most of the storms that traverse the area come from the northwest and are preceded by southeast to southwest winds which switch to northwesterly after the passage of the front. The amount of precipitation is dependent upon the time of year and the origin and proximity of the storm system. Infrequent heavy rainfall can occur in winter from storms originating in the lower latitudes. Heavy rainfall amounts can occur and some maximum 24-hour rainfall amounts have occurred during this situation.

Occasionally, subtropical moisture from the Gulf of California and/or the Gulf of Mexico invades the area and produces showers and thundershowers. Tropical disturbances can also create locally heavy rainfall during the late summer and fall. In September 1939, 5.42 inches (13.6 cm) of rain fell in one storm and, in August 1977, a similar situation brought several inches of rain to the Los Angeles area.

Table 3.3-5 presents mean monthly precipitation amounts for selected coastal stations.

TABLE 3.3-4

MAXIMUM AND MINIMUM TEMPERATURES IN THE SOUTHERN CALIFORNIA COASTAL AND OFFSHORE AREAS

Station	Maximum (°F)	Minimum (°F)
Catalina, Avalon Pier	100	32
Chula Vista	105	26
Laguna Beach	106	21
LAX	108	23
Long Beach	111	21
Oceanside	102	29
Pt. Mugu	104	27
San Diego	104	29
Santa Monica	105	33
San Nicolas Island	105	33

Source: U.S. Weather Bureau, "Climatology Summary of the United States - California Summary"

TABLE 3.3-5

MEAN MONTHLY PRECIPITATION IN SOUTHERN CALIFORNIA COASTAL AND ISLAND STATIONS (INCHES)

Station	Month												Annual
	J	F	M	A	M	J	J	A	S	O	N	D	
Avalon Pleasure Pier	2.37	2.4	1.75	1.21	.13	.03	.01	0	.11	.41	1.05	1.94	11.92
Chula Vista	1.64	1.27	1.55	.91	.17	.05	.02	.07	.12	.35	1.19	1.57	8.90
Laguna Beach	2.28	3.27	1.76	1.23	.20	.10	.01	.02	.16	.33	1.58	1.81	11.75
LAX	2.52	2.32	1.71	1.10	.08	.03	.01	.02	.07	.22	1.76	1.75	11.59
Long Beach	3.26	2.16	1.20	.89	.07	.04	0	.02	.09	.19	1.38	1.65	10.25
Oceanside	1.72	1.68	1.63	.81	.14	.08	.04	0	.04	.32	1.41	1.75	9.63
San Diego	1.88	1.48	1.55	.81	.25	.05	.01	.07	.13	.34	1.25	1.73	9.45
San Nicolas	1.42	1.03	.95	.42	.09	.01	.01	.01	.02	.15	1.36	1.04	6.51
Santa Monica	2.52	2.47	1.87	1.07	.06	.01	.03	.04	.02	.01	1.86	2.09	12.36

3.3.1.5 Relative Humidity, Cloud Cover and Visibility

Relative humidity refers to the amount of water vapor present in the air as compared to the greatest amount that could be present at that same temperature. The highest humidity usually occurs in foggy conditions. The normal relative humidity along the coastline varies from 50-60 percent in the afternoon to near 80 percent at night.

Over the ocean, diurnal variations in humidity are small. In the vicinity of the proposed platforms, the daytime relative humidity is in the high 70's while the nighttime relative humidity is about 82 percent.

There are approximately 143 clear, 115 partly cloudy, and 107 cloudy days per year along the immediate coastline. The average sky cover is somewhat less than 50 percent. These observations are reported at the Los Angeles International Airport located northeast of the study area. Elevation and distance from the ocean, as well as other topographical features, can influence the amount of cloud cover over the land. Fog and stratus, usually confined to the night and early morning, occur primarily during the summer. The remainder of the partly cloudy and cloudy days are associated with transitory storm systems in winter. Over the ocean the mean daytime cloud cover is about 55 percent.

There are few, if any, ceiling and visibility data in the project area. Data collected at first order meteorological stations such as Los Angeles International and San Diego can be used to estimate conditions over the coastal waters. Visibility along the coast is frequently restricted by haze, fog, or smoke. Low visibilities are favored by a layer of moist marine air with warm dry air above. Low visibilities usually occur with light winds and stable atmospheric conditions, but at times strong seabreezes can transport an offshore fogbank ashore, lowering the visibility considerably. Heavy fogging resulting in visibility less than 0.25 mile occurs an average of 28 days per year in San Diego and 45 days per year at LAX. Most of these are observed during the winter months. The frequencies of lower ceiling and visibility conditions at the platform locations are expected to be somewhat higher than reported along the coast due to formation and persistence of offshore fog and low clouds.

3.3.1.6 Severe Weather

Hurricanes do not directly affect the offshore coastal areas of southern California. On occasion, however, tropical disturbances from the equatorial zone reach the area. These storms are usually accompanied by widespread heavy rains, which cause flash flooding in low lying areas and the mountains.

California is generally removed from tornadoes but one or two per year may affect the state. Waterspouts usually associated with thunderstorms and frontal activity have been observed on occasion off the coast during periods of extreme instability.

Coastal California usually experiences one or two thunderstorms per year. They usually occur in late summer/early fall, and during the winter months after a frontal passage. The intensity of these storms is usually weak and hail is seldom observed to fall to the ground or ocean. Freezing temperatures in conjunction with precipitation are rare along the coastal waters of California; the probability of freezing rain, drizzle, or sleet is extremely remote.

3.3.1.7 Dispersion Meteorology

The primary meteorological parameters which control the dispersion of air contaminants are ventilation and vertical temperature stratification (air mass stability). Air movement in both the vertical and horizontal directions are key elements in the dispersion process. The atmospheric temperature stratification determines the depth through which pollutants can mix, and controls vertical air currents to a large degree. The dispersion potential tends to be poorest in sheltered areas such as inland valleys and best along the seacoast and other exposed locations.

Atmospheric stability near the ground is dependent primarily upon solar radiation and wind speed. Stability can be categorized as follows:

- Unstable - The lapse rate of temperature is greater than adiabatic (1C/100 meters of ascent) which supports the vertical dispersion of pollutants.
- Neutral - The lapse rate of temperature is equal to the adiabatic and the vertical dispersion of pollutants is indifferent.
- Stable - The lapse rate of temperature is less than adiabatic which inhibits the vertical dispersion of pollutants.

The dispersive power has been further divided into stability classes designated A through G, in which A is the most unstable and G is the most stable. Category D is the neutral case, while E, F, and G represent slight, moderate, and extreme stability.

The third important meteorological factor used to evaluate the air pollution potential of an area is the depth of the mixing layer, which is defined as the height above the surface through which relatively vigorous vertical mixing occurs. The top of the mixed layer is usually the base of an elevated temperature inversion (temperature increasing with height). In an inversion layer, vertical motion is inhibited and pollutant dispersion is reduced to the volume of air below the inversion base.

The height of the inversion base with respect to mean sea level is lowest along the north coastal parts of the Los Angeles

Basin, and increases in height toward the south and over the interior portions. The inversion base is also subject to daily oscillations. Both coastal and inland areas experience lowest mixing heights during the early morning hours. These daily variations in the inversion height bring about corresponding variations in the levels of pollution in the Basin. Table 3.3-6 shows the mean seasonal and annual morning and afternoon height for selected coastal stations. Annual and seasonal stability frequency distributions for selected coastal stations in southern California are summarized in Table 3.3-7.

Because of the differences in solar radiation absorbing surfaces (land versus water), there may be some minor differences in the frequency of extremely stable and unstable stability categories between the offshore waters and a coastal station. This is due in part to the following:

(1) Extreme stability or instability is less likely to occur over a water surface due to its conservative temperature components.

(2) During the evening hours, when surface winds are offshore, the stability F category would be less over the water than indicated at a coastal station.

In spite of these differences, due to the proximity of the proposed offshore platforms to the coastal stations, significant differences in dispersion conditions are not expected to occur between the two areas. Utilizing available data from a coastal station can be assumed to be valid for the impact analysis of the proposed offshore sources.

The period of record of the stability data was 1960-1964 at Long Beach and 1965-1969 at Los Angeles. The tables were summarized for the summer, winter, and annual periods. As can be seen, neutral and stable stability conditions occur most frequently. Stable conditions are usually associated with drainage land (offshore) breezes and occur to a greater extent in winter when the Pacific High pressure system is less dominant. The large percentage of neutral stabilities is indicative of the climate experienced at both Los Angeles and Long Beach in all seasons.

Unstable conditions are shown to occur most frequently during the summer months at both stations. This is due primarily to a greater percentage of sunny days and increased surface heating. This destabilization of the atmosphere tends to accelerate the diffusion process of air contaminants. However, even during the summer months the frequency for occurrence of unstable meteorological conditions along the coast is small as a result of the persistent marine climate.

TABLE 3.3-6

MEAN SEASONAL AND ANNUAL MORNING AND AFTERNOON MIXING HEIGHTS (m)

Station	Period	Season				Annual
		Winter	Spring	Summer	Fall	
Santa Monica	Morning	422	676	562	510	542
	Afternoon	893	973	603	798	814
San Diego	Morning	535	851	538	578	625
	Afternoon	1021	1085	566	834	877
Santa Barbara	Morning	470	720	400	500	523
	Afternoon	850	900	580	700	758

Source: Holzworth, G.C., (1972)

TABLE 3.3-7

SEASONAL AND ANNUAL STABILITY CLASSES

Pasquill Classification[1]	Percent Frequency of Occurrence		
	Summer	Winter	Annual
Long Beach Airport			
A	0.7	0.09	1.3
B	3.4	1.7	9.6
C	3.6	3.4	13.7
D	9.7	8.6	37.3
E	2.2	2.7	9.8
F	5.5	8.6	28.3
Los Angeles International Airport			
A	0.04	0.0	0.09
B	1.3	0.6	4.1
C	4.5	3.6	14.8
D	13.2	10.0	48.2
E	2.6	4.3	13.4
F	3.6	6.2	19.5

Source: National Climatic Center, Asheville, North Carolina (1972)

[1] Refer to page 139 for definition

3.3.2 Air Quality

3.3.2.1 Introduction

The air quality in any region is determined by a combination of factors: rate of pollutant emissions, meteorology (wind speed and stability), and solar radiation. Solar radiation is a major factor in the incidence of photochemical smog. Wind patterns modified by topographical characteristics can increase air pollution potential. Air quality can vary considerably in spite of constant levels of pollutant emissions. Atmospheric conditions are the major factors that determine the short-term changes in air quality. Long-term changes result from variations in total pollutant emissions.

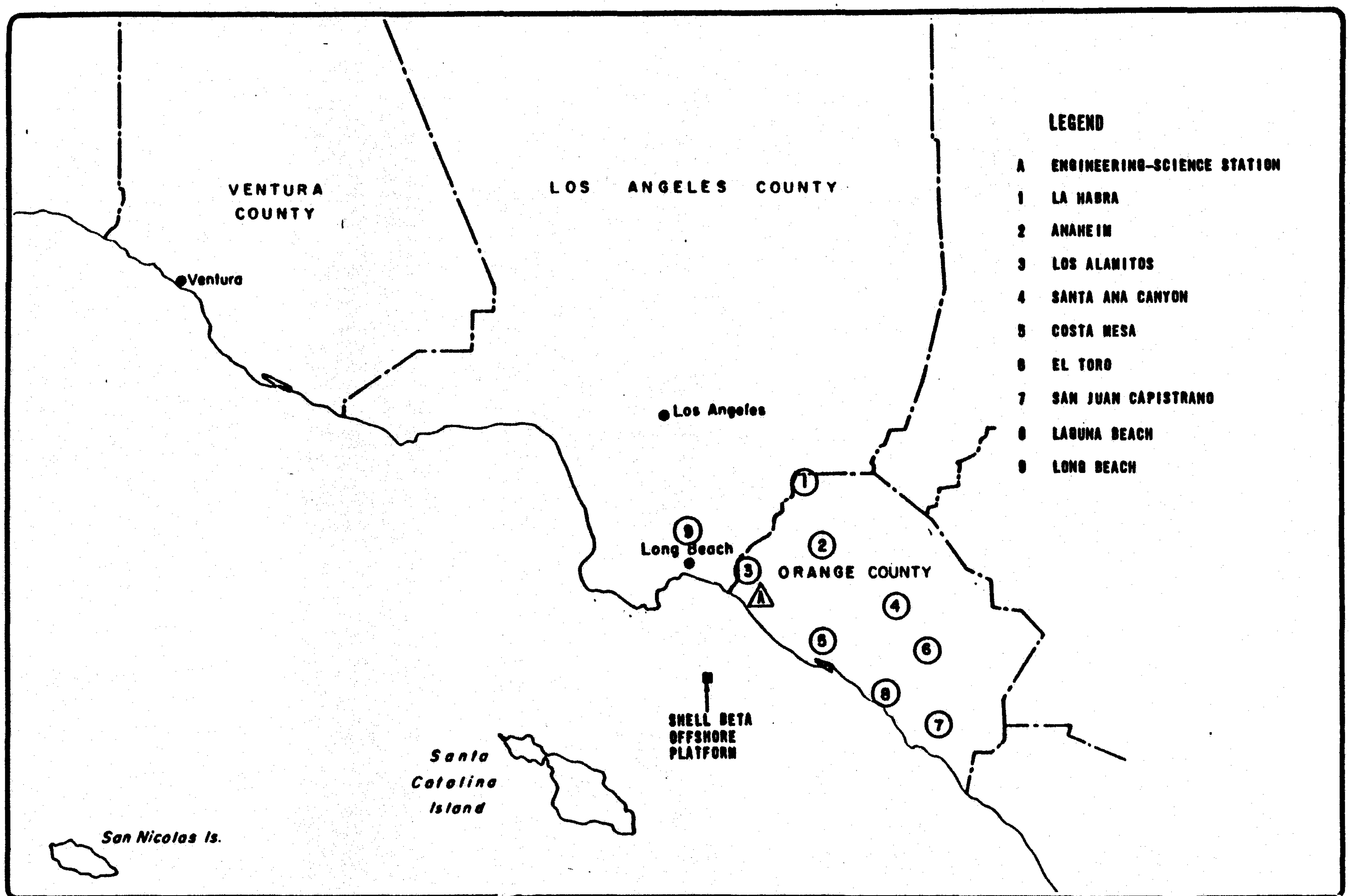
The South Coast Air Basin has a high potential for air pollution due to its geographic location between the sea and the high mountain ranges, its low average wind speeds, intense solar radiation, and the trapping effect of pollutants resulting from frequent, strong, temperature inversions. The coastline area of the South Coast Air Basin has very good air quality. The pollutant concentrations seldom exceed any existing air quality standards. The only time that air quality along the coastline is not good is during some of the periods of offshore wind flow. Offshore wind flow can occur for prolonged periods during Santa Ana wind conditions, at night during times when the drainage wind is stronger than the normal westerly wind gradient, or during periods of rain. Obviously, during rain conditions air quality is still good. The relationship of the Shell Beta project to the South Coast Air Basin and various monitoring stations are shown in Figure 3.3-10.

The proposed project is closest to the shoreline in the Huntington Beach area. The two air quality monitoring stations that are considered to be most representative of the coastal area adjacent to the project are Costa Mesa and Laguna Beach. A baseline air quality monitoring station has been installed in the Bolsa Chica Ecological Reserve. Data will be collected at this location for a three-month period. Current air quality levels at specific locations in the vicinity of the proposed project are presented in the following sections of this chapter.

Another condition that limits the downwind concentration of pollutants is the deposition and retention of a pollutant on a surface. In this case, the pollutants could be absorbed by the ocean surface. This phenomena will be discussed in more detail in Section 4.3.

3.3.2.2 Costa Mesa

The air quality of Costa Mesa is generally very good. This is determined by the number of days per year that state air standards are met or exceeded. Costa Mesa has had relatively few days with contaminants reaching these high concentrations. The



Air Monitoring Stations in Site Vicinity

Figure 3.3-10

methods of air monitoring in this vicinity are: Potassium Iodide - KI (O_3), Infrared - IR (CO), Saltzman - SLZ (NO_x), Coulometric - COU (SO_2), and High Volume - Hi-Vol (TSP). The resultant concentrations are presented in Table 3.3-8. The Costa Mesa air quality monitoring station is located about 3.2 miles (5.1 km) inland from the coast. The location of this station with respect to the project is shown in Figure 3.3-10.

The Costa Mesa site is typical of locations in the coastal areas of the South Coast Air Basin. The overall air quality for the base year 1976 is good. Air quality generally improves with nearness to the coastline.

Even though Costa Mesa exceeded the California standards for oxidant ten days out of the year, the maximum value of oxidant was only 0.16 ppm. The typical inland station in the South Coast Air Basin reached a maximum of 0.30 to 0.40 ppm and exceeded the California standard from 120 to 185 days during the year. Only four inland locations exceeded the standard for SO_2 during the year. As shown in Table 3.3-8, Costa Mesa did not exceed the SO_2 standard. Costa Mesa did exceed the NO_2 standard eight times during the year, with a maximum value of NO_2 of 0.34 ppm. The Metropolitan monitoring station exceeded the NO_2 standard at anywhere from 15 to 55 days with recorded maximums of 0.30 to 0.55 ppm.

All stations within the South Coast Air Basin exceeded the particulate matter (TSP) standards during 1976. However, Costa Mesa exceeded the TSP standards only 17 days during the year, while most non-coastal stations exceeded the standard from 25 to 45 days.

3.3.2.3 Laguna Beach

Laguna Beach has never had a full air monitoring station. Only CO and TSP data have been collected, utilizing the IR and Hi-Vol methods, respectively Noting the geographic location, however, it is very probable that the air quality of the area is generally very good. This station was discontinued during 1977 with the last full year of data being 1976. The air data for Laguna Beach is presented in Table 3.3-9.

3.3.2.4 Bolsa Chica

An air quality monitoring site was installed in August 1978 in the Bolsa Chica Ecological Reserve located next to the Bolsa Chica State Beach. The data will be used to perform a background air quality study for this project. Measurements of SO_2, NO_x, NO, wind speed, and wind direction were recorded on a continuous basis. Particulate matter (TSP) was measured at three-day intervals with every sixth day scheduled to match the South Coast Air Quality Management District monitoring schedule. The Bolsa Chica monitoring site is approximately 9.4 miles (15.1 km) northeast of Platform Elly, and 1735 feet (0.5 km) inland from the shoreline. The location of the site is shown in Figure 3.3-10.

TABLE 3.3-8

NUMBER OF DAYS CALIFORNIA AIR QUALITY STANDARDS EQUALED OR EXCEEDED IN COSTA MESA[a] IN 1976

Air Contaminant	State Air Quality (Averaging Time)	Number of Days Not Meeting Standard
Ozone (O_3)	0.10 ppm (1-hour)	10
Carbon Monoxide (CO)	10.0 ppm (12 hours)	29
Nitrogen Dioxide (NO_2)	0.25 ppm (1-hour)	8
Sulfur Dioxide (SO_2)	0.05 ppm (24 hours)	0
Particulate Matter (TSP)	100 $\mu g/m^3$ (24 hours)	17

TABLE 3.3-9

NUMBER OF DAYS CALIFORNIA AIR QUALITY STANDARDS EQUALED OR EXCEEDED IN LAGUNA BEACH[a] IN 1976

Air Contaminant	State Air Quality (Averaging Time)	Number of Days Not Meeting Standard
Carbon Monoxide (CO)	10 ppm (12 hours)	0
Particulate Matter (TSP)	100 $\mu g/m^3$ (24 hrs)	12

(a) Location of monitoring station shown on Figure 3.3-10

Source: South Coast Air Quality Management District, "Air Quality and Meteorology", 1976 Annual Report

Data collected from this site will be compared to the Costa Mesa monitoring site. It is expected that the air quality at this site, because of its proximity to the coastline, will be better than the Costa Mesa site. Air quality measurements will be correlated with meteorological conditions to determine the dependence of air quality with offshore and onshore air flow.

(1) Monitoring Equipment

The ambient air monitoring and meteorological equipment, with the exception of the suspended particulate monitor, were continuous measurement systems.

The gaseous analyzers and recorders were housed inside an air conditioned shelter. The high volume particulate samplers and the meteorological instrumentation were mounted on the roof of the shelter. A glass manifold/intake was used to route the sample air to the continuous analyzers. The intake mouth was at a height of 12 feet (3.7 m) above the roof of the shelter. The air quality monitoring instruments that were used and the appropriate federal reference or equivalent methods are listed in Table 3.3-10.

(2) Monitoring Station Operation

A full time technician manned the station five days per week during the hours of 0800 to 1700, normally during Monday through Friday unless the Hi-Volume sampling schedule of once every three days coincided with a weekend day. Upon arrival at the station, a check list was completed. This form served as a daily record of station status and included overall station integrity, Hi-Vol condition, intake manifold condition, analyzer status, and weather station status. Calibration checks of zero and span were performed on a daily basis. Multi-point calibrations were performed on a monthly basis plus at the beginning and end of the monitoring period. Data were checked each day and returned to the main office for reduction once per week. All data were recorded on Pacific Standard Time. The first month's preliminary data are presented in the following section.

(3) Monitoring Station Data

Thirty-one days of data from the Bolsa Chica monitoring site have been reduced. Detailed summaries and analyses of the data will be presented at a later date when the monitoring program has been completed. The entire data set will be compared to the SCAQMD monitoring station at Costa Mesa. At this time, the data from the Bolsa Chica site are not available for any preliminary comparisons.

A preliminary evaluation of the Bolsa Chica data indicates the following:

TABLE 3.3-10

METHOD OF MEASUREMENT AND INSTRUMENTATION

Parameter	Method	Instrumentation
Particulate Matter (TSP)	Gravimetric. Federal reference method 40CFR40 Appendix B	General Metal Works, Model GMWL200H High Volume Sampler
Sulfur Dioxide	Flame Photometric, Federal equivalent method, Designation No. EQSA-0876-013	Monitor Labs Model 8450E SO_2 Analyzer
Nitrogen Oxides (NO/NO_x)	Chemiluminescence. Federal Reference Method 40CFR50 Appendix F	Monitor Labs Model 8840E Nitrogen Oxides Analyzer

(a) Hi-Vol data: Both the California and the national 24-hour standards were exceeded only once. This occurred during the period when tropical storm "Norman" was affecting the southern California weather patterns. The next highest reading was recorded during the period of prolonged Santa Ana conditions at the end of September 1978. So far 10 percent of the days sampled have exceeded the California 24-hour standard. As a comparison, 28 percent of the days sampled during 1976 at Costa Mesa exceeded the California 24-hour standard.

(b) NO_2 data: The California 1-hour standard was exceeded twice during the 31-day period. Maximum concentration recorded was 0.35 ppm. The maximum concentrations occurred during the Santa Ana conditions at the end of September, 1978.

(c) SO_2 data: SO_2 concentrations did not exceed either the California or national standards for a 24-hour period or the California 1-hour standard. The maximum 1-hour concentration recorded was 0.03 ppm. The maximum 24-hour average was 0.009 ppm. The maximum concentrations of SO_2 also occurred during the Santa Ana conditions at the end of September 1978.

The preliminary evaluation of the data at the Bolsa Chica site support the general conclusion that generally the air quality along the southern California coastline is very good. Low concentrations of NO_2, SO_2 and particulates occur with onshore flow. The highest concentrations of gaseous pollutants along the coastline will occur with offshore flow. This was indicated by the SO_2 and NO_2 data taken during the Santa Ana conditions. The maximum concentration of particulates for this location will occur during offshore flow and gusty wind conditions.

3.3.2.5 South Coast Air Quality Management District

(1) Ambient Conditions

The air quality of the South Coast Air Basin has been generally improving over the past decade. Even with the improvement, on a majority of the days during the year the state standards are exceeded. As would be expected, most of the days of high contaminant levels are experienced at the inland monitoring stations. The number of days that the state standards are equaled or exceeded in the SCAB are shown in Table 3.3-11.

TABLE 3.3-11

NUMBER OF DAYS CALIFORNIA AIR QUALITY STANDARDS EQUALED OR EXCEEDED IN SOUTH COAST AIR BASIN [a] IN 1976

Air Contaminant	State Air Quality Standard (Averaging Time)	Number of Days Not Meeting Standard
Ozone (O_3)	0.10 ppm (1 hour)	238
Carbon Monoxide (CO)	10.0 ppm (12 hours) 40.0 ppm (1 hour)	119
Nitrogen Dioxide (NO_2)	0.25 ppm (1 hour)	97
Sulfur Dioxide (SO_2)	0.5 ppm (1 hour) 0.05 ppm (24 hours)	73
Particulate Matter	60 $\mu g/m^3$ (annual)	365

(a) South Coast Air Basin shown on Figure 3.3-10

SOURCE: South Coast Air Quality Management District, "Air Quality and Meteorology", 1976 Annual Report

(2) Existing Emissions

The Beta project location is southwest of the Huntington Beach area. The South Coast Air Quality Management District summarizes emission inventory data for the entire district and for each county of the district. The last full year of data that have been summarized are for 1975. The emission inventories for the entire District and Orange County for carbon monoxide, sulfur dioxide, nitrogen oxide, particulate matter, and organic gases are presented in Tables 3.3-12 and 3.3-13.

(3) Rules and Regulations

The New Source Review Rule (Rule 213) was adopted on October 8, 1976 for the South Coast Air Quality Management District. This rule states that the Air Pollution Control Officer (APCO) will refuse permission to construct a new stationary emission source if it does not meet the appropriate requirements of subsections (b) or (c) of the rule.

Subsection (b) maintains that the APCO will deny an authority-to-construct permit for a new source that will emit more than 15 pounds per hour or 150 pounds per day of nitrogen oxides or organic gases unless the best available control technology will be utilized by the new source.

Subsection (c) states that the APCO will deny an authority-to-construct permit to a new source emitting 25 pounds per hour or 250 pounds per day of nitrogen oxides or organic gases unless he decides that the emissions from the new source will not result in a violation of, or will not interfere with the attainment of, the state or national ambient air quality standard for the contaminant. It is also a provision of Rule 213 that the APCO may exempt the proposed new source from the requirements of subsection (c) if it can be proven that the new stationary source:

> "will cause demonstrable air quality benefits within the air basin, provided, however, that written concurrence of the California Air Resources Board and the Environmental Protection Agency shall be obtained prior to the granting of an exemption hereunder."

The APCO may exempt from the provisions of subsection (c) of this Rule 213 any new stationary source that utilizes unique and innovative control technology which will result in a significantly lower emission rate from the stationary source than would have occurred with the use of previously known best available control technology to be applied to similar stationary sources within the state.

(4) Projected Air Quality Trends

The existing air quality maxima for oxidant and

TABLE 3.3-12

EMISSION INVENTORY FOR SOUTH COAST AIR BASIN [a] IN 1975
(Tons/Year)

Contaminant	Stationary Source	Mobile Source	Misc. Area Source	Totals
Non-Methane Organic Gases	218,715	258,755	27,440	504,910
Organic Gases	231,980	272,965	27,440	532,385
TSP	31,570	45,920	29,330	106,820
NO_x	136,115	380,030	3,745	519,890
SO_2	114,170	25,585	0 [b]	139,755
CO	109,445	2,434,425	166,215	2,710,085

TABLE 3.3-13

EMISSION INVENTORY FOR ORANGE COUNTY [a] IN 1975
(Tons/Year)

Contaminant	Stationary Source	Mobile Source	Misc. Area Source	Totals
Non-Methane Organic Gases	30,940	44,170	2,415	77,525
Organic Gases	34,405	46,935	2,415	83,755
TSP	1,680	7,105	2,660	11,445
NO_x	7,735	61,005	140	68,880
SO_2	8,715	3,395	0 [b]	12,110
CO	1,435	420,175	10,640	432,250

(a) Last year that has been summarized
(b) Less than 0.05 ton/day

SOURCE: South Coast Air Quality Management District, 1975 particulate matter for the SCAB is still above the limit set by the state standard. The necessary reductions to meet federal and state standards are presented in Tables 3.3-14 and 3.3-15.

At present, the annual particulate background alone contributes 40 $\mu g/m^3$ as compared to the standard of 60 $\mu g/m^3$. However, at the present time, the South Coast Air Basin, including Orange County, has been designated as an attainment area for SO_2; this designation is not expected to change by 1987.

Between 1982 and 1987, Orange County and Los Angeles County are projected to have CO concentrations which are from 31 to 51 percent in excess of the standards.

By 1987, the NO_2 standard will be 57 percent in excess of the state standard, and 20 percent in excess of the federal standard for the South Coast Air Basin. Total hydrocarbons for the South Coast Air Basin are projected to exceed the standards by 1987 by 34 to 65 percent. Current and projected emissions in the SCAQMD for oxides of nitrogen, particulates, sulfur dioxide, and carbon monoxide are presented in Figures 3.3-11, 3.3-12, 3.3-13 and 3.3-14.

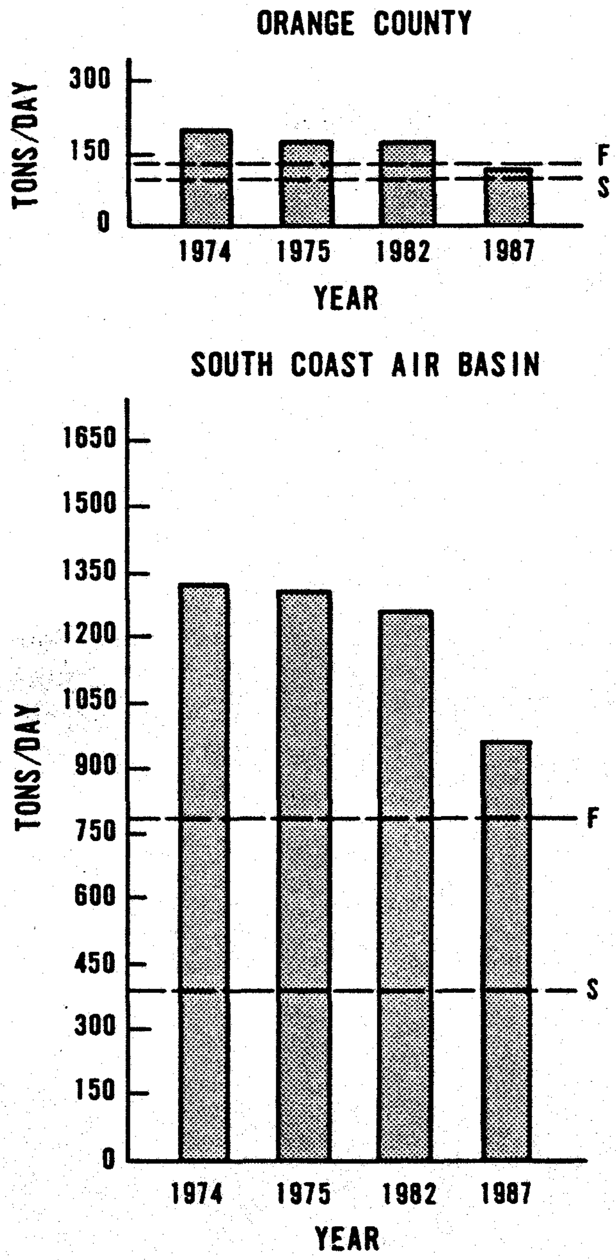
3.3.2.6 State and Federal Standards and Regulations

The EPA has provided specific quantifications as to the incremental level of pollution that would be considered as contributing to an existing violation of National Ambient Air Quality Standards (NAAQS). This is applicable when a major source is to be located in a "clean" area (locality in which primary and secondary standards are being met); however, the source might impact an area that does exceed a NAAQS some distance away, as is the case with the proposed project. The applicable standards are presented in Table 3.3-16.

These standards were set in an effort to protect the public health and six pollutants are now covered by existing NAAQS. These six pollutants are hydrocarbons (HC), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), suspended particulate matter (TSP), and photochemical oxidants (O_x).

The California Ambient Air Quality Standards (CAAQS) also apply to the aforementioned pollutants covered by the national standard. In addition to these, the California standards include five more contaminants. These are sulfates, airborne concentrations of lead, hydrogen sulfide, ethylene, and visibility reducing particles. In the event that the federal and state standards are not the same, the more stringent rule is to be followed.

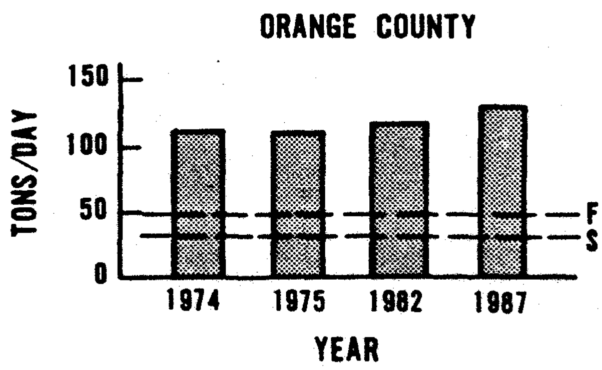
On December 21, 1976, EPA issued an Interpretive Ruling addressing the issue of whether and to what extent NAAQS established under the Clean Air Act may restrict or prohibit construction of major new or expanded stationary pollution sources. At the heart of

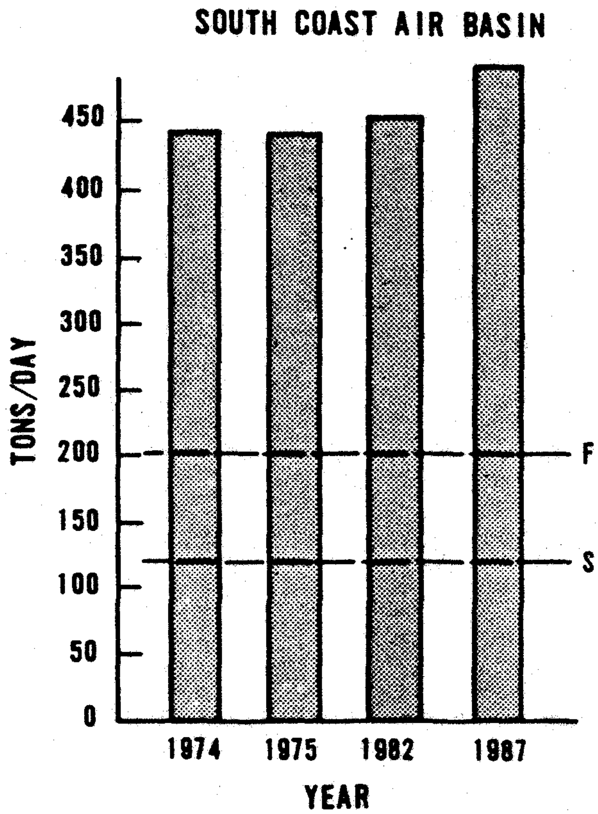


F ALLOWABLE EMISSIONS TO MEET FEDERAL STANDARDS.
S ALLOWABLE EMISSIONS TO MEET STATE STANDARDS.

SCAQMD Average Emissions: Oxides of Nitrogen—Tons/Day

Figure 3.3-11

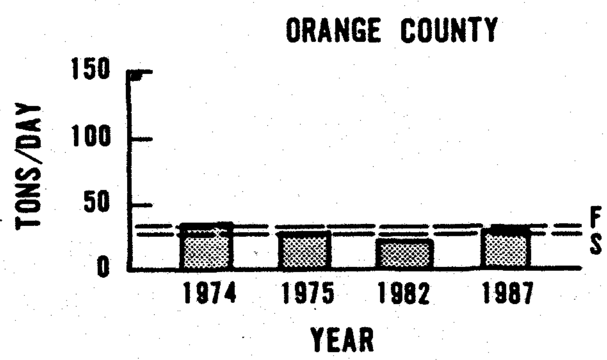


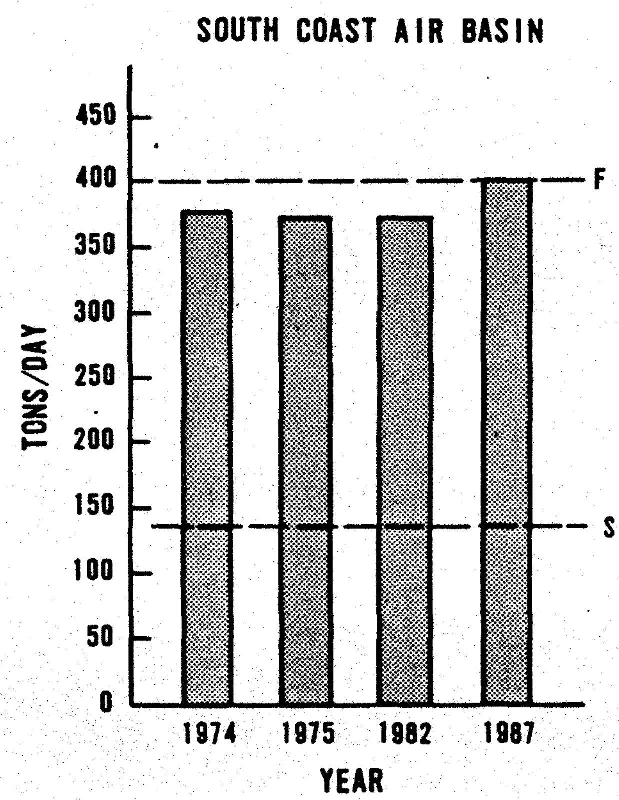


F ALLOWABLE EMISSIONS TO MEET FEDERAL STANDARDS.
S ALLOWABLE EMISSIONS TO MEET STATE STANDARDS.

SCAQMD Average Emissions: Particulates—Tons/Day

3.3-12 Figure

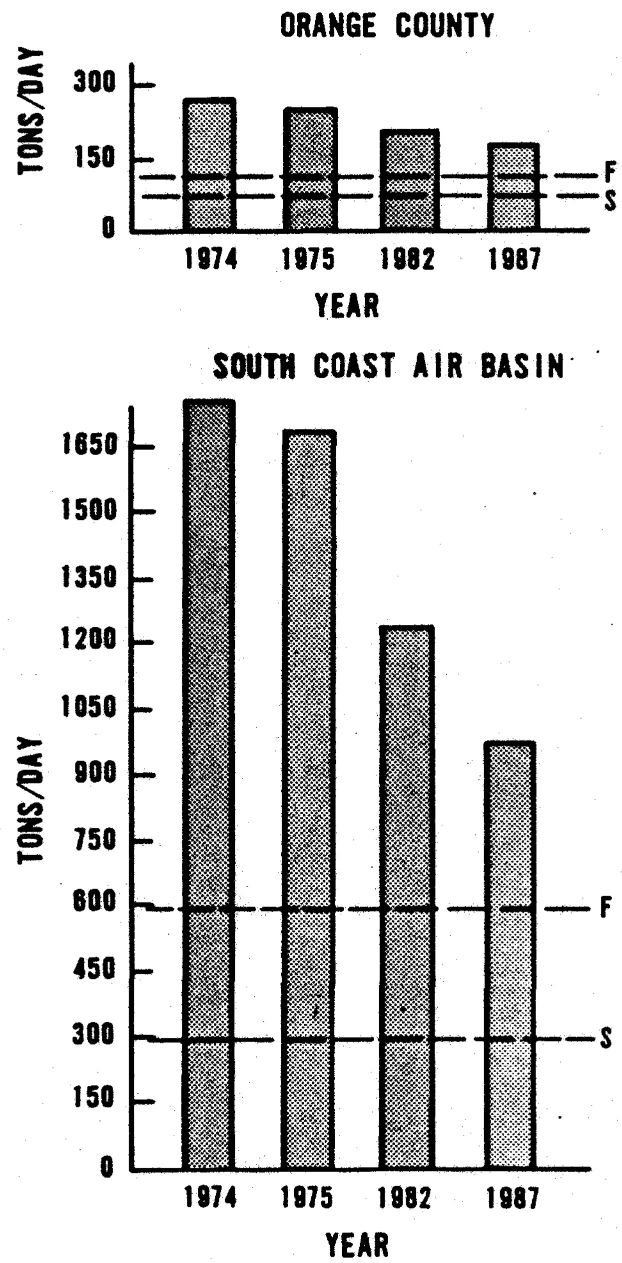




F ALLOWABLE EMISSIONS TO MEET FEDERAL STANDARDS.
S ALLOWABLE EMISSIONS TO MEET STATE STANDARDS.

SCAQMD Average Emissions: Sulfur Dioxide—Tons/Day

Figure 3.3-13



F ALLOWABLE EMISSIONS TO MEET FEDERAL STANDARDS.
S ALLOWABLE EMISSIONS TO MEET STATE STANDARDS.

SCAQMD Average Emissions: Hydrocarbon—Tons/Day

3.3-14 Figure

TABLE 3.3-14

EMISSION REDUCTIONS NEEDED IN 1982 TO MEET FEDERAL AND STATE STANDARDS[a]

SCAB (Tons/Day)

Pollutant	Standard	1974 Emissions	1982 Allowable Emissions	1982 Projected Emissions	Emission Reductions Needed in 1982	Percent Reduction From 1982 Emissions
THC	Federal O_3 and NO_2	1620	578	1159	581	50%
	Federal O_3 and State NO_2		305		854	74%
NO_x	Federal	1322	804	1259	455	36%
	State		431		828	66%
SO_x	Federal	400	425	393	---	---
	State		147		246	63%
CO	Federal	9037	2495	5056	2561	51%
	State		2786		2270	45%
TSP	Federal	457	202	468	266	57%
	State		116		352	75%

(a) Source: Draft Air Quality Management Plan, Southern California Association of Governments and the South Coast Air Quality Management District, August, 1978.

TABLE 3.3-15

EMISSION REDUCTIONS NEEDED IN 1987 TO MEET FEDERAL AND STATE STANDARDS[a]

SCAB (Tons/Day)

Pollutant	Standard	1974 Emissions	Allowable Emissions	1987 Projected Emissions	Emission Reductions Needed in 1987	Percent Reduction From 1987 Emissions
THC	Federal O_3 and No_2	1620	578	878	300	34%
	Federal O_3 and State NO_2		305		573	65%
NO_x	Federal	1322	804	1011	207	20%
	State		431		580	57%
SO_x	Federal	400	425	423	---	---
	State		147		276	65%
CO	Federal	9037	2495	4061	1566	39%
	State		2786		1275	31%
TSP	Federal	457	202	501	299	60%
	State		116		385	77%

(a) Source: Draft Air Quality Management Plan, Southern California Association of Governments and the South Coast Air Quality Management District, August, 1978.

TABLE 3.3-16

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS), CALIFORNIA AMBIENT AIR QUALITY STANDARDS (CAAQS) AND FEDERAL PREVENTION OF SIGNIFICANT DETERIORATION (PSD) SIGNIFICANCE LEVELS

Pollutant	Regulation	Maximum Concentration ($\mu g/m^3$)	Averaging Time
SO_2	NAAQS	80	Annual
	NAAQS	365	24-Hour
	NAAQS	1,300	3-Hour
	CAAQS	131*	24-Hour
	CAAQS	1,310	1-Hour
	PSD	1	Annual
	PSD	5	24-Hour
	PSD	25	3-Hour
TSP	NAAQS	60	Annual
	NAAQS	150	24-Hour
	CAAQS	60	Annual
	CAAQS	100	24-Hour
	PSD	1	Annual
	PSD	5	24-Hour
NO_2	NAAQS	100	Annual
	CAAQS	470	1-Hour
	PSD	1	Annual
CO	NAAQS	40,000	1-Hour
	NAAQS	10,000	8-Hour
	CAAQS	46,000	1-Hour
	CAAQS	10,000	12-Hour
	PSD	2,000	1-Hour
	PSD	500	8-Hour
NMHC	NAAQS	160	3-Hour
O_3	NAAQS	160	1-Hour
	CAAQS	200	1-Hour

* At locations where the state standard for oxidant and/or suspended particulate matter are violated.

this Interpretative Ruling is the offset or trade-off policy, whereby new sources could be allowed in non-attainment areas if the new or expanded source owner could insure emissions from existing sources in the area could be reduced an equal or greater amount than the new or expanded sources could emit. The Ruling requires that emission reductions from the trade-off sources, when combined with the new source emissions, result in a "net air quality benefit in the affected area."

"Significance Levels" have been included in the Ruling. They are generally based on Class I prevention of significant deterioration (PSD) increments found in Section 163 of the Clean Air Act. Significance increments are not specified for photochemical oxidants. This is due to the inadequacy of the atmospheric simulation models to predict the air quality impact of a single source of volatile organic compounds (VOC).

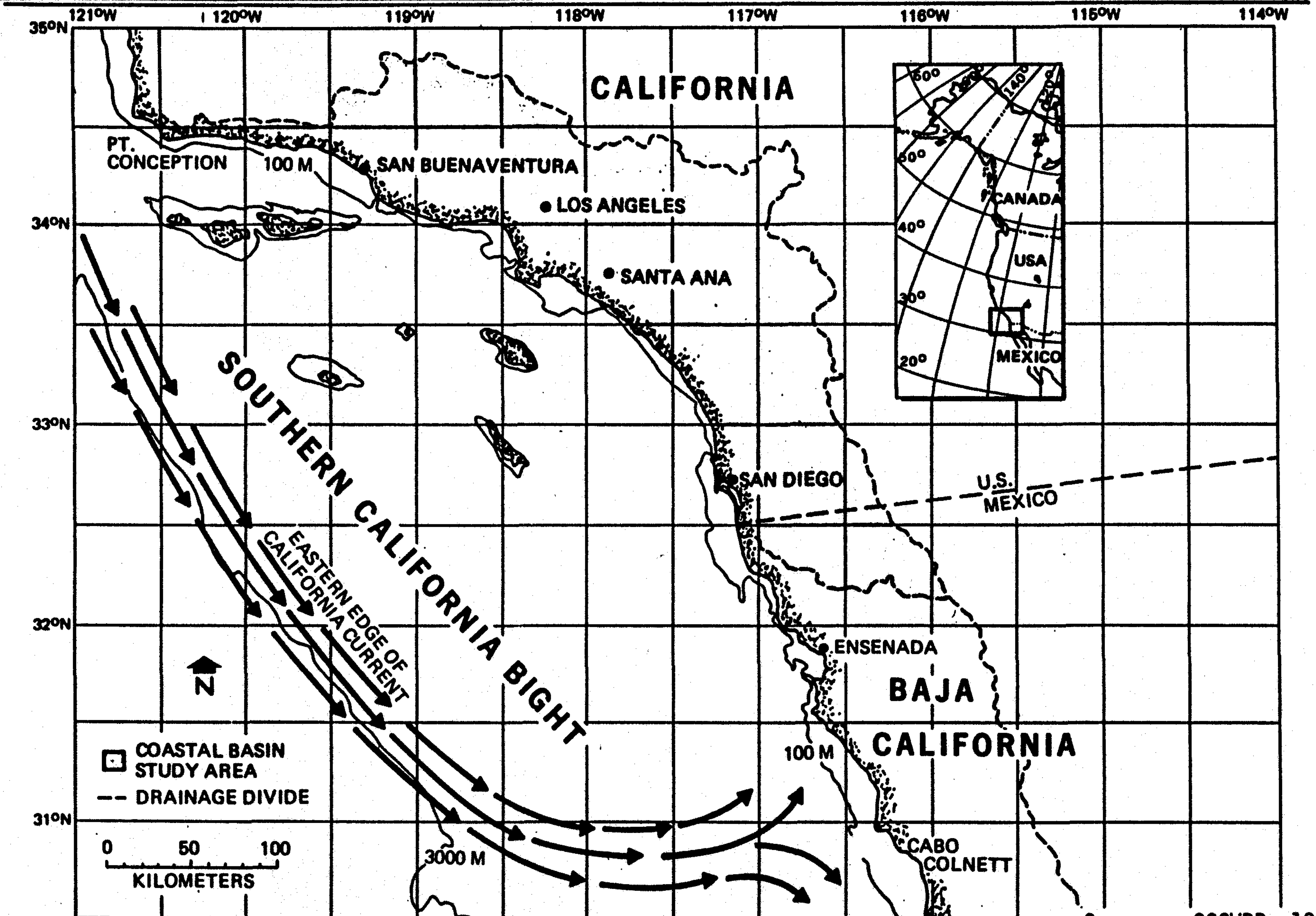
3.4 OCEANOGRAPHIC SETTING

The Shell Beta project study area lies within a much larger area referred to as the Southern California Bight (Figure 3.4-1). Most areas of the Bight are influenced by a common oceanic current pattern which affects local oceanographic conditions. The Bight area is bounded by the eastern edge of the California current and includes the open embayment extending from Point Conception to Cabo Colnett in Baja California, Mexico. Oceanographic conditions within the Bight are highly varied as a result of locally induced current and water circulation patterns influenced by natural and artificial structures.

Estimates indicate that water moving around the Channel Islands within the Southern California Bight is replaced about three to four times per year (Jones, 1971). Inshore waters are estimated to turn over at a rate of no greater than once per year (Fay, 1971). Such estimates indicate that although the oceans are considered limitless by many, the nearshore waters represent a somewhat closed ecosystem. This turnover rate is of key importance in understanding the factors which contribute to marine productivity and the effects that man's activities can have on this ecosystem.

A physical-chemical oceanographic field study was conducted by the Environmental Sciences Division of Brown and Caldwell between July 18 and July 26, 1978. The primary objective of the study was to gather site specific data for the proposed Shell Beta development so as to substantiate the validity of existing background information.

The scope of work included a single comprehensive examination of representative physical and chemical oceanographic parameters within the study area. Parameters examined included physical oceanographic measurements for currents, temperature, salinity, density, hydrogen ion concentration, dissolved oxygen, transmissivity, and solar irradiance, as well as chemical receiving water and sediment analyses for nutrients, grease and oil, trace metals, organic content, and coliform organisms.



Source: SCCWRP, 1973

Southern California Bight

3.4-1
Figure

The results of the study, which are provided in the Technical Appendix (Vol. III), concluded that all parameters measured around the Shell Beta platform site and pipeline route were typical of waters within the Southern California Bight and that all concentrations and measurements were in agreement with background research data collected by other agencies referenced in this report.

3.4.1 Physical Characteristics

The physical characteristics discussed in this section include currents, waves, tides, tsunamis, temperature, and transparency.

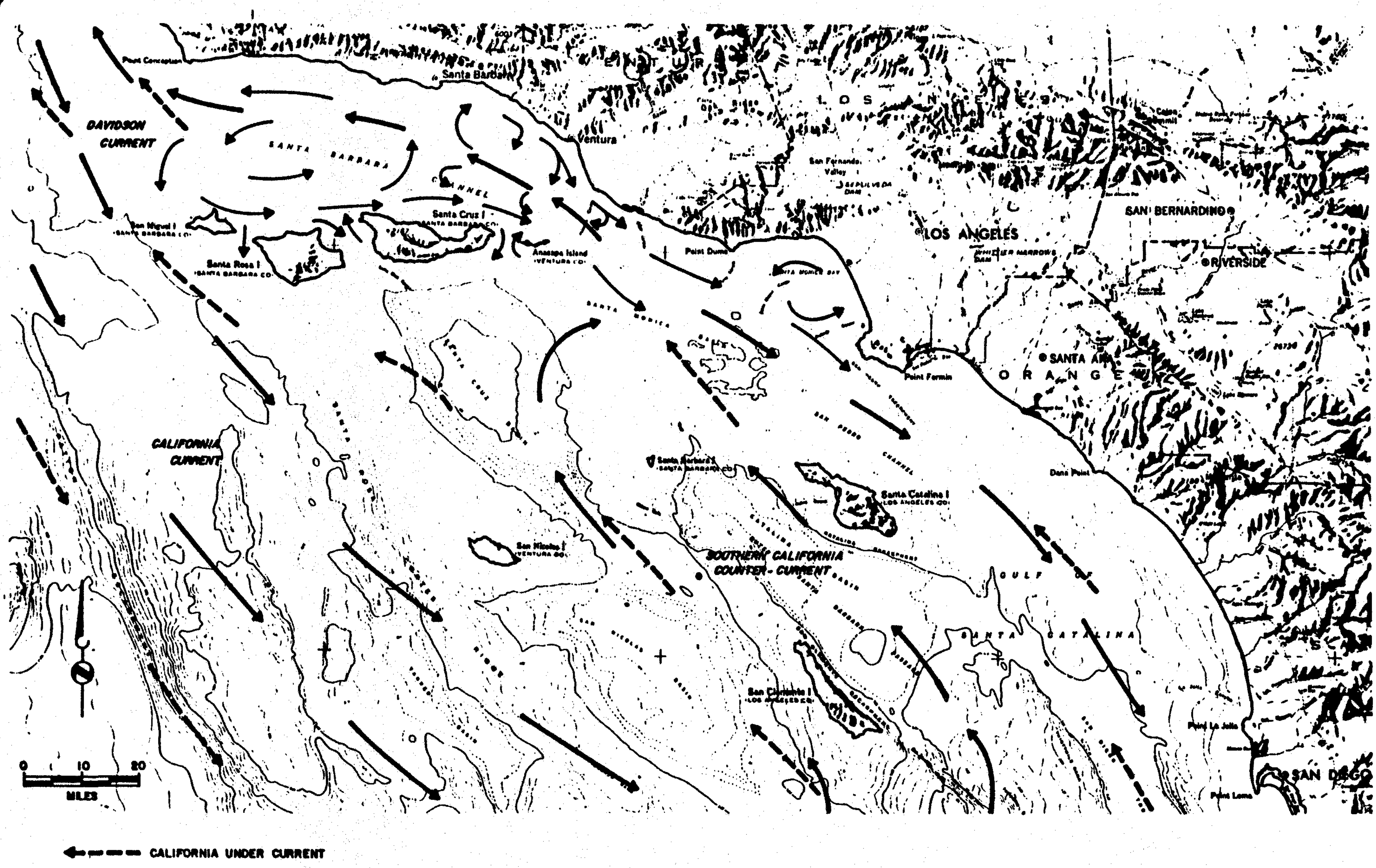
3.4.1.1 Currents

The project area is located within San Pedro Channel. The currents that flow in the region of the project site are termed coastal currents (Figure 3.4-2). The currents are complex in this region because water movements are the result of the action and interaction of a number of small-to-oceanic-scale forces along the rough fluid boundary formed by the Pacific Coast east of Point Conception. The overall pattern of circulation within the Southern California Bight is primarily a result of the interaction of the California Current system with locally-generated wind-drift currents and tidal currents.

The two major currents within the Southern California Bight are the California Current and the Southern California Countercurrent. The California Current is part of the general clockwise pattern of surface water circulation in the northern Pacific Ocean. The current flows southeast along the California coast. Within the Southern California Bight, the California Current lies outside of the 5,000 foot (1524 m) depth contour. Offshore of northern Baja California, the main portion of the California Current turns landward and divides into two branches. One branch continues southward, while the other branch, the Southern California Countercurrent, turns northward and flows through the Channel Islands inshore of the California Current.

East of the Southern California Countercurrent, the current again turns southeast, forming an eddy which flows along the coast. This flow is associated with the dynamic topography established under the influence of winds along the coast and consequently seaward movement of surface water. The Southern California Eddy, a nearly permanent feature of the flow pattern, is seasonal in character. The Eddy is usually well developed in summer and autumn and weak (and occasionally absent) in winter and spring.

Most of the present knowledge about the circulation in the Southern California Bight is based upon information from programs



Source: CSDOC, 1977

Major Ocean Currents Within the Southern California Bight

3.4-2
Figure

not specifically intended to deal with the dispersion of possible pollutants as they enter the ocean environment. Average seasonal variations of surface currents in the California Bight are summarized in Table 3.4-1. However, data pertaining to the small scale, horizontal eddy structures, which are important in describing lateral mixing as well as in determining the residence time of a parcel of water in the Bight, have not been reported in the literature. The data indicate that the flow in the California Current is highly responsive to the influence of wind. Surface currents tend to follow the direction toward which the wind blows; otherwise, currents follow the general circulation patterns (Southern California Coastal Water Research Project, 1973).

Turbulent mixing associated with currents in shallow water may be significant where current speeds are high (1-3 knots - 1.9-5.6 km/hr). Geostrophic currents, which flow at sufficient velocity to produce well developed turbulent mixing, rarely occur over the Southern California Shelf (Hancock, 1965). On the other hand, where upwelling occurs, or where the currents diverge or converge, mixing is developed which may contribute to modifications in the depth of the thermocline or in other thermal characteristics of the water.

Upwelling is a major factor which influences the ecology of the Southern California Bight. Northwesterly winds blow nearly parallel to the southern California coast in the spring, and drive surface waters offshore, causing bottom waters with low temperature, low dissolved oxygen, and high plant nutrient content to be carried inshore and to the surface.

3.4.1.2 Waves

Ocean waves are primarily the result of wind and storms. Less frequently, waves are generated by geologic activity such as earthquakes, volcanic activity, and submarine landslides. Tidal action produces another form of wave. Waves which grow in height under the influence of the wind are referred to as wind waves or seas, and the area over which they are generated is termed the fetch. Once the wind waves move out of the fetch area and continue on without additional energy input, they are referred to as swell. In southern California, wind waves are predominately from the northwest (prevailing winds), and swells may occur from any seaward direction. Wave height and direction may be the result of several different wave trains moving through the area.

Sea surface waves range in length from fractions of an inch (capillary waves) to hundreds of miles (tides and tsunamis). Most of the wave energy transmitted on the sea surface appears in the form of wind-generated waves with periods ranging from approximately 5 to 15 seconds.

Propagation of surface waves over water of depth less than about one-fourth the wavelength is inhibited by the friction or wave-breaking effects caused by the waves moving over or breaking

TABLE 3.4-1

SUMMARY OF SURFACE CURRENT MEASUREMENTS
WITHIN THE STUDY AREA

Parameter	Season Winter	 Spring	 Summer	 Fall
Maximum Speed	0.8 knot	1.3 knot	1.0 knot	0.8 knot
Average Speed	0.2 knot	0.4 knot	0.3 knot	0.2 knot
Minimum Speed	0.1 knot	0.2 knot	0.1 knot	0.1 knot
Direction(s)	SE & NW	E & NW	E & NW	SE & NW
Type:	Drogue and Current Meter	Drogue and Current Meter	Drogue and Current Meter	Drogue and Current Meter
REFERENCE:	1. Orange County Sanitation, Personal Contact 2. SCCWRP, 1973 3. Gaul, 1960	1. Orange County Sanitation, Personal Contact 2. SCCWRP, 1973 3. OSI, Biomass Study, 1977	1. Orange County Sanitation, Personal Contact 2. SCCWRP, 1973	1. Orange County Sanitation Personal Contact 2. SCCWRP, 1973

SOURCE: Oceanographic Services, Inc., 1978.

onto the bottom. According to the State Water Quality Control Board (1965), nearly all of the southern California coast is protected, to some degree, from swells generated outside the coastal area by the offshore islands. Certain portions of the coast are exposed to essentially unlimited fetches from the west and south, but no location is exposed to swell from all possible seaward directions. The project site lies in an area that is protected from incoming surface wave energy in all but westerly and southeasterly directions. Local wave generation is also limited because the surrounding topography reduces the length of wind fetch.

Along the coast from Long Beach to Newport Beach, most significant swells arrive from 260° to 280° and from 160° to 190° True. Even in areas which are exposed to long fetches, swells with periods greater than 10 seconds are altered, at least in direction, by refraction over banks and around the offshore islands.

The protection offered by offshore islands is generally so complete that significant waves over the shelf are mainly formed in the local area. The restricted fetches allow only the development of low waves with short wave lengths and periods. Larger waves (to 6 or 8 feet (1.8-2.4 m)) are formed during frontal crossings, but again with short wave lengths and periods due to the limited fetch. It is only when gale winds of greater than 35 knots (64.8 km/hr) blow from the west that high waves are formed in the local region and travel over the shelf. These are most common in the San Pedro Channel where waves as high as 25 feet (7.6 m) have occurred.

3.4.1.3 Tides

The tide within the San Pedro Channel, like that occurring everywhere along the Pacific Coast of North America, is classified as mixed, because there are both diurnal and semidiurnal tidal components with periods of approximately 12.5 and 25.0 hours. Semidiurnal tides are characterized by two unequal high tides and two unequal low tides occurring within one complete tidal period.

Extreme tides occur twice annually, once in June or July and again in December or January. These extreme tides, termed the solstices, are caused by the increased effect of the sun on the diurnal tide as the sun's declination reaches its two annual maxima. All along the Pacific Coast, the summer solstice tides reach lower low tidal levels in the predawn hours and higher high tidal levels in early evening, while the winter solstice tides reach their lowest levels in midafternoon and their highest levels after dawn.

The tide along the southern California coast varies in range from less than one foot (0.3 m) during a "vanishing tide" (when the difference between the lower high water and higher low water becomes so small that the two tides merge) to slightly more than 6.5 feet (2 m). This does not take into account storm tides, which may raise the sea level higher and which are unpredictably distributed. The period of the tide varies from about 10 to 14 hours. The most common tidal range is between 4 and 4.5 feet (1.2 and 1.4 m). The tide wave which accompanies this rise and fall is progressive and approaches the coast from the southeast. Any tidal currents generated by flooding tides flow toward the northwest. Ebbing currents flow toward southeast. Current measurements along the Southern California Shelf, however, have always shown characteristic diurnal patterns more closely related to the wind cycles than to the tide (Hancock, 1965).

3.4.1.4 Tsunamis

Tsunamis are surface gravity waves generated primarily by submarine earthquakes or volcanic eruptions. They are a finite series of waves that travel in a concentric pattern from the source of the disturbance. Generally they are long-period waves (from 5 minutes to several hours), low in height (a few feet or less) and may travel at speeds well over 400 knots (740 km/hr). On the open sea or in deep water, they usually go unnoticed by ships and platforms. However, as the wave moves to shallow water, it is modified by coastal and bottom configurations and increases in height and shortens in length eventually breaking against the coast. The damage associated with tsunamis often occurs in the form of rapidly rising water levels or bores rather than breaking waves.

Use of the term "tidal wave" to denote these seismic waves is misleading because of the allusion to astronomical tide, which is a surface gravity wave of a larger wavelength. Though the longer and higher astronomically-driven tide waves possess far more energy and inundate larger areas of land than do tsunamis, they are not as destructive. Tides may flood an area regularly and predictably, but tsunamis occur rarely and without warning.

According to the Coast Pilot #7 (1968), the coast of California is not generally subject to waves of the magnitude which strike the Hawaiian Islands and other Pacific areas, although widespread damage to shipping and to waterfront areas occurs occasionally. For example, much of the damage to the Los Angeles area from the 1960 Chilean tsunamis was caused by rapid currents and the swift rise and fall of the water level, which broke mooring lines and set docks and ships adrift.

3.4.1.5 Temperature

The temperature of the seawater in the vicinity of the project site is controlled by the advective processes that move water into the area and by solar warming and evaporative processes. Temperature is of major importance as a seawater characteristic influencing density, biological productivity, and dispersion properties of the water mass. An area of rapid temperature change (0.1C per meter) is referred to as a thermocline. Thermoclines are created by increases in surface water temperature, thus decreasing surface density. A strong thermocline results in vertical stratification that may inhibit natural physicochemical and biological vertical exchange, and may also affect dispersion and settling of suspended material.

During the summer months (July, August, and September), inshore waters are generally warm, and a well defined thermocline exists. In late summer, colder northern water carried by the California Current is moved to the inshore area via the Southern California Countercurrent. Part of the current flows north toward Point Conception, and the remainder reverses direction and moves southward along the coast. As fall passes, the surface waters become cooler due to wind-induced mixing with colder deeper waters, and the thermocline gradually disappears. During winter, storms maintain this mixing. In the spring, an upwelling of colder subsurface water occurs. This colder water also chills the air over the water surface creating fog during the months of April, May, and June. Summer heat then gradually warms the inshore waters to complete the cycle.

Stratification of water along the southern California mainland shelf is principally the result of temperature differences with depth. In summer the temperature change from surface to 200 feet (60 m) may be 15 to 20F (8 to 11C). Summer thermoclines are generally observed between 30 and 50 feet (9 to 15 m) and may show a temperature decrease as much as 5 to 8F (3 to 4C). In winter the temperature difference from surface to 200 feet (60 m) may be as small as 1 to 2F (0.6 to 1.2C). Upwelling tends to decrease the depth of the thermocline. The minimum and maximum values of temperature, salinity, and density are presented in Table 3.4-2 (CSDOC, 1977).

3.4.1.6 Transparency

Light is a major factor in the growth of phytoplankton and the growth and reproduction of attached marine plants. It also affects the diurnal vertical migration of zooplankton and some fishes. The transparency of water, which determines the depth to which light will penetrate, is of concern in considering many biological processes.

Turbidity, the reduction of water transparency created by the presence of suspended solids, is most commonly measured as the percent transmittance (%T) of white light through one meter of water. Naturally occurring contributors to turbidity offshore include high plankton concentrations (usually in surface waters), fine particles of suspended sediments from stormwater and river runoff, or resuspended bottom material from wave action and upwelling.

Transparency is lower in the spring than in the fall, particularly in the vicinity of the alluvial land plains along the coastline south of San Pedro. A band of low transparency water within a mile or so of the beach is characteristic of the southern

TABLE 3.4-2

MINIMUM AND MAXIMUM VALUES FOR TEMPERATURE, SALINITY, AND DENSITY WITHIN THE STUDY AREA

	Depth in Feet			
Parameter	0	50	100	200
Temperature (F)	53.0 - 73.6	53.8 - 68.0	53.6 - 62.2	50.4 - 57.0
Salinity (0/00)	32.94 - 33.70	33.20 - 33.72	33.25 - 33.86	33.40 - 33.82
Density (g/cm^3)	1.02347 - 1.02515	1.02355 - 1.02516	1.02446 - 1.02547	1.02510 - 1.02590

SOURCE: CSDOC, 1977

California coast (Hancock, 1965). There are two main rivers (San Gabriel and Santa Ana) which drain into the coastal area south of Long Beach Harbor. These rivers supply the majority of suspended particles from storm water runoff and provide the principle inputs which contribute to reduced transparency along the coast.

Visual transparency along the coast for all seasons varies from an average of less than 20 feet (6 m) to greater than 50 feet (15 m) with the lowest values occurring close to the coast and highest values further offshore. Transparencies of less than 20 feet (6 m) are characteristic of localities off alluvial plains, while transparencies between 20 (6 m) and 40 feet (12 m) are typical of rocky shores (Hancock, 1965). The amount of turbidity in the water column influences marine plant productivity by limiting the amount of light penetration. Heavy amounts of suspended particles can inhibit sight feeding animals, clog filter feeders, or damage gills of fishes (Kinne, 1970).

The turbidity of the water is an important factor in the determination of the fate of spilled oil. If the receiving water contains appreciable quantities of suspended sediments or solids, much of the oil will be absorbed by the particulate matter and will sink. Such sedimentation of the oil particles may be advantageous to intertidal and pelagic biota, but may be detrimental to benthic communities.

3.4.2 Chemical Characteristics

Chemical characteristics discussed in this section include salinity, dissolved oxygen, hydrogen ion concentrations, nutrients (nitrogen, phosphorus, silica), trace metals (receiving water and sediments), and coliform bacteria.

3.4.2.1 Salinity

Salinity, a measure of the concentration of dissolved salts in seawater, is relatively constant throughout the open ocean. However, it can vary in coastal waters, primarily because of the inputs of freshwater from land or because of upwelling (SCCRWP, 1973). Salinity typically increases with depth, although generally remaining uniform in the open ocean, with concentrations varying between 33.50 and 33.75 ppt (Hancock, 1965). Water in the site area is often isohaline below a depth of 50 feet (15 m) with the effects of dilution and evaporation detectable only in the surface 50 feet (15 m). During summer, a salinity inversion develops near the surface due to evaporation, however, the density stratification is usually sufficient to preserve water column stability.

3.4.2.2 Dissolved Oxygen

The Southern California Coastal Water Research Project

(SCCWRP, 1975) reports that surface waters are usually saturated or supersaturated with dissolved oxygen on the mainland shelf with the highest concentrations occurring during the summer months when oxygen saturation may reach as high as 140 percent. Coastal water concentrations of dissolved oxygen are more variable than those offshore, reaching as high as 10 to 14 mg/1. Highest concentrations are characteristic of nutrient rich water which maintain phytoplankton populations which release oxygen during photosynthesis. Dissolved oxygen may be depleted by respiration from marine organisms and chemical and/or biochemical oxygen demand.

Concentrations of dissolved oxygen are a function of photosynthetic processes, respiration, atmospheric exchange of gases, ocean temperature, salinity, currents, density, and wind-mixing. There is little horizontal variation of dissolved oxygen, but large vertical variations. Dissolved oxygen concentrations are greatest in spring and summer because of photosynthesis; they also vary with depth because photosynthesis occurs mainly in the upper strata of the ocean. Concentrations generally decrease with depth; however, values below 200 feet (60 m) of depth usually do not fall below 4 mg/1 in shelf waters, which is about 50 percent of saturation and adequate to support marine life. Table 3.4-3 presents minimum and maximum values of dissolved oxygen concentration in the pipeline corridor and platform site area from Allan Hancock (1965).

TABLE 3.4-3

MINIMUM AND MAXIMUM OXYGEN CONCENTRATIONS
WITHIN THE SAN PEDRO BASIN

Depth (feet)	Range (mg/1)
0	5.0 - 9.8
50	4.5 - 10.0
100	5.5 - 10.5
200	4.7 - 8.5
300	4.2 - 7.2

3.4.2.3 Hydrogen Ion Concentration

The hydrogen ion concentration, or pH, in southern California coastal waters, varies in a very narrow band around a mean of approximately 8.1. The pH of seawater, which usually ranges from 7.5 to 8.5, is determined by the balance of biocarbonate/carbonate/ CO_2 in a natural seawater buffer system. Changes in pH within this range are due to photosynthesis and respiration of marine organisms, which alter the balance of CO_2 in the buffer system. Low pH values are reflected in high concentrations of CO_2 and low concentrations of O_2. It is usual to find high concentrations of CO_2 and lower pH values where respiration is the dominant process. Thus, a high degree of correlation is expected between pH, DO, and photosynthesis.

3.4.2.4 Nutrients

Nutrients may be defined as the substances that are needed for marine life to reproduce and grow. Nutrients are considered to be one of the most important limiting factors in primary production (Hutchinson, 1957). They are assimilated from seawater through the autotrophs and transferred along the food web to heterotrophic organisms. In this section the most important nutrients, nitrogen and phosphorus, will be discussed. Silica, which is an important nutrient to diatoms, will also be discussed. Diatoms comprise much of the phytoplankton community along the Southern California Bight.

The primary sources of these nutrients are upwelling of nutrient rich deep waters, aductions, and discharges from land sources (rivers, rainwater runoff, industrial and domestic wastewaters). The primary process depleting the concentration of nutrients in the surface waters is uptake by phytoplankton. Other processes depleting nutrient concentrations are advection to other areas and mixing with nutrient depleted water masses. Low concentrations of nutrients are normally found in surface waters except in local source areas (BLM, 1975).

Vertical stratification is a major factor in the concentration of nutrients. When the water column is stratified and phytoplankton uptake depletes surface nutrient concentrations, nutrient rich deep waters are unable to replenish the nutrients assimilated in surface waters. Water undergoes considerable mixing because of wave action and currents. The water column, nevertheless, normally remains quite well stratified in the upper layers, especially in the summer. In the winter there is less stratification, and occasional high winds produce mixing.

Nitrogen represents the fourth most abundant element by weight present in plant tissues and one of the two constituents (along with phosphate) generally considered to be limiting in aquatic production. Nitrogen occurs naturally in the form of ammonia (NH_3), nitrite (NO_2^-), nitrite (NO_3^-), molecular nitrogen (N_2), and complex organic nitrogen molecules. Most of the nitrogen in the atmosphere is present in the form of molecular nitrogen (N_2) with lesser amounts of ammonia and oxides of nitrogen derived from the combustion of fossil fuels. Atmospheric ammonia originates from a number of sources, including air pollution, photochemical reactions of the stratosphere, and the decay of plant and animal byproducts. Rainfall rinses the air, bringing this vast array of nitrogenous products to the Bight. Only a few algal and bacterial species are able to utilize molecular nitrogen (N_2) for their nitrogen requirements. Ammonia is oxidized into nitrite (NO_2^-) by species of nutrifying bacteria, which is further converted to nitrate (NO_3^-), using the reaction as an energy source and making the product more available to phytoplankton and plants. Phytoplankton and plants use ammonia, nitrate, or nitrite in the production of proteins and nitrongenous nucleic acid compounds. This is an important interconversion of inorganic nitrogen to organic nitrogen. Consumers, being unable to make this interconversion, are entirely dependent on phytoplankton and other producers. During decomposition, biological processes convert organic nitrogen to ammonia, nitrite, and nitrate for recycling. The refractory organic forms are resistant to decomposition and are not able to be assimilated by organisms for long periods of time. Nitrogen occurs naturally in micromolar concentrations which can be completely assimilated from the water mass of a given area by phytoplankton. The major unnatural sources of nitrogen in the Bight are municipal and industrial wastes, fertilizers from agricultural runoff, and urban runoff.

Surveys by the Hancock Foundation (1965) found nitrate concentrations in surface waters ranging from 10 to 160 μg/l. Moberg and Fleming (1934) found ammonia to be irregularly distributed in concentrations ranging from 10 to 40 μg/l.

Nitrogen and phosphorus represent the two elements generally found to be limiting in natural ecosystems; however, nitrogen is considered to be the more important of the two. In the open ocean, it has been commonly observed that total nitrogen and total phosphorus are found in a relatively constant ratio of about 15 atoms of nitrogen to 1 atom of phosphorus (Redfield, 1958). This relationship is not nearly so constant in coastal waters, which are affected by higher rates of organic production and are subject to influences from land-based nutrient sources. Ryther and Dunstan (1971) suggest that since phosphate is normally present in concentrations twice that of nitrogen in the coastal marine environment, nitrogen must be the critical limiting factor.

Phosphorus exists in a great number of forms, the most prevalent of which is the phosphate group (PO_4^-). The slightly soluble inorganic phosphorus of the earth's crust is a relatively unlimited reservoir which slowly leaches into aquatic systems through the weathering of rock. These soluble orthophosphates are quickly assimilated by phytoplankton and transformed into particulate organic phosphorus. Dissolved inorganic phosphorus compounds are released into solution by excretion or decomposition and are transformed into particulate organic phosphorus, or, through degradation, are converted back into inorganic orthophosphates. As in nitrogenous forms, some of the organic products result in refractory compounds, unavailable for biological use, and become part of the sediments.

Phosphates in manmade detergents are similar to those produced by living organisms. Ryther and Dunstan (1971) estimate that 25 to 50 percent of the total land-derived phosphate comes from detergents. The amount of nutrient exchange between sediments and the water column is dependent on the exposed surface area between the two and not on the amount of nutrients present. Low oxygen concentration in bottom layers of the water column cause the release of phosphorus from the sediments. Several studies have found that under natural conditions an equilibrium is established between the phosphate concentration of the sediments and the water (Lee and Plumb, 1974). The phosphate in the bottom layers of the water column is upwelled to the surface and is the major source of phosphate in surface waters.

Phosphate values are relatively uniform over the southern California mainland shelf in winter with the smallest difference with depth occurring in October, November, and December. The greatest variability from area to area is also seen during the winter months. Highest phosphate concentrations are found during May through June at subsurface levels.

In summary, in the Southern California Bight, average nitrate and phosphate concentrations in the surface water, 0 to 50 feet (0-15 m) are always low (NO_3 = < 5 µg/l; PO_4 - P = < 0.5 µg/l). From a depth of 50 to approximately 330 feet (15-100 m), concentrations increase rather rapidly (NO_3 = 8 - 12 µg/l and PO_4 - P = 1 - 2 µg/l). Below 330 feet (100 m) of depth, the concentrations increase steadily, but at slower rates than near the surface. Below 740 feet (225 m) of depth, nitrate concentrations consistently are greater than 20 µg/l and PO_4 - P is greater than 2 µg/l. Phosphate shows a similar distribution of low concentrations occurring near the surface, a rapid increase in concentration between 30 - 50 feet (10-15 m), and a steady but lower rate of increase below that.

Nutrient concentrations in the surface waters vary with season near the coast due to spring upwelling and runoff from storms. Concentrations of both nitrate and phosphate are higher during the spring than in other seasons. This seasonal change is less evident farther from shore. The seasonal changes are not evident below 330 feet (100 m) of depth. Concentrations measured at equal depths throughout the Bight are usually similar, which indicate that the horizontal distribution of nutrients is fairly uniform. Some differences are expected in the surface water due to local differences in runoff and upwelling characteristics. The depth at which concentrations of at least 30 µg/l NO_3-N are continually available appears to be 1000 feet (300 m) or more. The distribution of both phosphate and nitrate concentrations were observed to be the same (Oceanographic Services, Inc., 1978).

The element silicon is not found free in nature but it occurs as silica in sand or quartz and as silicates in feldspar, kaolinite, and other minerals (CSWRCB, 1971). Silica is an important component of diatom structure, and the amount of silica present in the water column is related to the growth and decline of diatom populations. Diatoms comprise the majority of the phytoplankton population in coastal southern California waters.

Silica concentrations are relatively uniform in surface waters, with low values occurring in the fall and winter. The differences in concentrations between surface waters and waters at 300 feet (90 m) of depth appear to be the greatest during April, May, and June, when the upwelling of deep water is greatest. Silica concentrations at the surface range from approximately 200 μg/1 to 800 μg/1. Mean silica concentrations show fairly consistent patterns, increasing with depth. Silica concentrations at 300 feet (90 m) range from 800 μg/1 to 2250 μg/1 (SCCWRP, 1973).

3.4.2.5 Trace Metals

Trace metals (such as cadmium, copper, zinc, mercury, and lead) are normal constituents of receiving water and sedimentary material. In the Southern California Bight, trace metals within the water column and sediments are derived from natural sources (weathering of pre-existing rock material) and man-induced sources. The movement of trace metals from source area to depositional site is complex, and involves many interrelated physical, chemical, and biological processes (Dames and Moore, 1978).

Metals exist in the waters in ionic forms, associate with particulates, organically bound, or as complexes. Chemical and biological processes shift the equilibria between these states. Total trace metal concentrations and the state of trace material in coastal waters can be expected to vary significantly from those in offshore waters. Similarly, concentrations in surface waters and in deep ocean waters differ significantly. Other factors, such as heavy rains, storm runoff to coastal waters, upwelling of subsurface water, or changes in plankton population can also alter metals concentration.

The levels of metals in the waters of the Southern California Bight, even in the vicinity of river discharges and wastewater outfalls, are within ranges reported for seawater in various areas around the world (SCCWRP, 1975). Trace metal concentrations measured in the southern California study area are presented in Table 3.4-4.

TABLE 3.4-4

RECEIVING WATER TRACE METAL CONCENTRATIONS
WITHIN THE STUDY AREA

Trace Metal	Concentration (μg/1)
Cobalt	0.1 - 0.2
Copper	1.6 - 9.0
Iron	1.9 - 44.3
Mercury	0.03
Nickel	0.4 - 2.5
Lead	0.4 - 18.2
Zinc	1.1 - 41.2

SOURCE: BLM, 1975

Trace metal concentrations are important to marine life; at low concentrations they are essential to plant productivity, while at high concentrations, they can be inhibitory or toxic.

Studies indicate that in upper surface sediments affected by man's activities a relationship exists between sediment grain size and trace metal concentrations (Dames and Moore, 1978). Fine grain sediments with high clay content generally have higher trace metal concentrations than equivalent coarse grained sediments. However, this does not hold true in upper surface sediments not affected by man's activities, or in finer sediments found at depth.

Core samples collected by Dames and Moore (1975b) close to the proposed Beta Project pipeline route were analyzed for mercury, cadmium, zinc, lead, and oil and grease. This study concluded that the concentrations of pollutants in the samples analyzed were below the maximum allowable concentrations required by the EPA for the dredging and replacement of material in the pipeline trenches. Trace metal concentrations in surface sediments are presented in Table 3.4-5.

Additional trace metal samples were collected for sediments and receiving waters during the field study conducted by Brown and Caldwell. Results of the analyses performed on these samples are presented in the Technical Appendix.

3.4.2.6 Coliform Bacteria

Biological contamination of water may be defined as the introduction of potentially pathogenic organisms. The number of pathogenic organisms in natural waters is small but the variety is wide. This factor imposes severe restrictions on the direct quantitative determination of pathogens in water analysis. As a result, investigators are forced to resort to indirect quantitative measurements of pathogens by selecting indicator organisms to provide indirect evidence of their presence. The coliform group of bacteria, reported as most probable number (MPN) per 100 ml, is the most commonly used indicator organism in bacteriological tests for potentially contaminated waters.

Coliform concentrations in surface nearshore waters off southern California are usually higher from December to March than from June to October. These differences are associated with seasonal stratification of the waters. Concentrations tend to be higher in both surface and subsurface samples at stations closer to the shoreline than at stations farther offshore. Concentrations along the beach are affected greatly by surface runoff, and there is a strong correlation between rainfall, with its consequent runoff, and coliform concentrations in the littoral (surf) waters (CSDOC, 1977). The results of coliform samples collected by Brown and Caldwell were consistently <3 MPN per 100 ml (Volume III).

TABLE 3.4-5

TRACE METAL CONCENTRATIONS (PPM) IN SEDIMENTS FOR SAN PEDRO SHELF AND BASIN

Sample No.	Depth (fathoms)	Arsenic	Cadmium	Chromium	Copper	Iron	Mercury	Nickel	Lead	Zinc
				San Pedro Shelf (upper 2 inches of sediment)						
1	20	6.82	3.57	48.16	17.08	16640	0.160	37.59	61.29	75.74
2	< 20	14.10	2.00	46.07	26.99	22890	0.258	37.23	39.55	--
3	< 20	--	--	--	--	--	--	--	--	80.03
4	100	1.12	2.77	35.96	14.64	17270	0.210	41.82	52.70	41.82
5	< 20	1.65	1.83	42.62	21.75	19570	0.128	26.09	41.32	73.06
6	< 20	1.84	2.24	30.51	9.63	15130	0.106	20.03	44.00	36.11
7	75	1.26	1.92	34.63	13.68	24800	0.040	25.65	48.31	51.30
8	< 20	2.19	1.57	31.75	10.51	15130	0.043	20.22	31.98	43.22
9	< 20	1.25	1.91	23.72	9.18	14160	0.035	19.14	24.37	35.88
10	30	1.26	2.28	27.23	13.82	18430	0.072	33.51	56.56	55.72
11	150	3.21	2.41	58.80	14.39	35050	0.106	25.37	48.68	41.54
				San Pedro Basin (upper 2 inches of sediment)						
12	350	6.63	2.68	62.37	28.07	34740	0.134	53.02	46.78	96.48
13	>450	5.04	3.24	57.55	33.81	39280	0.117	61.15	50.36	87.77
14	>450	6.53	2.52	37.74	25.66	35080	0.179	55.34	55.20	110.40
15	>450	6.24	3.09	70.06	34.66	33190	0.183	67.10	51.62	94.40
16	350	6.84	3.50	42.55	29.04	28040	0.186	55.07	42.55	82.61
17	425	5.20	2.90	55.86	30.47	31920	0.256	50.78	47.15	92.85
18	400	4.36	3.44	50.39	29.64	29230	0.207	68.18	47.43	96.67
19	375	3.14	3.00	57.81	37.54	35510	0.244	60.06	56.31	93.85

SOURCE: Dames and Moore, 1978

3.4.3 Water Quality

The quality of ocean water is determined by its chemical characteristics. The chemical characteristics are usually represented by dissolved gases, organics, trace metals, and nutrients. Chemical analyses reveal the general balance of chemical constituents in water and may reflect subtle changes in the environment that are not visually noticeable.

Although open ocean waters are usually considered chemically uniform in a horizontal direction, waters on the Continental Shelf vary to some extent. These fluctuations occur with inputs from onshore activities, boating activities, depth of water, and other physical characteristics that differ from those typical of open waters. In the nearshore waters, there are a number of highly productive and diverse habitats which are inhabited by a large variety of organisms. The marine environment is a recreational resource used by millions of people each year, and as such, strongly influences the economy and life style in southern California.

The water quality in the vicinity of the Shell Beta project site is typical of the ocean waters throughout the Southern California Bight. Average surface and subsurface values of temperature, salinity, density, and dissolved oxygen are presented in Figures 3.4-3 and 3.4-4.

3.5 BIOLOGICAL RESOURCES

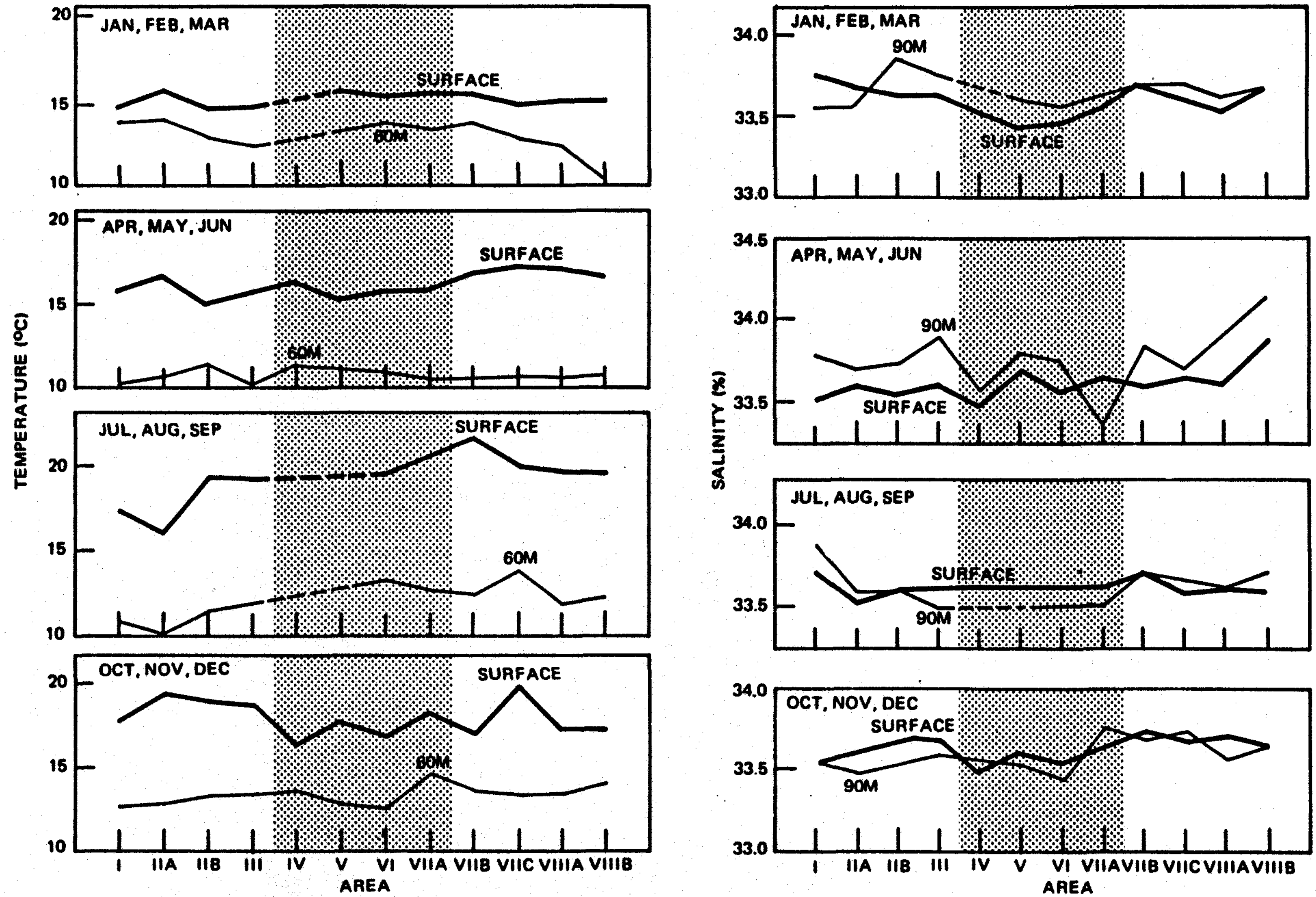
3.5.1 Marine Biology

3.5.1.1 Intertidal

Intertidal organisms must contend with a rigorous and changing environment which often limits their distribution to distinct zones. Physical factors (temperature, salinity, humidity, wave shock, etc.) must be tolerated as well as the effects of interspecific competition and predation. Despite the relative harshness of the environment, intertidal communities tend to be relatively stable in time and space.

Five recent studies have been completed on intertidal marine communities in the vicinity of the Shell Beta project. These studies have reported on the biological communities present on rocky, sandy, or muddy substrates.

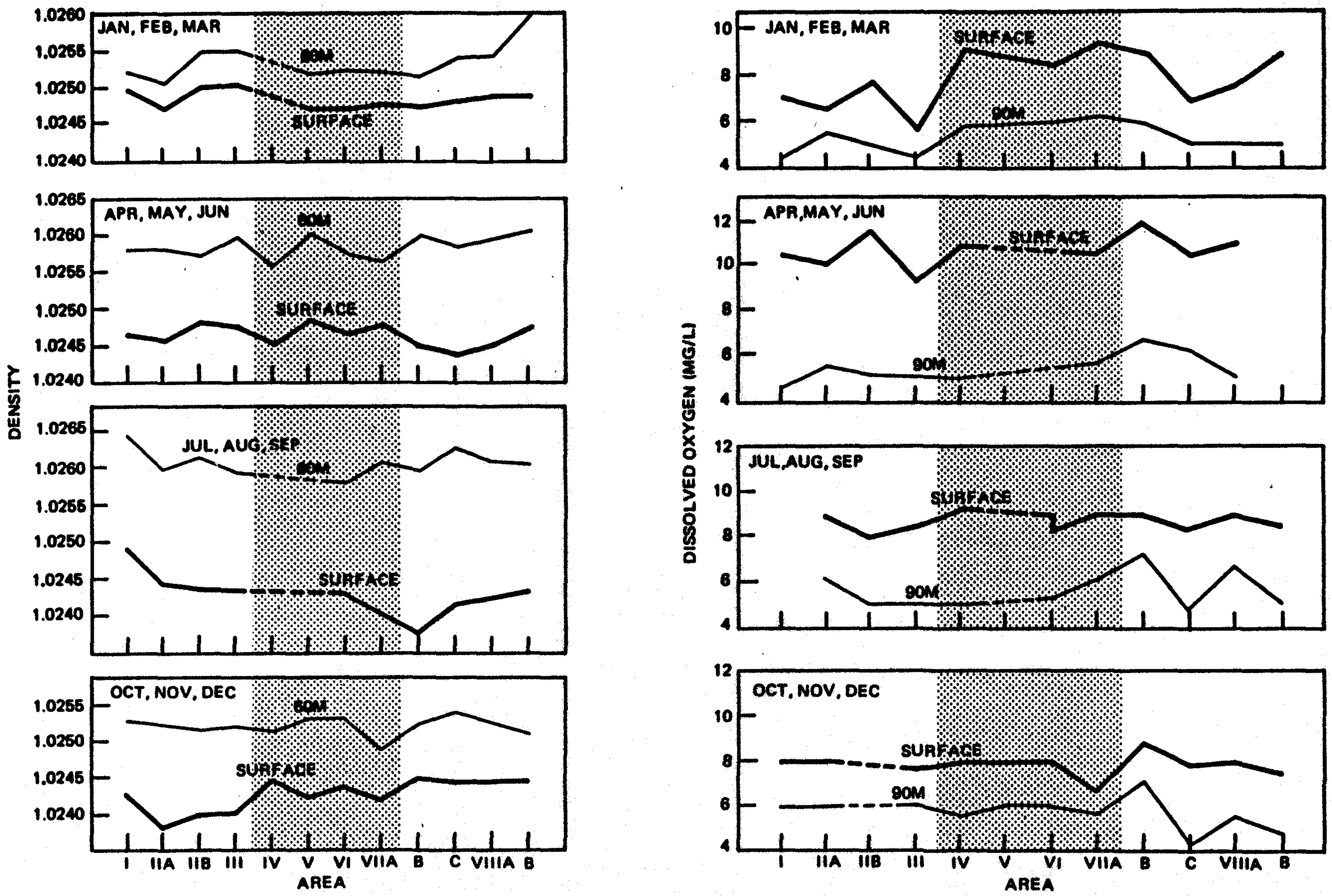
Long Beach Harbor Consultants (1976) sampled nine intertidal stations located either within or outside Long Beach Harbor. Stations 11A, 13A, and 23 were all established along the harbor shoreline (Figure 3.5-1), while stations 65A, 65B, 57A, 22A, and 22B were located along the outer breakwater between Angel's Gate and Queen's Gate.



Source: Allen Hancock, 1965.

Mean Temperature and Salinity Values

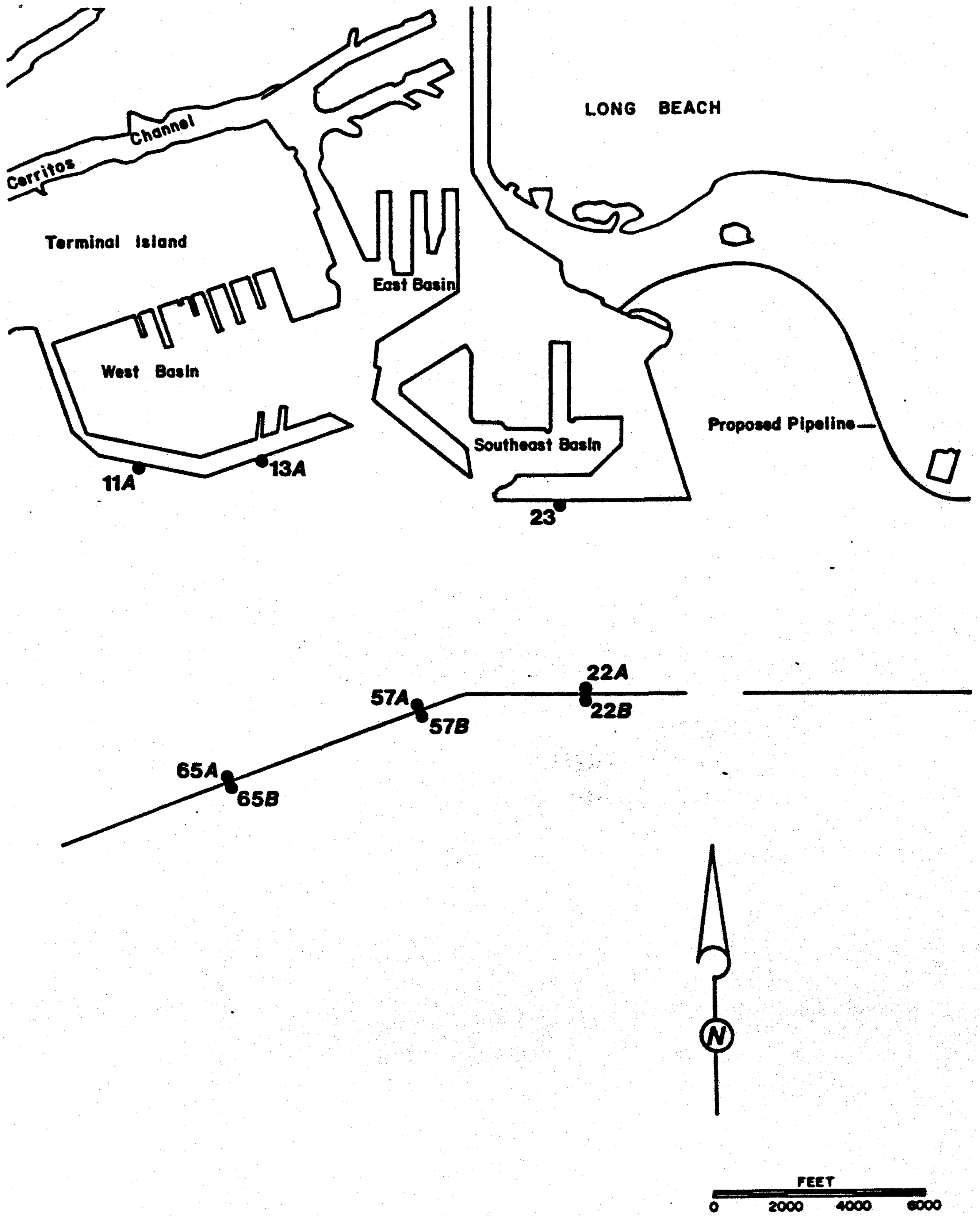
3.4-3
Figure



Source: Allen Hancock, 1965.

Mean Density and Dissolved Oxygen Values

3.4-4
Figure



Source: Long Beach Harbor Consultants, 1976

Intertidal Stations

3.5-1
Figure

A total of 55 species represented by 96,168 individuals were enumerated in the quantitative portion of the study. The greatest mean number of species was present at outer breakwater stations 63B, 57B, and 22B in contrast to the harbor shoreline Stations 11A, 13A, and 23, where the mean number of species was much lower (Figure 3.5-2). The mean number of species was also shown to decrease with distance above Mean Lower Low Water (MLLW). The mean number of individuals (Figure 3.5-3) showed the same relationship to height above MLLW, decreasing from a high of 37 individuals at one foot (0.3 m) above MLLW to five individuals at five feet (1.5 m) above MLLW.

Fourteen dominant species were identified in the study (Table 3.5-1), and their mean abundance at each station also noted. Three barnacle taxa (Chthamalus ssp., Balanus glandula, Tetraclita squamosa rubescens) were among the top four taxa in abundance. Chthamalus ssp. was the single most abundant species when considering all stations and all levels above MLLW. The sea anemone, Anthopleura elegantissima, was the second most abundant species overall.

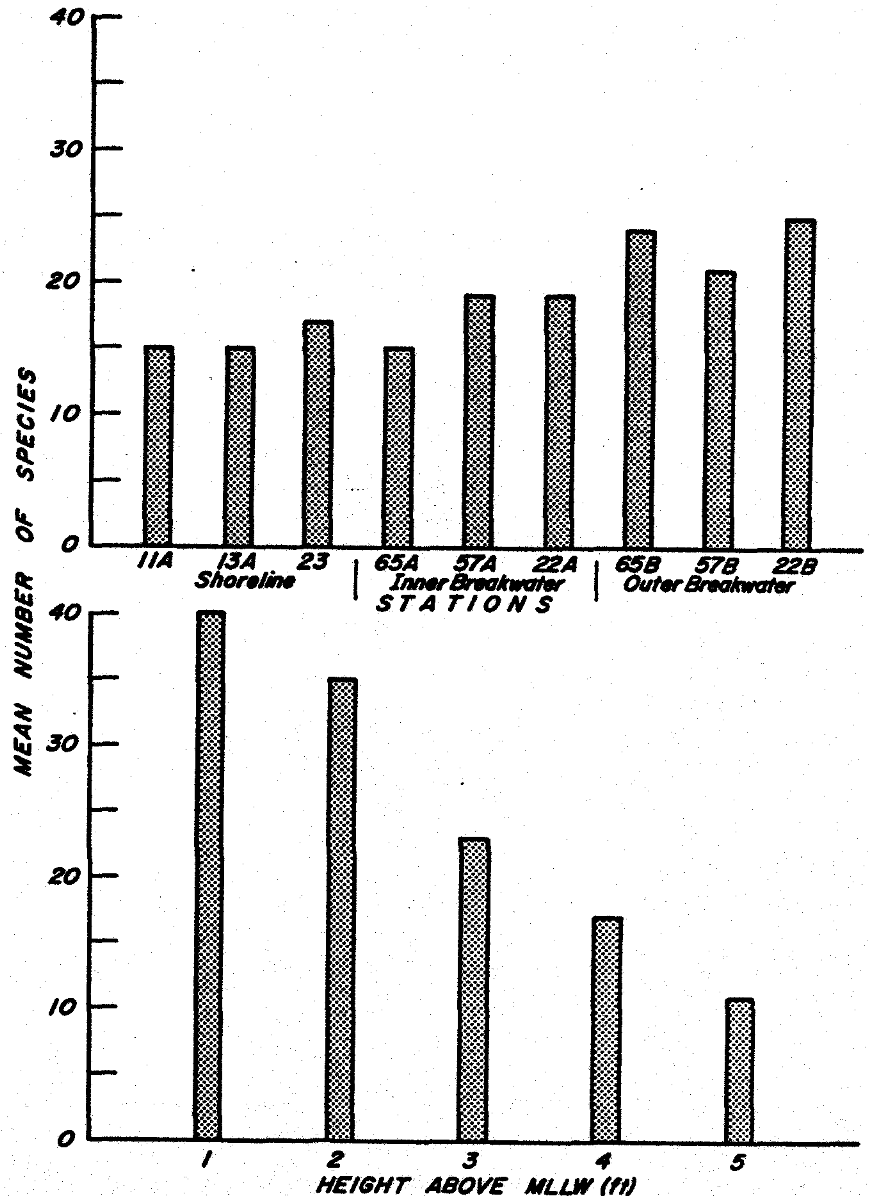
Distinct zonation was suggested by the data (Figure 3.5-4). The upper zone (+3-+5 feet, or +0.91-+1.5 m) was dominated by barnacles, while the lower zone (0-+3 feet, or 0. to +0.9 m) was dominated by Chlorophyta, Phaeophyta, Tetraclita, and Anthopleura.

At the MLLW level, Mytilus edulis and Pisaster ochraceus were the most abundantly ranked species in addition to A. elegantissima, Prionitis lanceolata, and T. squamosa rubescens. Dense patches of mussels were noted along shoreline stations, while large numbers of seastars were noticed on both sides of the breakwater. The report (Long Beach Harbor Consultants, 1976) also noted that harbor shoreline stations located in more stressed environmental conditions were characterized by an instability of species composition.

Station 23 is of particular importance since it is located on Pier J, the terminus of the Shell Beta pipeline. The five numerically dominant species at that station were Chthamalus ssp., Balanus glandula, and Tetraclita squamosa rubescens. Such algal taxa as the Phaeophyta and the Chlorophyta were very abundant. Aside from the limpets, Collisella digitalis and C. scabra, other species were very uncommon.

Straughan and Patterson (1975) and Straughan (1975) conducted studies of sandy beaches at Inner Cabrillo Beach, Outer Cabrillo Beach, and Long Beach (Figure 3.5-5). They found that Inner Cabrillo was the richest in species (22) and numbers of individuals (920). Outer Cabrillo contributed fewer species (16) and fewer (248) individuals. The Long Beach sampling station was particularly depauperate, contributing only nine species and 40 individuals.

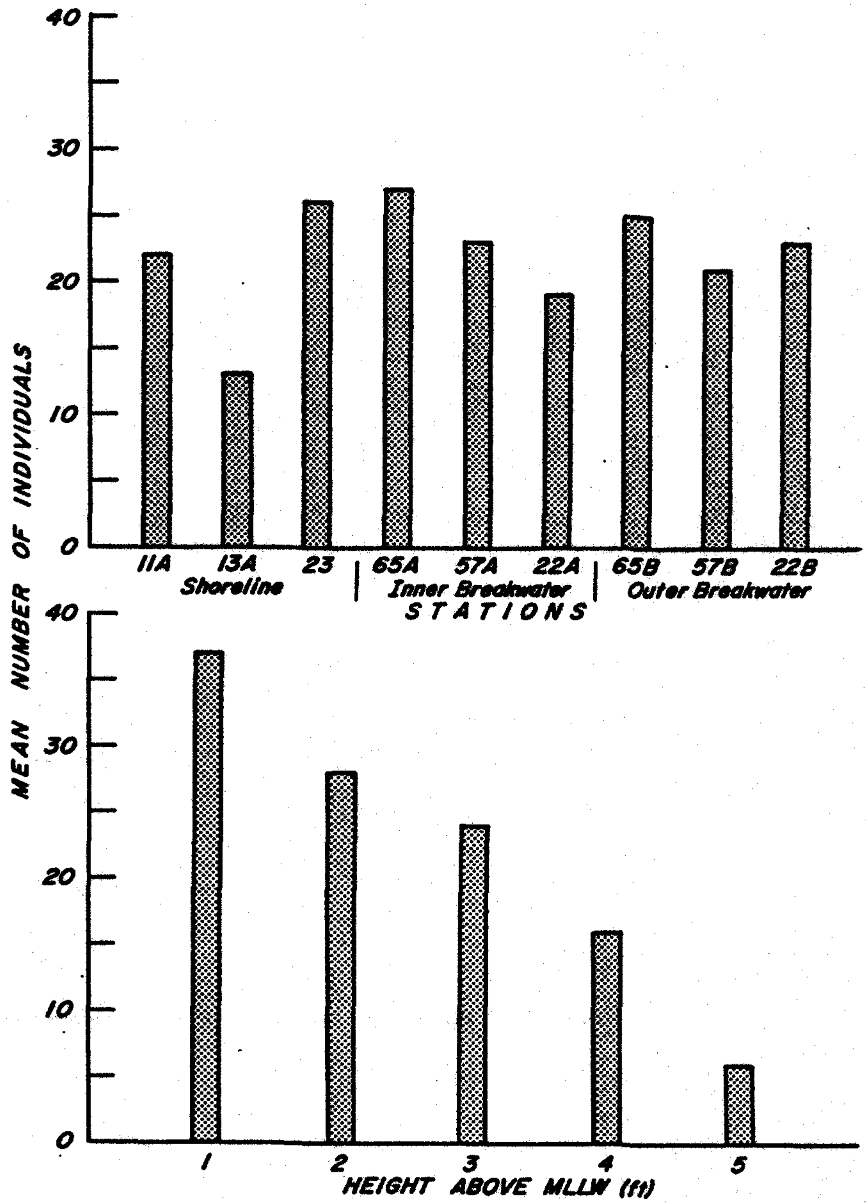
During the sampling period from March 1973 to July 1974 (Straughan, 1975), the sand crab, Emerita analoga, was the numerical



Source: Long Beach Harbor Consultants, 1976
Species per quadrat per 40 contact points per quadrat.

Mean Number of Species

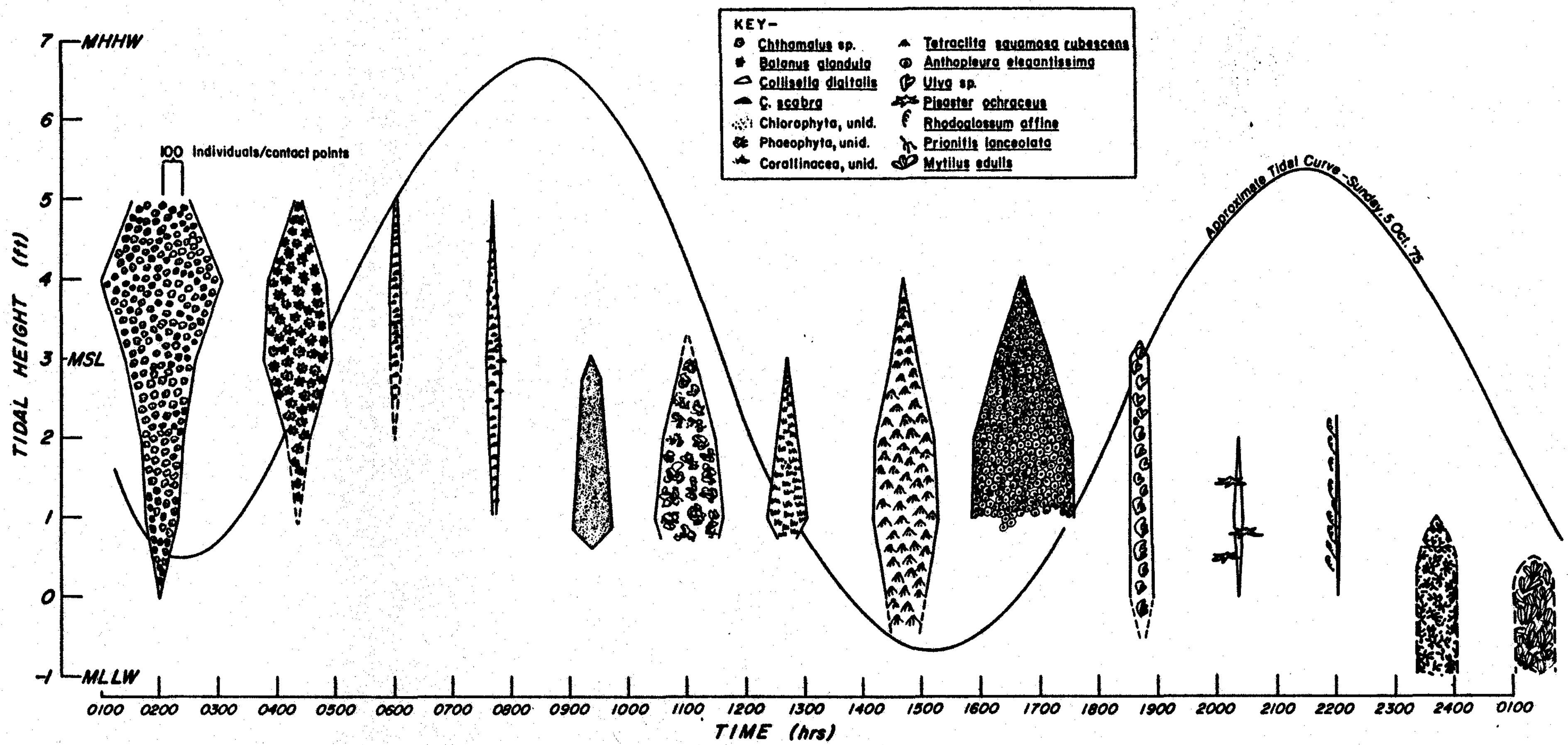
3.5-2
Figure



Source: Long Beach Harbor Consultants, 1976
Individuals per quadrat per 40 contact points per quadrat.

Mean Number of Individuals

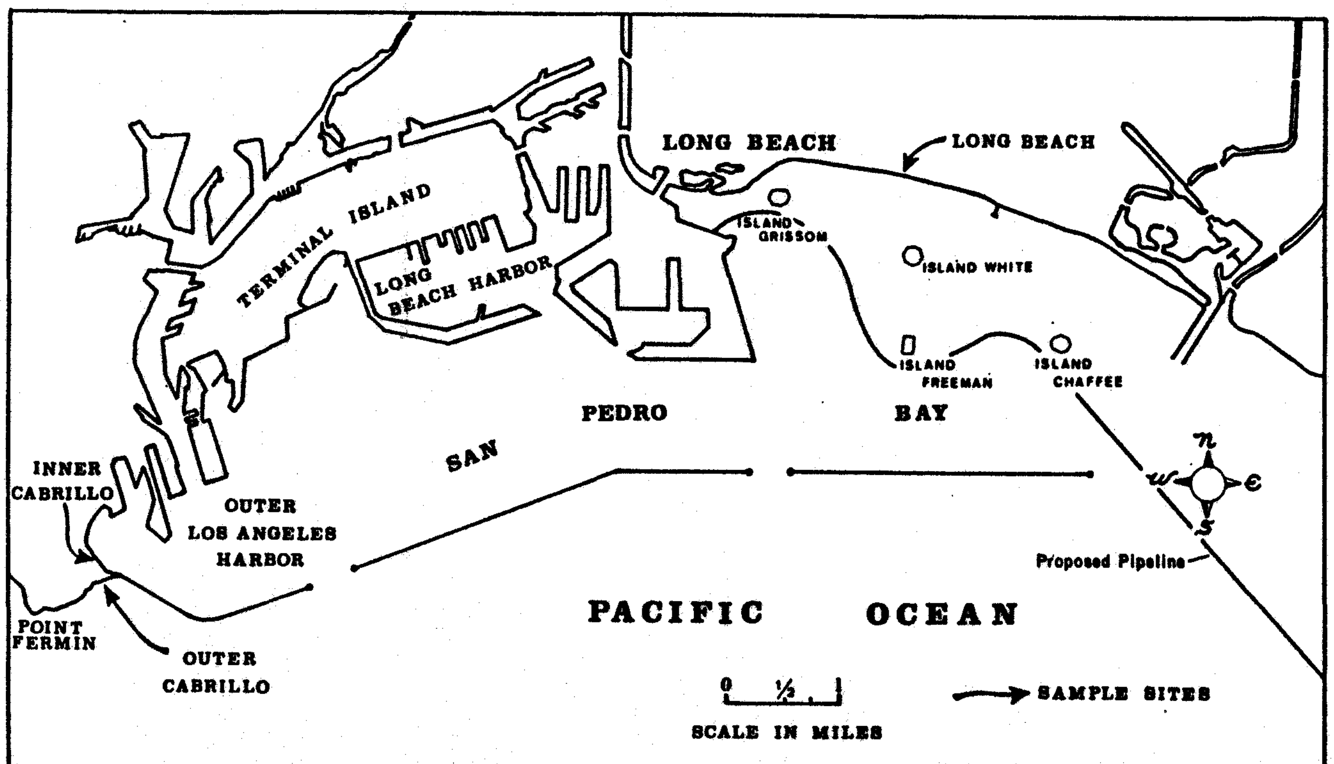
3.5-3
Figure



Source: Long Beach Harbor Consultants, 1976

Vertical Distribution of Selected Intertidal Species

3.5-4
Figure



Source: Straughan and Patterson, 1975

Intertidal Stations, Los Angeles/Long Beach Harbor

3.5-5
Figure

TABLE 3.5-1
FOURTEEN DOMINANT SPECIES AND THEIR MEAN ABUNDANCE AMONG STATIONS AND LEVELS
(FROM LONG BEACH HARBOR CONSULTANTS, 1976)

		Station								
Rank	Scientific Name	11A	13A	23	22A	22B	57A	57B	65A	65B
1	*Chthamalus* spp.	15.8	48.8	61.6	43.6	41.8	6.4	49.0	45.2	21.6
2	*Anthopleura elegantissima*	11.4	7.6	0.0	34.2	27.4	83.6	54.4	42.6	44.4
3	*Balanus glandula*	62.8	22.4	24.2	11.2	28.4	1.0	10.2	0.4	7.6
4	*Tetraclita squamosa rubescens*	0.8	5.2	39.6	6.6	11.2	11.6	18.2	44.2	12.4
5	Phaeophyta, unid.	0.0	5.2	30.6	6.2	0.2	35.0	0.8	69.8	5.2
6	*Ulva* sp.	42.8	0.0	0.0	4.0	6.8	8.6	4.8	0.4	6.2
7	Chlorophyta, unid.	0.0	0.0	34.2	9.4	1.2	0.0	0.0	26.2	0.2
8	*Corallina* sp.	0.0	2.0	0.2	8.4	10.0	16.6	2.0	2.2	24.4
9	*Collisella scabra*	1.8	7.6	5.0	9.4	5.6	1.2	6.4	5.8	7.4
10	*Prionitis lanceolata*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.0
11	*Collisella digitalis*	6.0	0.2	2.8	0.4	6.2	0.0	2.2	0.0	2.6
12	*Rhodoglossum affine*	0.0	0.0	0.0	1.8	10.8	1.2	3.0	0.0	1.6
13	*Mytilus edulis*	10.6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	5.8
14	*Pisaster ochraceus*	0.0	0.0	1.2	0.2	0.4	0.2	1.0	0.8	2.0

		Level					Grand
		1	2	3	4	5	Mean
1	*Chthamalus* spp.	15.77	23.88	41.55	70.00	34.22	37.08
2	*Anthopleura elegantissima*	61.33	54.44	33.22	4.11	0.00	30.62
3	*Balanus glandula*	5.88	13.11	42.66	30.33	1.44	18.68
4	*Tetraclita squamosa rubescens*	28.77	32.11	14.66	6.11	1.55	16.64
5	Phaeophyta, unid.	40.88	28.44	6.66	5.33	0.77	16.41
6	*Ulva* sp.	15.00	13.77	12.00	0.10	0.00	8.17
7	Chlorophyta, unid.	23.55	2.44	12.00	0.00	1.55	7.90
8	*Corallina* sp.	24.66	10.66	1.22	0.00	0.00	7.31
9	*Collisella scabra*	3.00	7.55	9.00	5.88	2.44	5.57
10	*Prionitis lanceolata*	21.11	0.00	0.00	0.00	0.00	4.22
11	*Collisella digitalis*	0.00	0.55	4.88	4.55	1.33	2.26
12	*Rhodoglossum affine*	8.33	1.66	0.22	0.00	0.00	2.04
13	*Mytilus edulis*	9.00	0.10	0.10	0.00	0.00	4.84
14	*Pisaster ochraceus*	1.33	1.88	0.00	0.00	0.00	0.64

dominant of the sampled fauna at Outer Cabrillo. It was collected during all nine samples and ranged from a low of two individuals in September 1973 to a high of 60 individuals in May 1973. Besides Emerita analoga, only the polychaete, Nephtys ferruginea, and the spiny sand crab, Blepharipeda occidentalis, were present in more than half the samples.

Inner Cabrillo samples contained 19 polychaete species, five crustacean species, and one molluscan species (Straughan, 1975). The polychaetes, Magelona pitelkai, Nerinides acuta, and Dispio sp., and the snail, Olivella biplicata, were the four most abundant species in the combined sampling period.

Long Beach samples yielded six polychaete species, two crustaceans, and one molluscan species (Straughan, 1975). Abundances were very low for virtually all species during every sampling period. The polychaete, Nerinides acuta, contributed eight specimens in the July 1973 sample, a high for any sampling period.

All three beaches revealed very little invertebrate fauna in the upper intertidal and supra-intertidal areas (Straughan and Patterson, 1975). The authors suggested that frequent beach maintenance activities may have accounted for the depauperate condition of the fauna.

Intertidal surveys of the oil islands (Grissom, White, Chaffee, and Freeman, 1977) were conducted for the Downtown Marina Environmental Impact Report (Southern California Ocean Studies Consortium, 1977). A list of all taxa identified in these surveys is included (Volume III).

Species abundances at four stations on Grissom Island for the low, middle, and high intertidal were also published (Volume III). The barnacles, Chthamalus fissus and Balanus glandula, were numerically dominant in the high and middle intertidal zones. Pachygrapsus crassipes, the shore crab, was abundant at all stations in the middle intertidal. Low intertidal stations yielded more species and greater abundances for many species than the middle or high intertidal zones. Abundant groups or species in this zone were the sea anemone, Anthopleura elegantissima, nemerteans, nematodes, and polychaetes (especially Capitella capitata, Eupomatus gracilis, Polydora limicola, Tharyx ssp., and Typosyllis fasciata). Barnacles remained abundant although in smaller numbers than in the middle and upper tidal zones. Such crustaceans as the isopod, Ianiropsis tridens, the amphipod, Elasmopus rapax, and the shore crab, P. crassipes, were abundant. The limpets, Collisella digitalis and C. scabra, the mussel, Mytilus edulis, the sea urchin, Strongylocentrotus purpuratus, and the sea star, Pisaster ochraceous, were common or abundant in most samples. The marine algae were plentifully represented by Ulva sp., Egregia sp., Gelidium sp., and Gigartina sp. in the low intertidal.

Ten intertidal stations within Long Beach Harbor were sampled (Environmental Quality Analysts and Marine Biological

Consultants, Inc., 1977) at quarterly intervals from February 1974 to November 1976 (Figure 3.5-6). The intertidal was sampled from MLLW to +4 feet (1.2 m). During the sampling period, almost 116,000 organisms representing 95 taxa were analyzed and evaluated.

Mean density of the intertidal community showed a general increase from Inner to Outer Harbor. Highest values for mean densities were recorded at the +1 and +2 tidal levels.

Barnacles of the genus Balanus were the most common single taxa in the 1976 quarterly samples (Table 3.5-2). Balanus glandula was first in abundance during February, May, and August, declining to number two in the winter November survey. Mytilus edulis showed an increase in mean density per replicate from 2.77 in August, which placed it third in abundance, to 4.22 in November, when it ranked number one in abundance.

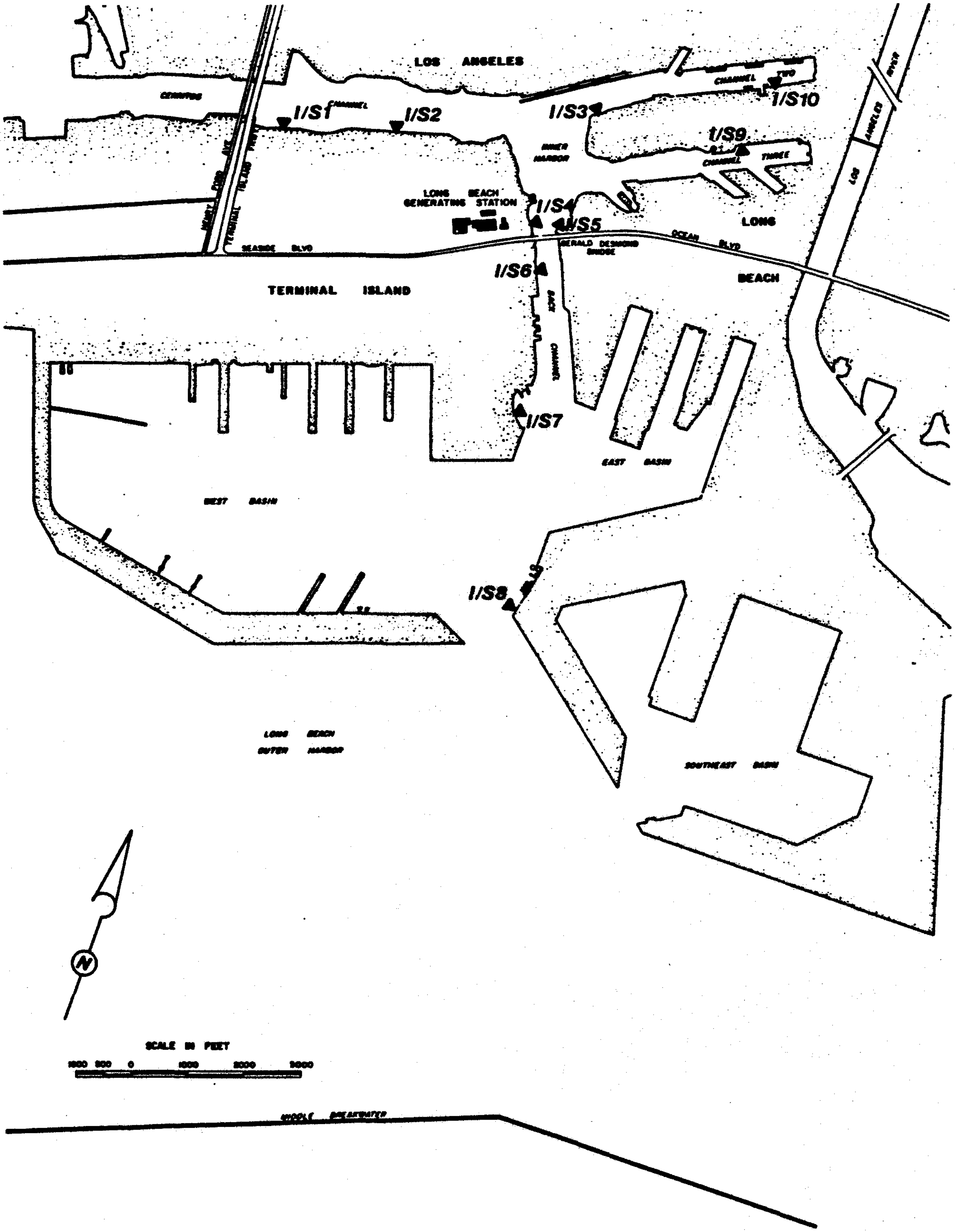
The alga Ulva sp. declined precipitously from fourth in abundance in February to 18th in November. Barnacles in the genus Chthamalus maintained roughly equivalent rank during 1976, vascillating from a low of fifth in February to third in May, declining to fourth in August, and rising slightly again to close the year in third place.

Five trophic types were identified in the intertidal biota. They are primary producers and consumers (including suspension feeders, grazers, carnivores, and generalized omnivores). During 1974 and 1975, the relative percentages of the five trophic types remained approximately the same, but in 1976 the percentage of suspension feeders decreased while primary producers and grazers increased. Suspension feeders still numerically dominated the community in 1976 as they had in 1974 and 1975.

Three intertidal stations (Figure 3.5-7) on the Alamitos Bay jetties were established as part of a thermal effects study (Environmental Quality Analysts and Marine Biological Consultants, Inc., 1973). A fourth station was located on the western side of the Anaheim Bay jetty.

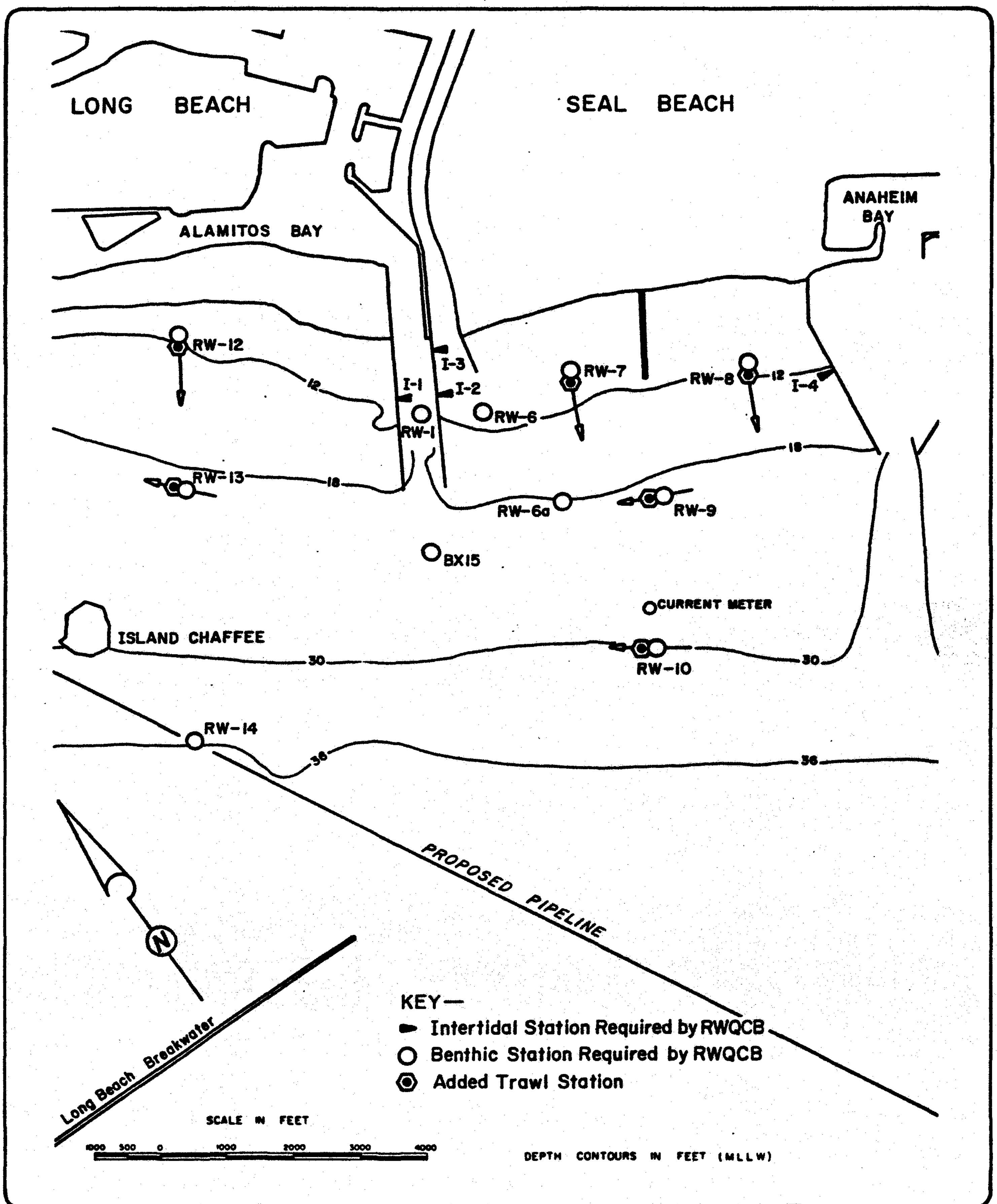
The barnacle, Chthamalus fissus, comprised the greatest percentage of cover at stations I-1, I-2, and I-4 (Table 3.5-3). At station I-3, another barnacle species, Balanus amphitrite, covered slightly more sampled area than C. fissus and ranked second behind the rock louse, Ligia occidentalis.

The low intertidal samples varied greatly from station to station in species composition and the percent cover represented by each species. The most diverse faunal assemblage was identified at station I-1 where the green alga Ulva sp. covered the greatest area. Other species representing in excess of 20 percent cover were the gastropod, Ocenebra poulsoni, the bryozoan, Membranipora tuberculata, the red alga, Corallina pinnatifolia, and the limpet, Fissurella volcano.



Intertidal Stations, Long Beach Harbor

Figure 3.5-6



Intertidal Stations, Alamitos Bay/ Anaheim Bay

3.5-7 Figure

TABLE 3.5-2

TEN MOST ABUNDANT SPECIES IN 1976 WITH QUARTERLY MEAN DENSITY PER REPLICATE (FROM ENVIRONMENTAL QUALITY ANALYSTS, INC. AND MARINE BIOLOGICAL CONSULTANTS, INC., 1977)

Rank	Species	Mean Number/ Replicate	Species	Mean Number/ Replicate
	February		May	
1	Balanus glandula	6.03	Balanus glandula	6.43
2	Chlorophyta, unid.	3.16	Mytilus edulis	3.31
3	Mytilus edulis	2.77	Chthamalus spp.	3.20
4	Ulva spp.	2.12	Gelidium pusillum	1.80
5	Chthamalus spp.	2.07	Chlorophyta, unid.	1.58
6	Balanus amphitrite	1.92	Balanus amphitrite	1.34
7	Gelidium pusillum	1.88	Ulva spp.	1.19
8	Cladophora spp.	0.55	Enteromorpha spp.	1.04
9	Tetraclita squamosa rubescens	0.54	Cladophora spp.	0.91
10	Collisella scabra	0.45	Ectocarpus spp.	0.55
	August		November	
1	Balanus glandula	4.65	Mytilus edulis	4.21
2	Mytilus edulis	3.15	Balanus glandula	3.06
3	Gelidium pusillum	2.45	Chthamalus spp.	1.96
4	Chthamalus spp.	2.09	Gelidium pusillum	1.67
5	Spirorbinae, unid.	1.78	Enteromorpha spp.	1.05
6	Balanus amphitrite	0.83	Chlorophyta, unid.	0.84
7	Phaeophyta, unid.	0.66	Balanus amphitrite	0.60
8	Cladophora spp.	0.45	Collisella scabra	0.41
9	Tetraclita squamosa rubescens	0.43	Holoporella brunnea	0.35
10	Ulva spp.	0.42	Spirorbinae, unid.	0.33

Table 3.5-3
PREDOMINANT SPECIES IN EACH ZONE OF THE FOUR INTERTIDAL TRANSECTS (FROM ENVIRONMENTAL QUALITY ANALYSTS, INC., AND MARINE BIOLOGICAL CONSULTANTS, INC., 1973)

Transect I-1		Transect I-2		Transect I-1		Transect I-2	
Species	Average % Cover	Species	Average % Cover	Species	Average % Cover	Species	Average % Cover
				High Intertidal Zone			
Chthamalus fissus	29	Chthamalus fissus	44	Ligia occidentalis	25	Chthamalus fissus	39
Ocenebra poulsoni	14			Balanus amphitrite	8	Pachygrapsus crassipes	12
Balanus glandula	10					Acmaea scabra	6
				Low Intertidal Zone			
Ulva sp.	29	Gracilariopsis sjoestedtii*	27	Ligia occidentalis	27	Pachygrapsus crassipes	40
Ocenebra poulsoni	27	Chthamalus fissus	19	Chthamalus fissus	13	Pisaster ochraceus	40
Membranipora tuberculata	25	Ocenebra poulsoni	7			Anthopleura elegantissima	25
Corallina pinnatifolia*	24					Gymnogongrus platyphyllus	15
Fissurella volcano	22					Corallina pinnatifolia*	11
Mitrella carinata	18					Acmaea scabra	9
Serpulorbis squamigerus	18					Membranipora tuberculata	9
Thalamoporella californica	17					Prionitis lanceolata*	7
Corophium ascherusicum	13					Tetraclita squamosa	7
Gelidium coulteri*	10					Crisia occidentalis	6
Hiatella arctica	10						
Bryozoa, unid.	9						
Chthamalus fissus	9						
Ophiactis simplex	9						
Gigartina spp.	6						
Pachygrapsus crassipes	6						
				Subtidal Zone			
Muricea californica	22			Amphipoda, unid.	15	Prionitis lanceolata*	34
Gigartina tepida*	15			Gracilariopsis sjoestedtii*	12	Paguridae, unid.	25
Corallina pinnatifolia*	11			Diadumene franciscana	8	Pisaster ochraceus	24
Serpulorbis squamigerus	11					Agardhiella tenera	19
Aglaophenia diegensis	10					Gymnogongrus platyphyllus*	15
Shaskyus festivus	10					Corallina pinnatifolia*	12
Mitrella carinata	6					Muricea californica	10
Thalamorporella californica	6					Mitrella carinata	7
						Membranipora tuberculata	6
						Thalamoporella californica	6

*Warm tolerant algae (Abbott and North, 1971)

Intertidal stations I-2 and I-3 both had Chthamalus fissus as the second most abundant taxon. At station I-2, the red alga, Gracilariopsis sjoestedtii (now Gracilaria sjoestedtii) covered the greatest area, while Ligia occidentalis covered the greatest area at station I-3. Station I-4's low intertidal samples were dominated by the shore crab, Pachygrapsus crassipes, the anemone, Anthopleura elegantissima, and the red alga, Gymnogongrus platyphyllus.

Four intertidal stations were established on sandy beaches in Huntington Beach as part of a thermal effects study (Environmental Quality Analysts, Inc., and Marine Biological Consultants, Inc., 1973a). Resident species were the polychaete worms, Hemipodus borealis, Nephtys californiensis, and Nerinides acuta, the sand crab, Emerita analoga, the Pismo clam, Tivela stultorum, and the bean clam, Donax gouldii.

The density of the polychaetes, H. borealis, N. californiensis, and N. acuta, varied from station to station and survey to survey. Emerita analoga was the only arthropod encountered regularly and in substantial numbers. The number of E. analoga taken per transect ranged from 7 to 120. Tivela stultorum was encountered throughout the year, but in limited numbers, while Donax gouldii was collected in modest numbers during most samples.

(1) Biofouling Communities - Harbor Areas

The biofouling community is the marine counterpart of terrestrial weeds, which are plants growing where they are not desired. Fouling organisms are those plants and animals which are normally attached to rock or other natural substratum, but which can also colonize man-made substrates as well. The presence of structures such as docks, pilings, and floats increases the available habitat for the biofouling community. The composition of the community is dependent upon the ability of individual species to successfully compete for space, light, and other limiting factors (Connell, 1972; Dayton, 1975). Four studies relevant to the Shell Beta project have been performed that describe the composition and distribution of biofouling communities in the Los Angeles/Long Beach Harbor complex (Environmental Quality Analysts and Marine Biological Consultants, Inc., 1977; U.S. Army Corps of Engineers, 1976; Barnard, 1958; Scheer, 1945). In situ settling rack studies were performed to describe spatial and seasonal fluctuations of biofouling communities (U.S. Army Corps of Engineers, 1976). In the section below, the composition of various biofouling communities is described.

The colonizing fouling community (usually short-lived) consists primarily of bacteria, algae, protozoans, and hydroids. The algae include small sedentary diatoms, colonial diatoms of the genus Licmorpha, and several species of Ectocarpus. The suctorian Ephelota is quite common to newly developed communities along with other sedentary protozoans. Several species of Obelia have been observed with Obelia dichtoma being the most conspicuous.

The bryozoan community tends to be quite dense and comprises the most of the biomass of many established biofouling communities. The principal organisms include the encrusting bryozoans Schizoporella unicornis, Cryptosula pallasiana, Rhynchozoon tumulosum, Membranipora tuberculata, and Holoporella aperta. The erect bryozoans tend to demonstrate a patchier distribution comprised of Bugula neritina, Eucaratea clavata, Crisulipord occidentalis, and Scrupocellaria diegensis. Associated with the bryozoan community are several species of polychaetes and amphipods (Table 3.5-4).

The ascidian community consists primarily of Ciona intestinalis and several species of Styela. Associated with this community is Mytilus and several species of sponges.

The mussel community (Mytilus sp.) is found in both Long Beach and Los Angeles Harbors. Mytilus edulis is the dominant species in the quiet harbor waters and its presence represents a successional climax for a given community (Sutherland, 1975). Associated with the Mytilus community are invertebrate phyla including Molluska, Crustacea, Echinodermata, and others.

The Balanus fouling community often competes with Mytilus for primary substrate, yet co-occurrence is not uncommon. In some cases, Mytilus is utilized as a secondary substrate for Balanus and Chthamalus (Sutherland, 1975). The three main components of this community are Balanus amphitrite, B. tintinnabulum (now Megabalanus californicus), and B. glandula.

(2) Biofouling Communities - Offshore Areas

In comparison to harbor areas, offshore platform structures are exposed to different physical, chemical, and biological conditions; consequently, the animals adapted to these factors are different and the composition of offshore biofouling communities differs significantly from inshore harbor areas. Offshore structures promote communities resembling those of rocky shores, attracting suspension feeders, herbivores, carnivores, and other feeding types that require a hard substrate for attachment or crevices for refuge, e.g., Mytilus californianus communities (Kanter, 1977, 1978).

Two distinct biofouling communities are associated with offshore structures. One is a littoral community existing near and at the surface of the support structures; the other is a subtidal community that is associated with the foundations of the structure (SCCWRP, 1976).

The littoral biofouling communities found on the pilings of offshore structures resemble those of rocky intertidal habitats, where species such as Mytilus californianus prevail over M. edulis. Other genera common to this habitat include Hiatella, Caprella, Balanus, and Styela (Kanter, 1977).

The subtidal biofouling communities resemble those of rocky shore subtidal communities and support several species of

TABLE 3.5-4
REPRESENTATIVE ORGANISMS OF THE BIOFOULING COMMUNITY OF LOS ANGELES-LONG BEACH HARBOR (From KANTER, 1977 AND U.S. ARMY CORPS OF ENGINEERS, 1976)

ANNELIDA
- POLYCHAETA
  - Armandia bioculata
  - Autolytus sp.
  - Capitella capitata
  - Ctenodrilus serratus
  - Eumida sanguinea
  - Halosydna brevisetosa
  - Hydroides pacificus
  - Ophiodromus pugettensis
  - Paleanotus bellis
  - Platynereis bicanaliculata
  - Polydora ligni
  - P. limicola
  - Polyopthalmus pictus
  - Schistomeringos longicornis
  - Typosyllis faciata

ARTHROPODA
- AMPHIPODA
  - Caprella californica
  - C. equilibra
  - C. gracilor
  - C. irregularis
  - C. verrucosa
  - Corophium acherusicum
  - Deutella californica
  - Elasmopus rapax
  - Eurystheus thompsoni
  - Ischyrocerus litotes
  - Jassa falcata
  - Photis bifurcata
  - Podocerus brasiliensis
  - Stenothoe valida

ARTHROPODA (Cont)
- CIRRIPEDIA
  - Balanus amphitrite
  - B. glandula
  - B. curiosus
  - Balanus sp.
  - Chthamalus dalli
- ISOPODA
  - Limnoria tripunctata
- TANAIDICEA
  - Anatanais normani

MOLLUSCA
- PELECYPODA
  - Hiatella arctica
  - Mytilus edulis
- GASTROPODA
  - Barleeia haliotiphilia
  - Styela sp.

NEMERTEA
  - Amphiponis imparispinosus
  - Emplectomena gracile

Pisaster, Strongylocentrotus, Anthopleura, and several tubicolous polychaetes (U.S. Corps of Engineers, 1976). Table 3.5-5 contains a list of representative species populating littoral and subtidal offshore biofouling communities.

Turner (1969) and later SCCWRP (1976) both confirmed an increase in diversity and numbers of pelagic and demersal fishes near offshore structures and other artificial reefs as well as an overall increase in productivity of the areas which was attributed to successful formulation and growth of biofouling communities associated with these areas.

3.5.1.2 Benthic

Several comprehensive studies (Hartman, 1955 and 1966; Jones, 1969; Science Applications, Inc., 1977) have described the species composition and faunal communities of the southern California borderland. The San Pedro Shelf, including Los Angeles and Long Beach Harbors, was the site of sampling stations for the Hartman (1955 and 1966), Jones (1969), and Long Beach Harbor Consultants (1976) reports. Hartman (1955 and 1966) and Jones (1969) investigated samples taken during the 1950's and early 1960's in the proximity of the Shell Beta platform site or near the proposed pipeline connecting it to the mainland. Recent and relevant work was reported in the benthic macrofaunal section of the Southern California Baseline Study Final Report (SAI, 1977), where a High Density Sampling Area (HDSA) offshore of Huntington Beach, Newport Beach, and Laguna Beach is noted.

The San Pedro Shelf is an area of considerable sedimentary, hydrographic, and physiographic complexity. This physical heterogeneity has given rise to high faunal diversity, complex distributional patterns, and a variety of community assemblages.

Hartman (1955 and 1966) analyzed samples from 267 stations located at two-mile (3.2 km) intervals on a grid covering the San Pedro Channel region. These samples were obtained by means of an orange peel grab sampler or by a Campbell grab. She noted that faunal diversity was so high in the San Pedro Channel region that large scale faunal communities could not be identified. She found that the number of species and species abundance was highest in nearshore shelf regions such as the San Pedro Shelf, and that the fewest species and numbers of individuals were sampled in deep basins offshore. Progressive replacement by different species of the same genus with depth was noted. As expected, biomass was typically higher in the shallower stations.

Hartman (1966) found that the San Pedro Shelf "suggests a diversified and complex fauna, changing from one location to the next, according to kinds of sediments, locations, and other physical factors." She found that most species had distinct depth preferences and some species tended to aggregate in predictable community assemblages.

TABLE 3.5-5
REPRESENTATIVE ORGANISMS OF
OFFSHORE BIOFOULING COMMUNITIES

Littoral Communities
  Sea anemone
    Anthopleura elegantissima
    Corynactis californica
    Metridium senile
  Tube anemone
    Ceriantharia sp.
  Gorgonian
    Lophogorgia chilensis
    Muricea sp.
  Sea pen
    Acanthoptilum sp.
    Stylatula elongata
  Mussel
    Mytilus californicus

Subtidal Communities
  Starfish
    Astropectin verrilli
    Luidia foliolata
    Patiria miniata
    Pisaster giganteus
    P. ochraceus
  Sea urchin
    Strongylocentrotus franciscanus
    S. purpuratus

Those Hartman samples designated AHF (Allan Hancock Foundation) taken within one mile of the proposed platforms or pipeline sites were all collected during 1953 or 1954. Some of the documented samples were never analyzed and those samples that have been analyzed represent considerable differences in the volume sampled. The great range in sample volumes (0.15-3.15 $feet^3$, or 0.004-0.089 m^3) makes comparison of samples a hazardous exercise. Nonetheless, nine benthic stations were enumerated within one mile (1.6 km) of the proposed project site. A brief characterization of these stations follows (Figure 3.5-8):

(a) AHF 2506-54 (actually 53) (12-10-53)

The station is located in outer Long Beach Harbor at eight fathoms (14.6 m) in black mud. Sixty-nine species were represented by 647 individuals. Most prominent were polychaete worms with 46 species and 512 individuals.

(b) AHF 2314-53 (5-16-53)

The sample was taken directly offshore from Alamitos Bay jetties at 4.5 fathoms (8.24 m) in silty mud. Most abundant taxa were *Nothria iridescens* and *Phyllochaetopterus prolifica*. Other abundant taxa were *Haploscoloplos elongatus*, *Lumbrineris* ssp., *Tharyx tesselata*, and *Nereis procera*.

(c) AHF 2312-53 (5-16-53)

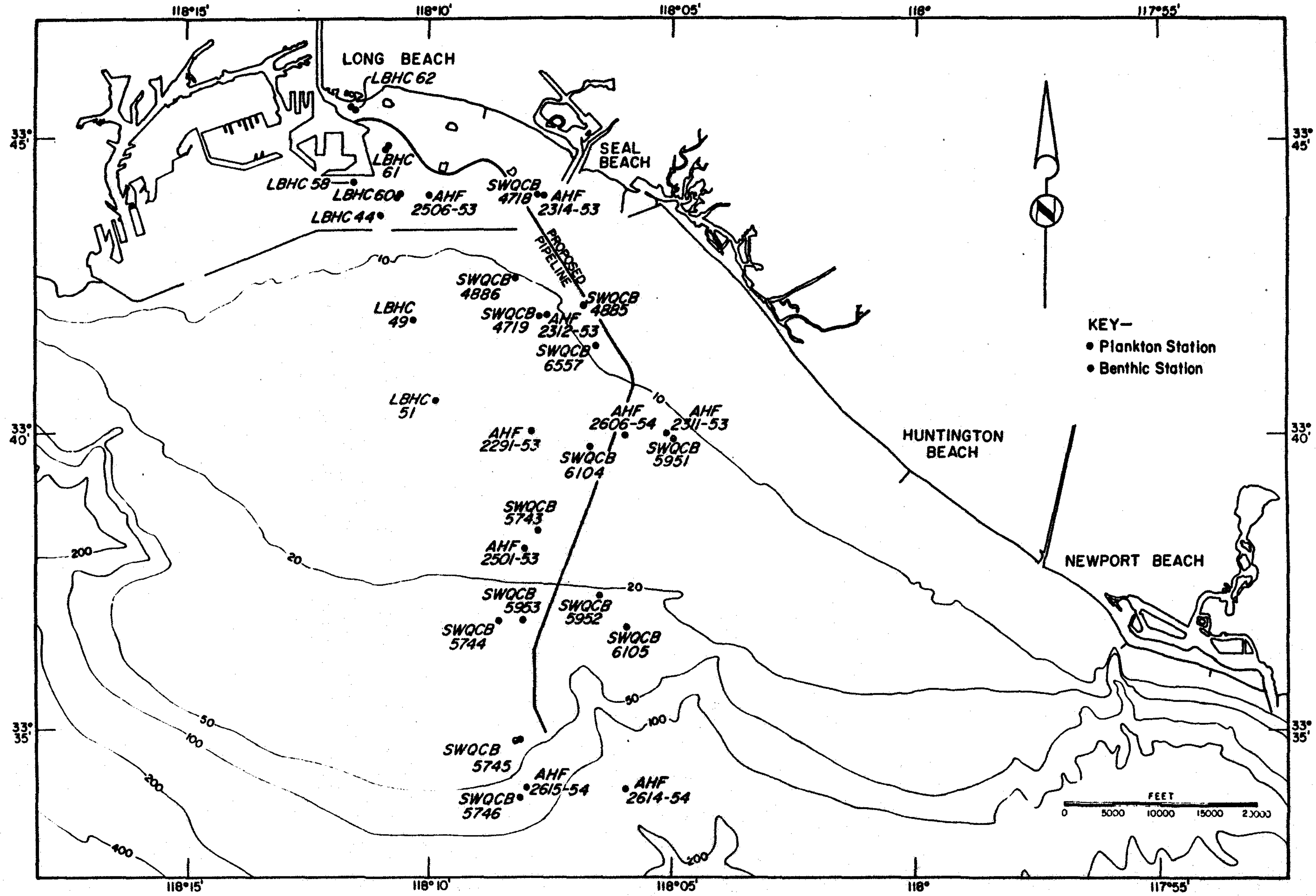
The station is located in brown sandy mud and gravel at 7.5 fathoms (13.7 m), approximately 2.5 miles (4 km) southeast of the Long Beach Harbor breakwater. Many mollusk species were abundant. Echinoderms were represented by many ophiuroids, some echinoids, a sea star, and small Crustacea, including amphipods and isopods. Most speciose and abundant were the polychaetes with more than 27 taxa represented.

(d) AHF 2311-53 (5-16-53)

Samples were taken approximately four miles (6.9 km) southeast of the Long Beach Harbor breakwater at 12 fathoms (2.2 m) in hard-packed sandy mud. Echinoderms collected included ophiuroids, holothurians, and asteriods, while the mollusks included scaphopods, gastropods, pelecypods, and a solenogaster. The Crustacea was represented by several crabs, amphipods, ostracods, and phoxocephalid amphipods. Polychaetes were the most speciose group, with *Chaetozone corona*, *Cossura* sp., and *Diopatra tridentata* being particularly abundant.

(e) AHF 2291-53 (4-24-53)

This station is located 6.4 miles (10.3 km) east southeast of the Los Angeles breakwater in 14 fathoms (25.6 m). The sample was dominated by polychaetes, particularly *Amphicteis scaphobranchiata*, *Diopatra tridentata*, *Sthenelanella uniformis*, and many *Nothria* ssp.



Benthic and Plankton Stations

3.5-8
Figure

(f) AHF 2501-53 (12-10-53)

Located 7.3 miles (11.8 km) southeast of the Los Angeles light, this station was taken in 19 fathoms (134.8 m). Sediments were composed of black, compact, oily mud. Only phoxocephalid amphipods (18 specimens) were identified from the sample.

(g) AHF 2606-53 (3-3-54)

The station is located directly along the proposed pipeline, approximately four miles (6.4 km) southeast from the end of the Long Beach breakwater in 13 fathoms (23.8 m). Sediments were compact black, sandy mud. Phoxocephalid amphipods, sea stars, and many annelids (not further identified) were prominent faunal components.

(h) AHF 2615-53 (3-3-54)

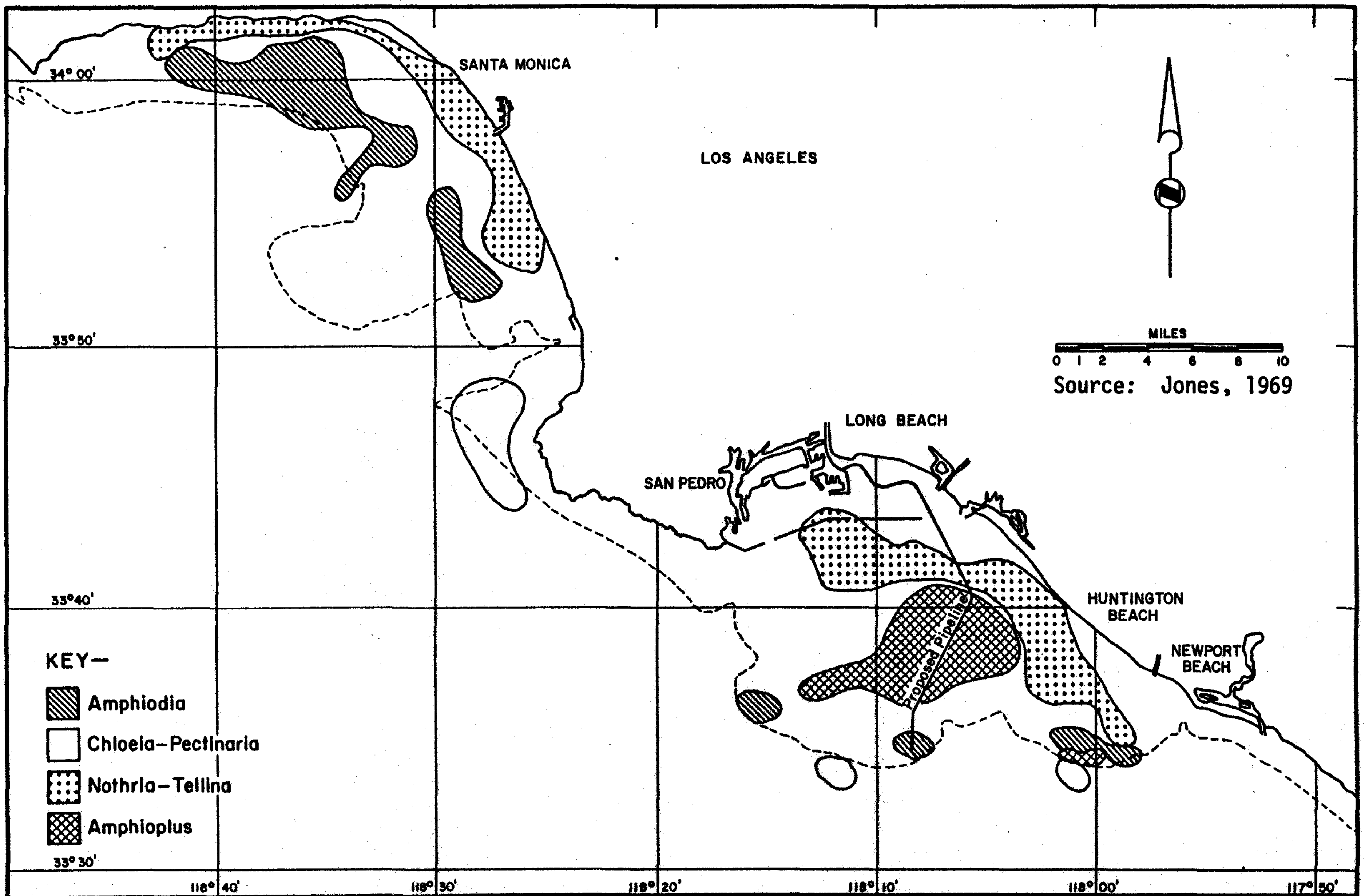
Located 8.2 miles (13.2 km) southwest of the Huntington Beach pier, the sample was taken at 50 fathoms (91.5 m) in gravelly mud, shell, and rubble. Parts of a large sea star, many ostracods, amphipods, and numerous polychaetes including Onuphis were identified. Some of the sample has not been analyzed.

(i) AHF 2614-54 (3-3-54)

This sample was taken seven miles (11.3 km) southwest of the Huntington Beach pier in dark green mud at a depth of 155 fathoms (283.7 m). The sample included pelecypods, especially Acila sp., scaphopods, and a tectibranch. Such polychaete genera as Aglaophamus, Anaitides, Ancistrosyllis, Brada, Glycera, Laonice, Lumbrineris, Melinna, Nothria, and Terebellides were enumerated. Other polychaetes, Nephtys ferruginea and Prionospio pinnata, were also identified.

Jones (1969) analyzed some of the same stations on the San Pedro Shelf sampled by Hartman. His principal objective was to characterize faunal assemblages along the southern California mainland shelf. In his analysis, he made use of (1) a subjective approach in examining the data and (2) a computer program which determined the number of occurrences of a given species and the number of joint occurrences of different species. The program computed an "index of affinity" for each species pair, offering a method of grouping species into possible faunal assemblages.

Subjective mapping of benthic macrofaunal assemblages for the San Pedro Shelf is given in Figure 3.5-9. Jones named each assemblage for its numerically dominant species or co-dominant species. One such dominant is the ophiuroid, Amphiodia urtica, which was characterized by Barnard and Ziesenhenne (1961) as the most abundant and widely distributed species on the coastal shelves of southern California. On the San Pedro Shelf, three patches of the Amphiodia association were mapped (Figure 3.5-9) by Jones (1969), each located along the 50 fathom (91.5 m) isobath. One patch was



Distribution of Benthic Macrofaunal Associations

3.5-9 Figure

located near the San Gabriel Submarine Canyon at the site of the proposed platforms.

Three other faunal associations occur on the San Pedro Shelf (Chloeia-Pectinaria, Nothria-Tellina, and Amphioplus). The most promiment inshore association is the Nothria-Tellina association, made up of species in the polychaete genus, Nothria, and the pelecypod genus, Tellina. This association is present for approximately 16 miles (25.8 km) from the Long Beach Harbor breakwater to a point west of the Newport Beach Marine Canyon. The oil pipeline will cross approximately two miles (3.2 km) of this association.

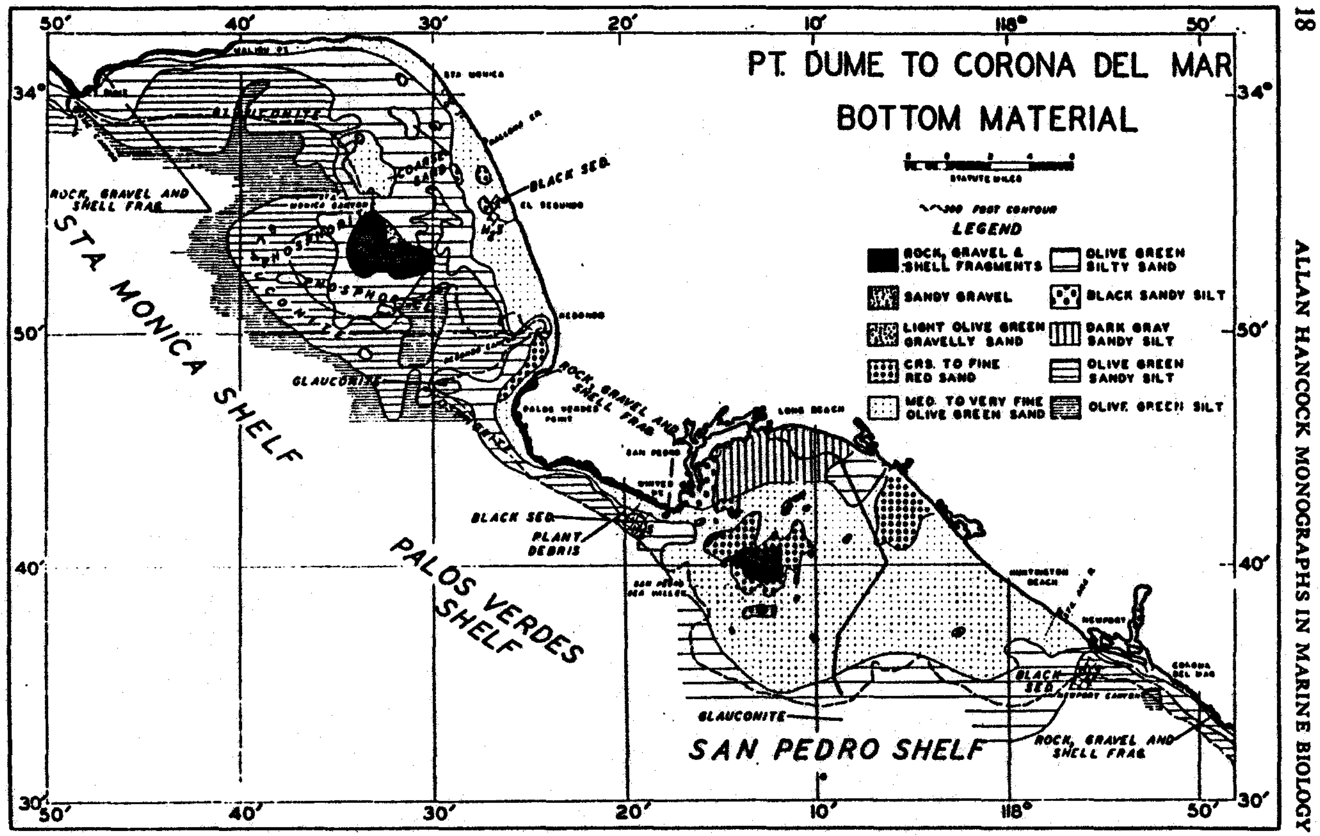
The Amphioplus association (Figure 3.5-9) is the second most prominent association on the San Pedro Shelf. It is located seaward of the Nothria-Tellina association and concentrated in the area of the proposed pipeline. Approximately seven miles (11.3 km) of seabed occupied by the Amphioplus association will be crossed by the pipeline. Small concentrations of the Chloeia-Pectinaria association were mapped in the deeper water of the San Pedro slope in two localities. This association is characterized by the polychaetes, Chloeia pinnata and Pectinaria californiensis.

Jones (1969 also applied recurrent groups analysis to the macrofaunal benthic data. Seven species groups were enumerated (Table 3.5-6) from an analysis of species occurrence patterns, or on the basis of species population size. Jones mapped the location of these designated groups on the San Pedro Shelf (Figure 3.5-10) and attempted to correlate their presence to sediment type (Figure 3.5-11).

Along the southern California coastline, recurrent groups II and V tend to be found in shallower areas (Jones, 1969), while groups I, III, IV, and VI are generally found in deeper water. On the San Pedro Shelf, however, the typical pattern of recurrent group distribution does not apply. Groups are distributed widely across the Shelf with the exception of Groups I and III, which are located exclusively in deeper water (Figure 3.5-10).

Long Beach Harbor Consultants (1976) took three replicate samples using a Shipek grab at 23 infaunal stations within Long Beach Harbor and three stations seaward of the outer breakwater. Four of the stations within the harbor were located east or south of Pier J, within one mile (1.6 km) of the Shell Beta pipeline. Station locations are given in Figure 3.5-12.

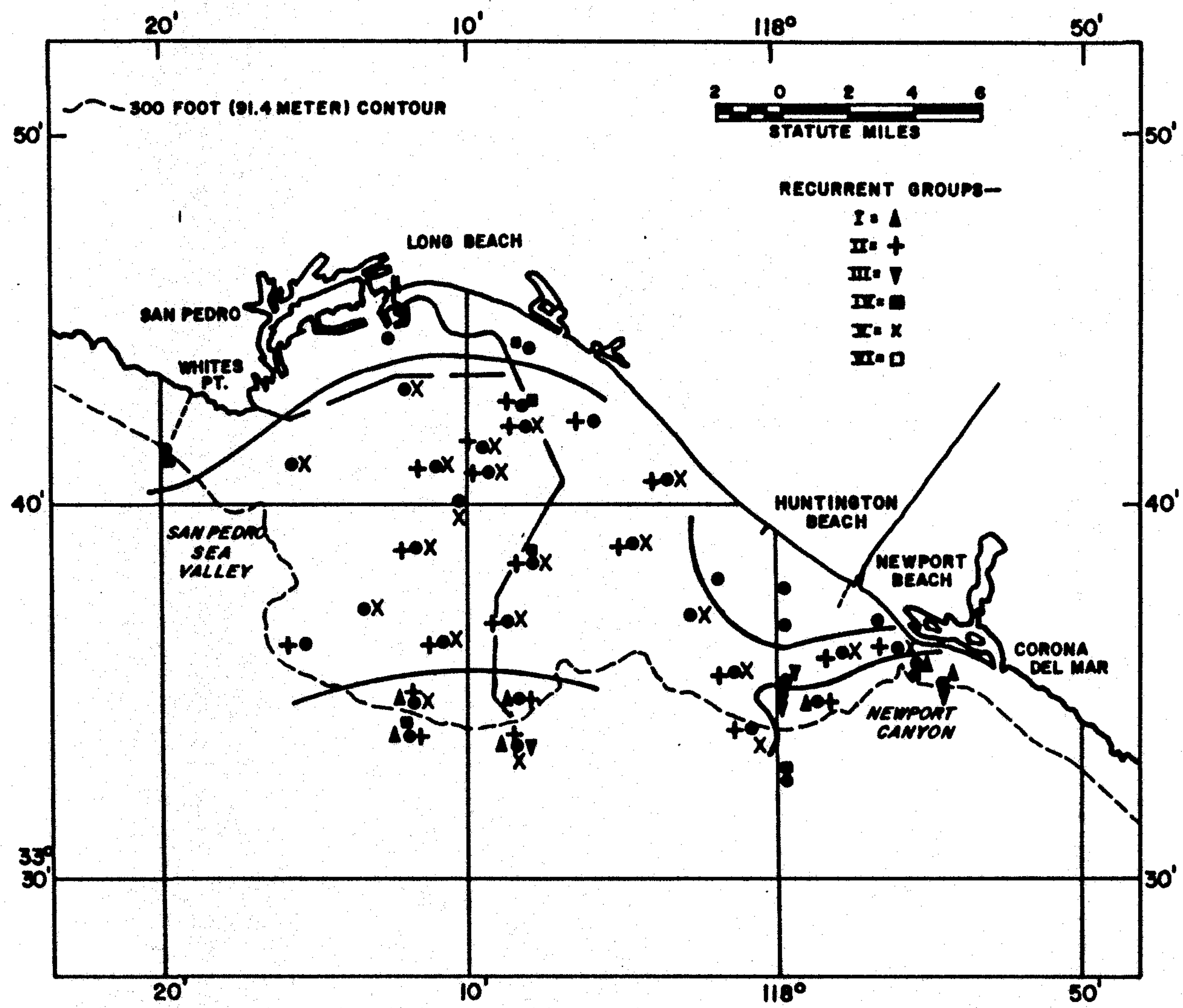
Station 61 showed the greatest number of individuals (1677) and the lowest species diversity (1.17) in contrast to station 44, where species diversity was comparatively high (3.04), but few individuals were collected (Table 3.5-7). Station 62, located at the mouth of the Los Angeles River, had few individuals (195) and few species (25) for a species diversity index of 1.67. Station 60, located near the Queen's Gate entrance to the harbor, supported the largest number of species (73) and a very large number of individuals (1620) for a species diversity of 2.00.



Source: Jones, 1969

Distribution of Bottom Material

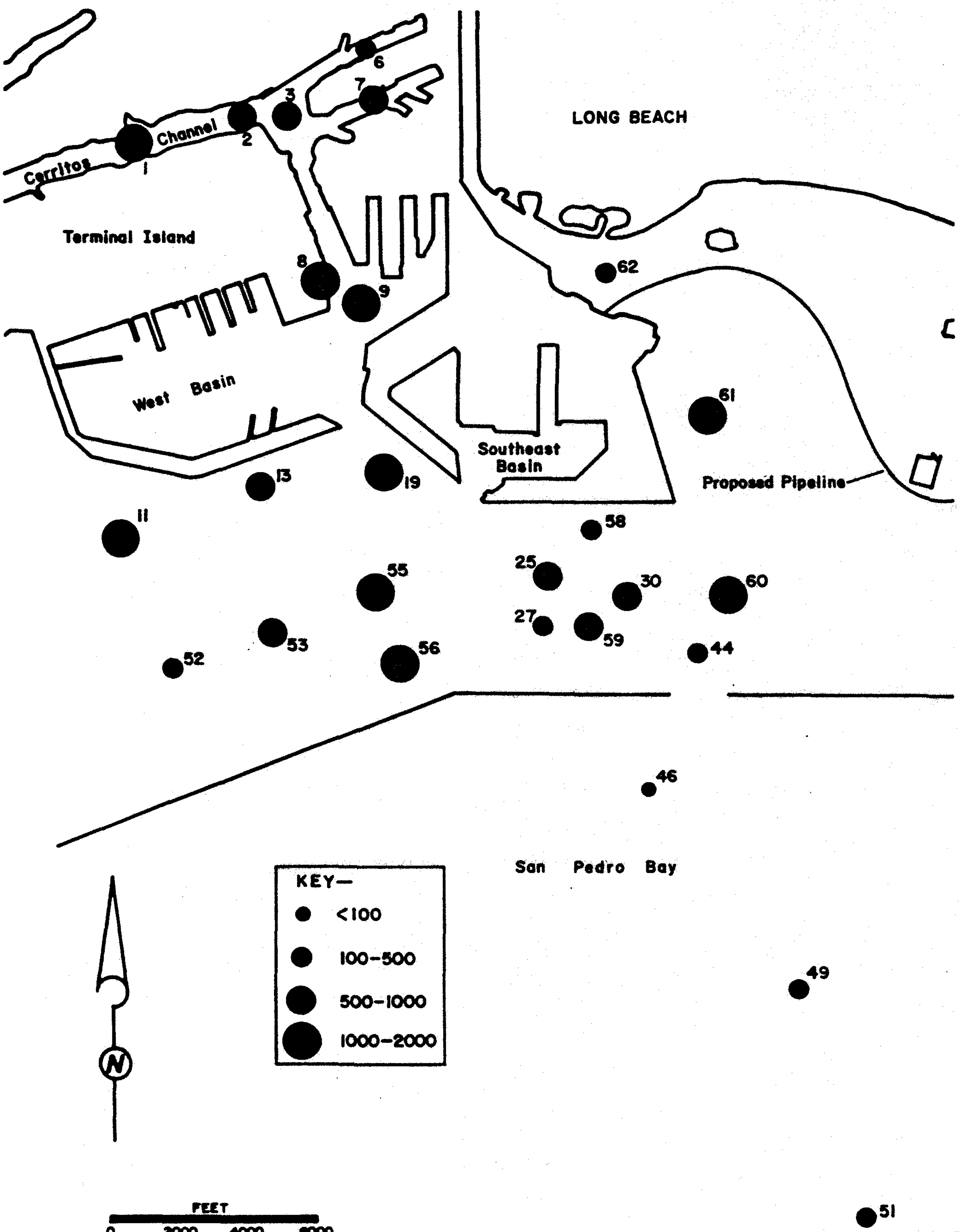
3.5-10
Figure



Source: Jones, 1969

Distribution of Recurrent Macrofaunal Groups

3.5-11
Figure



Source: Long Beach Harbor Consultants, 1976

Distribution of Individuals at Infaunal Stations

3.5-12
Figure

TABLE 3.5-6
THE RECURRENT GROUPS OF THE MAINLAND SHELF BASED ON THE ANALYSIS OF THE 196 SAMPLE SET, I.A. = 0.650 (FROM JONES, 1969)

Recurrent Groups	Occurrence	Affinities
GROUP I:		
Prionospio pinnata (P)	159	29
Pholoe glabra (P)	124	28
Amphiodia urtica (E)	153	26
Pectinaria californiensis (P)	131	26
Gnathia crenulatifrons (C)	92	18
Paraonis gracilis (P)	108	15
Axinopsida serricata (M)	92	14
Terebellides stroemi (P)	103	14
Glycera capitata (P)	94	13
Ampelisca brevisimulata (C)	101	13
Associated with Group I:		
Aricidea suecica (P)	84	1
Axiothella rubrocincta (P)	87	1
Paraphoxus robustus (C)	73	1
Chloeia pinnata (P)	64	1
Ampelisca cristata (C)	89	2
Glottidia albida (O)	91	2
Goniada brunnea (P)	114	7
Haploscoloplos elongatus (P)	105	5
Laonice cirrata (P)	96	3
Lumbrineris cruzensis P)	92	3
Spiophanes missionensis (P)	107	7
Sthenelanella uniformis (P)	84	2
Nephtys sp. (P)	90	2
Haliophasma geminata (C)	93	9
Metaphoxus frequens (C)	73	7
Nephtys ferruginea (P)	77	5
GROUP II:		
nemertean unknown (O)	150	20
Prionospio malmgreni (P)	148	17
Amphipholis squamata (E)	136	13
tanaid unknown (C)	105	13
ostracod unknown (C)	109	10
Tharyx tesselata (P)	105	7
Associated with Group II:		
Ampelisca cristata (C)	89	2
Glottidia albida (O)	91	2
Goniada brunnea (P)	114	7
GROUP II (Cont)		
Haploscoloplos elongatus (P)	105	5
Laonice cirrata (P)	96	3
Lumbrineris cruzensis (P)	92	3
Spiophanes missionensis (P)	107	7
Sthenelanella uniformis (P)	84	2
Nephtys sp. (P)	90	2
Haliophasma geminata (C)	93	9
GROUP III:		
Heterophoxus oculatus (C)	97	17
Paraphoxus similis (C)	76	12
Paraphoxus bicuspidatus (C)	77	6
Ampelisca pacifica (C)	76	12
Associated with Group III:		
Haliophasma geminata (C)	93	9
Metaphoxus frequens (C)	73	7
Nicippe tumida (C)	50	2
Nemocardium centifilosum (M)	53	1
Eudorella A (C)	63	2
Nephtys ferruginea (P)	77	5
GROUP IV:		
Cossura candida (P)	91	6
Sternaspis fossor (P)	95	10
GROUP V:		
Aricidea lopezi (P)	80	3
nematode unknown (00	91	4
Associated with Group V:		
Mediomastus californiensis (P)	65	1
GROUP VI:		
Diastylidae unknown (C)	70	4
Ampelisca pugetica (C)	69	6
GROUP VII:		
brown ostracod (C)	46	1
rectangular ostracod (C)	34	1

TABLE 3.5-7
NUMBER OF INDIVIDUALS, SPECIES, AND SPECIES DIVERSITY AT EACH INFAUNA STATION.
(FROM LONG BEACH HARBOR CONSULTANTS, 1976)

Station	Number of Individuals	Number of Species	Species Diversity (H')
1	1452	29	0.70
2	531	34	1.69
3	521	29	1.63
6	317	32	1.81
7	517	25	1.50
8	1573	48	1.32
9	1830	49	1.39
11	1021	81	2.45
13	758	70	2.68
19	1033	75	2.29
25	786	63	2.15
27	441	64	3.03
30	753	64	2.45
44	113	36	3.04
46	90	38	3.24
49	124	64	3.88
51	174	56	3.47
52	472	55	2.38
53	735	79	2.83
55	1010	52	1.90
56	1162	66	1.78
58	159	47	3.23
59	541	62	2.60
60	1620	73	2.00
61	1677	48	1.17
62	195	25	1.67

The polychaetes, Tharyx sp. and Cossura candida, were the most abundant species in the station 60 samples, comprising an average of 239 and 122 individuals per sample, respectively (Table 3.5-8). A similar relative abundance pattern was shown at station 61 where Cossura candida (286) replaced Tharyx sp. (229) as the most abundant species in the samples (Table 3.5-9). At station 62, Cossura candida was much more numerically dominant, with an average of 41 individuals per sample compared to second ranked Tharyx sp., with only 4.3 (Table 3.5-10). At Station 44, Tharyx sp. was again numerically dominant (8.6), followed by several species of comparable abundance (Table 3.5-11), including the polychaetes, Armandia bioculata, Apoprionospio pygmaeus, Capitellidae, unidentified and Sigambra tentaculata, and the clam, Macoma sp.

The three stations located seaward of the outer breakwater (stations 46, 49, and 51) sampled by Long Beach Harbor Consultants revealed affinities both to inner harbor stations (station 46) (Table 3.5-12) and to offshore faunal assemblages (stations 49 and 51) (Tables 3.5-13 and 3.5-14). Relative to harbor sampling stations, the three seaward stations showed high species diversities and comparatively small numbers of individuals per sample (Table 3.5-7). Stations 49 and 51 were located in or near the area mapped by Jones (1969) as Nothria-Tellina association. However, station 49 yielded an average of only 0.67 Tellina modesta or Tellina sp. from the sample and no members of the genus Nothria. At Station 51, Tellina sp. was the most abundant species in the sample (Table 3.5-14). One individual of Nothria iridescens was collected in the sample.

Infaunal samples from locations within one mile (1.6 km) of the proposed pipeline were taken during a thermal effects study (Environmental Quality Analysts, Inc., and Marine Biological Consultants, Inc., 1973b). These stations were arrayed near the entrance to Los Alamitos Bay and the mouth of the San Gabriel River.

Annelid worms, represented by nine polychaete species and unidentified oligochaetes, were the most abundant infaunal group. The top four species in abundance were all polychaetes: Prionospio pygmaeus (now Apoprionospio pygmaeus), Tharyx sp., Capitita ambiseta (now Mediomastus ambiseta), and Armandia bioculata (Table 3.5-15). Striking changes in seasonal abundance were also apparent. For example, Tharyx sp. abundance fell from a high of 1034 individuals in May 1972 to only four individuals in November 1972.

Station RW-14, located near the proposed pipeline, yielded such polychaetes as Prionospio pygmaeus, Nephthys cornuta franciscana, Lumbrineris ssp., Capitita ambiseta, Tharyx sp., Cossura candida, and Chaetozone corona. Also present were the amphipods, Amphideutopus oculatus and Photis ssp., and the pelecypod, Tellina modesta.

The Allan Hancock Foundation extensively sampled the nearshore benthic environment from Point Conception to the Mexican

TABLE 3.5-8

INFAUNAL ORGANISMS TAKEN AT BENTHIC STATION 60 (LONG BEACH HARBOR CONSULTANTS, 1976)

Species	Replicate A	Replicate B	Replicate C	Mean
Edwardsiella californica	2	4	0	2.00
Nemertea, unid.	3	9	0	4.00
Eteone alba	0	0	1	0.33
Eteone dilatae	0	0	1	0.33
Glycera americana	2	0	0	0.67
Gyptis brevipalpa	1	0	3	1.33
Harmothoe priops	0	0	1	0.33
Lumbrineris sp.	4	4	5	4.33
Marphysa disjuncta	1	0	2	1.00
Nephtys cornuta franciscana	5	4	6	5.00
Nereidae, unid.	0	0	1	0.33
Nereis sp.	1	0	0	0.33
Onuphidae, unid.	1	1	0	0.67
Pholoe glabra	1	0	0	0.33
Sigambra tentaculata	7	10	13	10.00
Amaeana occidentalis	1	0	0	0.33
Amphicteis scaphobranchiata	2	1	2	1.67
Apoprionospio pygmaeus	1	0	1	0.67
Aricidea suecica	0	0	1	0.33
Capitellidae, unid	118	19	20	52.33
Chaetozone corona	1	1	0	0.67
Chone ecaudata	1	0	0	0.33
Cossura candida	183	122	61	122.00
Flabelligeridae, unid.	1	0	0	0.33
Haploscloplos elongatus	12	1	2	5.00
Laonice cirrata	2	2	0	1.33
Magelona sp.	1	0	0	0.33
Maldanidae, unid.	3	1	1	1.67
Notomastus sp.	1	2	0	100
Paraonis gracilis oculata	70	24	36	43.33
Pectinaria californiensis	2	0	2	1.33
Pista fasciata	0	0	1	0.33
Prionospio cirrifera	3	3	0	2.00
Prionospio malmgreni	1	0	0	0.33
Spiophanes cirrata	2	2	2	2.00
Streblosoma crassibranchia	3	1	2	2.00
Terebellides stroemi	6	0	0	2.00
Tharyx sp.	409	174	135	239.33
Cylindroleberididae, unid.	0	1	0	0.33

Species	Replicate A	Replicate B	Replicate C	Mean
Euphilomedes sp.	5	5	5	5.00
Cumella sp. A	1	0	0	0.33
Leptostylis sp. A	0	1	1	0.67
Gnathia crenulatifrons	0	1	0	0.33
Gnathia sp.	1	0	0	0.33
Ampelisca sp.	3	1	0	1.33
Argissa hamatipes	0	0	1	0.33
Listriella goleta	1	0	0	0.33
Photis sp.	0	1	1	0.67
Opisthopus transversus	1	0	0	0.33
Pinnixa franciscana	1	0	0	0.33
Pinnixa sp.	0	0	1	0.33
Nassarius fossatus	0	0	1	0.33
Olivella baetica	0	1	3	1.33
Cephalaspidea, unid. A	3	0	0	1.00
Cyclichna diegensis	2	0	0	0.67
Odostomia sp. C	4	1	0	1.67
Rictaxis punctocaelatus	1	0	0	0.33
Turbonilla sp. G	3	0	0	1.00
Volvulella panamica	1	1	0	0.67
Compsomyax subdiaphana	6	1	2	3.00
Cooperella subdiaphana	5	0	2	2.33
Macoma acolasta	0	1	0	0.33
Macoma sp.	4	0	0	1.33
Mysella sp.	1	0	0	0.33
Parvilucina sp.	8	4	1	4.33
Saxidomus nuttalli	1	0	0	0.33
Solen rosaceus	1	0	0	0.33
Solen sp.	0	0	1	0.33
Theora lubrica	0	1	0	0.33
Thyasira flexuosa	2	0	0	0.67
Corbula luteola	1	1	0	0.67
Ophiuroidea, unid.	0	1	0	0.33
Number of Individuals	907	407	318	
Number of Species	55	35	33	
Species Diversities	1.93	1.84	2.05	

TABLE 3.5-9
INFAUNAL ORGANISMS TAKEN AT BENTHIC STATION 61 (LONG BEACH HARBOR CONSULTANTS, 1976)

	Replicate					Replicate			
Species	A	B	C	Mean	Species	A	B	C	Mean
Edwardsiella californica	2	2	0	1.33	*Oxyurostylis pacifica*	0	1	0	0.33
Nemertea, unid.	0	1	0	0.33	*Amphideutopus oculatus*	1	0	1	0.33
Anaitides sp.	1	0	0	0.33	*Argissa hamatipes*	1	1	0	0.67
Diopatra sp.	1	0	0	0.33	*Aglaja* sp.	1	0	0	0.33
Glycera americana	1	0	0	0.33	*Odostomia* sp.	0	1	0	0.33
Gyptis brevipalpa	0	0	1	0.33	*Odostomia* sp. C	1	1	1	1.00
Lumbrineris sp.	1	1	1	1.00	*Philine* sp.	0	2	0	0.67
Nephtys cornuta franciscana	1	6	0	2.33	*Rictaxis punctocaelatus*	0	1	0	0.33
Onuphidae, unid.	0	0	1	0.33	*Sulcoretusa xystrum*	1	0	0	0.33
Sigambra tentaculata	2	5	0	2.33	*Nuculana* sp.	1	0	0	0.33
Ampharetidae, unid.	0	1	0	0.33	*Crenella* sp.	0	0	1	0.33
Apoprionospio pygmaeus	0	0	1	0.33	*Modiolus neglectus*	1	0	0	0.33
Armandia bioculata	0	1	0	0.33	*Compsomyax subdiaphana*	2	0	1	1.00
Capitellidae, unid.	6	20	2	9.33	*Cooperella subdiaphana*	2	0	1	1.00
Chaetozone corona	3	2	0	1.67	*Macoma acolasta*	0	0	2	0.67
Cossura candida	221	450	187	286.00	*Macoma* sp.	3	3	4	3.33
Haploscoloplos elongatus	0	0	2	0.67	*Parvilucina* sp.	1	1	0	0.67
Paraonis gracilis oculata	1	1	3	1.67	*Protothaca* sp.	0	4	0	1.33
Paraprionospio pinnata	1	1	1	1.00	*Tellina* sp.	1	0	0	0.33
Pectinaria californiensis	0	3	3	2.00	*Theora lubrica*	0	0	1	0.33
Spiochaetopterus costarum	0	1	0	0.33	*Phoronis* sp.	1	2	0	1.00
Spiophanes cirrata	0	2	0	0.67					
Tharyx sp.	245	243	199	229.00	Number of Individuals	505	757	415	
Euphilomedes carcharodonta	1	0	0	0.33	Number of Species	29	26	21	
Euphilomedes sp.	1	0	1	0.67	Species Diversities	1.15	1.11	1.09	
Leptostylis sp. A	0	0	1	0.33					

TABLE 3.5-10
INFAUNAL ORGANISMS TAKEN AT BENTHIC STATION 62
(LONG BEACH HARBOR CONSULTANTS, 1976)

Species	Replicate A	Replicate B	Replicate C	Mean
Platyhelminthes, unid.	0	0	1	0.33
Nemertea, unid.	0	1	0	0.33
Eteone alba	0	0	2	0.67
Eteone dilatae	0	1	0	0.33
Gyptis brevipalpa	0	0	1	0.33
Lumbrineris sp.	1	0	0	0.33
Nephtys cornuta franciscana	1	0	0	0.33
Schistomeringos rudolphi	0	1	2	1.00
Sigambra tentaculata	2	1	4	2.33
Armandia bioculata	3	4	0	2.33
Capitella capitata	0	0	2	0.67
Capitellidae, unid.	4	1	2	2.33
Chaetozone corona	1	1	0	0.67
Cossura candida	34	46	43	41.00
Haploscoloplos elongatus	0	1	0	0.33
Paraonis gracilis oculata	4	0	0	1.33
Polydora ligni	3	5	1	3.00
Prionospio cirrifera	0	1	0	0.33
Tharyx sp.	7	3	3	4.33
Euphilomedes sp.	1	0	1	0.67
Cooperella subdiaphana	1	0	1	0.67
Macoma nasuta	0	0	1	0.33
Macoma sp.	1	1	0	0.67
Tellina sp.	1	0	0	0.33
Number of Individuals	64	67	64	
Number of Species	14	14	13	
Species Diversities	1.77	1.32	1.41	

TABLE 3.5-11
INFAUNAL ORGANISMS TAKEN AT BENTHIC STATION 44 (FROM LONG BEACH HARBOR CONSULTANTS, 1976)

Species	Replicate A	Replicate B	Replicate C	Mean	Species	Replicate A	Replicate B	Replicate C	Mean
Pennatulacea, unid.	0	0	1	0.33	*Prionospio cirrifera*	0	0	1	0.33
Nemertea, unid.	1	2	1	1.33	Terebellidae, unid.	0	0	1	0.33
Anaitides longipes	0	0	1	0.33	*Tharyx* sp.	7	3	16	8.67
Drilonereis mexicana	0	2	0	0.67	Cylindroleberididae, unid.	1	0	1	0.67
Eteone dilatae	1	0	1	0.67	*Euphilomedes carcharodonta*	0	1	2	1.00
Exogone lourei	0	0	1	0.33	*Euphilomedes* sp.	1	1	1	1.00
Glycinde polygnatha	0	1	0	0.33	*Hemilamprops californica*	1	2	0	1.00
Gyptis brevipalpa	1	0	0	0.33	*Leptostylis* sp. A	0	0	2	0.67
Lumbrineris japonica	1	1	1	1.00	*Ampelisca brevisimulata*	0	1	1	0.67
Marphysa disjuncta	1	0	1	0.67	*Photis* sp.	0	2	0	0.67
Nephtys cornuta franciscana	0	1	1	0.67	*Westwoodilla caecula*	0	1	0	0.33
Nereis sp.	0	0	1	0.33	*Cooperella subdiaphana*	0	0	1	0.33
Sigambra tentaculata	4	3	0	2.33	*Macoma acolasta*	1	0	0	0.33
Amphicteis scaphobranchiata	1	0	0	0.33	*Macoma* sp.	2	4	0	2.00
Apoprionospio pygmaeus	2	1	4	2.33	*Parvilucina* sp.	0	0	1	0.33
Armandia bioculata	0	2	7	3.00	Number of Individuals	30	28	55	
Capitellidae, unid.	2	0	5	2.33					
Haploscoloplus elongatus	0	0	1	0.33	Number of Species	17	16	25	
Maldanidae, unid.	1	0	2	1.00	Species Diversities	2.58	2.65	2.63	
Paraonis gracilis oculata	2	0	0	0.67					

TABLE 3.5-12
INFAUNAL ORGANISMS TAKEN AT BENTHIC STATION 46 (LONG BEACH HARBOR CONSULTANTS, 1976)

Species	Replicate A	Replicate B	Replicate C	Mean
Anaitides longipes	0	1	0	0.33
Eusigalion spinosum	0	1	0	0.33
Exogone lourei	0	1	0	0.33
Glycinde polygnatha	1	0	1	0.67
Gyptis brevipalpa	0	1	0	0.33
Onuphis parva	0	1	0	0.33
Apoprionospio pygmaeus	0	7	2	3.00
Capitellidae, unid.	3	3	1	2.33
Euchone incolor	0	2	2	1.33
Magelona sacculata	2	3	1	2.00
Maldanidae, unid.	0	1	0	0.33
Paraonis gracilis oculata	0	0	1	0.33
Prionospio cirrifera	1	1	0	0.67
Tharyx sp.	3	2	2	2.33
Euphilomedes carcharodonta	2	4	1	2.33
Euphilomedes sp.	2	3	3	2.67
Hemilamprops californica	1	0	0	0.33
Ampelisca compressa	0	1	0	0.33
Ampelisca cristata	1	0	0	0.33
Ampelisca sp.	1	1	0	0.67
Argissa hamatipes	0	0	1	0.33
Paraphoxus epistomus	1	0	0	0.33
Synchelidium sp.	1	0	0	0.33
Cyclichna diegensis	1	0	0	0.33
Odostomia sp. C	0	0	1	0.33
Modiolus neglectus	1	0	0	0.33
Cooperella subdiaphana	0	3	0	1.00
Macoma acolasta	0	0	1	0.33
Macoma sp.	0	1	0	0.33
Parvilucina sp.	0	1	0	0.33
Protothaca sp.	0	2	0	0.67
Solen sp.	0	1	0	0.33
Tellina modesta	0	1	1	0.67
Tellina sp.	0	5	0	1.67
Pandora sp.	0	1	0	0.33
Phoronis sp.	0	1	0	0.33
Ophiuroidea, unid.	0	1	1	0.67
Number of Individuals	21	50	19	
Number of Species	14	26	15	
Species Diversities	2.53	3.02	2.55	

TABLE 3.5-13
INFAUNAL ORGANISMS TAKEN AT BENTHIC STATION 49 (LONG BEACH HARBOR CONSULTANTS, 1976)

Species	Replicate A	Replicate B	Replicate C	Mean
Edwardsiella californica	0	1	1	0.67
Nemertea, unid.	1	1	0	0.67
Anatides sp.	0	1	0	0.33
Eteone alba	0	0	1	0.33
Eteone dilatae	0	0	3	1.00
Glycera sp.	0	1	0	0.33
Glycinde polygnatha	0	0	1	0.33
Goniada brunnea	1	0	0	0.33
Harmothoe priops	1	1	0	0.67
Harmothoe sp.	0	0	1	0.33
Nephtys caecoides	1	0	0	0.33
Nephtys cornuta franciscana	0	1	1	0.67
Nereis sp.	0	0	1	0.33
Onuphis nebulosa	0	2	0	0.67
scaleworm, unid.	1	0	0	0.33
Amphicteis scaphobranchiata	3	0	0	1.00
Apoprionospio pygmaeus	4	0	6	3.33
Aricidea wassi	0	1	0	0.33
Capitellidae, unid.	0	0	5	1.67
Chaetozone setosa	0	0	2	0.67
Chone ecaudata	0	0	1	0.33
Cossura candida	1	0	0	0.33
Euchone incolor	0	0	2	0.67
Haploscoloplos elongatus	0	0	1	0.33
Lysippe annectens	0	0	1	0.33
Magelona sacculata	0	0	3	1.00
Maldanidae, unid.	0	0	3	1.00
Melinna oculata	0	1	1	0.67
Paraonis gracilis oculata	1	0	1	0.67
Paraprionospio pinnata	0	0	1	0.33
Pista fasciata	3	0	1	1.33
Polycirrus perplexus	0	0	1	0.33
Prionospio malmgreni	0	1	1	0.67
Spionidae, unid.	0	1	0	0.33
Spiophanes cirrata	0	0	1	0.33
Spiophanes missionensis	0	0	1	0.33
Tharyx sp.	2	1	4	2.33
Euphilomedes carcharodonta	2	0	0	0.67
Euphilomedes sp.	0	3	0	1.00
Rutiderma sp.	0	0	1	0.33
Cumella sp. A	0	1	0	0.33
Gnathia sp.	1	0	0	0.33
Edotea sublittoralis	0	1	0	0.33
Ampelisca sp.	2	0	0	0.67
Amphideutopus oculatus	0	1	0	0.33
Paraphoxus obtusidens	1	0	0	0.33
Paraphoxus sp.	1	0	0	0.33
Balcis oldroydi	0	1	0	0.33
Olivella baetica	0	0	2	0.67
Diaphana californica	0	0	1	0.33
Turbonilla sp. F	1	0	0	0.33
Volvulella panamica	2	0	0	0.67
Cooperella subdiaphana	4	3	2	3.00
Macoma acolasta	1	0	0	0.33
Macoma sp.	1	1	1	1.00
Mysella pedroana	0	2	0	0.67
Parvilucina sp.	1	0	1	0.67
Tellina modesta	1	0	1	0.67
Tellina sp.	1	1	0	0.67
Thyasira flexuosa	0	1	0	0.33
Cadulus fusiformis	1	0	1	0.67
Scaphopoda, unid.	1	0	0	0.33
Ophiuroidea, unid.	0	0	1	0.33
Number of Individuals	40	28	56	
Number of Species	27	23	35	
Species Diversities	3.11	3.00	3.32	

TABLE 3.5-14
INFAUNAL ORGANISMS TAKEN AT BENTHIC STATION 51 (LONG BEACH HARBOR CONSULTANTS, 1976)

Species	Replicate A	B	C	Mean	Species	Replicate A	B	C	Mean
Platyhelminthes, unid.	2	0	0	0.67	Euphilomedes sp.	1	8	2	3.67
Nemertea, unid.	0	1	1	0.67	Rutiderma rostrata	5	0	1	2.00
Anaitides sp.	0	1	0	0.33	Campylaspis hartae	1	0	0	0.33
Diopatra sp.	0	0	1	0.33	Cumella sp. A	1	0	0	0.33
Eteone dilatae	1	0	0	0.33	Leptochelia sp.	1	0	3	1.33
Eulalia quadrioculata	0	0	1	0.33	Acuminodeutopus heteruropus	2	0	0	0.67
Eusigalion spinosum	0	0	1	0.33	Ampelisca brevisimulata	1	0	0	0.33
Exogone lourei	1	0	3	1.33	Ampelisca cristata	1	0	0	0.33
Glycera sp.	0	1	0	0.33	Gammarupsis sp.	0	0	1	0.33
Glycinde polygnatha	0	3	0	1.00	Listriella melanica	1	0	0	0.33
Nephtys caecoides	0	0	1	0.33	Paraphoxus obtusidens	0	0	1	0.33
Nephtys cornuta franciscana	1	2	2	1.67	Paraphoxus sp.	1	1	0	0.67
Nothria iridescens	0	0	1	0.33	Photis californica	0	0	1	0.33
Typosyllis sp.	0	0	1	0.33	Photis sp.	1	1	1	1.00
Apoprionospio pygmaeus	7	1	2	3.33	Cancer, megalops, unid.	0	0	1	0.33
Aricidea wassi	2	1	5	2.67	Olivella baetica	1	0	0	0.33
Capitellidae, unid.	4	0	2	2.00	Turbonilla sp. J	0	0	1	0.33
Chaetozone setosa	4	1	5	3.33	Cooperella subdiaphana	2	0	0	0.67
Magelona sacculata	1	0	0	0.33	Macoma sp.	0	0	4	1.33
Magelona sp.	0	2	1	1.00	Mysella pedroana	0	0	1	0.33
Maldanidae, unid.	0	1	0	0.33	Parvilucina sp.	4	1	2	2.33
Melinna oculata	0	0	1	0.33	Protothaca sp.	0	1	0	0.33
Pista fasciata	1	0	0	0.33	Tellina sp.	17	1	5	7.67
Pista sp.	0	0	1	0.33	Panopea generosa	0	0	1	0.33
Prionospio cirrifera	1	0	0	0.33	Cadulus fusiformis	0	0	2	0.67
P. malmgreni	0	3	0	1.00	Number of Individuals	72	43	59	
Scoloplos armiger	3	1	0	1.33	Number of Species	30	19	33	
Spiophanes bombyx	1	0	0	0.33	Species Diversities	2.91	2.46	3.30	
Tharyx sp.	0	0	2	0.67					
Euphilomedes carcharodonta	3	12	1	5.33					

TABLE 3.5-15
PROMINENT INFAUNAL SPECIES AMONG SAN PEDRO BAY STATIONS, RW-6 TO RW-14.(FROM ENVIRONMENTAL QUALITY ANALYSTS, INC., AND MARINE BIOLOGICAL CONSULTANTS, INC., 1973b)

Species	Nov 1971	May 1972	Aug 1972	Nov 1972	Total
Armandia bioculata[1]	468	292	192	619	1,571
Capitita ambiseta[2]	490	874	262	435	2,061
Chaetozone corona[1]	44	33	51	247	375
Cossura candida[1]	80	73	145	38	336
Lumbrineris spp.[2]	136	48	61	62	307
Nephtys cornuta franciscana[2]	209	402	340	77	1,028
Prionospio pygmaeus[1]	712	159	588	1,016	2,475
Tharyx spp.[1]	280	1,034	874	4	2,192
Oligochaeta, unid.[3]	0	128	54	883	1,065
Amphideutopus oculatus[1]	116	54	68	14	252
Cylindroleberis mariae[1]	41	34	90	40	205
Diastylopsis tenuis[1]	10	83	65	46	204
Munna sp.[3]	44	168	66	72	350
Euphilomedes carcharodonta[1]	711	182	196	21	1,110
Photis spp.[1]	61	164	316	35	576
Synchelidium sp.[1]	23	38	106	51	218
Tellina modesta[1]	151	83	46	37	317
Total	3,576	3,849	3,520	3,697	14,642

[1] Suspension feeder
[2] Deposit feeder
[3] Scavenger

border using an orange peel grab (State Water Quality Control Board, 1965). Several samples were analyzed within two miles (3.2 km) of the proposed platforms and pipeline. A short synopsis of these stations follows (Figure 3.5-8):

- SWQCB 5745-58 (5-16-58) - This station is the closest to the Shell platforms of any known benthic sampling station. It is located approximately two-thirds of a mile (1 km) southwest from the platform at a depth of 45 fathoms (82.4 m) in fine green sand. The ophiuroid, Amphiodia urtica, and the polychaete, Lumbrineris cruzensis, were numerical co-dominants with 98 individuals collected. Echinoderms represented only 9.1 percent of all specimens collected, but constituted 80 percent of the wet weight of the specimens.

- SWQCB 5746-58 (5-16-58) - Located one and one-third miles (2.1 km) south of the platform site in 80 fathoms (146.4 m), the sample was taken in light green foraminiferan sand. The most abundant single species was Onuphis nebulosa, a polychaete worm. Polychaetes were the most numerous group, representing 52 percent of the total number of specimens.

- SWQCB 5744-58 (5-16-58) - The station is located approximately one and one-fourth miles (2 km) west of the pipeline and two miles (3.2 km) northwest of the platforms. The sample was taken in fine green sand at a depth of approximately 19 fathoms (34.8 m). Polychaetes were numerically dominant, representing 52.1 percent of the sampled specimens. Prionospio malmgreni, a polychaete, and Amphiodia urtica, were the most abundant species.

- SWQCB 5743-58 (5-16-58) - This station is located west of the pipeline in green sand at 18 fathoms (32.9 m). Polychaetes comprised 47.1 percent of the species and 48 percent of the specimens enumerated. The single most abundant species was Prionospio pinnata (now Paraprionospio pinnata), a polychaete, which accounted for 168 specimens.

- SWQCB 6105-59 (2-19-59) - The sample was taken from a depth of 28 fathoms (51.2 m) in green silty-sand. The pelecypod, Axinopsis serricatus (now Axinopsida serricata), was the most abundant species (67 specimens). Other prominent species in the sample were the clams, Tellina carpenteri (51), and a cumacean, Eudorella sp. A.

- SWQCB 5743-58 (5-16-58) - A sample was taken from fine, green sands at a depth of 18 fathoms (32.9 m), approximately one mile (1.6 km) west of the pipeline and three and one-fourth miles (5.2 km) north of the platforms. The most abundant species in the sample was the polychaete, Prionnospio pinnata, accounting for 168 specimens, followed in abundance by the brachiopod, Glottidia albida (51), and the polychaete, Aricidea lopezi (52). Polychaetes were the most abundant group and accounted for 48 percent of the specimens.

- SWQCB 6104-59 (2-19-59) - This station is located approximately five miles (8 km) north of the platforms and about one-half mile (0.8 km) west of the pipeline in 14 fathoms (25.6 m) with dark grey silty-sands. The most prominent members of the sample were the ophiuroids, Amphiodia urtica, Amphioplus hexacanthus, and Amphitholis squamata (now Axiognathus squamata). Two pelecypods were also prominent: Tellina carpenteri and Nuculana taphria.

- SWQCB 4719-56 (11-19-56) - This station is located approximately one and one-half mile (2.4 km) southeast of the Long Beach breakwater in 14 fathoms (24.5 m) with sediments of green sand with no gravel. The polychaetes, Tharyx sp., Scalibregma inflatum, and Nothria elegans, were the most abundant species in the sample. Polychaetes accounted for 65.8 percent of the specimens.

- SWQCB 4885-57 (2-22-57) - The station is located in six fathoms (11 m), less than 0.1 miles (0.16 km) west of the pipeline, and approximately two miles (3.2 km) southeast of the Long Beach breakwater. The bottom consisted of a layer of red sand atop black or grey silt. Polychaetes were most prominent, accounting for 77.1 percent of the specimens. Mediomastus californiensis and Tharyx tesselata, both polychaetes, were the most abundant species.

- SWQCB 4886-57 (2-22-57) - The sample was taken one mile (1.6 km) south of the Long Beach breakwater and one mile (1.6 km) southwest of the pipeline, and contained grey to black medium coarse sands at a depth of 10 fathoms (18.3 m). Tharyx sp. was the overwhelming numerical dominant with 400 specimens collected. The ophiuroids, Axiognathus squamata and Amphiodia urtica, were also abundant.

- SWQCB 4718-56 (11-19-56) - This station is located within one-fourth mile (0.4 km) of the proposed pipeline approximately 0.5 mile (0.8 km) southwest of the end of the Alamitos Bay west jetty in coarse grey-green sands. Tharyx tesselata (104) and Tharyx ssp. (32) were the most abundant taxa.

Benthic infaunal samples were also taken within Long Beach Harbor for the Downtown Marina Environmental Impact Report (Southern California Ocean Studies Consortium, 1977). Samples were taken in September and December 1976 and January 1977 at stations arrayed near the site of a proposed marina, seaward of the Shoreline Aquatic Park. Polychaete species were the most prominent members of the infaunal community at all stations on both sampling dates. In September 1976, the most abundant polychaetes were Tharyx sp., Cossura candida, Capitita ambiseta, Prionospio pygmaeus, and Prionospio pinnata. In December 1976, Capitita ambiseta, Cossura candida and Tharyx sp. were most abundant. All other marine taxa were poorly represented. The January 1977 samples yielded very high abundances of Capitita ambiseta, Cossura candida, Nephthys cornuta franciscana, and Tharyx sp. Other taxa were present but not abundant.

Box core samples were taken along the southeastern boundary of the San Pedro Shelf as part of the Bureau of Land Management's Outer Continental Shelf Survey (SAI, 1977). The benthic macrofaunal section reported the presence of shallow water, shelf, and deep water faunal associations in the High Density Sampling Areas (HDSA) selected along the southern California coast.

The shallow-water shelf fauna was characterized as an area of high population densities and species richness. The ophiuroid Amphiodia urtica was the best indicator of this fauna, occurring in densities of between 270/m^2 in the Huntington Beach HDSA and 770/m^2 in the Laguna Beach HDSA. It was collected at all stations except shallow sandy bottom stations unfavorable to the species. Dominant microcrustaceans were amphipods, particularly such families as ampeliscids, phoxocephalids, and oedicerotids. The pelecypods, Axinopsida serricata, Paramya sp. A, Mysella tumida, and Parvilucina tenuisculpta, were the numerically dominant mollusks. Polychaetes were particularly well represented and very diverse. Deeper shelf stations yielded high population densities for the ice cream cone worm, Pectinaria californiensis. Other abundant infaunal components were the echiuroid Listriolobus pelodes, phoronids, the brachiopod, Gottida albida, and burrowing anemones.

Benthic amphipods and polychaetes within Newport Harbor were studied by Barnard and Reish (1959). They enumerated 61 polychaete species and 34 amphipod species. They further distinguished between species collected in Newport and Los Angeles/Long Beach Harbors (cosmopolitan), those found only within Newport Harbor (non-cosmopolitan), and pollution indicator species.

They sampled such non-cosmopolitan species within Newport Harbor as the amphipods Amphideutopus oculatus, Acuminodentopus heteropus, Rudilemboides stenopropodus, and Paraphoxus sp. They also found the polychaetes Lumbrineris minima, Dorvillea articulata (now Schistomeringos longicornis), Haploscoloplos elongatus, Prionospio sp., Armandia bioculata, Capitita ambiseta (now Mediomastus ssp.), and Cossura candida.

Among the common cosmopolitan species in Newport Bay were the amphipods Corophium acheruscium, C. insidiosum, Erichthonius brasiliensis, Podocerus brasiliensis, and Stenothoe valida and the polychaetes Neanthes caudata, Prionospio cirrifera, P. pinnata (now Apoprionospio pinnata). They also identified such pollution indicators as the amphipods Corophium acheruscium, C. insidiosum, and Podocerus brasiliensis, and the polychaete Capitella capitata.

3.5.1.3 Plankton

The Southern California Bight is characterized by a diverse assemblage of oceanic phytoplankton not usually found in large numbers in any given sample. A small percentage of the Bight borders island or mainland coastline, and the phytoplankton found in these areas are more numerous and less diverse than those found in the more oceanic areas. Studies by the State of California (1965) recorded 60 species of diatoms and 11 dinoflagellates in samples taken at 769 stations throughout the Bight. Chaetoceros was the most abundant diatom species sampled and Prorocentrum micans the most abundant dinoflagellate. Allen (1939) reported large differences in species composition and abundance in each of 20 years of sampling of phytoplankton in La Jolla and Point Hueneme. No two years were alike, although major trends were apparent. Variations in species composition may be due to temperature differences (Balech, 1960). Phytoplankton abundances expressed as displacement volumes were reported by the Southern California Coastal Water Research Project (SCCWRP, 1973). They reported displacement volumes of 2.07-2.77 ml/1500L at 18 stations along the coast, indicating fairly homogeneous distributions in that area. Chlorophyll a concentrations, an indicator of plankton biomass, ranged from 18-101 mg/m^2. (The water column from the surface to 150 m was integrated below each m^2 of sea surface.) Slightly lower results (20-30 mg/m^2) were reported by Owen (1974) for the California Cooperative Oceanic Fishery Investigations (CalCOFI).

Fager and McGowan (1963) reported heterogeneous zooplankton assemblages in the California area. Fleminger (1967) reported over 190 species of copepods in the Southern California Bight area. Samples from CalCOFI (Thrailkill, 1969) indicated yearly zooplankton variations similar to, but not necessarily concurrent with, those for phytoplankton.

Larval fishes are very abundant in the Southern California Bight area due to the large amount of coastline available for inshore spawning both on the mainland and around numerous islands. The most abundant larvae is that of the northern anchovy, Engraulis mordax (Messersmith *et al.*, 1969). Kramer and Ahlstrom (1968) reported abundances of E. mordax exceeding 10,000/1,000 m^3. Other important ichthyoplankton include larvae of the white croaker, the California hake, and the atherinid family (topsmelt, jacksmelt, and grunion).

(1) Plankton of the Proposed Pipeline Corridor

Plankton samples taken in the proposed pipeline corridor [one mile (1.6 km) on each side of the proposed pipeline] exhibited lower abundances of phytoplankton than stations to the west (SWQCB, 1965). These other stations were more directly influenced by runoff from Los Angeles and Long Beach Harbors (Figure 3.5-8). Concentrations of diatoms at the surface ranged from 500-5,000/l (SWQCB stations 5745, 5953, 5952, 5951). Major species collected included Chaetoceros ssp. and Nitzschia sp. Other species exhibiting occasionally high abundances included Leptocylindrus danicus and Nitzschia closterium. Diatom abundances were greatest at the surface. Mean concentrations at 25 feet (7.6 m) and 50 feet (5.3 m) were similar; however, concentrations at 50 feet (15.3 m) were more variable, and often exceeded those at 25 feet (7.6 m). Concentrations of dinoflagellates were occasionally high, especially at stations where the corridor is more inshore [SWQCB station 6557, three miles (4.8 km) south of the entrance to Anaheim Bay, and one-fourth mile (0.4 km) from the proposed pipeline]. Abundances as high as 9,300/l were recorded. The dominant dinoflagellate was

Prorocentrum micans, while an unidentified euglenid displayed occasional high values.

The method used to collect phytoplankton by SWQCB (1965) was a Nansen reversing water bottle, which was inadequate for collection of zooplankton. Ichthyoplankton eggs and larvae were also rarely captured due to their low abundances. In a study of the distribution of Engraulis mordax eggs and larvae at stations near the corridor, Kramer and Ahlstrom (1968) reported abundances commonly within the 10-1,000/1,000 m^3 range.

(2) Plankton of Long Beach Outer Harbor

The phytoplankton of Long Beach Outer Harbor display the increased numbers and reduced diversity common to inshore areas (Long Beach Harbor Consultants, 1976). Chlorophyll a concentrations over the entire harbor had mean values of 6.17 mg/m^3 (averaged over all three depths). Diatoms made up 96 percent of the phytoplankton population, with 18 species of Chaetoceros accounting for 72 percent of these. Seventy-two species of diatoms were identified. Dinoflagellates were represented by 47 species, but comprised only four percent of the population. Highest concentrations of diatoms were found at 2 m (some were collected at 2, 6, and 12 m depths), decreasing with depth. After Chaetoceros, the most abundant diatoms present were Nitzschia ssp., Skeletonema costatum, and Asterionella japonica. The water column was highly stratified during the summer, with high seasonal productivities measured in adjacent Los Angeles Harbor (Oguri, 1974).

Zooplankton in Long Beach Harbor were represented by 87 species collected simultaneously with phytoplankton samples (Long Beach Harbor Consultants, 1976). Average concentrations over the harbor were 1,000 individuals/m^3. The most abundant organisms were calanoid copepods, represented by Acartia tonsa and Paracalanus parvus, which comprised 38 and 16 percent of the zooplankton population, respectively. Also abundant were Corycaeus anglicus, a cyclopoid copepod, and the barnacle nauphii, which begin a spawning cycle in September (samples taken September 16-17, 1975). Most of the zooplankton were found at 12 m, with numbers decreasing with decreasing depth.

Stations within Long Beach Harbor generally had higher abundances of phytoplankton than stations nearer the outer breakwater. Phytoplankton individuals at the Outer Harbor stations were less stratified than at Inner Harbor stations, frequently occurring at lower depths in numbers close to concentrations found at the surface. Station LBHC60 (Figure 3.5-8)(Long Beach Harbor Consultants, 1976), off the southeastern tip of Pier J, displayed some of the highest phytoplankton numbers recorded during the survey, although the species composition was generally the same as the harbor mean. Concentrations at Station LBHC61 were similar to the harbor area, but the water column was highly stratified. Station LBHC62, in the mouth of the Los Angeles River, displayed very low phytoplankton concentrations, probably due to poor water quality.

Highest concentrations of zooplankton were recorded at station LBHC58 (Long Beach Harbor Consultants, 1976), along the south wall of Pier J. Highest plankton concentrations in the outer harbor area appear to occur around the boundary of Pier J, near where the proposed pipeline will come ashore.

3.5.1.4 Fishes

The only recent, original, comprehensive compilations of knowledge about fish communities along the southern California coast are found in two documents. The first is a report on a three-year investigation into the ecology of the Southern California Bight by the Southern California Coastal Water Research Project (SCCWRP, 1973a), in which the emphasis was on the shallow-water demersal fishes of the mainland and island shelves. The second is a literature review by the Southern California Ocean Studies Consortium (SCOSC, 1974a), which presents a summary of knowledge of the southern California coastal zone and offshore areas. The chapter on fishes summarizes the information compiled by SCCWRP (1973a) on shallow-water fish populations, and presents a discussion of knowledge of fishes from deep-sea basins in a comparable format. It includes a section on pelagic fishes, and an updating of the SCCWRP report on fish abnormalities and environmental stresses.

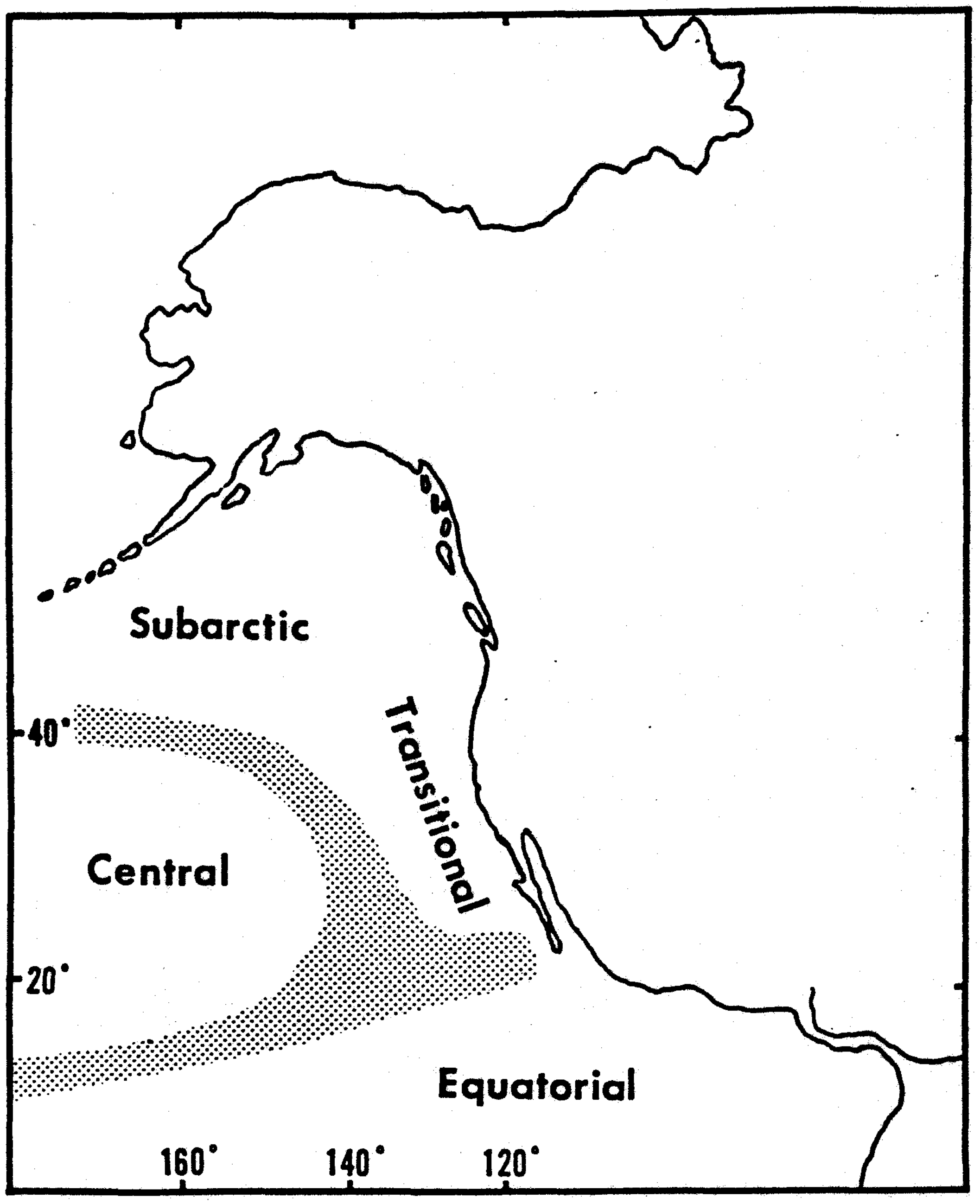
Several more recent relevant documents in the form of environmental reports and statements are available. Among these are: the five-volume Bureau of Land Management Final Environmental Statement for the Proposed Outer Continental Shelf Lease Sale No. 35 (BLM, 1975); a March 1977 draft of an environmental impact statement by the County Sanitation Districts of Orange County (CSDOC, 1977a); and a draft report on regional baseline environmental data for the proposed Shell Beta project by Dames and Moore (1978).

For the most part, these, and other comparable documents, are verbatim copies, or paraphrasings of the information originally presented by SCCWRP and SCOSC. In those instances where additional data have been incorporated, no significantly new analyses or interpretations were presented.

In the absence of site specific field work for the proposed Shell Beta project, most of the information presented in the sections that follow was abstracted and summarized from the same widely quoted reports on various aspects of the marine environment in the area. However, also included are data from recently completed field work in parts of the project area which will be in forthcoming reports that are currently in preparation.

(1) Faunal Associations

Convergence of North Pacific Central Water with Pacific Subarctic Water and Equatorial Pacific Water (Figure 3.5-13) endows the waters offshore of southern California with the



Source: After Lavenberg and Ebeling, 1967

Eastern Pacific Water Masses

Figure 3.5-13

characteristics of a transitional zone between northern cold-temperature waters and southern warm-temperature, sub-tropical waters (Lavenberg and Ebeling, 1967). Consequent latitudinal temperature gradients are reflected in the distribution of the fish fauna of the eastern Pacific, which SCCWRP (1973a) categorized into three major faunal groups according to temperature regions (Figure 3.5-14). They are the cold water fauna of the Alaskan-Vancouveran Regions, the temperate fauna of the Californian Region, and the tropical fauna of the Panamic Region. Because of varying degrees of affinity with faunas to the north and south, the Californian Region can be further divided into Montereyan and San Diegan subregions. The fish fauna of the San Pedro Channel area, which is a major concern to the Shell Beta project, belong to the warm water, temperate fauna of the San Diegan subdivision of the California Region.

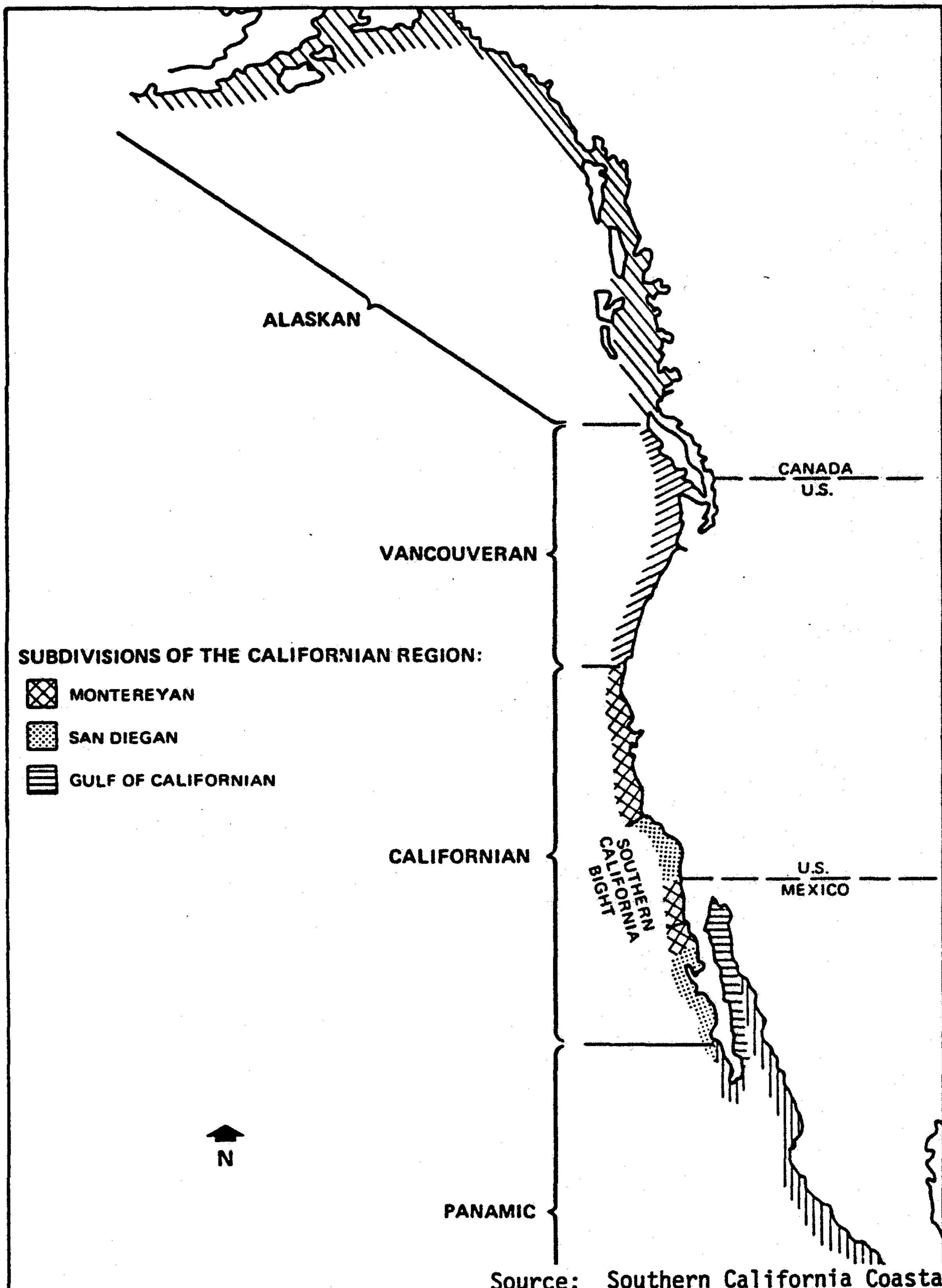
(2) Regional Abundance

As pointed out by Horn (1974a), 87 percent (or 481) of the 554 species of marine fishes reported by Miller and Lea (1972) to occur along the California coast are found in southern California waters, which encompasses the coastal reach between Point Conception and the Mexican border. Furthermore, since Miller and Lea included only a part of the deep-sea fauna, the total number of species in the Southern California Bight exceeds 481. The number of species and number of families of principally coastal marine fishes are listed for southern, central, and northern California in Table 3.5-16.

The list provided in Table 3.5-17 names the ten fish families occurring offshore of southern California that contain the greatest number of species. The presence of a relatively large number of species, however, is not necessarily coordinate with the ecological importance of that family to the ichthyofauna of the region. Other families with far fewer species often constitute much more consistent elements of the fauna because of the individual numerical abundance of one or more of their species. Among the most important of these families that inhabit nearshore waters are the Clupeidae, Engraulididae, Atherinidae, Serranidae, Sciaenidae, Bothidae, and Cynoglossidae.

(3) Principal Species and Species Associations

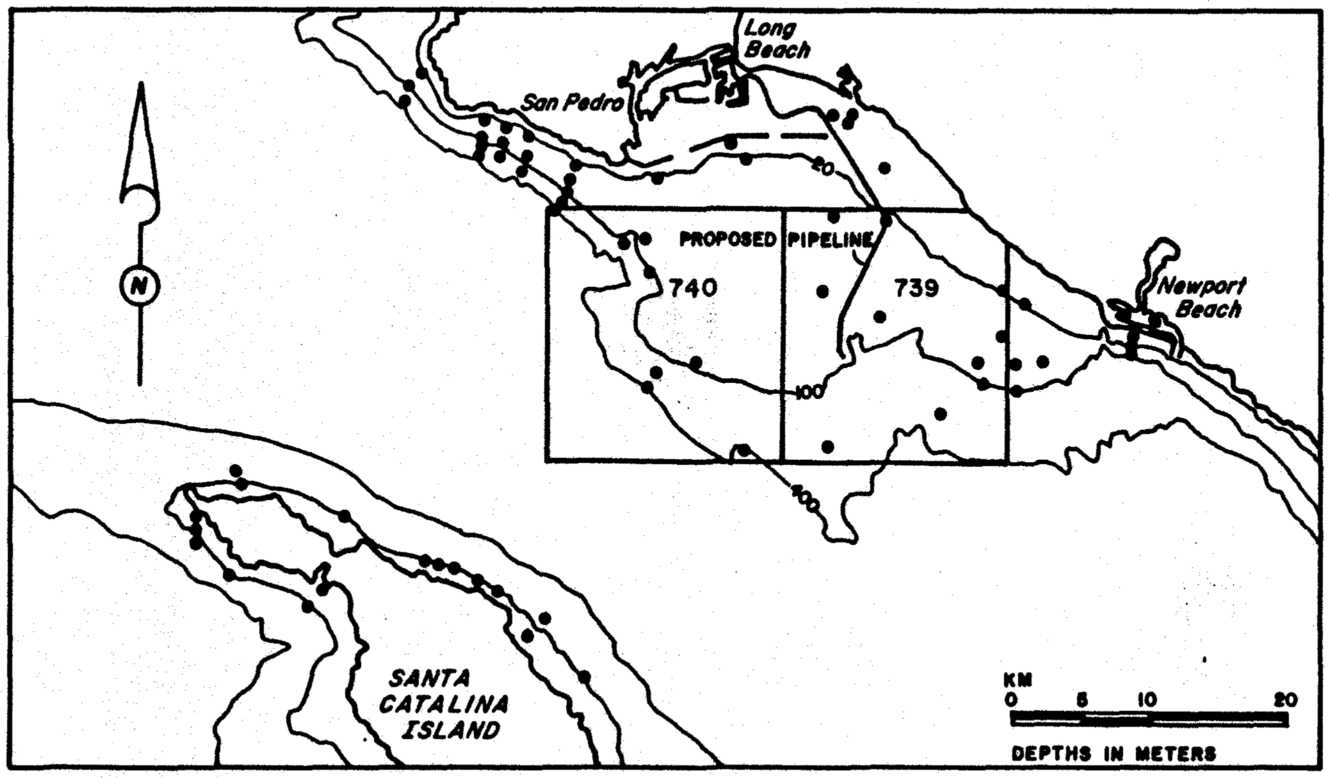
The compilation of data on the nearshore fish fauna in the SCCWRP (1973a) report was based on the results of 330 otter-board trawl samples from 119 stations located throughout the Southern California Bight. Station locations relevant to the Shell Beta project are shown in Figure 3.5-15. A summary of the species taken during these surveys is given in Table 3.5-18, and the frequency of occurrence of the 20 most abundantly captured species by sub-areas within the Southern California Bight is presented in Table 3.5-19. The total number of specimens of each of the 20 species captured during the trawling programs is given in Table 3.5-20.



Source: Southern California Coastal Water Research Project, 1973 a

Fish Faunal Regions of Western North America

3.5-14
Figure



Fish Blocks - California Fish and Game Department
Trawling Stations - SCCWRP 1969 - 1972 locations.

Trawling Stations and Fish Blocks

3.5-15
Figure

TABLE 3.5-16
NUMBER OF SPECIES AND FAMILIES OF PRINCIPALLY COASTAL FISHES IN SOUTHERN, CENTRAL, AND NORTHERN CALIFORNIA[1]

Region	Species	Families
Southern California (Mexican border to Pt. Conception)	481	129
Central California (Pt. Conception to San Francisco)	396	118
Northern California (San Francisco to Oregon border)	333	102

[1]Data from Miller and Lea (1972).

TABLE 3.5-17
TEN MOST SPECIOSE FAMILIES OF FISHES OCCURRING IN SOUTHERN CALIFORNIA[1] (FROM HORN, 1974a).

Family	Common Name	Number of Species
Scorpaenidae	scorpionfishes/rockfishes	55
Cottidae	sculpins	34
Embiotocidae	surfperches	18
Pleuronectidae	righteye flounders	18
Myctophidae	lanternfishes	16
Scombridae	mackerels and tunas	14
Carangidae	jacks and pompanos	13
Gobiidae	gobies	13
Clinidae	clinids	12
Carcharhinidae	requiem sharks	12

[1]Data from Miller and Lea (1972) except Myctophidae from Ebeling, et al. (1970).

TABLE 3.5-18

SPECIES TAKEN IN THE 1969-72 TRAWLING SURVEYS OF SOUTHERN CALIFORNIA COASTAL WATERS (FROM SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT, 1973a).

Species	Common Name
MYXINIDAE	
Eptatretus stouti	Pacific hagfish
HETERODONTIDAE	
Heterodontus francisci	horn shark
SCYLLIORHINIDAE	
Cephaloscyllium ventriosum	swell shark
CARCHARHINIDAE	
Mustelus californicus	gray smoothhound
M. henlei	brown smoothhound
SQUALIDAE	
Squalus acanthias	spiny dogfish
SQUATINIDAE	
Squatina californica	Pacific angel shark
RHINOBATIDAE	
Platyrhinoidis triseriata	thornback
Rhinobatos productus	shovelnose guitarfish
TORPEDINIDAE	
Torpedo californica	Pacific electric ray
RAJIDAE	
Raja kincaidi	sandpaper skate
R. stellulata	starry skate
DASYATIDAE	
Urolophus halleri	round stingray
MYLIOBATIDAE	
Myliobatis californica	bat ray
CHIMAERIDAE	
Hydrolagus colliei	ratfish
CONGRIDAE	
Gnathophis catalinensis	Catalina conger
ENGRAULIDAE	
Anchoa compressa	deepbody anchovy
A. delicatissima	slough anchovy
Engraulis mordax	northern anchovy
ARGENTINIDAE	
Argentina sialis	Pacific argentine
SYNODONTIDAE	
Synodus lucioceps	California lizardfish
BATRACHOIDIDAE	
Porichthys myriaster	specklefin midshipman
P. notatus	plainfin midshipman
MORIDAE	
Physiculus rastrelliger	hundred-fathom codling
GADIDAE	
Merluccius productus	Pacific hake
OPHIDIIDAE	
Chilara taylori	spotted cusk-eel
Otophidium scrippsae	basketweave cusk-eel
ZOARCIDAE	
Aprodon cortezianus	bigfin eelpout
Lycodopsis pacifica	blackbelly eelpout
Lyconema barbatum	bearded eelpout
MACROURIDAE	
Nezumia stelgidolepis	California rattail
SYNGNATHIDAE	
Syngnathus californiensis[1]	kelp pipefish
SERRANIDAE	
Paralabrax clathratus	kelp bass
P. maculatofasciatus	spotted sand bass
P. nebulifer	barred sand bass
BRACHIOSTEGIDAE	
Caulolatilus princeps	ocean whitefish
SCIAENIDAE	
Genyonemus lineatus	white croaker
Menticirrhus undulatus	California corbina
Seriphus politus	queenfish
EMBIOTOCIDAE	
Amphistichus argenteus	barred surfperch
Cymatogaster aggregata	shiner perch
Embiotoca jacksoni	black perch
Hyperprosopon anale	spotfin surfperch
H. argenteum	walleye surfperch
Phanerodon furcatus	white seaperch
Rhacochilus toxotes	rubberlip seaperch
R. vacca	pile perch
Zalembius rosaceus	pink seaperch

TAB[redacted].5-[redacted](Con[redacted]

SPECIES TAKEN IN THE 1969-72 TRAWLING SURVEYS OF SOUTHERN CALIFORNIA COASTAL WATERS
(FROM SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT, 1973a).

Species	Common Name
BATHYMASTERIDAE	
Rathbunella sp.	
Rathbunella hypoplecta	smooth ronquil
URANOSCOPIDAE	
Kathetostoma averruncus	smooth stargazer
CLINIDAE	
Alloclinus holderi	island kelpfish
Heterostichus rostratus	giant kelpfish
Neoclinus blanchardi	sarcastic fringehead
neoclinus uninotatus	onespot fringehead
STICHAEIDAE	
Plectobranchus evides	bluebarred prickleback
GOBIIDAE	
Coryphopterus nicholsi	blackeye goby
Lepidogobius lepidus	bay goby
STROMATEIDAE	
Peprilus simillimus	Pacific pompano
SCORPAENIDAE	
Scorpaena guttata	California scorpionfish
Sebastes chlorostictus	greenspotted rockfish
S. crameri	darkblotched rockfish
S. dalli	calico rockfish
S. diploproa	splitnose rockfish
S. elongatus	greenstriped rockfish
S. eos	pink rockfish
S. flavidus	yellowtail rockfish
S. goodei	chilipepper
S. hopkinsi	squarespot rockfish
S. jordani	shortbelly rockfish
S. lentiginosus	freckled rockfish
S. levis[2]	cow rockfish
S. macdonaldi	Mexican rockfish
S. melanostomus	blackgill rockfish
S. miniatus[3]	vermilion rockfish
S. mystinus	blue rockfish
S. paucispinis	bocaccio
S. rosaceus	rosy rockfish
SCORPAENIDAE (Cont)	
S. rosenblatti	greenblotched rockfish
S. rubrivinctus	flag rockfish
S. saxicola	stripetail rockfish
S. semicinctus	halfbanded rockfish
S. serranoides	olive rockfish
S. serriceps	treefish
S. umbrosus	honeycomb rockfish
S. vexillaris	whitebelly rockfish
Sebastolobus alascanus	shortspine thornyhead
ANOPLOPOMATIDAE	
Anoplopoma fimbria	sablefish
HEXAGRAMMIDAE	
Oxylebius pictus	painted greenling
Zaniolepis frenata	shortspine combfish
Z. latipinnis	longspine combfish
COTTIDAE	
Chitonotus pugetensis	roughback sculpin
Icelinus filamentosus	threadfin sculpin
I. quadriseriatus	yellowchin sculpin
I. tenuis	spotfin sculpin
Leptocottus armatus	Pacific staghorn sculpin
Radulinus asprellus	slim sculpin
Rhamphocottus richardsoni	grunt sculpin
AGONIDAE	
Agonopsis sterletus	so. spearnose poacher
Asterotheca pentacanthus	bigeye poacher
Odontopyxis trispinosa	pygmy poacher
Xeneretmus latifrons	blacktip poacher
X. tricanthus	bluespotted poacher
BOTHIDAE	
Citharichthys sordidus	Pacific sanddab
C. stigmaeus	speckled sanddab
C. xanthostigma	longfin sanddab
Hippoglossina stomata	bigmouth sole
Paralichthys californicus	California halibut
Xystreurys liolepis[4]	fantail sole

TABLE 3.5-18 (Cont.)
SPECIES TAKEN IN THE 1969-72 TRAWLING SURVEYS OF SOUTHERN CALIFORNIA COASTAL WATERS
(FROM SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT, 1973a).

Species	Common Name	Species	Common Name
PLEURONECTIDAE			
Eopsetta jordani	Petrale sole		
Glyptocephalus zachirus	rex sole		
Hypsopsetta guttulata	diamond turbot		
Lepidopsetta bilineata	rock sole		
Lyopsetta exilis[5]	slender sole		
Microstomus pacificus	Dover sole		
Parophrys vetulus	English sole		
Pleuronichthys coenosus	C-O sole		
P. decurrens	curlfin sole		
P. ritteri	spotted turbot		
P. verticalis	hornyhead turbot		
CYNOGLOSSIDAE			
Symphurus atricauda	California tonguefish		

1 Included here are specimens identified as an undescribed species of Syngnathus.

2 Included here are specimens identified as an undescribed species of Sebastes nigrocinctus (tiger rockfish).

3 Included here are specimens identified as an undescribed species of Sebastes ruberrimus (yelloweye rockfish).

4 Included here are specimens identified as an undescribed species of Isopsetta isolepis (butter sole).

5 Included here are specimens identified as an undescribed species of Atheresthes stomias (arrowtooth flounder).

TABLE 3.5-19

FREQUENCY OF OCCURRENCE (PERCENT) OF THE 20 MOST COMMON SPECIES IN SAMPLES FROM THE 1969-72 TRAWLING SURVEYS OF SOUTHERN CALIFORNIA COASTAL WATERS (FROM SCCWRP, 1973a).

Rank	Species	All Areas	Port Hueneme	Santa Monica Bay	Palos Verdes	San Pedro	Santa Catalina Island
1	Dover sole	66	16	55	84	73	52
2	Pacific sanddab	57	72	31	68	53	91
3	speckled sanddab	55	80	74	45	55	10
4	plainfin midshipman	49	20	74	34	52	57
5	English sole	48	68	33	46	56	0
6	California tonguefish	48	64	57	13	64	5
7	hornyhead turbot	46	84	45	22	61	19
8	pink seaperch	42	32	35	30	48	76
9	stripetail rockfish	36	8	39	36	36	43
10	yellowchin sculpin	32	24	53	3	41	81
11	shortspine combfish	31	16	14	16	41	81
12	longspine combfish	30	64	33	16	31	19
13	curlfin sole	29	72	25	50	12	24
14	rex sole	29	8	14	28	41	33
15	bigmouth sole	26	28	12	18	35	48
16	slender sole	25	8	23	12	38	33
17	shiner perch	24	12	8	33	33	0
18	halfbanded rockfish	23	0	8	22	33	24
19	white croaker	22	20	12	22	30	0
20	California scorpionfish	20	0	10	28	23	19
	Number of Hauls	303	25	49	76	132	21

TABLE 3.5-20
TOTAL NUMBER OF SPECIMENS OF EACH OF THE 20 MOST ABUNDANT SPECIES IN SAMPLES FROM THE 1969-72 TRAWLING SURVEYS OF SOUTHERN CALIFORNIA COASTAL WATERS (FROM SCCWRP, 1973a).

Rank	Species	Number of Specimens
1	speckled sanddab	17,626
2	Pacific sanddab	10,312
3	Dover sole	9,375
4	stripetail rockfish	5,535
5	white croaker	4,155
6	plainfin midshipman	3,943
7	slender sole	3,893
8	California tonguefish	3,590
9	halfbanded rockfish	3,310
10	yellowchin sculpin	2,836
11	shiner perch	2,008
12	pink seaperch	1,975
13	northern anchovy	1,952
14	rex sole	1,865
15	queenfish	1,864
16	longspine combfish	1,402
17	splitnose rockfish	1,186
18	curlfin sole	1,063
19	blackbelly eelpout	849
20	shortspine combfish	815
	Total	79,554
	Total (all species)	87,418

The data were examined by a recurrent group analysis as detailed by Fager (1957, 1963) and Fager and Longhurst (1968) to identify species that tend to be associated with each other in the trawl catches, and which, therefore, may be considered as samples from operational communities. About 20 percent of the 121 nearshore demersal species captured during the 1969-72 trawling surveys appeared together in statistically significant groupings. Five major groups and six associated individual species emerged from the analysis (Figure 3.5-16). The first named species in each of the groups is the dominant member. The geographical distribution of these recurrent groups is shown in Figure 3.5-17.

SCCWRP (1973a) acknowledged that the groups may or may not represent complete fish communities since the data were collected by daytime trawling, excluding nighttime trawl sampling, and the use of additional methods such as longline fishing, purse seining, fish trapping, and in situ photography. The last technique, used in a later study (SCCWRP, 1973b), revealed that at least two species, sablefish (Anopoploma fimbria) and spiny dogfish (Squalus acanthias) were more abundant than the trawl catches indicated, and that, conversely, many of the more commonly trawl-caught species such as sculpins, combfish, small flatfishes, and several species of rockfishes and croakers were not observed in the films.

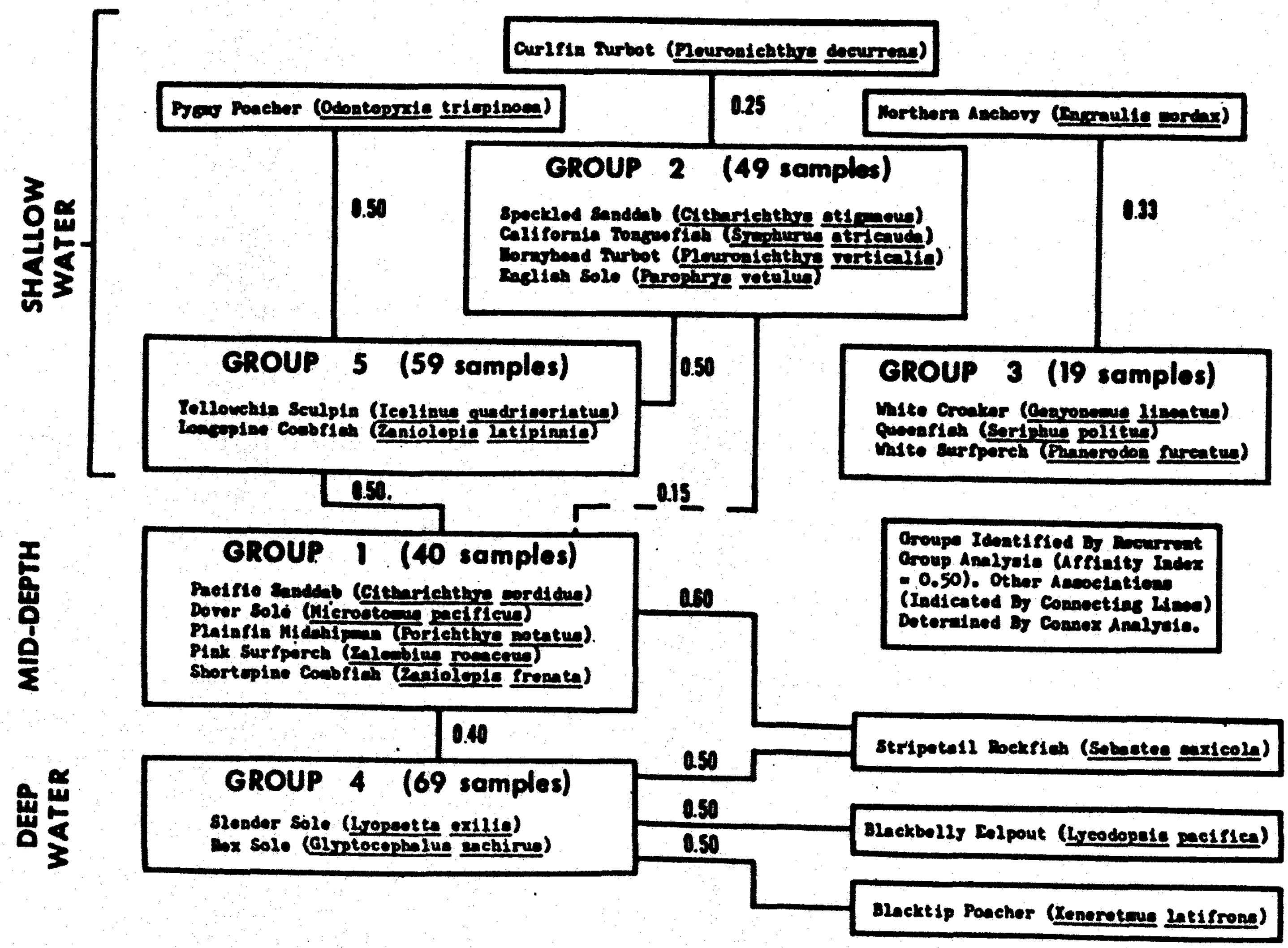
Nevertheless, recurrent group analysis did identify groups that appeared in the trawl catches in sufficient frequencies so that their mutual appearance was statistically significant. It was assumed that this was a consequence of an association in nature resulting from preference for, and selection of, similar environmental conditions.

(4) San Pedro Bay

Community analysis of the demersal fishes of San Pedro Bay was presented by Stephens *et al.* (1973) on the results of 61 trawls made in the area outside of the Los Angeles/Long Beach breakwaters between 1971 and 1973. The location of the major trawling stations is shown in Figure 3.5-18, and the names of the captured species are listed in Table 3.5-21.

Many of Stephens' data were included in the broader scope of the SCCWRO (1973a) report, but they were presented again separately by Stephens *et al.* (1973) with the intention of providing a characterization of the populations in the area to serve as a baseline study for examinations of fishes within the harbor complex. The analysis showed that the demersal fishes could be divided into a number of communities which were distributed according to depth.

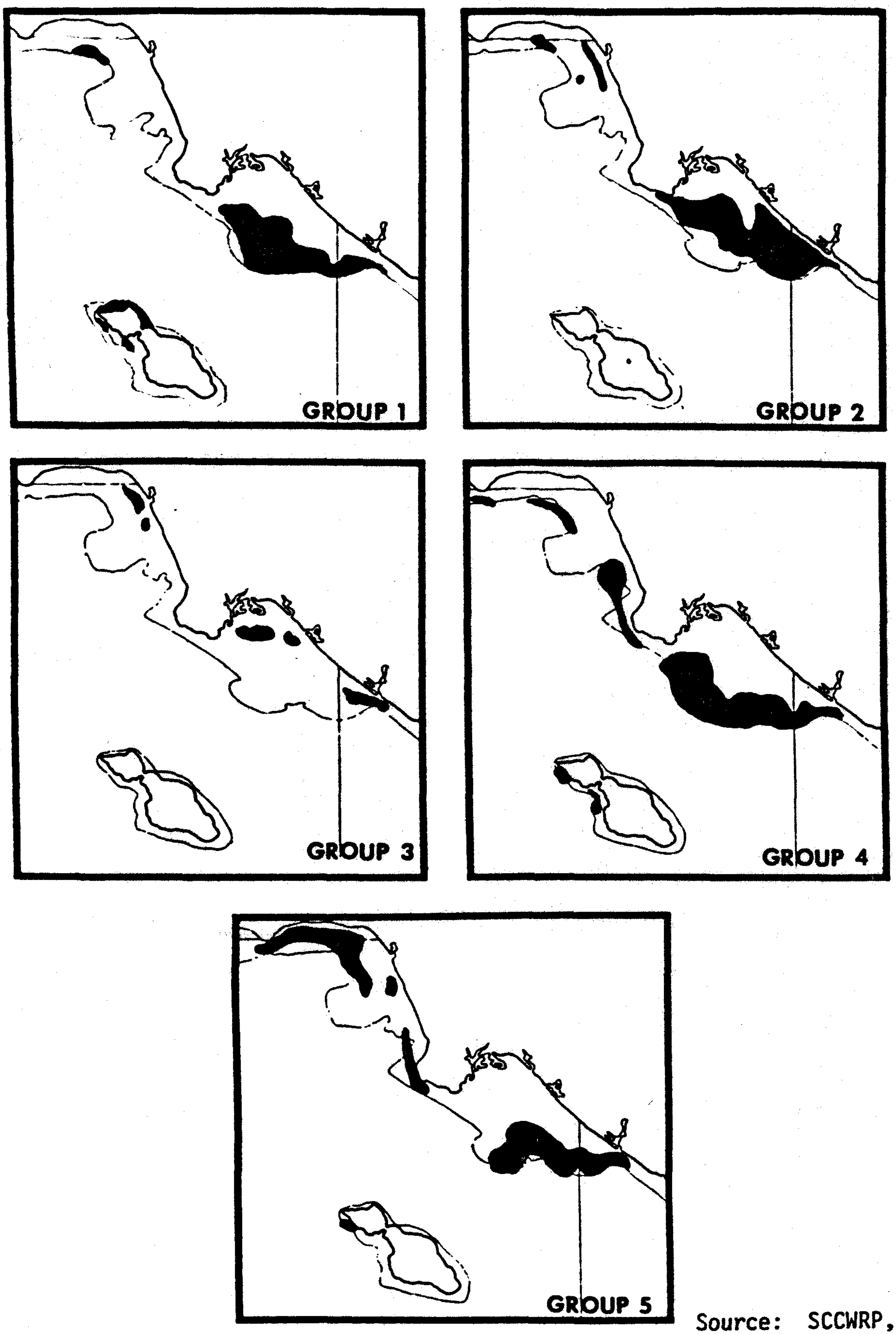
A recurrent group analysis of the shallow water (10-30 m) species (Figure 3.5-19) showed that the strongest associations were between three of the four flatfishes which were included in Group 2 of the analysis by SCCWRP (Figure 3.5-16). In both group analyses, speckled sanddab (Citharichthys stigmaeus), California



Source: SCCWRP, 1973 a

Species Associations of Nearshore Demersal Fishes

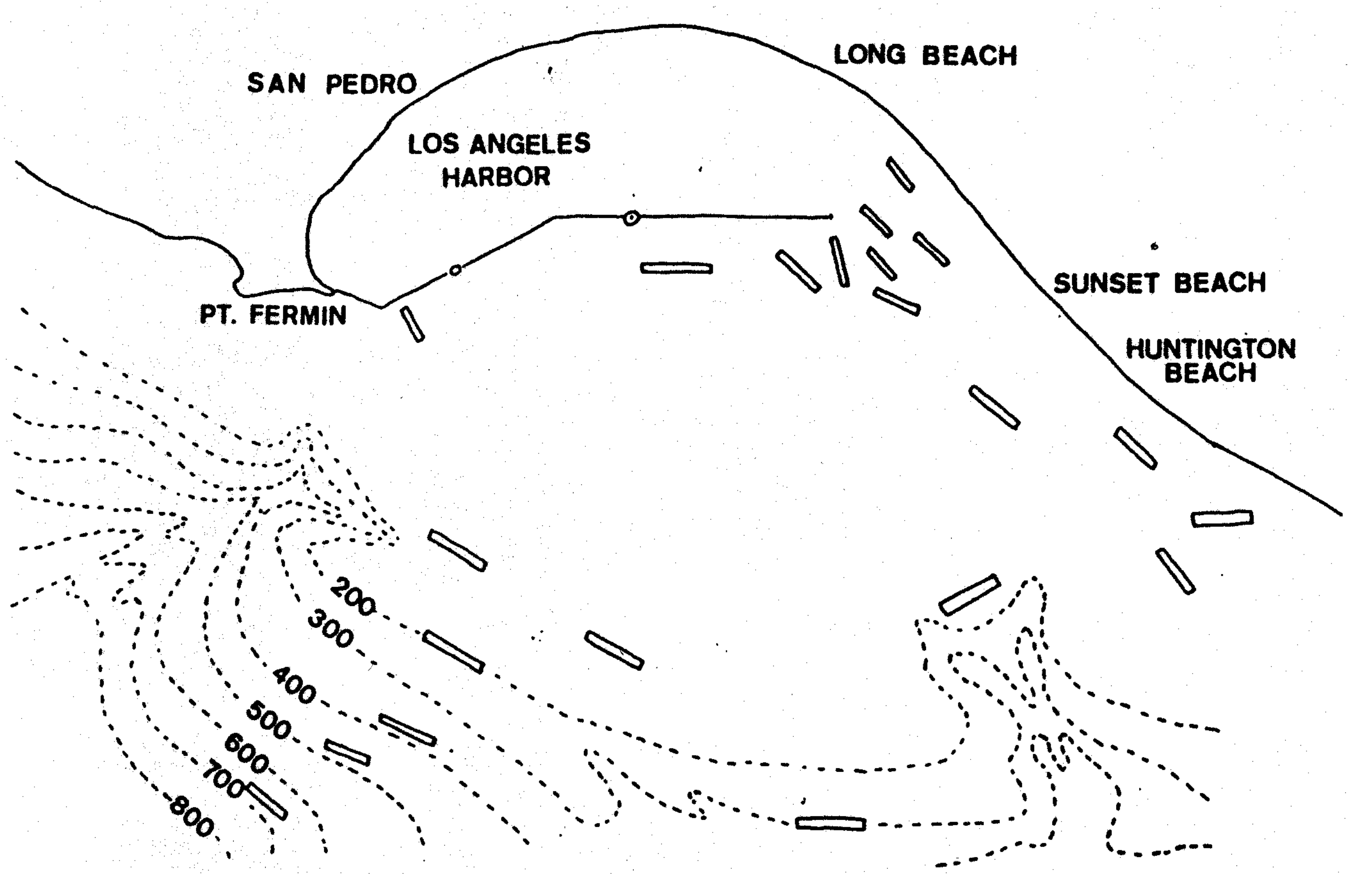
3.5-16
Figure



Source: SCCWRP, 1973 a

Distribution of Recurrent Nearshore Demersal Fishes

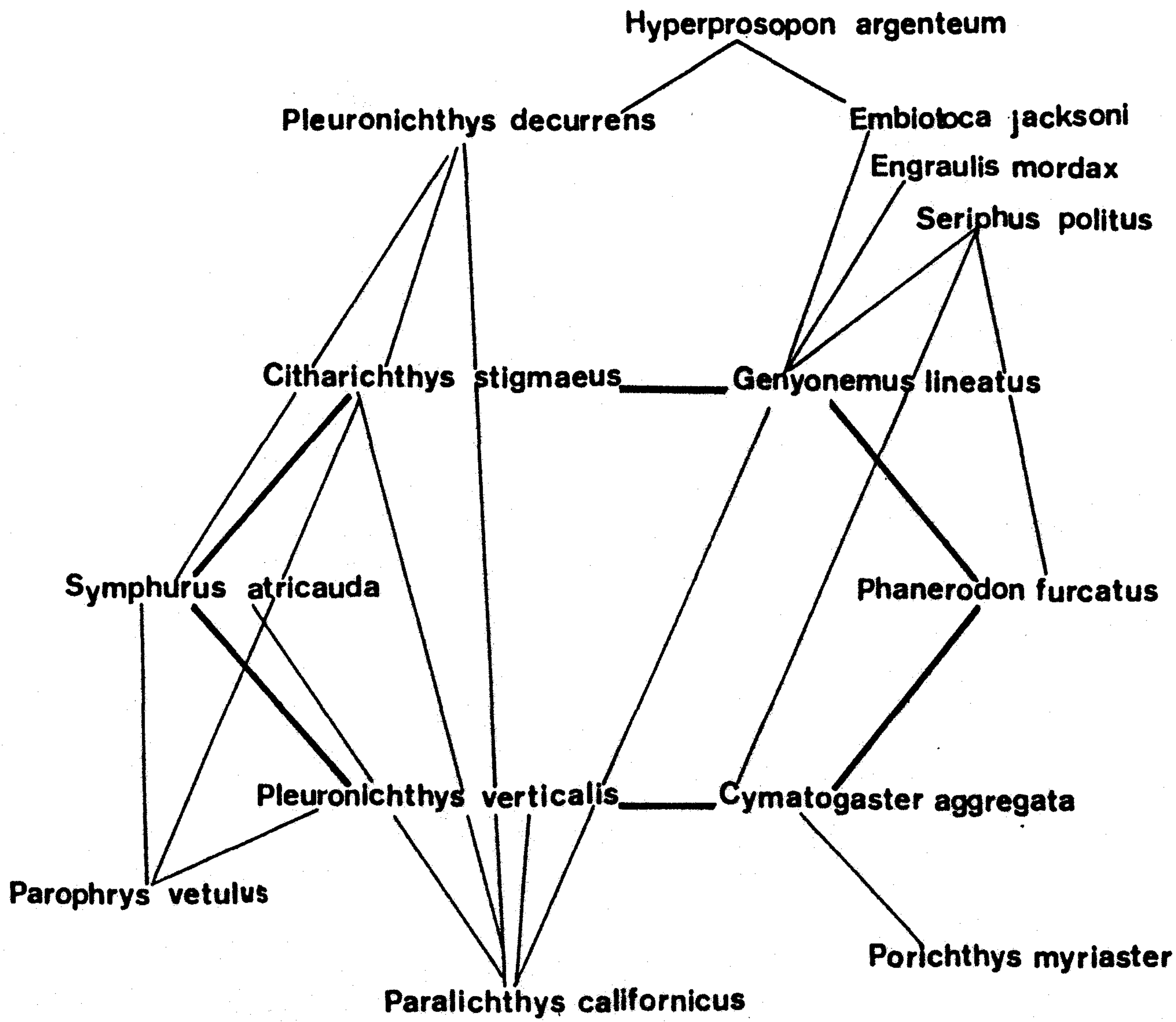
3.5-17
Figure



Source: Stephens et. al., 1973

Trawling Station Locations, San Pedro Bay

3.5-18
Figure



Source: Stephens et. al., 1973
Shallow water - (10-30 M)

Recurrent Group Species Associations

3.5-19
Figure

TABLE 3.5-21
SAN PEDRO BAY FISHES (EXCLUSIVE OF LOS ANGELES HARBOR) TAKEN BY THE VANTUNA 1971-73)
(FROM STEPHENS ET AL., 1973)

Eptatretus stouti
Cephaloscyllium ventriosum
Mustelus californicus
Squalus acanthias
Squatina californica
Platyrhinoidis triseriata
Rhinobatos productus
Torpedo californica
Raja kincaidi
R. stellulata
Urolophus halleri
Myliobatis californica
Hydrolagus colliei
Gnathophis catalinensis
Facciolella gilberti
Anchoa compressa
A. delicatissima
Engraulis mordax
Argentina sialis
Synodus lucioceps
Porichthys myriaster
P. notatus
Physiculus rastrelliger
Merluccius productus
Chilara taylori
Otophidium scrippsi
Aprodon cortezianus
Lycodopsis pacifica
Lyconema barbatum
Nezumia stelgidolepis
Syngnathus californiensis
Paralabrax nebulifer
Caulolatilus princeps
Genyonemus lineatus
Menticirrhus undulatus
Seriphus politus

Amphistichus argenteus
Cymatogaster aggregata
Embiotoca jacksoni
Hyperprosopon argenteum
Phanerodon furcatus
Rhacochilus vacca
Zalembius rosaceus
Rathbunella hypoplecta
Kathetostoma averruncus
Neoclinus blanchardi
N. uninotatus
Plectobranchus evides
Lythrypnus dalli
Coryphopterus nicholsi
Peprilus simillimus
Scorpaena guttata
Sebastes chlorostictus
S. crameri
S. dalli
S. diploproa
S. elongatus
S. eos
S. goodei
S. hopkinsi
S. jordani
S. levis
S. melanostomus
S. miniatus
S. mystinus
S. paucispinis
S. rosaceus
S. rosenblatti
S. rubrivinctus
S. saxicola
S. semicinctus
S. serranoides

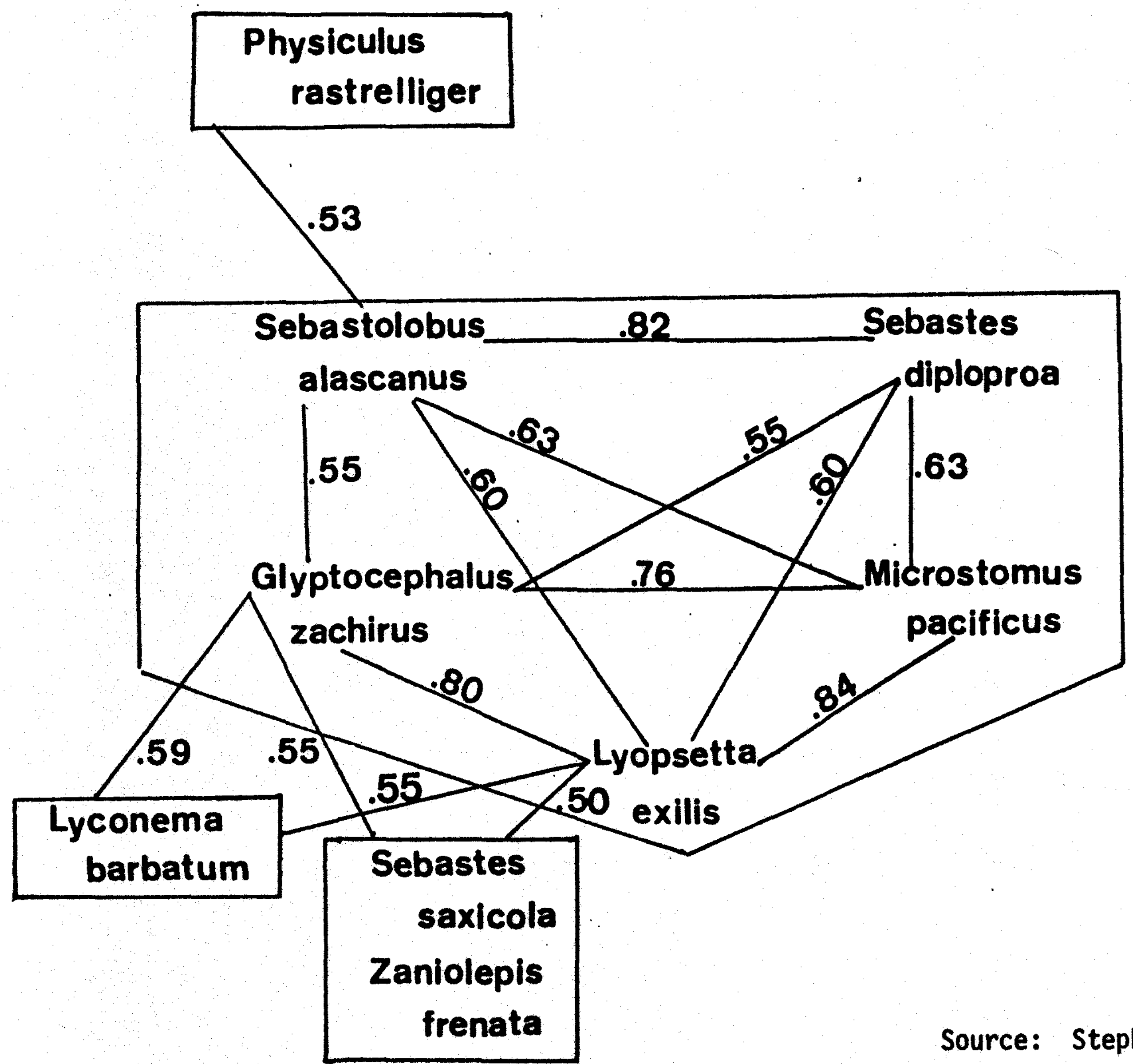
Sebastes serriceps
S. umbrosus
Sebastolobus alascanus
Anoplopoma fimbria
Zaniolepis frenata
Zaniolepis latipinnis
Chitonotus pugetensis
Icelinus filamentosus
I. quadriseriatus
I. tenuis
I. fimbriatus
Radulinus asprellus
Rhamphocottus richardsoni
Agonopsis sterletus
Asterotheca pentacanthus
Odontopyxis trispinosa
Xeneretmus latifrons
X. triacanthus
Citharichthys sordidus
C. stigmaeus
C. xanthostigma
Hippoglossina stomata
Paralichthys californicus
Xystreurys liolepis
Eopsetta jordani
Glyptocephalus zachirus
Hypsopsetta guttulata
Lyopsetta exilis
Microstomus pacificus
Parophrys vetulus
Pleuronichthys coenosus
P. decurrens
P. ritteri
P. verticalis
Symphurus atricauda

tonguefish (Symphurus atricauda), and hornyhead turbot (Pleuronichthys verticalis) were co-associated at a high level. These three flatfishes, together with white surfperch (Phanerodon furcatus), shiner surfperch (Cymatogaster aggregata), and white croaker (Genyonemus lineatus) were considered by Stephens *et al.* (1973) to represent the typical shallow water fauna of San Pedro Bay.

The composition of mid-depth (80-200 m) species group associations varied, but the stripetail rockfish (Sebastes saxicola) was found to be the most abundant and consistently captured species. However, at these mid-depths, the stripetail rockfish associated consistently with three species of flatfishes which were considered to be more characteristic of the deep water community (200-400 m). If, as proposed by Stephens *et al.* (1973), the three flatfishes are to be disregarded, the largest inclusive associative mid-water group then includes pink surfperch (Zalembius rosaceus), shortspined combfish (Zaniolepsis frenata), plainfin midshipman (Porichthys notatus), Pacific sanddab (Citharichthys sordidus), and the stripetail rockfish. This arrangement differs then from the mid-depth faunal association (Group 1 in Figure 3.5-16), defined by SCCWRP, only in the replacement of the striptail rockfish by the Dover sole (Microstomus pacificus), a species which Stephens considered to be more closely allied with a deep-water (200-400 m) association. Recurrent group analysis by Stephens *et al.* (1973) showed the deep depth association to consist of five primary species and three satellites (Figure 3.5-20). As pointed out, the five species are cool or cold water elements that live below the thermocline and whose primary centers of distribution normally lie to the north of Point Conception. The three flatfishes, rex sole (Glyptocephalus zachirus), slender sole (Lyopsetta exilis), and Dover sole (Microstomus pacificus), however, are not as limited by depth as the two rockfishes, and continue to be characteristic species to depths as shallow as 100 m, whereas the shortspine thornyhead (Sebastolobus alascanus) and splitnose rockfish (Sebastes diploproa) are uncommon at depths less than 200 m.

Distribution differences between Stephens *et al.* (1973) species associations and those derived by SCCWRP may be attributed to: differences in fish samples collected from outside of San Pedro Bay, which were included in the SCCWRP data; slight modifications in methodologies; and a bias introduced by making species comparisons between certain depth ranges only.

Since July 1969, the County Sanitation Districts of Orange County (CSDOC) have sponsored monitoring studies of the benthic environment in the vicinity of their ocean wastewater outfalls in South San Pedro Bay. Included in the program were quarterly trawl sampling of demersal fishes at the stations shown in Figure 3.5-21. Trawl data were included in the SCCWRP (1973a) report up to the time of its publication. The results of subsequent trawling surveys exist in the form of quarterly data reports, of which parts were used to develop a draft environmental impact statement for the treatment plant (CSDOC, 1977a). However, little specific information is provided on the characteristics of the demersal fish community in the area, and the draft EIR consists

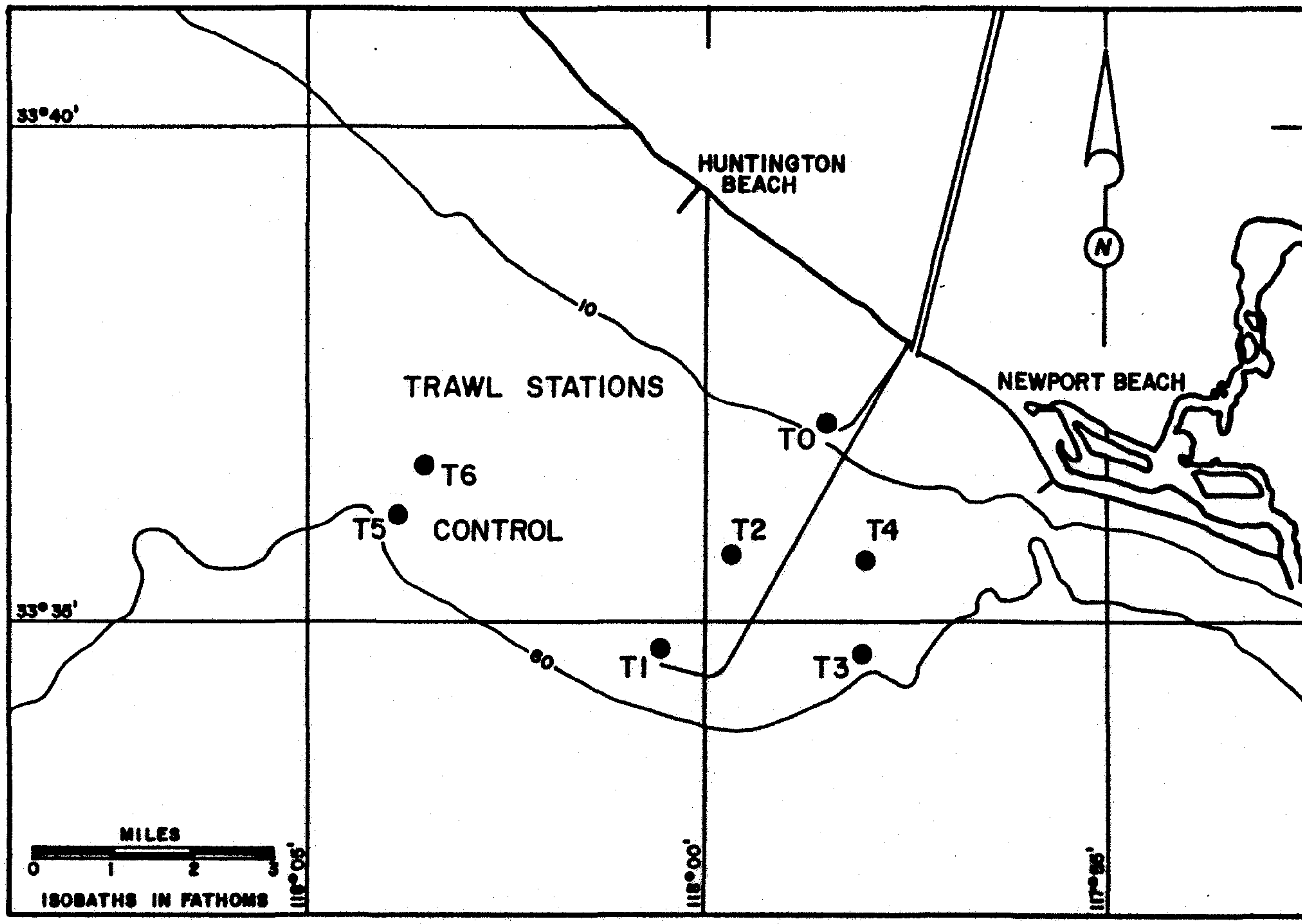


Source: Stephens <u>et</u>. <u>al</u>., 1973

Deep water - (200-400 M)

Recurrent Group Species Associations

Figure 3.5-20



Locations: 1969 - 1978

Orange County Sanitation District Trawling Station

3.5-21
Figure

primarily of some generalities derived from SCCWRP and a list of names of fish species that were caught in the study area.

The total number of individuals and species captured and the rank by numerical abundance of the top five species captured during the CSDOC trawling surveys for each quarter from 1975 through the second quarter of 1977 is shown in Table 3.5-22. The raw catch data by survey and station are presented in the Technical Appendix. Both the number of species and abundances of individuals were high, indicating that the area supports a rich population of demersal fishes. The number of species per catch varied from 23 to 44 for a mean of 34.1 species. The mean number of individuals captured per trawl ranged from 225.1 to 689.1 for a mean catch of 444.9 individuals per trawl over the entire survey period. These figures are very high when compared to catches per trawl in other parts of the Southern California Bight.

In each survey, five species of fishes constituted between 60.0 and 91.4 percent of the total numerical catch. Three of these species ranked among the top five of each survey which suggests that they are important and stable elements of the demersal population. The species were yellowchin sculpin (Icelinus quadriseriatus), Pacific sanddab (Citharichthys sordidus), and speckled sanddab (C. stigmaeus). Calico rockfish (Sebastes dallii) ranked prominently among the top five most abundant species from the middle of 1975 through the third quarter of 1976, but dropped to a lower rank in subsequent years. The dramatic appearance of the species in mid-1975 was also noted by Environmental Quality Analysts, Inc., and Marine Biological Consultants, Inc. (1977) during a three-year trawling survey of Long Beach Harbor. California tonguefish (Symphurus atricauda) ranked among the top five species in five of the ten surveys, and was always present in the trawl catches at various lower ranks in the remaining surveys. White croaker ranked among the top five species in only three of the surveys, but it appeared in every survey.

Trawl sampling of the shallow-water demersal fish populations in South San Pedro Bay was undertaken by Marine Biological Consultants, Inc. during thermal effects studies for the Huntington Beach and the Alamitos and Haynes Generating stations during 1971 and 1972. The proximity of the proposed pipeline route to trawling stations offshore of Alamitos Bay is shown in Figure 3.5-7. The results are analyzed and discussed in final summary reports for the two generating stations by Environmental Quality Analysts, Inc., and Marine Biological Consultants, Inc. (1973a, b). The total demersal fish catch by quarter and station for the two locations is presented in the Technical Appendix. Table 3.5-23 compares and contrasts catch statistics of the five most abundantly captured species at each station. Nearly twice as many individuals were captured offshore of Alamitos Bay as were taken offshore of Huntington Beach. The number of species was comparable with only one species difference between the two localities. In both locations, five species of fishes made up between 78.0 percent (Huntington Beach) and 81.9 percent (Los Alamitos) of the total

TABLE 3.5-22
SPECIES AND NUMBER CAPTURED OF THE TOP FIVE RANKED FISHES TAKEN AT CSDOC TRAWLING STATIONS BY QUARTER, 1975-1977 (FROM CSDOC, 1975a-d, 1976a-d, 1977a-d).

Rank	Species	Number	Species	Number
1975	1st Quarter		2nd Quarter	
1	Citharichthys stigmaeus	1020	Sebastes saxicola	954
2	Icelinus quadriseriatus	984	Icelinus quadriseriatus	580
3	Citharicthys sordidus	362	Citharichthys sordidus	469
4	Parophrys vetulus	232	C. stigmaeus	454
5	Chitonotus pugetensis	174	Genyonemus lineatus	369
	Percent of Total Catch	81.7		68.0
	Number of Individuals	3393		4157
	Number of Species	33		43
	3rd Quarter		4th Quarter	
1	Sebastes dallii	1976	Icelinus quadriseriatus	965
2	Citharichthys sordidus	701	Citharichthys sordidus	903
3	C. stigmaeus	602	C. stigmaeus	700
4	Icelinus quadriseriatus	456	Sebastes dallii	376
5	Genyonemus lineatus	388	Symphurus atricauda	291
	Percent of Total Catch	85.5		77.2
	Number of Individuals	4824		4188
	Number of Species	44		34
1976	1st Quarter		2nd Quarter	
1	Icelinus quadriseriatus	916	Sebastes dallii	403
2	Citharichthys sordidus	626	Citharichthys sordidus	390
3	Sebastes dallii	476	Icelinus quadriseriatus	327
4	Citharichthys stigmaeus	375	Citharichthys stigmaeus	292
5	Symphurus atricauda	210	Microstomus pacificus	235
	Percent of Total Catch	75.3		73.2
	Number of Individuals	3457		2250
	Number of Species	37		30
	3rd Quarter		4th Quarter	
1	Genyonemus lineatus	795	Citharichthys sordidus	589
2	Icelinus quadriseriatus	413	C. stigmaeus	361
3	Citharichthys sordidus	381	Icelinus quadriseriatus	344
4	Sebastes dallii	374	Symphurus atricauda	82
5	Citharichtyhys stigmaeus	321	Parophrys vetulus	65
	Percent of Total Catch	72.3		91.4
	Number of Individuals	3159		1576
	Number of Species	40		23
1977	1st Quarter		2nd Quarter	
1	Icelinus quadriseriatus	661	Citharichthys stigmaeus	1032
2	Citharichthys stigmaeus	450	C. sordidus	364
3	C. sordidus	177	Porichthys notatus	308
4	Symphurus atricauda	113	Icelinus quadriseriatus	303
5	Citharichthys xantrostigmas	43	Symphurus atricauda	67
	Percent of Total Catch	89.6		82.1
	Number of Individuals	1612		2527
	Number of Species	28		29

TABLE 3.5-23
SPECIES AND NUMBER CAPTURED OF THE TOP FIVE RANKED FISHES TAKEN BY TRAWLING OFFSHORE HUNTINGTON BEACH AND LOS ALAMITOS, 1971-72 (FROM ENVIRONMENTAL QUALITY ANALYSTS, INC., AND MARINE BIOLOGICAL CONSULTANTS, INC., 1973a, 1973b)

Rank	Species	Number	Species	Number
	Huntington Beach		Los Alamitos	
1	*Seriphus politus*	2572	*Engraulis mordax*	4322
2	*Genyonemus lineatus*	1179	*Seriphus politus*	3096
3	*Engraulis mordax*	940	*Genyonemus lineatus*	1836
4	*Citharichthys stigmaeus*	927	*Phanerodon furcatus*	1689
5	*Cymatogaster aggregata*	507	*Cymatogaster aggregata*	1221
	Percent of Total Catch	78.0		81.9
	Number of Individuals	7850		14848
	Number of Species	42		41

individual catch. Four species, queenfish (Seriphus politus), white croaker (Genyonemus lineatus), northern anchovy (Engraulis mordax), and shiner surfperch (Cymatogaster aggregata) ranked among the five most abundant species at each location. Other than minor rearrangements in the rankings of the top five species, the only difference in the trawl catches between the two areas was the elevation from a lower rank to the top five of speckled sanddab (Citharichthys stigmaeus) and white surfperch (Phanerodon furcatus) in the Huntington Beach and Los Alamitos catches, respectively.

The most recent information on the shallow-water demersal fish population of south San Pedro Bay is derived from biannual trawls that were conducted offshore of Huntington Beach and Alamitos Bay as part of National Pollutant Discharge Elimination Permit System monitoring programs. The results of benthic trawls offshore of Huntington Beach are presented and discussed in reports by Marine Biological Consultants, Inc. (1977) for August 1976 and 1977. The reports on trawls conducted at both locations during February and August 1978 are in preparation (Marine Biological Consultants, Inc., 1978a, b). Raw catch data for the two locations are given in the Technical Appendix.

Abundances for the five top ranked fishes collected offshore of Huntington Beach during trawls conducted in August 1976, 1977, and 1978 are listed in Table 3.5-24. Comparable data are presented in Table 3.5-25 for a trawling survey made offshore of Alamitos Bay during February 1978.

In the Huntington Beach trawls, five species of fishes made up between 94.2 and 96.7 percent of the total individual catch, and the species composition of the top five was similar to that reported for the catches made in 1973 (Table 3.5-23). Two species, white croaker (Genyonemus lineatus) and northern anchovy (Engraulis mordax) ranked third or higher in each of the August surveys as well as in 1973. Queenfish (Seriphus politus) ranked first in 1973 and in August 1976, dropped to sixth in August 1977, and rose to second again in August 1978. Trawls offshore of Alamitos Bay yielded comparable results. The top five ranked species constituted 95.8 percent of the total individual catch with white croaker, queenfish, and northern anchovy again among the five most abundant species.

The species composition of the demersal fish population in San Pedro Bay, exclusive of the harbor complex, is more influenced by depth than by any other parameter, as shown by SCCWRP (1973a) and Stephens *et al.* (1973). Recurrent group analyses and simple inspection of trawl catches revealed that certain species tend to be associated with each other and are characteristic of discrete depth ranges.

Of primary concern to the Shell Beta project are demersal fish associations in shallow water (10-30 m) and mid-depth (80-200 m) ranges, and less so in the deep-water (200-400 m) association. The characteristic species for these depth ranges are summarized in Table 3.5-26.

TABLE 3.5-24
SPECIES AND NUMBER CAPTURED OF THE TOP FIVE RANKED FISHES TAKEN BY TRAWLING OFFSHORE OF HUNTINGTON BEACH, 1976-78 (FROM MARINE BIOLOGICAL CONSULTANTS, INC., 1977, 1978).

Rank	Species	Number Captured
	August 1976	
1	Seriphus politus	1822
2	Genyonemus lineatus	1773
3	Engraulis mordax	356
4	Hyperprosopon argenteum	145
5	Peprilus simillimus	68
	Percent of Total Catch	96.7
	Number of Individuals	4309
	Number of Species	21
	August 1977	
1	Genyonemus lineatus	3743
2	Engraulis mordax	3126
3	Phanerodon furcatus	275
4	Hyperprosopon argenteum	254
5	Amphistichus argenteus	206
	Percent of Total Catch	94.2
	Number of Individuals	8068
	Number of Species	28
	August 1978	
1	Genyonemus lineatus	6030
2	Seriphus politus	1272
3	Engraulis mordax	220
4	Citharichthys stigmaeus	94
5	Anchoa compressa	92
	Percent of Total Catch	95.6
	Number of Individuals	8062
	Number of Species	31

TABLE 3.5-25
SPECIES AND NUMBER CAPTURED OF THE TOP FIVE RANKED FISHES TAKEN BY TRAWLING OFFSHORE OF ALAMITOS BAY, FEBRUARY 1978 (FROM MARINE BIOLOGICAL CONSULTANTS, INC., 1978).

Rank	Species	Number Captured
	August 1976	
1	Genyonemus lineatus	3782
2	Symphurus atricauda	791
3	Seriphus politus	345
4	Engraulis mordax	114
5	Anchoa compressa	98
	Percent of Total Catch	95.8
	Number of Individuals	5356
	Number of Species	26

TABLE 3.5-26
CHARACTERISTIC SPECIES IN SAN PEDRO BAY BY DEPTH RANGES (AFTER SCCWRP, 1973a, STEPHENS ET AL. 1973)

Shallow Water (10-30 m)	Mid-Depth (80-200 m)	Deep Water (200-400 m)
Genyonemus lineatus	Citharichthys sordidus	Glyptocephalus zachirus
Seriphus politus	Porichthys notatus	Lyopsetta exilis
Cymatogaster aggregata	Zalembus rosaceus	Sebastolobus alascanus
Phanerodon furcatus		Sebastes diploproa
Icelinus quadriseriatus		
Zaniolepis latipinnis	Intermediate	
Symphurus atricauda	Sebastes saxicola	
Parophrys vertulus	Zaniolepis frenata	
Pleuronichthys verticalis	Microstomus pacificus	
Citharichthys stigmaeus		

(5) Long Beach Harbor

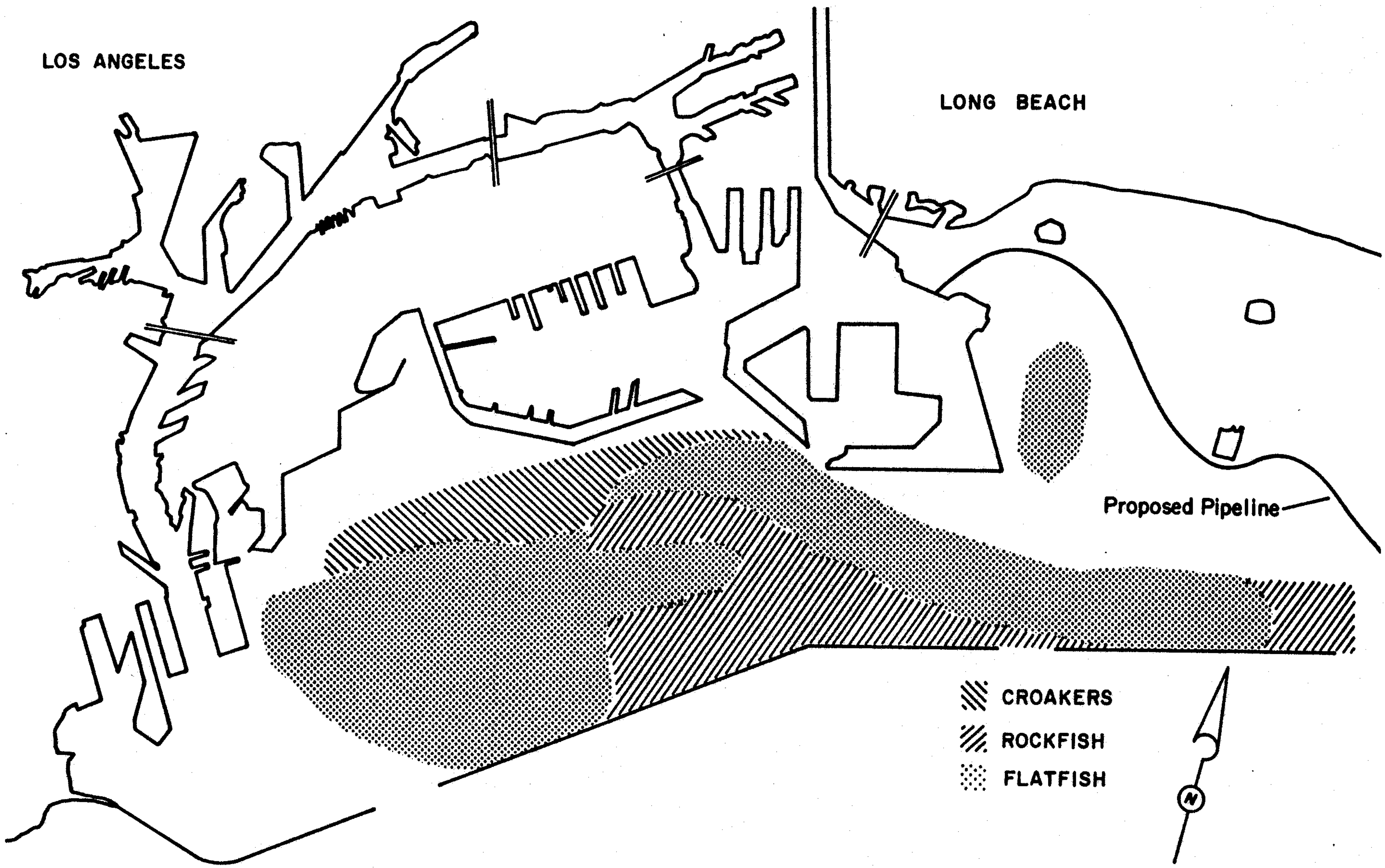
Chamberlain's (1974) checklist of fishes from Los Angeles/Long Beach Harbors indicates that 132 species representing 48 families are known to inhabit, or to have been present at one time or another, in the harbor complex. This constitutes 27.4 percent of all the species reported by Miller and Lea (1972) as occurring in the Southern California Bight.

Recent knowledge of the status of the demersal fish population in the harbor complex began with a report by Chamberlain (1973) on the results of 14 benthic trawls in the harbor area. The trawls took a total of 3,100 fishes representing 28 species. The catch was dominated by speckled sanddab (Citharichthys stigmaeus), California tonguefish (Symphurus atricauda), white croaker (Genyonemus lineatus), shiner surfperch (Cymatogaster aggregata), and white surfperch (Phanerodon furcatus). Together, these five species made up 85.6 percent of the total numerical catch.

The following year, Stephens *et al.* (1974) reported on a series of 76 trawls made in the Los Angeles/Long Beach Harbor complex between May 1972 and October 1973. The catch consisted of 57,647 individuals representing 48 species. The identity of the most abundantly represented species in these catches remained essentially the same as reported by Chamberlain; the only differences in the results of the two surveys were some minor rearrangements in relative rankings. In Stephens' survey, white croaker ranked first, followed by northern anchovy (Engraulis mordax), California tonguefish, speckled sanddab, and queenfish (Seriphus politus). Shiner surfperch and white surfperch, which ranked fourth and fifth in Chamberlain's survey, dropped to sixth and seventh, respectively, in the 1972-73 survey.

Stephens *et al.* (1974) also noted that fishes were not evenly distributed within the harbor. Three overall patterns of distribution were recognized (Figure 3.5-22). They were: (1) an area at the western end of the Outer Harbor that is high in number of flatfish species but relatively low in individual numerical abundance; (2) an area extending from the eastern opening of the harbor to the mouth of Fish Harbor (and probably including Cerritos Channel) which appears to support few flatfish species but high numbers of certain species such as croakers; and (3) an area adjacent to the middle breakwater that is high in rockfish abundance.

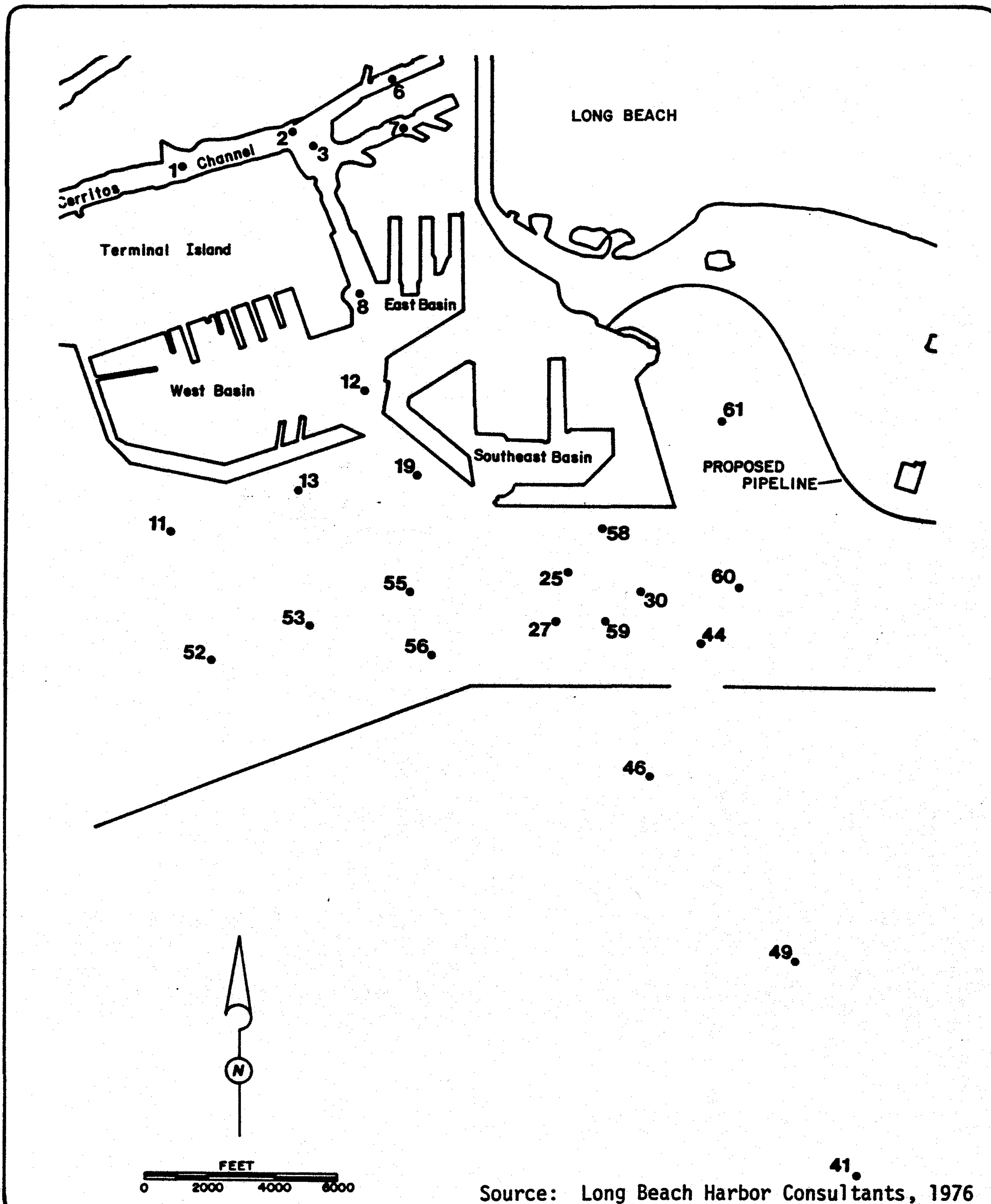
The Long Beach Harbor Consultants (1976) reported on a series of trawls made in September 1975 at 26 stations in the Long Beach Harbor area (Figure 3.5-23). A list of the species captured is given in the Technical Appendix. Table 3.5-27 is a list of the ten top ranked species which shows that they constitute 99.1 percent by number of the total catch. Again, white croaker, northern anchovy, white surfperch, California tonguefish, and shiner surfperch were among the most abundantly represented species. Calico rockfish, which as previously noted, appeared in dramatic numbers in trawls offshore of the southern California coast in mid-1975, ranked sixth in this survey.



Source: Stephens et. al., 1974.

Distributional Pattern of Fishes in Los Angeles Harbor

3.5-22
Figure



Source: Long Beach Harbor Consultants, 1976

Location of Trawling Stations

Figure 3.5-23

TABLE 3.5-27
SPECIES, COMMON NAME, AND RANKED ABUNDANCE OF THE TEN MOST ABUNDANT FISHES CAPTURED BY TRAWLING IN LONG BEACH HARBOR SEPTEMBER, 1975 (FROM LONG BEACH HARBOR CONSULTANTS, 1976)

Species	Common Name	Number Captured
Genyonemus lineatus	white croaker	3,437
Engraulis mordax	northern anchovy	993
Phanerodon furcatus	white surfperch	445
Symphurus atricauda	California tonguefish	353
Cymatogaster aggregata	shiner surfperch	282
Sebastes dallii	calico rockfish	261
Seriphus politus	queenfish	229
Citharichthys stigmaeus	speckled sanddab	81
Pleuronichthys verticalis	hornyhead turbot	38
Lepidogobius lepidus	bay goby	24
Percent of Total Catch	99.1	
Number of Individuals	6,197	
Number of Species	31	

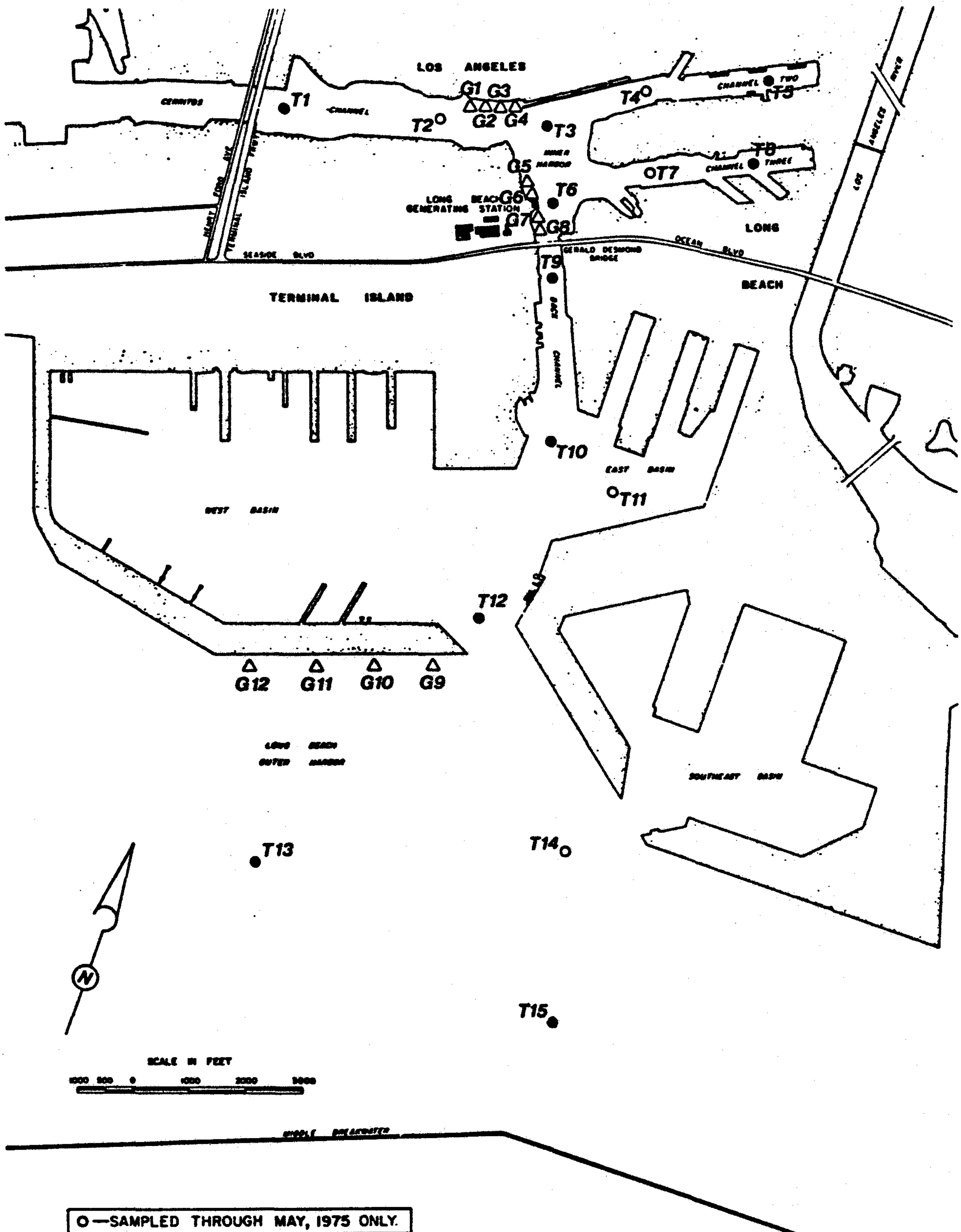
The most recent information on demersal fishes in Long Beach Harbor is based on the results of a total of 629 otter-board trawls made between January 1974 and March 1978 at the stations shown in Figure 3.5-24. Trawls were conducted bimonthly and were done during the daytime and after dark. During the same period, seven gill netting surveys were accomplished at the locations indicated in the figure. The results of these surveys were discussed in annual reports by Environmental Quality Analysts, Inc., and Marine Biological Consultants, Inc. (1975, 1976, 1977, 1978).

A summary of the total gill netting and trawling catches is presented in the Technical Appendix. A ranked list of the ten most commonly captured species for each of the fishing methods is presented in Table 3.5-28. The ten top species captured by trawling constituted 98.0 percent of the total trawl catch. The ten most abundantly represented species taken by gill netting accounted for 91.0 percent of the total catch. In spite of pronounced differences in selectivity between the two fishing methods, the species composition of the catches were very similar with white croaker, northern anchovy, queenfish, shiner surfperch, and white surfperch appearing as the most abundantly captured species.

The demersal fish fauna of Long Beach Harbor can be characterized as a slightly modified version of the shallow water San Pedro Bay species association derived from SCCWRP (1973a) and Stephens *et al.* (1973) which is summarized in Table 3.5-26. The demersal fish fauna of the harbor is clearly dominated by white croaker, queenfish, California tonguefish, and two to three species of surfperches. Not present within the harbor in significant numbers, but considered to be members of the shallow-water association of San Pedro Bay, are such species as the yellowchin sculpin (Icelinus quadriseriatus) and the longspine combfish (Zaniolepis latipinnis), which are species commonly found at the deeper end of shallow-water range (between 10 and 30 m). The northern anchovy, which is frequently among the top ranked species, is not a demersal species, but rather one that tends towards a surface water by virtue of its pelagic schooling habit. However, its abundance and behavior is such that it is often caught by trawl, even though the method is not designed for this purpose. As a result, the northern anchovy may appear in the catch in very large numbers. In view of its persistent presence in the harbor and its use of harbor waters as a nursery area, the species can also be considered one of the characteristic elements of the harbor ichthyofauna.

(6) Commercial and Sport Fisheries

As pointed out by Horn (1974b), almost all of the commercial and sport fishes landed in southern California are either pelagic species that are taken by a variety of methods or inshore predatory species that are taken by selective hook-and-line fishing. In contrast to central and northern California, where bottom trawling accounts for much of the fish landed, only an insignificant fraction of the total commercial catch in southern California is taken by



TRAWL AND GILL NET STATIONS

Data collected 1974 - 1978

Location of Trawling and Gill Netting Stations

3.5-24
Figure

TABLE 3.5-28

SPECIES, COMMON NAME, AND RANKED ABUNDANCE OF THE TEN MOST ABUNDANT FISHES CAPTURED BY TRAWLING AND GILL NETTING IN LONG BEACH HARBOR (FROM ENVIRONMENTAL QUALITY ANALYSTS, INC. AND MARINE BIOLOGICAL CONSULTANTS, INC., 1975; 1977; 1978)

Species	Common Name	Number Captured	Species	Common Name	Number Captured
	Trawling			Gill Netting	
Genyonemus lineatus	white croaker	68,547	*Genyonemus lineatus*	white croaker	1,811
Engraulis mordax	northern anchovy	28,898	*Seriphus politus*	queenfish	1,102
Seriphus politus	queenfish	15,601	*Cymatogaster aggregata*	shiner surfperch	901
Lepidogobius lepidus	bay goby	8,159	*Phanerodon furcatus*	white surfperch	632
Symphurus atricauda	California tonguefish	5,483	*Engraulis mordax*	northern anchovy	554
Phanerodon furcatus	white surfperch	3,693	*Hyperprosopon argenteum*	walleye surfperch	314
Cymatogaster aggregata	shiner surfperch	2,756	*Embiotoca jacksoni*	black surfperch	218
Peprilus simillimus	California butterfish	1,869	*Porichthys myriaster*	specklefin midshipman	127
Sebastes dallii	calico rockfish	1,742	*Atherinops affinis*	topsmelt	108
Citharichthys stigmaeus	speckled sanddab	654	*Damalichthys vacca*	pile surfperch	89
Percent of Total Catch	98.0		Percent of Total Catch	91.0	
Number of Individuals	140,235		Number of Individuals	6,436	
Number of Species	55		Number of Species	64	

trawling. In Fish and Game District 19 (Santa Barbara-Ventura County line to the Mexican border), the possession of trawl nets is governed by terms of a permit issued by the California Department of Fish and Game.

The present status of exploitation and estimated potential of the major recreational and commercial fish stocks is given in Table 3.5-29. As shown, the most important commercial species are jack mackerel (Trachurus symmetricus), Pacific bonito (Sarda chiliensis), white sea bass (Atractoscion nobilis), northern anchovy (Engraulis mordax), and Pacific mackerel (Scomber japonicus).

Although a large number of species enter the sportfishing catch, the bulk is comprised of the following species: yellowtail (Seriola dorsalis), albacore (Thunnus alalunga), barracuda (Syphraena argentea), Pacific bonito, Pacific mackerel, halibut (Paralichthys californicus), rockfish (Sebastes ssp.), kelp bass (Paralabrax clathratus), white sea bass (Atractoscion nobilis), and sand bass (P. nebulifer).

According to Allen and Voglin (1977), northern anchovy, Pacific sardine (Sardinops sagax), Pacific mackerel, and jack mackerel accounted for over 80 percent of the total pelagic wetfish fishery catch per year in southern California since 1930. The 1975 commercial catch for fish blocks encompassing the entire Southern California Bight was 178,040 metric tons, with anchovies accounting for approximately 77 percent, or 137,268 metric tons.

The Shell Beta project lies within California Department of Fish and Game Fish Blocks 739 and 740 (Figure 3.5-15). The commercial catch in pounds and sport catch in number of individuals landed for the two Fish Blocks is given in Tables 3.5-30 and 3.5-31, respectively. The data show that since 1964, ten pelagic species taken from Fish Blocks 739 and 740 were important in terms of total weight, of which four appear to have contributed most of the commercial catch from these blocks. These were in ranked order of pounds captured: northern anchovy, jack mackerel, Pacific bonito, and Pacific mackerel. Although substantial differences in pounds landed exist between the two blocks, the species composition of the commercial catch was very comparable. The total commercial catch in Blocks 739 and 740 was 22,841 metric tons, which amounted to approximately 13 percent of the total southern California commercial catch, and nearly the entire catch was composed of 21,556 metric tons of northern anchovy (Dames and Moore, 1978).

The sport fishing catch for Blocks 739 and 740 was dominated by five species: rockfish (Sebastes ssp.), rock bass (Paralabrax ssp.), Pacific bonito (Sardchilliensis), Pacific mackerel (Scomber japonicus), and California barracuda (Sphyraena argentea). Together, they accounted for over 85 percent of the total sport fishing catch.

TABLE 3.5-29

PRESENT STATE OF EXPLOITATION AND ESTIMATED POTENTIAL OF MAJOR RECREATIONAL/COMMERCIAL FISH STOCKS (CSDOC, 1977)

Stock	Estimated Mean Annual Catch 10^3 Short Tons				Present Major Fishery Segments (% 1970/72 Total Catch)			Potential Yield 10^3 Short Tons	State of Exploitation	Remarks
	1940-1949	1950-1959	1960-1969	1970-1973	U.S.-based Sport	U.S. Comm.	Mexican Sport/Comm.			
Northern anchovy	3	18	30	129	5 (bait)	55	40	[a]1,500-2,000	Very lightly exploited	Allocation requirements may reduce rates of exploitation.
Pacific sardine	428	91	10	3	some (bait)	0	large	[b]300-500	Depleted	Rehabilitation unlikely in near future.
Pacific mackerel	30	20	16	1	33	33	34	[c]30-50	Depleted	Rehabilitation unlikely in near future.
Jack mackerel	34	38	39	24	0.1	89	11	210-450	Probably lightly exploited	Size of local stock is indeterminate, but large.
California barracuda	2.1	1.9	1.2	0.5	48	2	48	[d]1-2	Depleted	Rehabilitation possible in near future.
Yellowtail	3.1	3.2	1.2	1.5	67	13	20	[d]3-6	Lightly exploited	Migration into Calif. is heavily exploited.
Pacific bonito	2.7	1.4	7.6	11.8	11	87	2	10-20	Probably moderately to highly exploited	Biomass and potential highly fluctuating with recruitment. Calif. residency may be a temporary event.
White sea bass	0.5	1.0	0.6	0.5	8	76	17	0.8	Moderately/highly exploited.	Indices of abundance conflict.

a At the 1970-1973 population level.

b If rehabilitated to the pre-1944 population level.

c If rehabilitated to the pre-1950 population level.

d The California yield is influenced by ocean temperature.

TABLE 3.5-30

COMMERCIAL CATCH FISH BLOCKS 739 AND 740 (1964-1975) (POUNDS LANDED) (FROM DAMES AND MOORE, 1978)

	Fish Block 739	Fish Block 740
1964	6,595,292	547,177
1965	2,667.124	159,629
1966	12,744,386	7,919,878
1967	5,224,562	9,498,742
1968	720,410	2,982,855
1969	13,760,795	5,418,524
1970	35,713,603	22,693,019
1971	10,657,642	6,082,456
1972	15,650,120	10,653,619
1973	35,682,996	26,161,501
1974	23,615,954	6,197,018
1975	18,248,044	41,984,336
Total	181,580,928	140,298,744
Mean	15,131,744	11,691,562

Five Most Abundant Taxa

Anchovy	109,691,488	Jack mackerel	22,083,534
Jack mackerel	2,701,557	Anchovy	17,224,459
Rock crab	1,550,289	Pacific bonito	3,730,367
Pacific bonito	1,408,070	Pacific mackerel	3,518,118
Pacific mackerel	579,533	Squid	1,068,705
Total	116,119,401 (64%)		47,625,183 (34%)

TABLE 3.5-31
SPORT CATCH FISH BLOCKS 739 AND 740 (1964-1975) (NUMBER OF INDIVIDUALS) (DAMES AND MOORE, 1978)

	Fish Block 739	Anglers	Angler Hours	Fish Block 740	Anglers	Angler Hours
1964	167,582	29,641	1,062,349	113,023	18,533	641,362
1965	131,789	25,791	1,067,838	158,670	24,445	929,424
1966	98,998	19,267	731,436	201,349	37,080	1,395,104
1967	65,207	12,027	527,687	109,639	28,315	1,034.983
1968	85,801	12,502	48,614	158,851	28,240	108,715
1969	106,397	15,503	67,306	150,406	25,645	99,546
1970	119,288	18,517	73,033	102,916	21,533	72,665
1971	81,777	11,046	46,129	156,102	24,469	83,285
1972	159,071	16,541	66,767	147,843	19,146	75,597
1973	186,357	26,336	99,667	184,216	25,722	97,778
1974	149,670	19,203	62,394	191,906	19,198	72,432
1975	87,765	8,642	30,743	211,498	22,999	86,271
Total	1,439,702	215,016	3,883,963	1,886,412	295,325	4,697,162
Mean		17,918	323,663		24,610	391,430

Five Most Abundant Taxa

	Fish Block 739		Fish Block 740	
	Rockfish	501,315	Rockfish	806,188
	Rock bass	323,426	Pacific bonito	311,410
	Pacific bonito	184,777	Rock bass	298,398
	California barracuda	137,390	California barracuda	116,732
	Sandbass	97,713	Pacific mackerel	109,001
Total		1,244,621 (86%)		1,641,729 (87%)

3.5.1.5 Marine Mammals

At least 17 marine mammals are known to occur in the San Pedro Channel (Table 3.5-32). The most common of these are the California grey whale, common dolphin, pilot whale, Pacific white-sided dolphin, Pacific bottlenosed dolphin, California sea lion, and harbor seal. In addition to these species, ten others are considered uncommon (or rare) in the region; these are the Minke whale, Sei whale, blue whale, humpback whale, killer whale, sperm whale, northern fur seal, Steller sea lion, the northern elephant seal, and the very rare California sea otter.

An additional 17 species of marine mammals have been documented in Californian waters (Daugherty, 1972). However, these species either have not been seen in the San Pedro Channel or occur very rarely.

Several thousand California grey whales, fully protected by state, federal, and international statutes, migrate southward from their summer feeding grounds in Alaskan waters along the coast of California to their winter calving grounds in the lagoons of Baja California. Grey whales generally migrate very close inshore, frequently navigating from one prominent point to another. For this reason, whale watchers often have best results in such localities as Point Dume in Malibu, Point Fermin on the Palos Verdes Peninsula, and Dana Point in southern Orange County. A straight line from Point Fermin to Dana Point would bring a migrating grey whale through the San Pedro Channel within one mile of the Shell Beta platforms. After calving has been completed, the whales move northward again through the San Pedro Channel close to the coastline on their way to the Arctic Circle.

All marine mammals are afforded complete protection by the Marine Mammal Protection Act of 1972 (National Oceanic and Atmospheric Administration, 1974). Five cetaceans which occur in California waters (California grey whale, blue whale, sei whale, humpback whale, and sperm whale) are designated as endangered species by the federal government. One species of pinniped, the Guadelupe fur seal, is designated rare by the State of California. Only the California grey whale commonly occurs in the San Pedro Channel.

3.5.1.6 Birds

The avifauna of the San Pedro Channel occupy numerous distinct habitats. Some birds are typically found in the shelter of protected bays, others prefer sandy beaches or coastal estuaries, and still others occupy rocky shores or steep sea cliffs. Many pelagic birds which spend most of their lives offshore have made a nearly complete transition from a terrestrial existence and return to land only for nesting.

TABLE 3.5-32
MARINE MAMMALS OBSERVED IN THE SAN PEDRO CHANNEL[1].

Scientific Name	Common Name	Common	Uncommon	Migrant
CETACEA				
MYSTICETI				
BALAENOPTERIDAE				
Balaenoptera acutorostrata	Minke whale		X	
B. borealis	Sei whale		X	
B. musculus	blue whale		X	
Megaptera novaeangliae	humpback whale		X	
ESCHRICHTIDAE				
Eschrichtius gibbosus	California grey whale	X		X
ODONTOCETI				
DELPHINIDAE				
Delphinus delphis bairdi	common dolphin	X		
Globicephala macrorhynca	pilot whale	X		
Lagenorhynchus obliquidens	Pacific white-sided dolphin	X		
Orcinus orca	killer whale		X	
Tursiops truncatus gilli	Pacific bottlenosed dolphin	X		
PHYSETERIDAE				
Physeter catodon	sperm whale		X	
PINNIPEDIA				
OTARIIDAE				
Callorhinus ursinus	northern fur seal		X	
Eumetopias jubatus	Steller sea lion		X	
Zalophus californianus	California sea lion	X		
PHOCIDAE				
Mirounga augustirostis	northern elephant seal		X	
Phoca vitulina	harbor seal	X		
CARNIVORA				
MUSTELIDAE				
Enhydra lutris	sea otter		X[2]	

[1]G. Nitta, National Marine Fisheries Service (personal communication), 1978.

[2]Occasional sightings along the southern California caostline from Pt. Conception to the Mexican border have been documented (Hubbs and Leatherwood, 1978 (in press)

(1) Harbor Birds

The Los Angeles/Long Beach Harbor area contains a variety of suitable bird habitats. Some birds feed principally on the few available mudflats (Table 3.5-33). These include the black bellied plover, semipalmated plover, least sandpiper, knot, willet, killdeer, whimbrel, ruddy turnstone, sanderling, great blue heron, and marbled godwit. Inner Cabrillo Beach attracts those birds which prefer sandy beach habitats. These include snowy plover, willet, whimbrel, ring-billed gull, mew gull, ruddy turnstone, black turnstone, sanderling, and marbled godwit.

Many birds use the waters of the bay for feeding and resting. This group includes: American coot, glaucous-winged gull, western gull, herring gull, California gull, ring-billed gull, mew gull, Bonaparte's gull, Heerman's gull, common tern, Arctic tern, royal tern, brown pelican, Arctic loon, horned grebe, eared grebe, western grebe, pied-billed grebe, surf scoter, pintail, and red-breasted merganser.

Few bird species remain in the harbor during the entire year. Among these species are: snowy plover, killdeer, ring-billed gull, brown pelican, Brandt's cormorant, great blue heron, green heron, and white-tailed kite. Relatively larger numbers of species are winter residents. This group includes: American coot, black-bellied plover, semipalmated plover, spotted sandpiper, least sandpiper, knot, willet, whimbrel, glaucous-winged gull, western gull, herring gull, California gull, mew gull, Bonaparte's gull, ruddy turnstone, black turnstone, sanderling, Arctic loon, red-throated loon, horned grebe, eared grebe, western grebe, pied-billed grebe, common scoter, surf scoter, white winged scoter, pintail, red-breasted merganser, and marbled godwit. Only the Heerman's gull is an exclusively summer resident.

(2) Offshore Birds

Within the offshore marine habitat, non-breeding transients or visitors make up nearly all the avifauna. During fall, winter, and spring, Northern Hemisphere species move into the area. A smaller influx of Southern Hemisphere marine birds occur from April through October.

Birds in the offshore area feed primarily on epipelagic fish and a variety of marine invertebrates. Food is obtained by picking organisms from the ocean surface or by diving and plunging.

A few of the most common pelagic (offshore) species (Table 3.5-34) are: common loon, Arctic loon, red-throated loon, western grebe, horned grebe, eared grebe, pied-billed grebe, pink-footed shearwater, sooty shearwater, Manx shearwater, black storm-petrel, brown pelican, double-crested cormorant, black brant, surf scoter, red-breasted merganser, glaucous-winged gull, western gull, California gull, ring-billed gull, mew gull, Bonaparte's gull, Heerman's gull, Forster's gull, elegant tern, and Caspian tern.

TABLE 3.5-33

BIRDS FOUND IN LOS ANGELES-LONG BEACH HARBORS* (FROM OFFICE OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, LOS ANGELES-LONG BEACH FINAL ENVIRONMENTAL IMPACT STATEMENT, 1974)

Common Name	Status	Notes
American coot	M, WR	Common during winter, feeds in shallow water.
Black-bellied plover	M,WR	Common in winter during migration. Feeds on mudflats.
Semipalmated plover	M,WR	Feeds on mudflats.
Snowy plover	R	Feeds on sandy beaches.
Solitary sandpiper	M	Visits area during spring and fall Feeds on sheltered beaches, streams, and lake shores.
Least sandpiper	M,WR	Feeds on mudflats.
Knot	M,WR	Feeds on mudflats.
Willet	M,WR	Feeds on mudflats and sandy beaches.
Killdeer	R	Breeds in fill areas. Feeds on mudflats and in areas above tidal influence.
Whimbrel	M,WR	Feeds on sandy beaches and mudflats.
Glaucous-winged gull	M,WR	Feeds on small fish.
Western gull	M,WR	Breeds locally. Feeds on small fish and garbage.
Herring gull	M,WR	Feeds on small fish and garbage.
California gull	M,WR	A scavenger; also feeds on small fish.
Ring-billed gull	R	Feeds along beaches and inland bodies of water; a scavenger.
Mew gull	M,WR	Not common. Feeds on beaches and in bays.
Bonaparte's gull	M,WR	Feeds on fish and insects.
Green heron	R	Feeds in fresh and brackish water marshes.
Common scoter	M,WR	Rare. Feeds on bottom fauna.
Surf scoter	M,WR	Abundant. Feeds on mollusks and other benthic invertebrates.
White-wing scoter	M,WR	Rare. Feeds on bottom organisms.
Pintail	M,WR	Prefer freshwater areas for feeding. Uses harbor mainly as a refuge.
Red-breasted merganser	M,WR	Prefers sheltered waters. Dives for food in shallow water.
White-tailed kite	R	Not common. Often feeds on rodents in riparian woodlands.
Marbled godwit	M,WR	Feeds in marshes, and on mudflats and beaches.
Heerman's gull	M,SR	Feeds on small fish, frequently robbing catch from Brown pelicans.
Ruddy turnstone	M,WR	Feeds on mudflats and beaches.
Black turnstone	M,WR	Frequents rocky beaches.
Sanderling	M,WR	Feeds on outer beaches and mudflats.
Common tern	M	Feeds in bay and on open ocean.
Arctic tern	M	Uncommon spring and fall visitor. Feeds in open ocean.
Royal tern	M	Feeds largely offshore.
Brown pelican	R	Breeds on offshore rocks and islands. Feeds on small fish.
Arctic loon	M,WR	Feeds offshore diving to moderate depth to catch small fish.
Red-throated loon	M,WR	Feeds mostly in open ocean.
Horned grebe	M,WR	Feeds on fish and invertebrates in shallow waters.
Eared grebe	M,WR	Abundant. Feeds on fish and invertebrates in shallow and moderately deep waters. Prefers sheltered waters.
Western grebe	M,WR	Feeds offshore.
Pied-billed grebe	M,WR	Feeds on invertebrates living in shallow waters.
Brandt's cormorant	R	Breeds locally; most common in winter. Feeds on fish living in moderately deep water.
Great blue heron	R	Most common in winter. Feeds in shallow water areas and on mudflats.

* This list is based upon Christmas bird counts carried out by the National Audubon Society and information supplied by S. Wells of the Eldorado Chapter of the Audubon Society.

Abbreviations: M = migrant R = resident W = winter S = summer

TABLE 3.3-34

MARINE BIRDS OF THE PORT OF LONG BEACH-PORT OF LOS ANGELES VICINITY (FROM DAMES AND MOORE, 1978)

Scientific Name[1]	Common Name	Seasonal Occurrence and Abundance[2] Resident	Summer Visitor	Winter Visitor	Migrant	Habitat Offshore
GAVIFORMES						
GABIIDAE						
Gavia immer	common loon			C	C	X
G. arctica	Arctic loon				C	X
G. stellata	red-throated loon			C	C	X
PODICIPEDIFORMES						
PODICIPEDIDAE						
Aechmophorus occidentalis	western grebe		U	A		X
Podiceps auritus	horned grebe			C		X
P. nigricollis	eared grebe			A		X
Podilymbus podiceps	pied-billed grebe			U		X
PROCELLARIIFORMES						
DIOMEDEIDAE						
Diamedea nigripes	black-footed albatross		R			X
PROCELLARIIDAE						
Fulmarus glacialis	northern fulmar			U		X
Puffinus creatopus	pink-footed shearwater				C	X
P. griseus	sooty shearwater				C	X
P. fuffinus	manx shearwater			C		X
P. teauirostris	short-tailed shearwater			R		
HYDROBATIDAE						
Halocypetera microsoma	least storm-petrel		R			X
Oceanodroma melania	black storm-petrel		C			X
O. homochroa	Ashby storm-petrel		R			X
O. leucorhoa	Leach's storm-petrel		R			X
O. furcata	fork-tailed storm-petrel			R		X
PELICANIFORMES						
PELICANIDAE						
Pelecanus occidentalis[3]	brown pelican	C				X
PHALACROCORACIDAE						
Phalacrocorax auritus	double-crested cormorant	C				X
P. penicillatus	Brandt's cormorant	U				X
P. pelagicus	pelagic cormorant	U				X

TABLE 3.5-34 (CONT.)
MARINE BIRDS OF THE PORT OF LONG BEACH-PORT OF LOS ANGELES VICINITY (FROM DAMES AND MOORE, 1978)

Scientific Name	Common Name	Seasonal Occurrence and Abundance[2] Resident	Summer Visitor	Winter Visitor	Migrant	Habitat Offshore
ANSERIFORMES						
ANATIDAE						
Branta canadensis	Canada goose			R		
B. nigricans	black brant				C	X
Melanitta deglundi	white-winged scoter			U	U	X
M. perspicillata	surf scoter	C		A	C	X
Mergus serrator	red-breasted merganser			C		X
STERCORARIIDAE						
Stercorarius parasiticus	parasitic jaeger			U	U	X
LARIDAE						
Larus hyperboreus	glaucous gull			R		
L. glaucescens	glaucous-winged gull			C		X
L. occidentalis	western gull	C				X
L. argentatus	herring gull			U		X
L. californicus	California gull		U	A	A	X
L. delawarensis	ring-billed gull			A		X
L. canus	mew gull			C		X
L. philadelphia	Bonaparte's gull			A		X
L. heermanni	Heermann's gull	A				X
Xema sabinii	Sabine's gull				R	X
Rissa tridactyla	black-legged kittiwake			U		X
Sterna forsteri	Forster's tern			C		X
S. hirundo	common tern					X
S. paradisaea	Arctic tern				U	X
S. albifrons[3]	least tern		U			X
Thalasseus maximus	royal tern			U		X
T. elegans	elegant tern		C			X
Hydropropogne caspia	Caspian tern				C	X
Childonius nigra	black tern				U	X
ALCIDAE						
Uria aalge	common murre			R		X
Brachyramphus marmoratus	marbled murrelet			R		X
Endomychura hypoleuca	Xantus' murrelet		U			X
Synthliboramphus antiquus	anchient murrelet			R		X
Ptychoramphus aleuticus	Cassin's auklet			U		X

TABLE 3.5-34 (CONT.)

MARINE BIRDS OF THE PORT OF LONG BEACH-PORT OF LOS ANGELES VICINITY (FROM DAMES AND MOORE, 1978)

		Seasonal Occurrence and Abundance[2]				Habitat
Scientific Name	Common Name	Resident	Summer Visitor	Winter Visitor	Migrant	Offshore
ALCIDAE (Cont)						
Cerorhinca monocerata	rhinocerous auklet			U		X
Lunda cirrhata	tufted puffin	R				X

1 Scientific nomenclature follows American Ornithologists' Union (1957, 1973).

2 A = abundant; C = common; U = uncommon; R = rare.

3 Endangered species, California Department of Fish and Game (1976).

Vast numbers of birds migrate along the California coastline seasonally. Shorebirds, gulls, loons, scoters, and brants make up the bulk of the spring nearshore migration, which is the largest migration of the year. More distant from the shoreline, cormorants, alcids (murrelets and auklets) and Procellarii-formes (such as shearwaters and storm petrels), and other gulls, loons, and scoters migrate through the area.

(3) Shore Birds

Sandy beaches comprise the majority of marine intertidal habitat from the harbor area to Newport Beach. This habitat is appropriated by a large number of shore birds. Some of the most common birds supported by this habitat are: the long-billed curlew, semipalmated plover, American golden plover, black bellied plover, whimbrel, sanderling, killdeer, western sandpiper, willet, least sandpiper, knot, marbled godwit, California gull, ring-billed gull, and herring gull. The majority of these birds feed in estuaries (such as Upper Newport Bay, Bolsa Chica Bay, and Anaheim Bay) during part of the day, moving to feeding localities in response to daily tidal changes.

(4) Roosting Sites and Rookeries

Five major roosting sites are located along the Los Angeles and Orange County coastlines (Figure 3.5-25). Rookeries of the western gull, double-crested cormorant, and Brandt's cormorant are located on Santa Catalina Island.

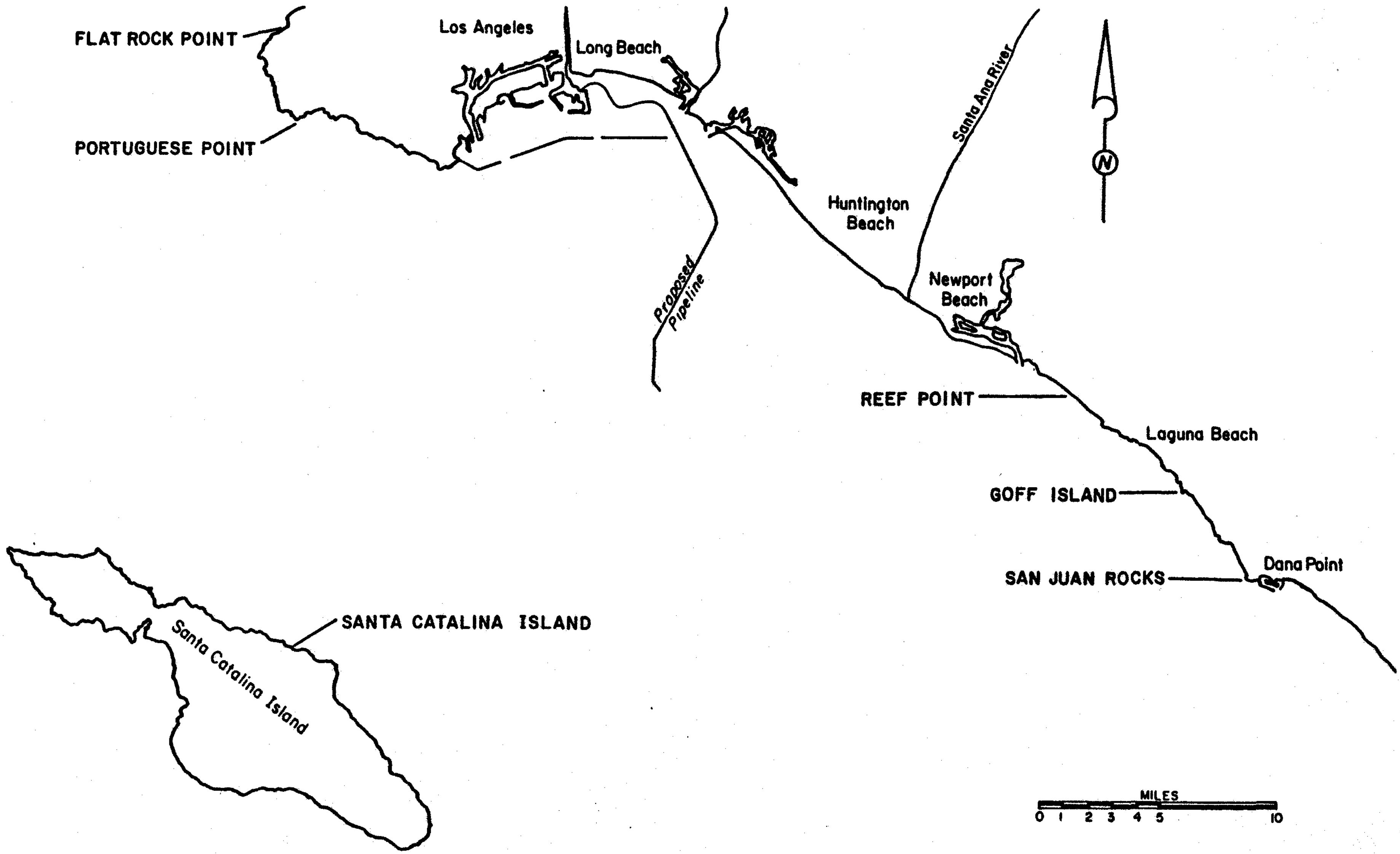
(5) Rare and Endangered Species

Two species of rare or endangered marine birds (California brown pelican and California least tern) occur within the San Pedro Channel. The California brown pelican has rookeries at West Anacapa Island, while a small colony of least terns nests near Anaheim Bay and at Huntington State Park adjacent to the Santa Ana River. Suitable least tern nesting sites have been cleared by the California State Department of Fish and Game at Bolsa Chica Lagoon although successful nesting has not yet occurred.

3.5.1.7 Kelp

The giant kelp beds (*Macrocystis pyrifera*) of southern California are an important natural resource of the nearshore environment. The plant is important as a primary producer and source of food for many marine organisms. It is harvested by man and converted into many useful products. The plant is also important as a habitat for many species of fish preferred by the sport fishermen.

Several beds of giant kelp appear along the coast between Point Fermin and Dana Point. None of these beds are excessively



Sensitive Bird Rookeries and Nesting Areas

3.5-25
Figure

large, and most have been propagated to some extent during the past 20 years. The majority are located south of Newport Beach in waters where the benthic substrate is suitable for kelp holdfast attachment (Figure 3.5-26). The largest concentration of kelp occurs between Arch Rock off Corona del Mar and Morro Canyon just north of Laguna Beach. The kelp population in this area consists of a series of lesser beds whose boundaries overlap. Efforts to replenish kelp in this area have met with some success (North *et al.*, 1974). The giant kelp is found between Laguna Beach and Dana Point.

The third habitat region is the kelp canopy. This region is the least stable, being subject to wave action, frequent changes in temperature, boating disturbance, and periodic harvesting. Individual kelp stipes grow rapidly, but have short lifetimes. Many of the inhabitants are encrusting forms. The blades of the canopy are often heavily encrusted with hydroids, bryozoan, calcareous tube polychaetes, and pelecypods. Several species of fish utilize the canopy as a habitat during all phases of development from larvae to adult.

3.5.1.8 Marine Reserves and Refuges

Areas of Special Biological Significance (ASBS) have been defined by the California State Water Resources Control Board (1973) as "those areas containing biological communities of such extraordinary, even though unquantifiable, value that no acceptable risk of change in their environment as a result of man's activities can be entertained." Subsequent regulations prevent waste discharges of any sort into areas so designated.

Officially designated ASBS's (Figure 3.5-27) in Los Angeles and Orange Counties are listed below:

<u>Santa Catalina Island</u>

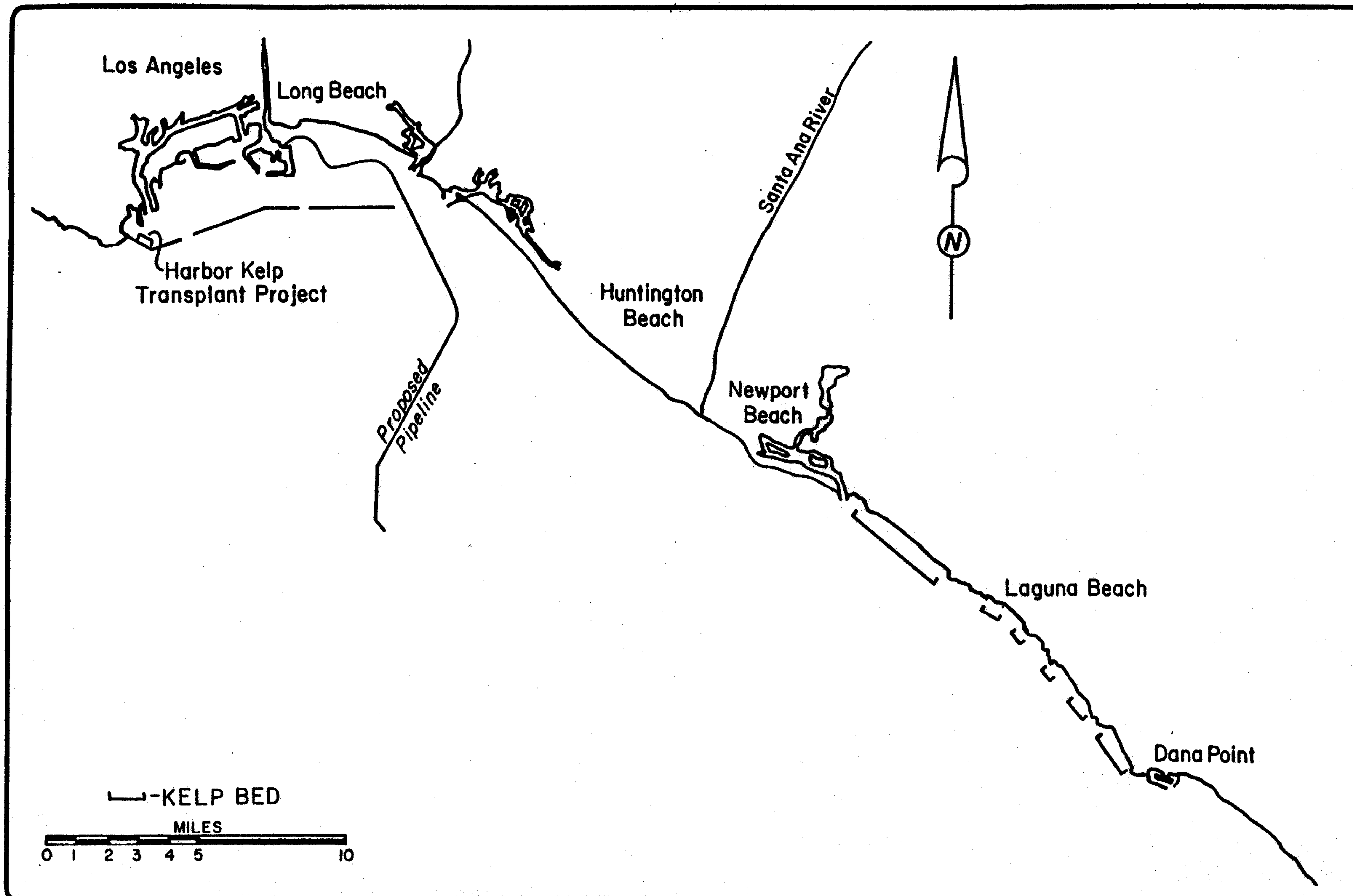
- Sub-area One - Isthmus Cove to Catalina Head
- Sub-area Two - North end of Little Harbor to Ben Weston Point
- Sub-area Three - Farnsworth Bank Ecological Reserve
- Sub-area Four - Binnacle Rock to Jewfish Point

<u>Newport Beach Marine Life Refuge</u>

<u>Irvine Coast Marine Life Refuge</u>

<u>Heisler Park Ecological Reserve</u>

Marine Ecological Reserves are areas held in their natural condition for "the benefit of the general public and to observe native flora and fauna and for scientific study" (Smith and Johnson, 1974). Areas so designated along the coast of Los Angeles and Long Beach Harbors (Figure 3.5-26) are listed below:



Macrocystis Beds

3.5-26
Figure

Lover's Cove Reserve, Santa Catalina Island

Farnsworth Bank Ecological Reserve, Santa Catalina Island

Bolsa Chica Ecological Reserve

Heisler Park Ecological Reserve

Marine Life Refuges (Figure 3.5-27) are designated to protect unique habitats of native marine life. Regulations concerning public use of these areas are somewhat less stringent than for Ecological Reserves or ASBS. The following Marine Life Refuges are located along the Los Angeles and Orange County coasts:

Point Fermin Marine Life Refuge

Newport Beach Marine Life Refuge

Irvine Coast Marine Life Refuge

Laguna Beach Marine Life Refuge

South Laguna Beach Marine Life Refuge

Niguel Marine Life Refuge

Dana Point Marine Life Refuge

Doheny Beach Marine Life Refuge

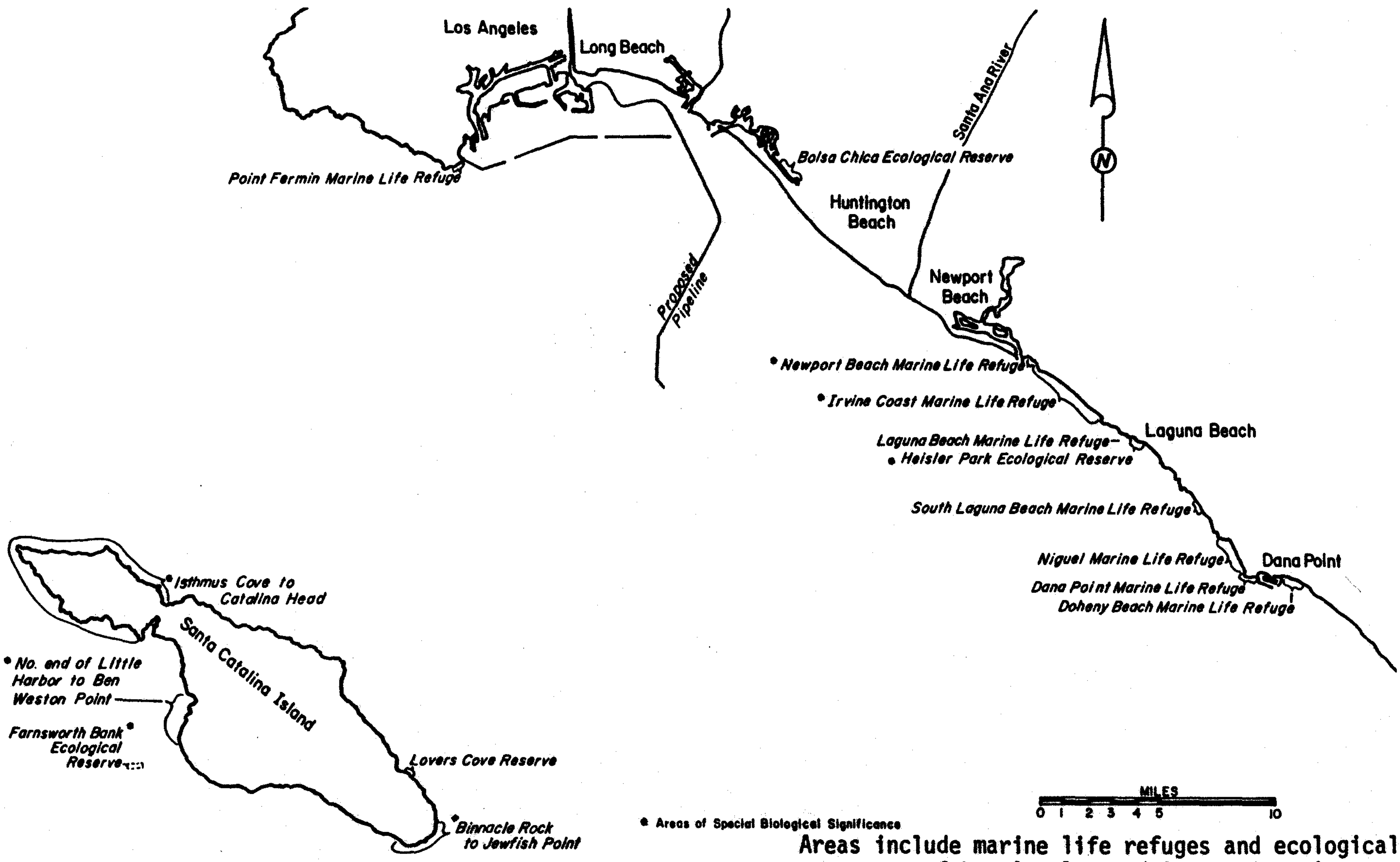
3.5.2 Terrestrial Biological Resources

3.5.2.1 Vegetation and Wildlife

Most terrestrial vegetation communities situated along the coast of the study area contain disturbed vegetation typical of urban environments. Native vegetation communities are limited to the Irvine Coast (10,000 acres, or 4050 ha) and scattered pockets of 1-2 acres (0.4-0.8 ha) in the South Laguna area. Native vegetation still remaining consists mostly of Maritime Sage Scrub (Thorne, 1976), Disturbed Grassland, and limited Coastal Strand vegetation.

Several Coastal Wetlands are of primary biological importance along the coast. These wetlands include Upper Newport Bay, Anaheim Bay, Huntington Harbour, and Alamitos Bay. The location of these wetlands is shown in Figure 3.5-28. Of these wetlands, Upper Newport Bay is relatively undisturbed and is designated as a wildlife sanctuary. Anaheim Bay, Huntington Harbour, Alamitos Bay, and Sunset Aquatic Park have been disturbed through dredging and channelization, but still contain important biological resources.

In addition to containing marine invertebrates, the estuaries serve as an area of high productivity for many game and nongame fish species. The wetlands serve as a valuable habitat for marine birds and shorebirds, including four rare or endangered species.



Areas include marine life refuges and ecological preserves of Los Angeles and Orange Counties.

Areas of Special Biological Significance

3.5-27
Figure

3.5.2.2 Rare and Endangered Species

Three species classified as endangered by the U.S. Fish and Wildlife Service occur regularly within the study area. The California brown pelican (*Pelecanus occidentalis californicus*) breeds on Anacapa Island, but can be expected to occur both within the estuaries, along shoreline, coastline, and in the open ocean on a frequent basis.

The California least tern (*Sterna albifrons brownii*) nests along the coastline within the study area. Figure 3.5-28 illustrates the approximate boundaries of proposed Essential Habitat as delineated by the U.S. Fish and Wildlife Service. Portions of San Gabriel River/Alamitos Bay, Anaheim Bay/Huntington Harbor, and the mouth of the Santa Ana River have been designated as Proposed Essential Habitat for the species. Additionally, the species feeds along the coast and breeds in limited numbers in Upper Newport Bay.

The light-footed clapper rail (*Rallus longirostris levipes*) is found within the marshland in the study area. As shown in Figure 3.5-30, the U.S. Fish and Wildlife Service has designated Proposed Critical Habitat for the species in portions of Anaheim Bay and Upper Newport Bay.

The Belding's savannah sparrow (*Passerculus sandwichensis beldingi*) is classified by the California Fish and Game Commission as endangered. The species nests in stands of *Salicornia* along coastal wetlands and salt flats. Primary areas of concentration of the species include Anaheim Bay, salt flats along the coast in Huntington Beach, and Upper Newport Bay.

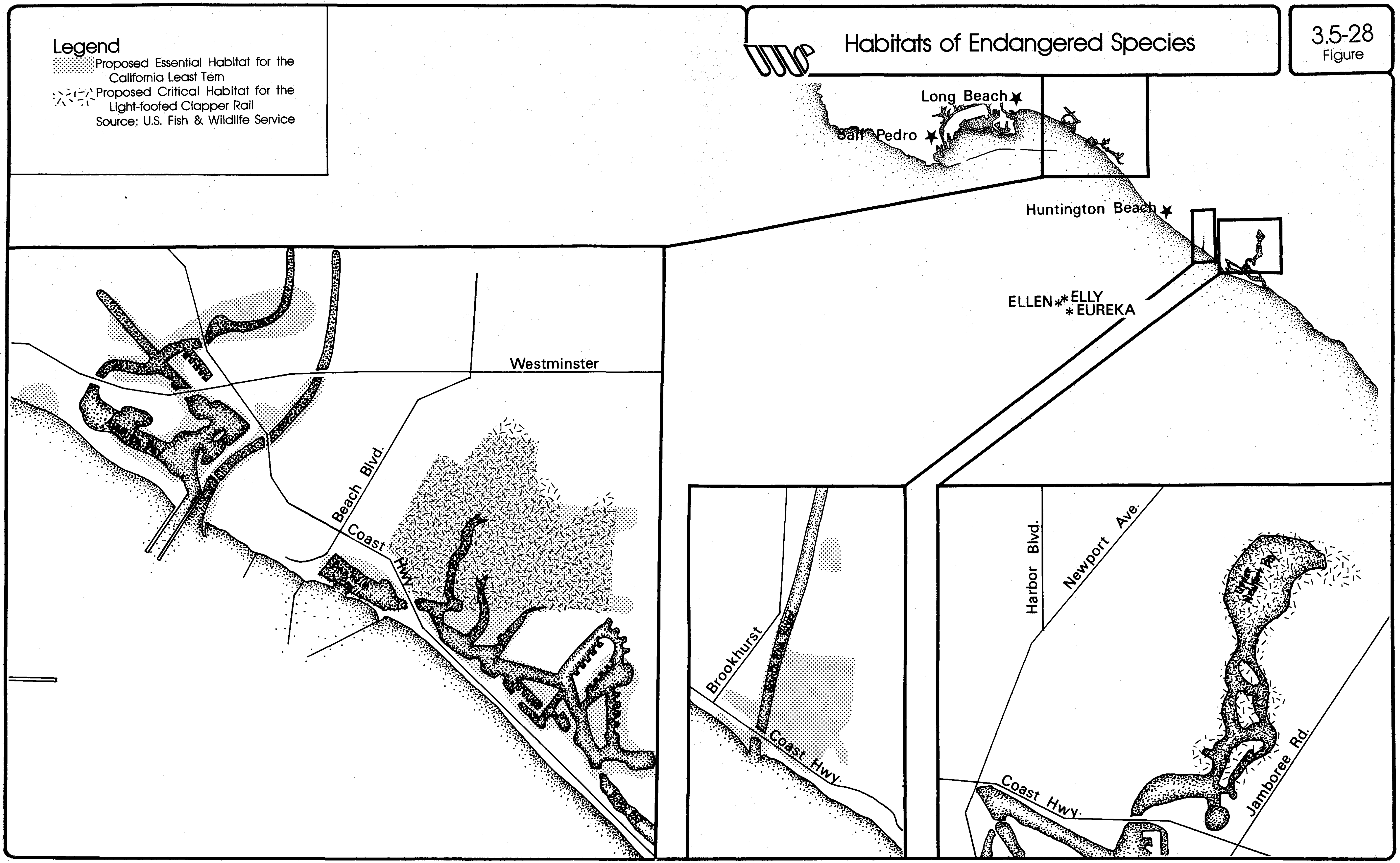
The southern bald eagle (*Heliaeetus leucocephalus leucocephalus*) also frequents the study area. The species, which is considered endangered, has been observed on numerous occasions along the coast and within estuaries in the study area.

3.6 SOCIOECONOMIC SETTING

3.6.1 Archaeological/Historical Resources

3.6.1.1 Background

The emphasis of the archaeological/historical research associated with this project is the submerged pipeline route from the platform site to the point of landfall in the Port of Long Beach. The shallow water platform site was evaluated as part of this research process since it is the commencement point of the submerged pipeline. However, it is considered that the original Lease Block Survey at the platform location adequately investigated this site. The results of that survey were negative as regards to any archaeological or historical resources. Onshore the closest



Habitats of Endangered Species

3.5-28
Figure

presently recorded historical site to the point of landfall is the Looff Carousel and residence located approximately one mile (1.6 km) north of that point.

A search was made of available literature for indications of submerged historic or prehistoric archaeological sites along the pipeline route. Although numerous sunken and wrecked vessels are known to exist within the general area of the pipeline route, their recorded positions do not place them in the pipeline route. No prehistoric sites are known for the pipeline route. The potential for discovery of both historic and prehistoric maritime archaeological sites in the vicinity of the pipeline route is high (Maxwell, 1978) due to the water-borne commerce known from both periods.

(1) <u>Sea Level Changes</u>

Sea level along the northern California coast 15,000 years ago was approximately 100 m (332 ft) or more below present sea level, according to a recent investigation of sediment cores from the San Francisco Bay area (Atwater, Hedel, and Helley, 1977). A sea-level curve developed for the U.S. Atlantic seaboard indicates worldwide sea-level position may have been as much as 130 m (427 ft) below present level for the same time period (Milliman and Emergy, 1968). Studies along the Malibu coastline north of Los Angeles and closer to the Shell Beta project area do not conflict with these other findings (Birkeland, 1972). A Bureau of Land Management OCS Office literature search report, as yet unreleased, will discuss these and other studies relevant to the Southern California Bight (Maxwell, 1978).

Assuming the 100-m bathymetric contour as a realistic lowered sea level, it can be concluded that the proposed offshore pipeline route was dry land or coastal esturial environment approximately 15,000 to 17,000 years ago. Since the presence of man in the western hemisphere is currently accepted to at least 20,000 years before present (b.p.), it is reasonable to assume that they followed a lowering sea level to its lowest point while exploiting the littoral environment. As the post-Wisconsin age glacial meltwater raised sea level to its present position, man left behind sites that may be encountered in our current exploration of the marine environment.

The rate of rise of sea level from its lowest position during the Pleistocene age until reaching its present position is not available for the offshore project area. However, it is possible to infer from the studies of sea level inundation of San Francisco Bay (a local event in a larger process known as the Holocene transgression) and safely predict a similar rate, corrected for local tectonic subsidence and recovery, for the Shell project area. Sea level rose along the California coast from the 100 m or a lower contour at a rate of about 2 cm/year from about 9,500 to 8,000 years ago, and has been rising at the rate of about 0.1-0.2 cm/year from 6,000 b.p. to the present (Atwater *et al.*, 1977).

(2) Dredging History

The first recorded dredging activity within Long Beach Harbor occurred during construction of the inner harbor, and consisted of deepening and configuring three channels and a turning basin during 1906 and 1907. Later, maintenance and expansion dredging operations for the inner and middle harbors (west of Pier J) were ongoing, particularly after high rainfall seasons with heavy runoff sediment loads. The impact of dredging activities within the inner and middle harbors upon the pipeline route in the harbor is considered minimal.

With the completion of the Los Angeles flood control channel north of the pipeline route in 1923, suspended sediments were directed out into the area of the pipeline route. The effects of siltation upon potential cultural resources, if even to mask them from view, is unknown. Maintenance dredging for the outfall area of this flood control channel occurred in the years 1944, 1950, 1952, and 1969, and dredging is presently underway to clear sediments from this year's excessively heavy rainfall. The effects of this dredging upon the pipeline route area are uncertain.

The construction of the federal breakwater encompassing the outer Long Beach Harbor, built in segments (1932-1937, 1940, 1941-1949) and bordering the pipeline route on the south and west, required a base of dredged fill materials. These fills were dredged from the adjacent seabottom parallel to the seawall location. The effects of barrow and fill operations from this construction to the pipeline route area and potential archaeological materials are unknown.

By far the most obvious disturbance to the pipeline route area within the harbor is the result of the THUMS islands and interisland submarine facilities constructed in the later 1960's. Barrow pits and trenches reach a depth of 70 ft (21 m) in the vicinity of the oil islands. Buried pipe and cable routes and spoil cast aside during these operations are still evident throughout the inshore portion of the pipeline route.

In conclusion, the bottom disturbance within the harbor portion of the pipeline route is relatively unknown except for the obvious dredging and spoil casting activities within the inshore area. Siltation may be a factor in masking cultural remains to all remote sensing systems except magnetometers sensitive to ferrous materials.

3.6.1.2 Remote Sensing Survey

In March of 1978, a cultural resource survey was conducted by Dames and Moore for Shell Oil. In an effort to verify and update that survey, a second remote sensing survey was conducted October 5-7, 1978 by Intersea Research Corporation on board the F/V Care Less which was deployed daily from Los Alamitos Bay. The sea state was 1 (including the Beaufort scale) throughout the survey.

The survey procedure ran five transect lines parallel to the proposed pipeline route and spaced 100 m (328 ft) apart. Turns necessitated in the survey course were straightened by approaching the new direction from off the route. This was done to reduce heading error and locational uncertainty in towed sensors. Figure 3.6-1 shows the transect lines along the pipeline route.

Subbottom profiling data obtained by Dames and Moore during the survey of March 11-19, 1978 was considered adequate for the purposes of archaeological analysis. Water depth over the pipeline route varied from under 30 ft (9 m) near Pier J in the harbor to 260 ft (79 m) at the Platform Elly location. The pipeline route position for segment 1 of 2626 feet (800 m) in federal waters was previously surveyed by Dames and Moore on the above referenced days and is adequate for this analysis.

The procedures and equipment used were:

(1) Navigational Positioning

Survey shot point location was provided by using a Motorola Miniranger II positioning system. Navigational accuracy of ± 3 m (10 ft) was obtained using the primary shore positioned network of three available transponders. Shot points were 250 feet (76 m) apart.

(2) Instrumentation

Remote sensing equipment used during the survey were in continuous operation and included:

- Geometrics C-801/3 magnetometer system with dual channel recorder set at 100 and 1000 gammas full scale. The sensitivity was 1 gamma with a 3-second cycle rate. The cable deployed on survey lines 11 through 83 was 200 feet (61 m) with buoys on cable 50 feet (15 m) forward of sensor. The cable deployed on lines 93 to 107 was 225 feet (68.5 m) without buoys. The chart speed was 2 in/min.

- Klein Model 400 Side Scan Sonar system with Model 402 towfish with K-wing depressor. The range scale setting was 150 m/channel throughout the survey. The sensor cable deployment was variable with water depth.

- Precision Depth Recorder (fathometer) was an EDO Model 578 and Raytheon Model 731, both side-mounted three feet below sea surface.

Analysis of the Dames and Moore survey of March 1978 indicated that the pinger, boomer, and sparker systems provide data that were adequate. The parameters of those systems are listed below:

• ORE Subbottom Profiling system (pinger), consisting of a Model 136 towfish, Model 140 transceiver, and an EPC Model 4100 recorder. The output frequency was 3.5 kHz with firing and sweep rates of 250 msec.

• EG&G Uniboom System (boomer) consisting of a Model 230 sound source, Model 255 recorder, and Model 265 hydrophone array. The power output was normally 400 joules with a 600 msec firing rate. The sweep rate was 100 msec, except for line 4A, which was 200 msec.

• EG&G Sparkarray System (sparker) Model 267A electrode frame, Model 262J (modified) hydrophone assembly, and Model 255 recorder. The power output was 1,000 joules with a 1.2 second firing rate and 400 msec sweep.

(3) Instrument Platform

The survey vessel was the F/V Care Less, whose characteristics are: length 45 feet (14 m), beam 16 feet (5 m), draft 6 feet (1.8 m). The vessel is powered by twin diesels and has twin screws. The vessel speed throughout the survey was five knots.

(4) Survey Personnel

This survey was conducted to augment previous work submitted by Shell Oil. The survey was performed using staff and equipment from Intersea Research Inc. Mr. William Speidell was the survey chief and navigator, with Mr. Terry Curley serving as senior technician and Mr. Jack Donovan as mechanic. Mr. Jack Hudson, a SOPA-certified marine archaeologist and Mr. Jack Hunter, marine archaeologist, were on board the vessel representing WESTEC Services. The vessel owner/operator was Mr. Norman Rogge.

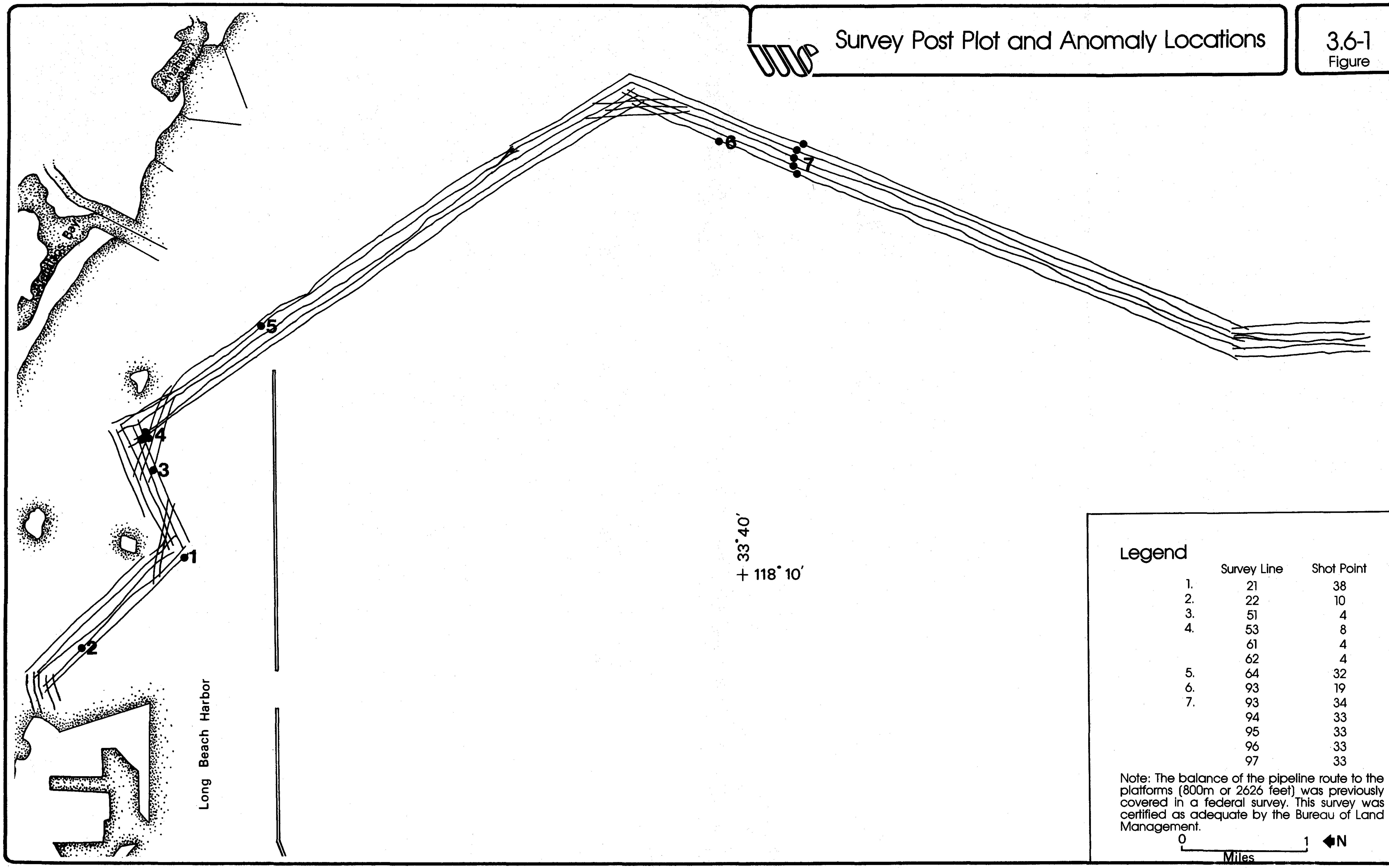
3.6.1.3 Magnetometer Data Analysis

Magnetic background values in the survey area fluctuated from 49,375 gammas to 49,450 gammas. Magnetic anomaly values above ambient (excursion measured from positive peak to negative peak on waveform) and locations are listed by survey line to the nearest shot point and are shown on Figure 3.6-1. Sensor setback correction was applied throughout the data. There were magnetic fluctuations in the field gradient recorded along leg 9, however these appear to be of geological origin with the exception of a linear anomaly.

Two categories of anomalies are identified in Tables 3.6-1 and 3.6-2 according to whether they are a known or unknown magnetic disturbance source. Most are annotated with an identification of the disturbance or a remark concerning their appearance.

Survey Post Plot and Anomaly Locations

Figure 3.6-1



Legend

	Survey Line	Shot Point
1.	21	38
2.	22	10
3.	51	4
4.	53	8
	61	4
	62	4
5.	64	32
6.	93	19
7.	93	34
	94	33
	95	33
	96	33
	97	33

Note: The balance of the pipeline route to the platforms (800m or 2626 feet) was previously covered in a federal survey. This survey was certified as adequate by the Bureau of Land Management.

TABLE 3.6-1

CATEGORY I (IDENTIFIED) MAGNETIC ANOMALIES - SHELL BETA PIPELINE ROUTE

Survey Line	Shot Point	Gamma Value	Remarks
11	all	200± g	THUMS Is. Grissom & Queen Mary
12	all	200± g	THUMS Is. Grissom & Queen Mary
13	all	100± g	Grissom - Pier J pipeline
14	all	100± g	Grissom - Pier J pipeline
15	13-10	100± g	Grissom - Pier J Pipeline
21	35-25	30 g	THUMS Is. Freeman
	10- 1	45 g	THUMS Is. Grissom
22	1	50± g	THUMS Is. Grissom
	28-35	30 g	THUMS Is. Freeman
23	35-25	55 g	THUMS Is. Freeman
	1	300 g	THUMS Is. Grissom
	4	53 g	Long Beach Core Hole No. 7
24	1	400 g	THUMS Is. Grissom
	5	18 g	Long Beach Core Hole No. 7
	25-38	180 g	THUMS Is. Freeman
25	38-25	400 g	THUMS Is. Freeman
	8-1	500 g	THUMS Is. Grissom
32	8-1	120 g	THUMS Is. Freeman
33	all	420 g	THUMS Is. Freeman
42	24	100± g	Chaffee/White Interisland facilities
43	1-8	55 g	THUMS Is. Freeman
	24	200 g	Chaffee/White Interisland facilities
44	24	200 g	Chaffee/White Interisland facilities
	10-1	135 g	THUMS Is. Freeman
45	1-10	350 g	THUMS Is. Freeman
	15	150 g	Long Beach Core Hole No. 2
	21	140 g	Chaffee/White Interisland facilities
51	15	100± g	THUMS Is. Chaffee
52	10-17	350 g	THUMS Is. Chaffee
53	1	100+ g	Long Beach Core Hole No. 2
	12-17	400 g	THUMS Is. Chaffee
61	44-39	15 g	Oil Island Belmont
	14-12	15 g	THUMS Is. Chaffee
	1-10	30 g	THUMS Is. Chaffee
	38-48	30 g	Oil Island Belmont
63	46-38	55 g	Oil Island Belmont
	12-3	100 g	THUMS Is. Chaffee
	2	140 g	Chaffee/White Interisland facilities
64	1	180 g	Chaffee/White Interisland facilities
	5-15	250 g	THUMS Is. Chaffee
	41-46	300 g	Oil Is. Belmont
65	46-41	350 g	Oil Is. Belmont
	16-5	250 g	THUMS Is. Chaffee
	3	150 g	Chaffee/White Interisland facilities
75	24	75 g	Chevron abandoned well 64-3135
96	1	43 g	Chevron abandoned well 64-3135
97	118	30 g	Mobil abandoned well 65-5700
104	6	90 g	Chevron abandoned well 4-312-20018
105	6	20 g	Chevron abandoned well 4-312-20018
	22	20 g	Aminoil abandoned well 64-3614
106	22	12 g	Aminoil abandoned well 64-3614
107	23	12 g	Chevron abandoned well 4-312-20006

TABLE 3.6-2

CATEGORY II (UNIDENTIFIED) MAGNETIC ANOMALIES
SHELL BETA PIPELINE ROUTE

Anomaly	Survey Line	Shot Point	Gamma Value	Remarks
1	21	38	14 g.	
2	22	10	69 g.	
3	51	4	12 g.	
4	53	8	5 g.	Also seen on line 61 & 62, s.p. 4
	61	4	14 g.	Also seen line 53, s.p. 8 and line 62, s.p. 4
	62	4	10 g.	Also seen line 53, s.p. 8 and line 61, s.p. 4
5	64	32	45 g.	
6	93	19	22 g.	
7	93	34	57 g.	Also seen on lines 94-97, s.p. 33
	94	33	68 g.	Also seen lines 93-97, s.p. 33
	95	33	78 g.	Also seen lines 93-97, s.p. 33
	96	33	62 g.	Also seen lines 93-97, s.p. 33
	97	33	83 g.	Also seen lines 93-97, s.p. 33

3.6.2 Recreation

3.6.2.1 Beach Facilities

From the Long Beach area extending south to the Orange/San Diego County line there are over 42 miles (67.6 km) of shoreline. Numerous public beaches and coastal parks are located in this stretch of the coast. A list of state, county, and city facilities appears in the Technical Appendix. These facilities are utilized most heavily during the months of May-September. The annual number of visitors to the beaches exceeds 28 million. A substantial number of visitors come from inland areas, contributing to the tourist industry of these coastal areas. Table 3.6-3 provides estimates of annual visitors to major beach facilities.

TABLE 3.6-3

NUMBER OF ANNUAL VISITORS TO MAJOR PUBLIC BEACHES (millions)

Beach	1977	1978 Year to Date as of September
Long Beach	10.2	N/A
Seal Beach	N/A	N/A
Huntington Beach	2.43	3.23
Newport Beach	12.99	9.15
Laguna Beach	N/A	3.25
San Clemente Beach	2.75	2.77

SOURCE: Estimates calculated by lifeguard headquarters October, 1978

N/A = Not Available

3.6.2.2 Marine Reserves

Adjacent to the beach from the project landfall south are several ecological reserves and marine life refuges. These were established under California law in order to protect rare or endangered wildlife, aquatic organisms, or special land and aquatic habitat types. The reserves are protected not only for scientific study, but also for the benefit of public observation. These reserves are discussed in Section 3.5.

3.6.2.3 Recreational Boating

The State of California has one of the largest recreational boating fleets in the world. Roughly 30 percent of all registered pleasure boats in the State are docked in Los Angeles and Orange Counties, as reported in the California Small Craft Harbor and Facilities Plan in 1964 (Southern California Ocean Studies Consortium, 1975). Another seven percent are at ports and marinas of Ventura and San Diego Counties. Several studies have projected a continued growth of recreational boating in the State, with a heavy emphasis upon the southern California area (i.e., Ventura, Los Angeles, Orange, and San Diego Counties (Southern California Ocean Studies Consortium, 1975). Due to weather, climate, and population distribution, about 70 percent of those recreational boats venturing into open seas operate out of harbors and marinas in the above four counties. Table 3.6-4 indicates current counts of recreational berthings. Accurate and current records are not available for the number of recreational boat visitors and launchings at the various local marinas, nor are they available for recreational activity at the platform sites.

3.6.2.4 Sport Fishing

Southern California is also the most important region in the State for nearly all categories of sport fishing, in terms of both activity and expenditures. The primary type of sport fishing is party boat fishery, which yields the highest catch per manhour and accounts for about 55 percent of all sports fish catch. Shoreline fishing yields the lowest catch, but forms one of four main types of sportfishing in addition to private boat and pier/jetty fishing. In Orange County in 1970, there were over 2.7 million angler days equating to over $33 million in expenditures, as shown in Table 3.6-5. An increase of nearly 25 percent in angler days has been projected by 1980 (CDFG, 1973). Section 3.5.1 described commercial fishing activities in the vicinity of the platform sites.

3.6.3 Marine Traffic and Navigation

3.6.3.1 Project Location

The three proposed Shell Beta project offshore platforms are to be located in the north end of the Gulf of Santa Catalina in the separation zone of the Traffic Separation Scheme, as shown in the Project Description, Figure 2.2-4. Section 2.2 of the Project Description provides specific information concerning the distances of the platforms from the traffic lanes.

3.6.3.2 Gulf of Santa Catalina Traffic Separation Scheme

Traffic Separation Schemes (TSS) have the objective of

TABLE 3.6-4

NUMBER OF BERTHINGS IN THE MARINAS UNDER GOVERNMENTAL JURISDICTION IN THE SOUTHERN CALIFORNIA COASTAL ZONE IN 1978

Marina	Existing	Slips Planned	Projected Maximum
Long Beach Shoreline	0	850	1660
Long Beach Marina	1850	31	2000
Long Beach Harbor	800	571	1371
Marina Pacifica[1]	178		
Newport Harbor Area	1050[2]	50	5066
	2700[3]		
	1266[4]		
Dana Point	2500	0	2500
Huntington Harbour[5]	1736	856	2500

[1]Privately owned and operated.

[2]Residential piers with more than one boat tie per pier possible.

[3]Commercial slips.

[4]Offshore moorings.

[5]1974

SOURCES: Barry McDaniel. Planner, Port of Long Beach, September, 1978.
Ellis Crow. Planner, City of Long Beach Planning Department, September 1978.
Environmental Management Agency. Dana Point Harbor, October, 1978.
Huntington Harbour Boat Capacity Study. Environmental Impact Study Profiles, 1974.
Long Beach Marine Department, September, 1978.
Marine Pacific Development Company, September, 1978.
Marine Department Newport Beach, September, 1978.

TABLE 3.6-5

ANNUAL NUMBER OF ANGLER DAYS AND ESTIMATED EXPENDITURES OF SPORT FISHERMEN IN THE FIVE COASTAL COUNTIES OF SOUTHERN CALIFORNIA
(From California Department of Fish and Game Planning Team, 1973)

County	Angler Days (Annual Average) 1970	1980 (Projection)	Estimated Expenditures, 1970
Santa Barbara	187,500	236,300	$ 2,294,000
Ventura	662,500	834,800	8,104,000
Los Angeles	2,875,000	3,622,500	35,166,000
Orange	2,700,000	3,400,000	32,800,000
San Diego	1,200,000	1,500,000	14,700,000
TOTALS:	7,625,000	9,593,600	$93,064,000

improving the safety of navigation in converging areas and in areas where the density of traffic is great or where the freedom of movement of shipping is inhibited by restricted sea room, the existence of obstructions to navigation, limited depths, or unfavorable meteorological conditions. A particular objective is to separate opposing streams of traffic so as to reduce the incidence of head-on encounters (IMCO, 1977).

The Gulf of Santa Catalina traffic separation scheme leads from the Gulf of Santa Catalina to the precautionary zone at the entrance to Los Angeles/Long Beach Harbors. Adjacent to the Shell Beta Unit platforms, the TSS consists of a separation zone about two miles wide and traffic lanes on each side of the separation zone approximately one mile wide each. Northbound traffic is on the east and southbound traffic is on the west side of the separation zone, as shown in Figure 2.2-4.

The Inter-Governmental Maritime Consultative Organization (IMCO) has adopted the Gulf of Santa Catalina TSS (IMCO, 1977). Shipping using the TSS is, therefore, guided by Rule 10 of the 1972 International Regulations for Preventing Collisions at Sea (72 COLREGS), in addition to its general rules for preventing collisions. Pertinent extracts from Rule 10 are:

> "(b) A vessel using a traffic separation scheme shall:
>
> (i) proceed in the appropriate traffic lane in the general direction of traffic flow for that lane;
>
> (ii) so far as practicable keep clear of a traffic separation line or separation zone; . . .
>
> (e) A vessel, other than a crossing vessel, shall not normally enter a separation zone or cross a separation line except:
>
> (i) in cases of emergency to avoid immediate danger;
>
> (ii) to engage in fishing within a separation zone . . .
>
> (g) A vessel shall so far as practicable avoid anchoring in a traffic separation scheme or in areas near its terminations.
>
> (h) A vessel not using a traffic separation scheme shall avoid it by as wide a margin as is practicable.
>
> (i) A vessel engaged in fishing shall not impede the passage of any vessel following a traffic lane.

(j) A vessel of less than 20 meters in length or a sailing vessel shall not impede the safe passage of a power-driven vessel following a traffic lane."

Thus, the rules for navigation in the TSS are quite specific and strict. Moreover, as indicated in consultation with the U.S. Coast Guard, observations of shipping entering and departing the precautionary area to the Los Angeles/Long Beach harbors from the Gulf of Santa Catalina show good adherence to the TSS.

The Corps of Engineers earlier this year gave notice that the Commander, Eleventh Coast Guard District, had requested the establishment of a Safety Fairway in the Gulf of Santa Catalina, Traffic Separation Scheme (Corps, 1978). The fairways would prohibit the erection of structures therein and aid a safe approach into, and safe departure from, the precautionary area of the Ports of Los Angeles and Long Beach. The Corps received comments and evaluated the proposal, which would consist of an area coincident with each existing traffic lane plus a 500 meter buffer zone on each side of each existing lane. The Corps of Engineers has decided not to implement safety fairways in the Gulf of Santa Catalina at this time. Instead, they are planning to publish guidelines for placement of fixed structures in the Traffic Separation Scheme. These guidelines are not expected to be available for several months.

Regardless of the safety fairway proposed, the Shell Beta platform sites are all situated greater than 500 meters from the traffic lanes.

3.6.3.3 Other Marine Safety Factors

The U.S. Navy has designated a large area, which includes the proposed platform sites, as the Long Beach Electronics Test Area (LBETA). The area is used, as required, for torpedo tests, antenna radiation tests, anti-submarine warfare research, and electronic counter-measures. Consultation with the staff of the Commander Naval Air Force, U.S. Pacific Fleet, who is operational commander for the LBETA, revealed no specific conflicts in the project vicinity with the foregoing Navy activities.

There are several navigation aids available in the vicinity of the proposed platforms. At a distance of 3 and 4 miles (4.8-6.4 km) to the north there are two lighted buoys, one marking the northeast corner of the northbound traffic lane and the other marking the northwest corner of the southbound traffic lane. There are two other lighted buoys about five miles (8 km) to the west and one about 2.5 miles (4 km) northeast. Additionally, onshore there are fixed navigation lights at Los Angeles with a visibility of 22 miles (35.4 km) and at Long Beach with a visibility of 24 miles (38.5 km).

The platform area has Loran A-C coverage. Loran is a radio navigation signal transmitted from shore stations. Loran A is being phased out as the more accurate Loran C coverage is extended. Long range navigation radar produces a good picture of the California coast and the eastern part of Catalina Island. Various landmarks and lights on shore are identified for visual navigation purposes on the charts and in the publication United States Coast Pilot 7 (Coast Guard 1978). There is no shallow water in the vicinity of the proposed platforms that would obstruct the passage of shipping using the TSS or operating in the vicinity.

Meteorological and oceanographic conditions at the project area are covered in Sections 3.3 and 3.4, respectively. It should be noted, however, that as they affect marine traffic and navigation, the conditions prevailing are quite mild, with the exception of periods of reduced visibility.

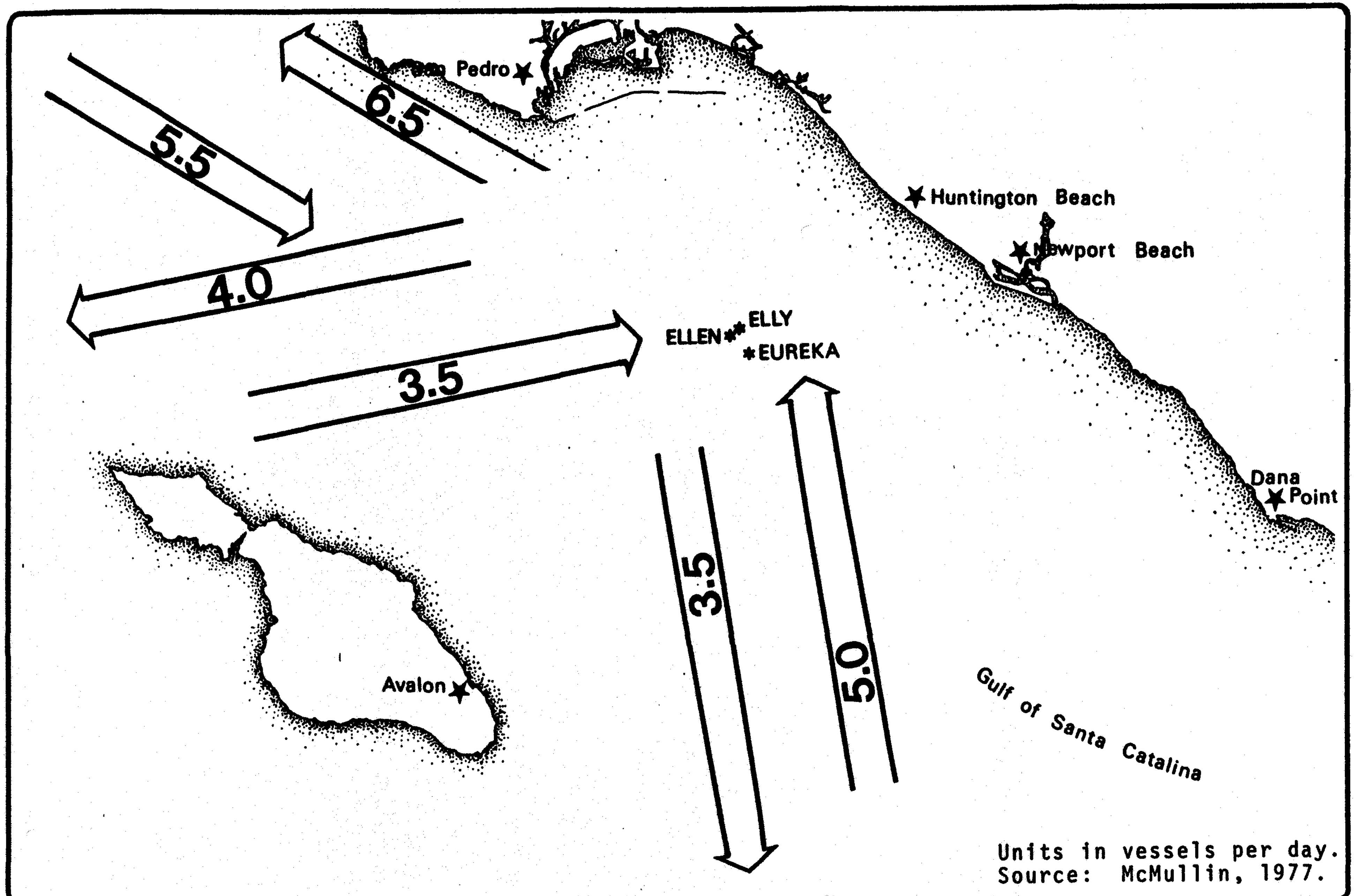
The Los Angeles/Long Beach/Newport Bay areas have large numbers of small craft that are used for recreational purposes, as discussed in Section 3.6.2. The number of boats that operate in the Gulf of Santa Catalina varies with the day of the week, the season, and weather conditions. There is no statistical data available concerning the numbers of craft operating at the specific proposed platform area. However, most recreational craft appear to operate to the north and east of the proposed platform sites unless they are transmitting to or from Santa Catalina Island.

3.6.3.4 Shipping Traffic

Ship traffic transiting the Traffic Separation Scheme lanes adjacent to the proposed platforms will normally be proceeding to and from Los Angeles/Long Beach harbors, and proceeding to and from San Diego, Mexico, the Panama Canal, or South America. Ships arriving from or proceeding to other locations from these harbors normally use the passage north of Santa Barbara Island or the Santa Barbara Channel. Ships proceeding along the coast and not calling at Los Angeles/Long Beach can be expected to take a more direct route and avoid the precautionary area off of the harbor entrance (Figure 3.6-2). This traffic will avoid the Gulf of Santa Catalina Traffic Separation Scheme where the proposed platforms are to be located.

The Coast Guard Office of Marine Safety at Eleventh District Office in Long Beach conducted a commercial traffic (including Navy) density study generated by Los Angeles/Long Beach harbors. Twenty-seven percent of the outbound and 35 percent of the inbound traffic utilized the Gulf of Santa Catalina. The harbors generated an average of 14 inbound and 14 outbound ships per day during 1974 and 1975. Thus it was computed that there was an average of about five ships per day northbound and about 3.5 ships per day southbound using the TSS in the vicinity of the proposed oil platforms.

Information obtained from the Marine Exchange for the ports of Los Angeles/Long Beach indicates that there was a 15 percent



Traffic Density Shell Beta Site

3.6-2
Figure

increase in commercial traffic between 1975 and 1977. This was a period of expanding economic activity in southern California.

A Vessel Traffic Analysis for the Environmental Impact Report for the Point Conception LNG Terminal forecast the probable future number of commercial vessel movements which will be generated by the Ports of Los Angeles and Long Beach (McMullen, 1977). Utilizing data in that report, the maximum and nominal change in the number of vessel movements (inbound and outbound) can be expressed as a percentage. For ship movements in the year 2000 the report predicts a maximum change of plus 25 percent and a nominal change of minus 15 percent, compared to 1977 figures. The predicted change in vessel traffic density in the vicinity of the proposed Shell Beta platforms does not, therefore, appear to be a major factor in assessing marine safety risks.

3.6.4 Demography

As of January 1, 1978, California had a population of 22,075,000, an increase of 195,000 (or 0.9 percent) over July 1 of the previous year. The two counties that will be most directly affected by the proposed Shell Beta project, namely Los Angeles and Orange, had populations of 7,079,200 and 1,808,200 respectively as of January 1, 1978 (DOF, 1978). Table 3.6-6 shows recent population figures for these three entities.

It can be seen from Table 3.6-6 that the growth of Orange County during the 1972-78 period, at 18 percent, far surpassed that of the State. During the same period, Los Angeles County experienced a net gain in population of 96,200, equivalent to one percent. Further information regarding these phenomena and the dynamics which underlie them have been fully discussed in the Draft Environmental Statement for OCS Sale No. 48 (BLM, 1978).

Table 3.6-7 depicts the relative population density of Los Angeles and Orange Counties, as well as that of the State as a whole. It shows that, at 2,312 persons per square mile, Orange County currently has a significantly higher density than the State and a somewhat higher population density than Los Angeles County. In fact, Orange County is the most densely packed county in the five-county area comprising the coastal area of southern California (Los Angeles, Orange, San Diego, Santa Barbara, and Ventura Counties).

Looking to the future, Table 3.6-8 provides population projections for the State and the two counties that would be most directly affected by the proposed project. These data indicate that by the year 2000, Orange County will add just over one million people to its 1975 population, which represents an increase of 61 percent. During the same period, Los Angeles is projected to gain roughly the same number of people, but, due to its large existing baseline figures, the percentage increase over 1975, at 16 percent, will be much less than that of Orange County.

TABLE 3.6-6

POPULATION PATTERNS

	Total Population (000)						
Entity	1972	1973	1974	1975	1976	1977	1978 (1)
State of California	20,437	20,664	20,907	21,198	21,520	21,880	22,075
Los Angeles County	6,983	6,960	6,946	6,947	7,008	7,030	7,079
Orange County	1,530	1 595	1,658	1,713	1,756	1,798	1,808

SOURCE: California Department of Finance, Report 77 E-2, 1977, except where noted

(1) Source: Department of Finance, 1978

TABLE 3.6-7

POPULATION DENSITY

ENTITY	LAND AREA (SQUARE MILES)	POPULATION PER SQUARE MILE 1960	1970	1975	1978[1]
State of California	156,573	101	128	135	141
Los Angeles County	4,060	1,492	1,731	1,717	1,744
Orange County	782	920	1,832	2,167	2,312

Source: BLM, 1978

(1) Source: Department of Finance, 1978

TABLE 3.6-8

POPULATION PROJECTIONS

ENTITY	ESTIMATED POPULATION (000) 1975	1980	1985	1990	1995	2000
State of California	21,198	22,827	24,594	26,340	27,935	29,342
Los Angeles County	6,949	7,144	7,378	7,627	7,854	8,042
Orange County	1,713	1,935	2,173	2,398	2,594	2,756

Source: BLM, 1978

By the year 2000, if the projections shown in Table 3.6-8 are realized, Orange County will have a population density of 3524 persons per square mile. During the same period, the density of the State will have increased to 187 persons per square mile, while that of Los Angeles County will approximate 1981 persons per square mile.

3.6.5. Economics

3.6.5.1 Employment

Information regarding the economies of the State and the Nation, as well as broad employment trends, has been previously offered in prior analyses (BLM, 1978). This section will, therefore, focus on the employment conditions in Los Angeles and Orange Counties from which the majority of the work force for the proposed project will come.

Table 3.6-9 provides July, 1977 employment breakdowns for Los Angeles and Orange Counties. There was a nominal increase in employment over mid-1976 for both counties. The Orange County labor market, in mid-1977, had the lowest unemployment rate of any major metropolitan area in California (BLM, 1978).

Unemployment in Los Angeles County, which was fairly substantial in the 1974-1975 period, declined to 244,200 persons in July 1977. This figure represented the lowest number of unemployed persons in the County since January 1975. The number of unemployed is expected to continue its decline though 1978 (BLM, 1978).

In Orange County, the employment rate dropped from 5.9 percent in 1976 to 4.7 percent during the early part of 1977. As of mid-1978, it is estimated that the total civilian labor force in Orange County is up approximately five percent from July 1977. Unemployment in the County is currently in the range of 38,000-40,000 persons. However, it is probable that unemployment in the building trades for both Los Angeles and Orange Counties exceeds the unemployment rate for the civilian labor force as a whole.

3.6.5.2 Personal Income

The Environmental Impact Statement for Lease No. 35 (BLM, 1975) provides a fairly detailed discussion of Gross National and Gross State Products. In the interest of conciseness, such a discussion will not be repeated here, but instead, this subsection will focus on income trends in Los Angeles and Orange Counties.

Los Angeles County, with a total 1976 personal income of $53.12 billion, was by far the largest income-producing county of the southern California coastal area. However, Orange County's 13.3 percent increase over 1975 to $13.2 billion represented the highest growth rate. Table 3.6-10, which provides a breakdown of these

TABLE 3.6-9

REGIONAL EMPLOYMENT

Item	July 1977 Employed Persons (000) Los Angeles County	Orange County
Agriculture, forestry and fisheries	18.0	10.9
Agricultural production	10.2	6.6
Agri. services, forestry, fisheries	7.8	4.3
Nonagricultural total	3,229.7	644.1
Mining	11.5	2.0
Contract construction	106.0	38.9
Manufacturing	820.4	167.6
Nondurable goods	278.6	44.0
Food and kindred products	53.0	9.0
Textile	10.4	1.9
Apparel	75.4	2.5
Paper and allied products	17.0	3.5
Printing and publishing	45.7	9.0
Chemicals and allied products	27.2	7.0
Petroleum and coal products	11.8	1.3
Rubber/plastic/leather	38.1	9.8
Durable goods	541.8	123.6
Lumber and wood products	11.3	2.8
Furniture and fixtures	34.1	3.6
Stone, clay, glass products	26.0	3.1
Primary metal industries	24.1	1.7
Fabricated metal products	74.0	14.0
Machinery, except electrical	74.4	19.7
Electrical and electronic machinery	110.9	41.5
Motor vehicles	25.8	N/A
Aircraft and parts	88.0	N/A
Guided missiles and space vehicles	15.0	N/A
Other transportation equipment	9.0	N/A
Instruments	27.0	12.3
Miscellaneous manufacturing	22.2	5.6
Transportation and public utilities	182.0	19.9
Wholesale trade	240.5	28.4
Retail trade	508.1	129.9
Finance, insurance and real estate	199.4	36.2
Services	680.5	122.8
Government	481.3	98.4
Federal	67.8	9.8
State and local, incl. education	413.5	88.6
All industries total	3,247.7	655.0

Source: BLM, 1978.

TABLE 3.6-10

PERSONAL INCOME

Entity	Personal Income ($ Million)			Percent Change	
	1975[1]	1976[1]	1977[2]	75/76	76/77
Los Angeles County	47,800	53,120	58,900	+ 10.6%	+ 10.9%
Orange County	11,635	13,205	15,150	+ 13.3%	+ 14.7%
State of California	138,000	155,000	173,000	+ 11.2%	+ 11.6%

Source: BLM, 1978
[1]Estimated
[2]Forecast

TABLE 3.6-11

PER CAPITA PERSONAL INCOME

Entity	Per Capita Personal Income ($)			Percent Change	
	1975[1]	1976[1]	1977[2]	75/76	76/77
Los Angeles County	6849	7614	8414	+ 11.2%	+ 10.5%
Orange County	6772	7348	8163	+ 8.5%	+ 11.1%
State of California	6497	7184	7905	+ 10.6%	+ 10.0%

Source: BLM, 1978
[1]Estimated
[2]Forecast

TABLE 3.6-12

MEDIAN FAMILY INCOME

Entity	Median Family Income ($)			Percent Change	
	1975[1]	1976[2]	1977[3]	75/76	76/77
Los Angeles County	15,475	17,215	18,730	+ 9.5%	+ 8.8%
Orange County	16,560	17,780	19,420	+ 8.8%	+ 9.2%
State of California	13,900	14,800	16,000	+ 6.9%	+ 6.5%

Source: BLM, 1978

[1]Actual

[2]Estimated

[3]Forecast

TABLE 3.6-13

PROPERTY TAXES GENERATED

Entity	Net Taxable Assessed Valuation($000)	Taxes Levied ($000) 1975-76					Average Tax Rate per $100 of Assessed Valuation($)
		City	County	School	Other District	Total	
Los Angeles County	22,094,306	405,958	1,011,746	1,335,987	67,988	2,821,679	12.77
Orange County	6,377,135	66,593	115,087	389,625	45,030	616,335	9.66
State of Calif.	73,245,581	864,741	2,545,379	4,359,707	526,925	8,296,752	11.33

Source: BLM, 1978

data, indicates that this trend was expected to continue through the current period with an Orange County growth forecast of 14.7 percent over 1976.

On a per capita basis, Los Angeles County was expected to maintain its leadership role in 1977 with a per capita income of $8,414. Orange County was forecast to be second in this category among the five southern California coastal counties, with a per capita figure of $8,163 in 1977. Table 3.6-11 and 3.6-12 provide a breakdown of per capita personal income and median family income, respectively, for Los Angeles and Orange Counties, as well as for the State.

3.6.5.3 Taxes

As with the previous subsections, this discussion will focus on the Counties of Los Angeles and Orange and will include statewide data for comparison purposes. For a detailed discussion of the overall coastal economy, refer to the EIS for Lease No. 35 (BLM, 1978).

Table 3.6-13 provides a number of items involving taxes for the State and the two counties mentioned above. In the five-county southern California coastal area, Los Angeles of course leads in all categories of tax revenues. Orange County, with just over $600 million of generated taxes during the 1975-1976 period is a distant second. It should be recognized that the data contained in Table 3.6-13 represents pre-Proposition 13 conditions. The "Average Tax Rates" shown in the right-hand column of Table 3.6-13 are now essentially meaningless as a result of Proposition 13 and subsequent legislation.

Regarding sales tax revenues as shown in Table 3.6-14, total sales subject to State sales and use taxes totaled over $83 billion throughout the State in 1976, representing an increase of about 14 percent over the prior year. Detailed information regarding the sources of these sales, as well as longer term trends, is presented in the prior study (BLM, 1978). Taxable sales for Los Angeles and Orange Counties, and the State, are provided in Table 3.6-14.

Table 3.6-14

TAXABLE SALES

Entity	Taxable Sales ($000) 1976	Percent Change 75/78
Los Angeles County	27,415,161	+ 11.2%
Orange County	6,965,894	+ 21.1%
State of California	83,185,397	+ 13.8%

SOURCE: BLM, 1978

3.6.5.4 Crude Oil Supply and Demand

a. Introduction and Background

In assessing the environmental impact of Shell's proposal to develop offshore tracts known as the Beta Unit and to transport produced reserves onshore for refining and marketing, it is necessary to analyze the project vis-á-vis the overall national and regional crude oil supply and demand picture. Because the term, barrels, is the common terminology to discuss oil economics, conversion to metrics is not provided in this section.

Shell Oil Company proposes to develop oil and gas reserves on two of the parcels (Leases P-0300 and P-0301) covered by OCS Lease Sale 35. The federal government has a 33-1/3 percent royalty interest in these tracts. All crude production is expected to be distributed, processed, and refined in the Los Angeles area. Pertinent to the economic analysis is the fact that oil production from the first drilling platform will commence in 1980 and will peak at a rate of approximately 16,000 barrels/day (b/d) in 1982, assuming no delays. The estimated peak rate of production from both drilling platforms will be roughly 24,000 b/d in mid to late 1986. The salient characteristics of this oil are that it will be heavy crude (14°-16°API average) and sour, containing approximately 3-4 percent sulfur by weight. All natural gas produced from these reserves will be used on the platform for power generation and oil dehydration. This analysis focuses on the crude oil supplies rather than on both crude oil and natural gas.

Shell proposes to ship the oil to shore via a pipeline capable of transporting 40,000 b/d, well above the expected peak production of 24,000 b/d. The excess capacity will be utilized in the event further offshore reserves are produced and require transportation to onshore facilities. The preferred landfall is Long Beach, from where the oil could be routed to any of the Los Angeles Basin refineries via existing onshore distribution facilities.

b. National Crude Oil Supply

In order to place the following discussion of the present and projected California crude oil supply in perspective, a brief overview of the national outlook may be helpful. In 1976, U.S. domestic production of crude oil dropped by three percent, from 8.4 million b/d to 8.1 million b/d, but, according to the Energy Information Administration (EIA), rose again slightly (0.09 percent) during 1977. During this time, crude imports have steadily risen, as can be seen in Table 3.6-15. For the first quarter of 1978, figures published by the EIA indicate production of crude oil has risen slightly to approximately 8.5 million b/d, due primarily to stepped-up flow through the Trans-Alaskan crude line. Imports for this period have averaged 6.0 million b/d, reflecting an increase of almost 98 percent in import volumes since 1973, the embargo year.

TABLE 3.6-15

CRUDE OIL IMPORTS/PRODUCTION

Supply	Thousands of Barrels per day 1974	1975	1976	1977[1]
Crude Imports[2]	3,477	4,105	5,287	6,556
Domestic Crude Production	8,764	8,375	8,119	8,196
Total New Supply:	12,241	12,480	13,406	14,752

[1]Preliminary - Includes unaccounted-for crude.
[2]Excludes imports of refined products.

SOURCE: Oil and Gas Journal, January 30, 1978

Looking ahead, the EIA predicts that domestic energy production will increase from 1975 to 1985 at a rate of 1.5 to 2.5 percent annually and from 1985 to 1990 at 0.8 to 2.5 percent annually -- generally lower than the rates of increase in consumption.[1] Another forecast, confined to 1978, projected a significantly higher increase in crude production -- up 5.3 percent to 8,631,000 b/d, due primarily to stepped-up flow through the Trans-Alaskan crude line. Nevertheless, this forecast also predicted that crude imports would surpass all previous years, except for 1977, approximating 6.4 million b/d for 1978.

c. Regional Crude Oil Supply

The extensive compilation of data prepared by Arthur D. Little & Associates (ADL, 1976) for inclusion in the Environmental Impact Report (EIR) for the SOHIO project served as an excellent data base for preparation of this energy supply/demand analysis, particularly those portions pertaining to the regional crude oil supply and demand. Updates or revisions to this report have been included where comparable statistics have been available. The SOHIO analysis concentrated on the energy supply and demand balances impacted by SOHIO's proposal to transport Alaskan North Slope production from the West Coast, specifically from Long Beach, California, east to Midland Texas (and ultimately to Midwest and Gulf Coast markets) where SOHIO's refining capacity is located. The data generated for this study focused on both regional [Petroleum Administration for Defense District V[2] (PADD V)], statewide (California) and, to a lesser extent, local (Los Angeles area) impacts, all of which are highly relevant to this study.

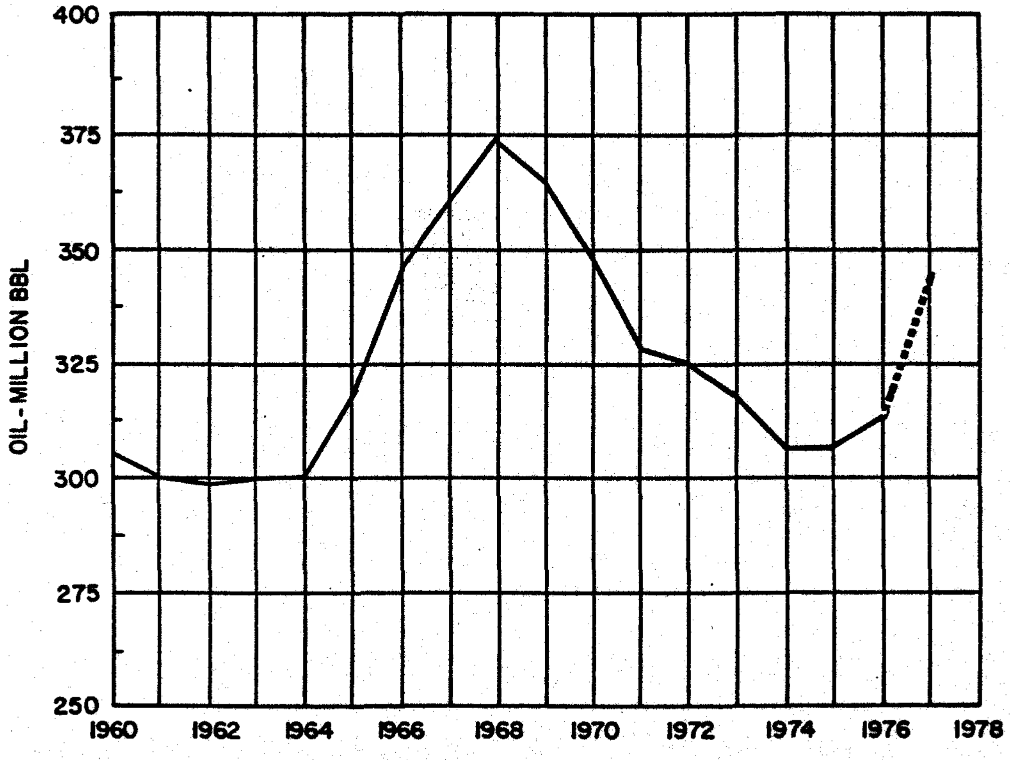
[1]EIA-Annual Report to Congress, Vol. II -- Executive Summary, "Projections of Energy Supply and Demand and Their Impacts."
[2]PADD V includes the States of Washington, Oregon, California, Nevada, Arizona, Alaska, and Hawaii.

The examination of the energy supplies which are expected to be available to fulfill California's projected energy requirements has been confined, for purposes of this study, to the historically forecasted production of crude oil. Broadening the scope of the study beyond that of crude oil production at the regional, state, and local levels would tend to preclude any meaningful evaluation of the impact that 24,000 barrels per day of crude oil may have on the energy supply situation in California.

For the SOHIO study, a range of forecasts was prepared for PADD V oil production for the period 1976 to 1990. The major considerations in making these projections were the rates of production decline from existing reserves and the location and accessibility of future discoveries. Consideration of the former is necessarily based upon the aging of fields and the status and success of enhanced recovery programs. Estimates of future offshore and onshore discoveries are predicated on numerous factors, such as the frequency of lease sales and the influence that environmental regulations may have on exploration and development activity. Among the four cases posited in the SOHIO study relating to production ranges, Case I, which details the Best Estimate Projection of California and Alaska hydrocarbon liquids, and Case II, which projects a slightly more pessimistic view, were chosen for use in this study. Based upon a review of available data and actual events, the figures which follow were considered the most accurate. Where possible, actual production volumes have replaced forecasted volumes or have been inserted for the two years following the SOHIO publication.

Table 3.6-16 gives a historical overview of California and Alaska crude oil production and two projections of future production in these states (Case I and Case II). Figure 3.6-3 graphically illustrates California crude oil production since 1960. The forecast for Case I considers both (1) the declining production from existing reserves, and (2) projected annual reserve additions. Production from existing California reserves (excluding Elk Hills) is projected to decline at approximately five percent per year through 1980 and at two percent per year through 1990. The existing Alaskan reserves, all located in the Cook Inlet Basin fields, are assumed to decline at four percent per year through 1980, five percent per year to 1985, and seven percent per year to 1990.

Case II assumed that (1) there would be a one-year delay in the scheduled initial operation of the Trans-Alaskan Pipeline; (2) that crude oil production from existing California reserves would decline at 11 percent per year instead of the five percent decline presented in Case I; and (3) that annual reserve additions for California would be 200 million barrels per year instead of 250 million barrels per year, as noted in Table 3.6-17. This table presents an estimate of undiscovered, recoverable resources based on USGS data, plus a projection of annual onshore and offshore reserve additions for California and Alaska. These latter figures were based on historic trends in California of new crude reserves as published by the Conservation Committee of California Oil Producers in its Annual Review of California Oil and Gas Production.



Source: 62nd Annual Report of the State Oil and Gas Supervisor, 1976.

California Oil Production

3.6-3
Figure

TABLE 3.6-16

HISTORICAL AND PROJECTED WEST COAST, CALIFORNIA AND ALASKAN CRUDE OIL PRODUCTION

(Thousand of Barrels per Day)

	Actual				Case I Best Estimate			Case II		
	1974	1975	1976	1977[1]	1980	1985	1990	1980	1985	1990
Alaska										
Total Crude Oil	198	197	173	462	1760	2580	2838	1760	2580	2838
California										
Coastal	151	148	189	185	135	150	142	98	74	56
Los Angeles Basin	171	170	308	287	156	173	163	113	85	65
San Joaquin Valley[2]	334	347	395	470	543	552	508	680	574	482
Offshore	230	216	NOTE 3	NOTE 3	270	271	302	270	271	302
Total Crude Oil	886	881	892	942	1104	1146	1115	1161	1004	905
Alaska and California										
Total Crude Oil	1084	1078	1065	1404	2864	3726	3953	2921	3584	3743

[1]Preliminary.

[2]Includes Elk Hills production. Recent forecasts project Elk Hills production to reach 300,000 b/d by 1980, 75,000 b/d more than utilized in the A.D. Little study.

[3]Offshore production included in Coastal and Los Angeles Basin figures

SOURCE: A.D. Little & Associates (1974-1975 figures; Case I and II estimates).

TABLE 3.6-17

FUTURE CALIFORNIA AND ALASKA DISCOVERABLE RESOURCES AND ANNUAL RESERVE ADDITIONS

	Undiscovered Recoverable Resources (B/bbls)[1]	Projected Annual Reserve Additions (M/bbls)	
		Case I	Case II
California			
Onshore	4.9	250	200
Offshore	3.0[2]	60	60
Total:	7.9	310	260
Alaska			
Onshore	12.0	900	900
Offshore	15.0	600	600
Total:	27.0[3]	1500	1500

SOURCE: ADL, Inc. (1976)

1 Estimates based on geophysical data and not on drilling experience.

2 It was assumed (ADL, 1976) that all undiscovered recoverable resources off the West Coast would be discovered in California waters. In view of recent increased federal offshore leasing activity, this projection may err on the low side.

3 The Alaskan total of 27 billion barrels is 30 percent of the USGS estimate of future petroleum resources for the total U.S.

d. California Crude Oil Supply

This section presents a general overview of California crude oil production, including an analysis of recent production trends and a description of the major oil regions and proven reserves, with primary emphasis on southern California. Differences noted between the following discussion and Table 3.6-16 are due to the usage of different data sources.

(1) Recent Production. For the years 1976 and 1977, California was the third largest oil producing state in the nation. After six years of declining production, the State posted a gain of some 600,000 barrels in 1975. In 1976 the California Oil and Gas Supervisor again reported an increase in production over the previous year. Crude oil production on state and federal reserves for 1976 totaled 326.3 million barrels, a slight increase over 1975. Output based on final figures for the first 10 months of the year and preliminary figures for the last two months (Oil World, 1978). At the end of 1976, there were 42,534 state oil wells in production, an increase of 1,500 from the previous year. There were approximately 43,300 state wells in operation in 1977, an increase of 766 wells over 1976 figures.

In 1976 Kern County (San Joaquin Valley) produced approximately 43 percent of the State's total production, surpassing oil fields in the Los Angeles Basin which accounted for 36 percent of production in 1976. The largest share of the oil boosting production in both 1976 and 1977 came from the Elk Hills Naval Petroleum Reserves, which had an output of some 121,000 b/d at the end of 1977. As a result of steam injection projects, three of San Joaquin Valley's oldest and largest fields, Kern River, Midway-Sunset, and South Belridge, produced at all-time highs for both 1976 and 1977.

In the state and federal offshore areas, California production continued to decline in 1976 accounting for only 23 percent of the State's crude oil production. Of the 70.6 million barrels produced, state production accounted for 56.6 million barrels while production from federal reserves totaled 14 million barrels. By the end of 1977, production had once again declined to 60.6 million barrels, accounting for roughly one out of every six barrels of oil produced in the State. Of this total, 48 million barrels were produced in the state offshore and 12.6 million barrels were attributable to federal offshore production.

Exxon and Chevron are moving to bring on-stream new oil fields discovered on OCS lands leased in 1968 in the Santa Barbara Channel. Exxon also began development in September 1977 of the Hondo Offshore field, one of three fields discovered by Exxon in the Santa Ynez Unit. The other two fields, the Pescado and Sacate offshore fields, plus Hondo, are estimated to have reserves of approximately one billion barrels of oil.

(2) California Reserves. As Table 3.6-18 illustrates, the largest remaining crude reserves in California are located in the San Joaquin Valley, which extends 250 miles southwestward from east of San Francisco, down an inland valley between the Sierra Nevada Mountains and the coastal ranges to Kern County, north of Los Angeles. A large portion of the reserves attributable to the Valley is from the Elk Hills Naval Reserves, opened for production in 1976. The Los Angeles Basin, including offshore extensions of its major fields, registers the next largest remaining reserves.

For comparative purposes, California crude reserve estimates prepared by the American Petroleum Institute for 1976 and 1977 are outlined in Table 3.6-19. The API's estimates indicate an increase in overall State reserves for 1977, but show a sharp drop in Los Angeles Basin reserves from 1976 to 1977. No explanation for this decrease was given, nor is one apparent, other than it being attributable to the usual process of evaluating and revising figures as new data become available.

e. National Energy and Crude Oil Demand

On the national level, the EIA predicts that total energy consumption, which has grown at an average annual rate of 3.7 percent from 1975 through 1977, will increase from 1975 to 1985 at 2.6 to 3.2 percent annually, and from 1985 to 1990 at 2.0 to 2.5 percent annually. Domestic production is projected to increase at 1.5 to 2.5 percent annually and from 1985 to 1990 at 0.08 to 2.5 percent, or at rates which are generally lower than the rates of increase in consumption. Therefore, projections by the EIA forecast a continuing national dependence on energy importation, mainly oil, through 1990. Oil imports rose from 6.1 million b/d in 1975 to 8.7 million b/d in 1977. The government foresees an increase in ranges between 9.1 million b/d and 12.5 million b/d in 1985 and between 9.8 million b/d and 16.1 million b/d in 1990.

A forecast by the Oil and Gas Journal (1978) indicates the U.S. will require oil products this year equal to approximately 19.12 million b/d. This amount will be required to supply a 4.3 percent increase in energy demand.[1] Oil is also expected to account for 48.8 percent of the total energy market, the highest share in the nation's history and 2.2 percent higher than in 1973, the year of the embargo. Oil's share of the total energy market was 48.5 percent in 1977 and 47.2 percent in 1976.

f. California Energy and Crude Oil Demand

Typically, California energy consumption has grown at a slightly faster rate than that of the U.S. For example, between

[1]This demand represents a need for 38.3 trillion BTU. This increase would, however, be lower than last year's five percent gain.

TABLE 3.6-18

CALIFORNIA CRUDE RESERVES BY PRODUCING REGIONS[1]

(Millions of Barrels)

	1974	1975	1976	1977
Coastal	536	627	638	634
Los Angeles	1,198	1,113	1,138	949
San Joaquin	1,754	1,817	1,872	2,049
TOTAL	3,488	3,557	3,648[2]	3,632

[1]Includes offshore crude oil reserves

[2]Figures published by the State Oil and Gas Supervisor estimated State reserves to be substantially higher at roughly 4.75 million barrels.

SOURCE: For years 1974-1976, ADL (1976).
For 1977, API estimates, rounded to nearest thousand.

TABLE 3.6-19

CHANGES IN CALIFORNIA CRUDE RESERVES
BY PRODUCING REGION (1976-1977)[1]

	Crude Oil (1,000 bbl)			
	Proven Reserves 1/1/77	Proven Reserves 1/1/78	Change From 1/1/77	Indicated Added Reserves[2]
California	3,589,937	3,631,851	+ 41,914	1,082,825
Coastal Region	600,231	634,038	+ 33,807	322,025
Los Angeles Basin	1,056,125	949,304	-106,821	192,000
San Joaquin Basin	1,933,581	2,048,509	+114,928	1,288,800

[1] Includes offshore reserves

[2] Includes additional recoveries in known reservoirs (in excess of proved reserves) which engineering knowledge and judgment indicate will be economically available by application of enhanced recovery techniques, whether or not such program is currently installed.

SOURCE: American Petroleum Institute estimates, Oil and Gas Journal (1978).

1965 and 1973, California primary energy consumption increased at an average annual rate of 4.6 percent, while total U.S. primary energy consumption grew at an average of 4.3 percent per year.

Oil consumption has steadily risen in California since the late 1950's when oil production and consumption were balanced at roughly 850,000 barrels per day. In the 1970's, half or more of California's energy requirement has been satisfied by oil, including 100 percent of its transportation fuel and 40 percent of its its industrial energy requirement (BLM, 1975).

In order to assess the impact of the proposed SOHIO project on California, ADL (1976) forecast the likely ranges of primary fuel supply/demand balances in the State. The first step in this analysis was to estimate the range of total energy requirements for each primary fuel by combining the projected energy consumption of individual end-use sectors. Since the methodology employed assumed that all non-oil fuels would be supply-constrained, a comparison of total energy demand and availability of non-fuel oils yielded ADL's estimate of oil requirements. The High, Best, and Low energy demand scenarios presented (each with varying assumptions) were matched with energy supply estimates. The results are illustrated in Table 3.6-20. As noted, the most dramatic change is expected to occur in the industrial sector between now and 1980 due to the projected short-term availability of natural gas. The electric utility sector will also consume a larger share of oil as natural gas is eliminated for boiler usage and replaced with oil and nuclear power.

3.6.6 Public Services/Utilities

3.6.6.1 Utilities

At present, consumption of energy sources does not occur at the proposed sites for the pump and manifold system or supply terminal. Energy use at the proposed Huntington Beach crew terminal relates to the operations of the present service station. Future energy needs would be supplied at the onshore facilities by the Southern California Edison Company.

3.6.6.2 Solid Waste and Sewage

Generation of waste materials onshore is presently confined to service station/marina operation, site of the future crew launch facility. It is estimated that the facilities annually generate approximately 62,000 pounds of solid waste and 55,000 gallons of sewage.

Disposal of oily or toxic drilling muds and debris from the cleanup of oil spills requires onshore disposal to a Class 1 landfill. The Palos Verdes Landfill presently serves as the nearest

TABLE 3.6-20

FORECAST OF OIL CONSUMPTION BY END USE IN CALIFORNIA
(Millions of Barrels)

		Estimated 1980			Estimated 1985		
	1975	Low	BEST	High	Low	BEST	High
Residential/Commercial	12,346	176,367	24,691	29,982	13,238	37,037	50,265
Industrial	14,109	26,455	117,284	149,030	9,700	69,615	160,494
Transportation	363,316	388,889	404,762	445,326	408,289	442,681	503,527
Utility	95,238	145,503	169,312	196,649	81,129	232,804	280,423
Other (inc. feedstocks and non-energy)	64,374	69,665	69,665	74,074	68,783	74,074	92,593
	549,382	648,148	785,714	895,062	581,062	856,261	1,087,302
Million Barrels/Day	1.50	1.77		2.45	1.60		2.98

Growth Rates (Bbl. basis)	Low	BEST	High
1975 - 1980	3.2		10.7
1980 - 1985	1.0	1.8	4.0

SOURCE: Arthur D. Little, 1976.

location for deposit of this type of liquid waste. The Palos Verdes facility also will accept the solid waste generated by the project. However, as the capacity of that facility will be reached in 1980, liquid and solid waste products thereafter must be transported to the BKK Landfill in Whittier. This second site has a remaining lifespan of 70 years (MacIntosh, 1978).

3.6.6.3 Police

The Harbor Department Security provides daily 24-hour patrol services in the Port area. Service levels are considered good, with response to emergency calls averaging two to five minutes, and non-emergency averaging ten to thirty minutes. When additional services are warranted, the Long Beach Police are requested. Police services at the crew terminal site would be the joint responsibility of the Seal Beach and Huntington Beach police forces. Their response time to emergencies is generally three to five minutes.

3.6.6.4 Fire

Fire Department services supplied by the City of Long Beach, Huntington Beach, and Seal Beach are all considered adequate. The City of Long Beach, rated Class I, is considered to have excellent services. In addition to Port fire boats serving water-related fire calls, four stations would furnish onshore services:

- Station 1 — 100 Magnolia Avenue
- Station 6 — 835 Windsore Place
- Station 15 — Pier C Berth 22
- Station 20 — 1980 Water Street

Facilities in the vicinity of the crew terminal include:

- Warner Fire Station - Warner and Pacific Coast Highway, Huntington Beach.
- Station #1 - 8th Street and Central, Seal Beach.

Response time for emergencies at each of these stations averages less than four minutes.

3.6.6.5 Emergency Medical Services

Emergency medical services in the Harbor District come under the jurisdiction of the Long Beach Fire Department, Paramedics. Service levels, with a response period of two to five minutes, are considered good. Paramedic teams servicing the area near the crew terminal facility would, by priority, emanate from the Seal Beach Fire Station #3 at Seal Beach Boulevard and the 405 Freeway, followed by the Huntington Beach Stations at Murdy Street and Gothard Avenue and at Lake Street and Indianapolis Avenue.

Response times range from seven minutes (Seal Beach) to ten to fifteen minutes (Huntington Beach).

3.6.7 Onshore Traffic

3.6.7.1 Port of Long Beach

Regional access to the Port of Long Beach and the proposed project's onshore facilities is provided by three freeways: the Harbor, the Terminal Island, and the Long Beach via Harbor Scenic Drive. The primary surface street access is via Ocean Boulevard/ Seaside Avenue, which is an east-west arterial across the combined Long Beach/LosAngeles Port area. Secondary access is provided to the Port of Long Beach by way of Henry Ford Avenue, Santa Fe/Pico Avenue, and the Queens Way Bridge.

Many freeways, arterials, and secondary access routes in this area are operating at or near capacity. Many portions of the east-west street system are operating above capacity at peak-use hours. Table 3.6-21 contains information on traffic volumes and volume capacity relationships for selected access routes in and around the Port of Long Beach. Truck traffic in the Port area composes 7.5 percent of the overall traffic volumes, and can be as high as 20 percent of the total traffic in industrialized areas.

Parking around the construction area for the proposed project's pipeline and manifold station is accessible and adequate. Public transportation is provided by the Long Beach Transit Company. For a more detailed discussion of traffic and transportation in the Port of Long Beach, refer to Port of Long Beach Master Environmental Setting (Port, 1976).

3.6.7.2 Rail Traffic

Rail access is good to most areas of the Port of Long Beach. The prime marshalling yard is on the 7th Street Peninsula, however the alternate site on Pier E does not have rail service. The proposed distribution site south of Piers 1 and 2 does have rail access. In fiscal year 1974-75, rail traffic in and out of the Port consisted of about 27,000 rail cars, with the peak month of July contributing 3,368 cars. The existing rail network easily accommodated these demands.

3.6.7.3 Huntington Harbour Crew Boat Launch

Access in the Surfside-Sunset Beach area is provided by Pacific Coast Highway via Seal Beach Boulevard to the west and by Warner Avenue to the east. Traffic volumes in the project site area along Pacific Coast Highway are about 26,000 vehicle average daily traffic (ADT) (Orange County Environmental Management Agency Traffic

TABLE 3.6-21

1975 VEHICLE TRAFFIC VOLUME CAPACITY (V/C) RELATIONSHIPS FOR SELECTED ROUTES IN THE PORT OF LONG BEACH

		Volume			Volume Capacity	
	Direction	AM Peak Hour	PM Peak Hour	Capacity	AM	PM
PRIMARY ACCESS						
Long Beach Freeway	Northbound	2400	3000	5400	0.44	0.56
	Southbound	3200	2000	5400	0.59	0.37
Terminal Island Freeway	Northbound	250	850	3600	0.25	0.24
	Southbound	900	300	3600	0.07	0.08
Harbor Freeway	Northbound	2800	4100	5400	0.52	0.76
	Southbound	4400	3100	5400	0.81	0.57
Ocean Boulevard/ Seaside Avenue	Eastbound	900	1900	3600	0.25	0.53
	Westbound	2000	800	3600	0.56	0.22
Anaheim Street	Eastbound	800	1700	1500	0.53	1.13
	Westbound	1550	1000	1500	1.03	0.69
SECONDARY ACCESS						
Queensway Bridge	Northbound	130	450	2400	0.05	0.19
	Southbound	430	130	2400	0.18	0.05

	Peak VPH AM/PM Average	Capacity	V/C Ratio
Pico Avenue	2000	1500	1.33*
Henry Ford Avenue	900	1500	0.60

* Between Pacific Coast Highway and Ocean Boulevard

SOURCE: DEIR Proposed General Plan, Port of Long Beach, Volume 1, Appendix C

Flow Map, 1977). The design capacity for Pacific Coast Highway is 30,000 ADT. Both north and south of Surfside, traffic volumes along Pacific Coast Highway increase to 36,000 ADT, significantly above design capacity.

Parking is the major ongoing problem plaguing the project site and the Sunset Beach/Surfside area. Offstreet parking is inadequate in the area, forcing residents to utilize parking intended for beach users (County of Orange, 1977).

Marine traffic in the Huntington Harbour and Anaheim Bay Area is quite light and uncongested as compared to other marinas in the coastal areas of southern California. In 1974 on an average Sunday there were 547 boat movements per day under the Pacific Coast Highway Bridge leading into Anaheim Bay. A peak number of 70 movements occurred between 1:00 and 2:00 P.M. The saturation point for movements under the bridge would be 586 movements per hour and 14,064 boat movements per 24-hour day (City of Huntington Beach, 1975). At the time these data were collected, construction of more boating facilities (i.e., slips, moorings, etc.) was occurring and more was being planned. At maximum buildout levels, the projected worst-case amount of traffic movement under the bridge would be 815 vessels per day -- well within saturation levels. Peak traffic levels would also remain well below saturation levels.

Clearance under the Pacific Coast Highway Bridge is 25 feet (7.6 m) at Mean High High Water level, and the minimum channel depth from the proposed terminal to open sea is ten feet (3 m) at mean low low water level.

3.6.8 Noise

At present, there have been no substantial noise studies or surveys conducted in the Port of Long Beach. However, information as to the present noise levels does exist in the Noise Element of the City's General Plan and in various environmental impact reports written for the approval of various projects in the Port (M.E.S., 1975).

The primary source of noise for both the distribution facility site and supply terminal in the Long Beach Port area and the crew terminal site in Surfside stems from motor vehicles. Marine and other vehicular transportation and Port facilities constitute the other major noise sources in the Port area. Ambient noise levels in the Port area range from 55 to 62 dBA during the day and from 51 to 56 dBA at night, or 58 to 63 L_{dn} (Noise Element, 1975). Single event noise occurrences (including ship arrivals, construction, trucks, trains, and low-flying aircraft) temporarily exceed those levels. The Pacific Coast Highway borders the proposed crew terminal site at Surfside. Background noise levels there at a distance of 50 feet (15 m) from the centerline are presently 74-75 L_{dn}.

3.6.9 Aesthetics

3.6.9.1 Onshore Facilities

(1) Port of Long Beach

There are two areas within the Port of Long Beach which will be used for facilities related to the offshore operations: (1) marine transport and materials supply and (2) a production distribution facility. As noted in the project description, there are two potential locations for this yard; however, the prime location is on the 7th Street Peninsula north of channel three (Figure 2.5-1).

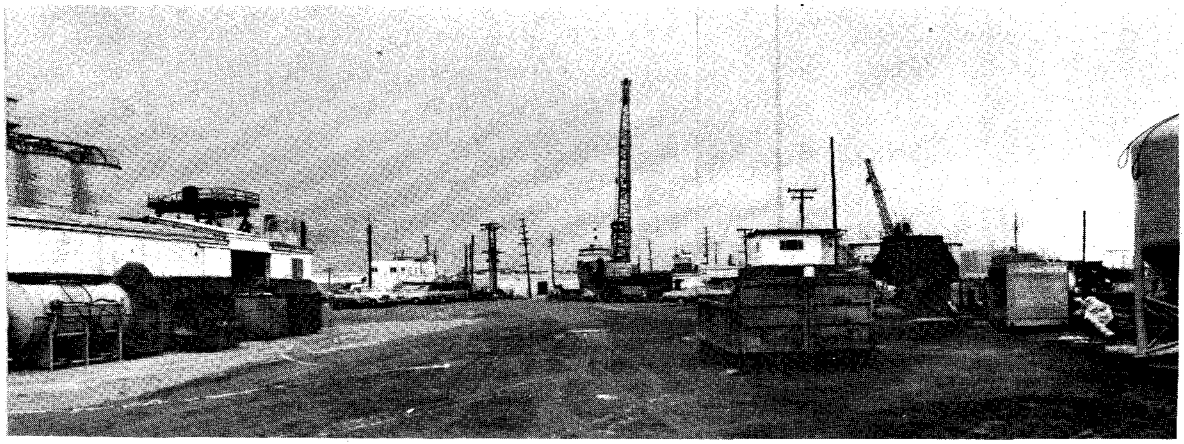
This primary site for the supply yard is presently used for ship repair and servicing. The site appears to be underutilized, and has an unorganized, blighted appearance. Spare equipment and scrap is lying about, giving the site an unpleasant appearance. The site can be viewed from the two adjacent lots, on 7th Street, from Piers One and Two, and from the California Ship Building and Drydock Company (Figure 3.6-4). There is an alternative site being considered for the supply yard located between the east end of Seaside Boulevard and the north end of ARCO's berth at Pier E (Figure 3.6-5). Shell will use only one of these sites, and would prefer the 7th Street location for this facility,

The second area within the Port will be a permanent crude oil distribution facility. The proposed site of approximately one acre (0.4 ha) will contain a surge tank, distribution manifold and electric pumps. The site is located within the street loop connecting the westbound lanes of Ocean Boulevard with the southbound lanes of the Long Beach Freeway, as shown in the Project Description (Figure 2.5-1). The site is presently partially occupied by one oil well pump. The remainder of the site is covered by loose soil and weeds. Vantage points for the site are from the traffic loop surrounding the site and from the southbound Long Beach Freeway (Figure 3.6-6).

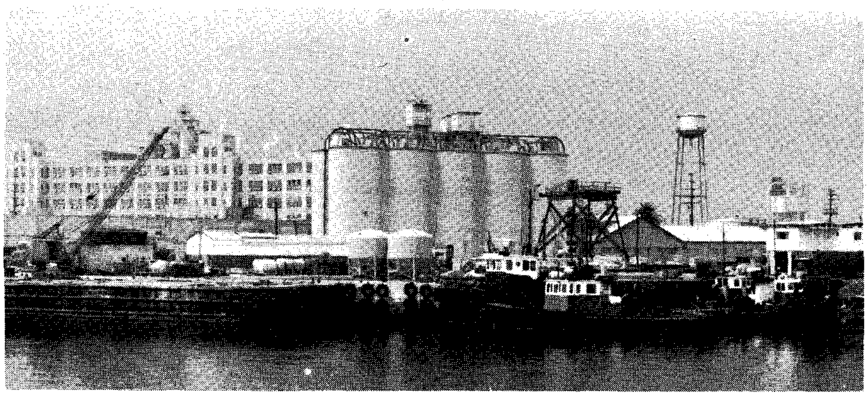
In terms of visual access to any of the activity areas described above, the entire Port area is visible from many of the taller buildings in downtown Long Beach. However, the crude oil distribution site is more visible than either of the potential supply yard sites which are obscured by line of sight obstruction.

(2) Huntington Beach/Seal Beach

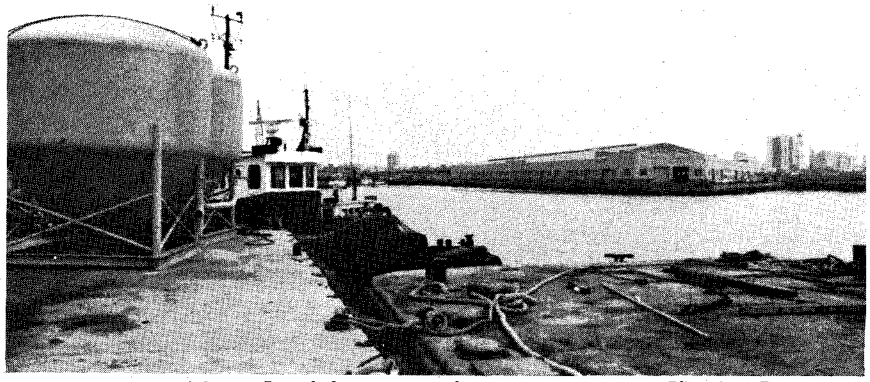
As noted in Section 2.5, Shell proposes to have an additional onshore facility which will be used for crew departures. The site preserve being considered for the crew launching facility is located adjacent to Pacific Coast Highway between the Bolsa



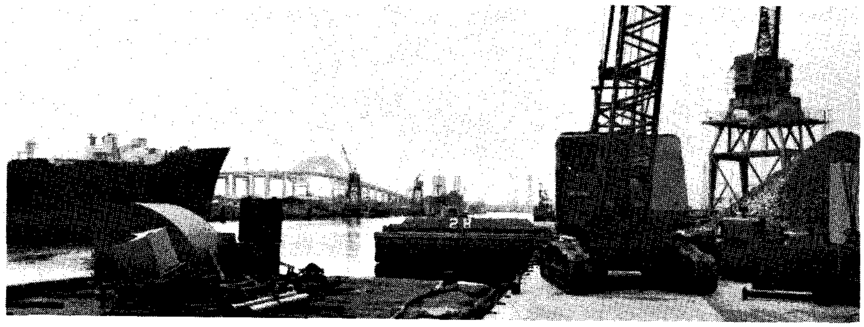
View on site looking north



Site viewed from Pier 1 berth 49 looking northwest across Channel 3



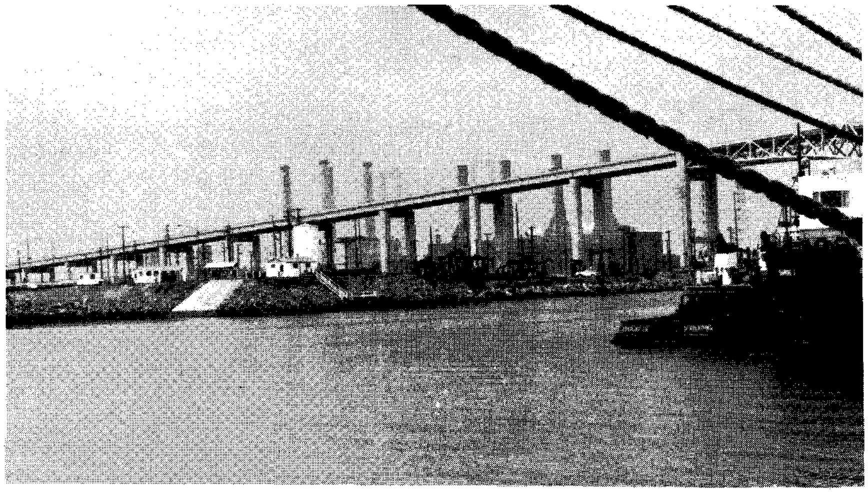
View from site looking southeast across Channel 3



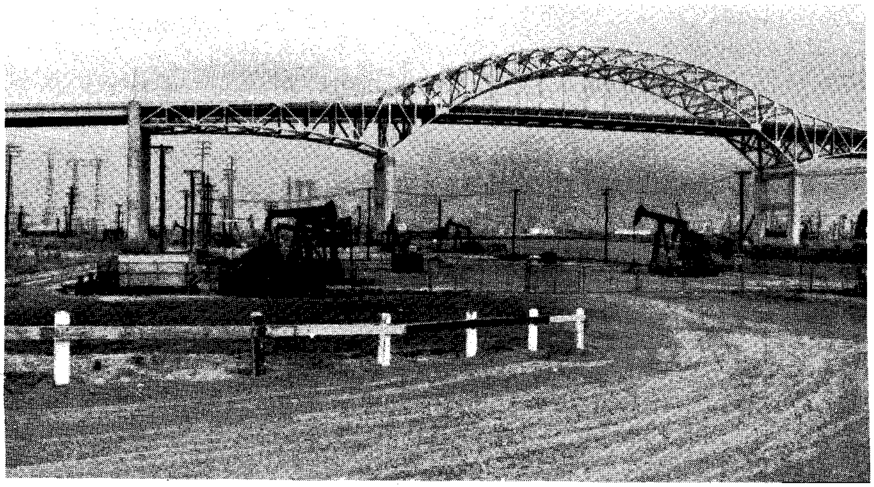
View from site looking southwest across Channel 3

Proposed Supply Yard

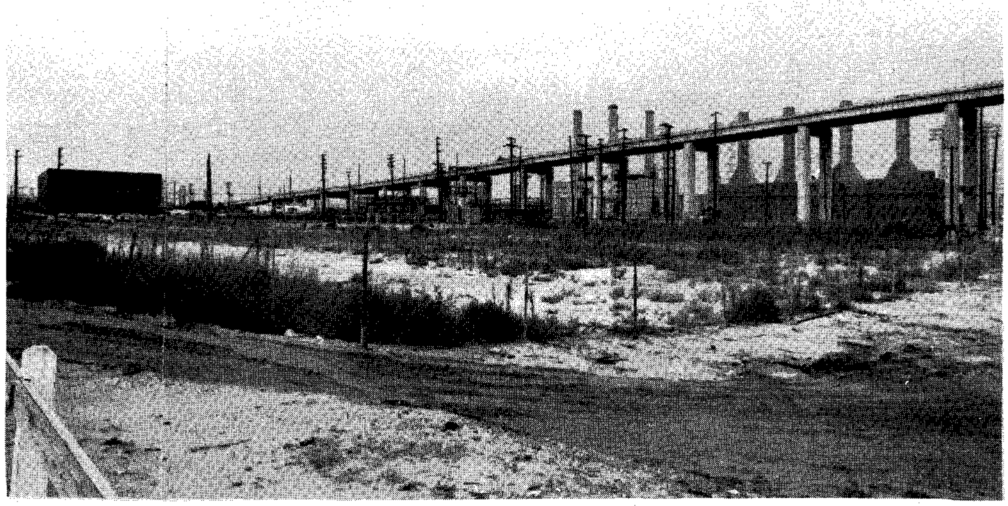
3.6-4
Figure



Water frontage of site looking northwest across back channel.



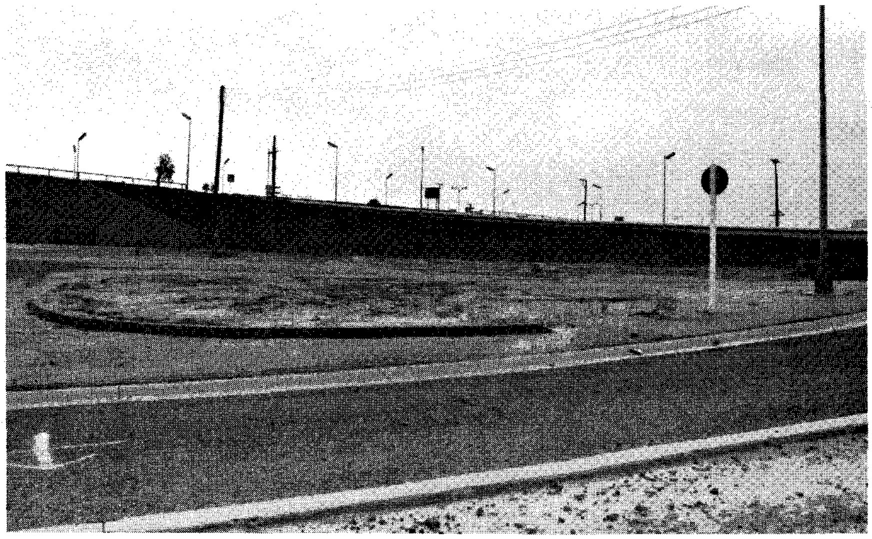
Oil pumps in "water" frontage portion of site looking north



Storage portion of site looking northwest

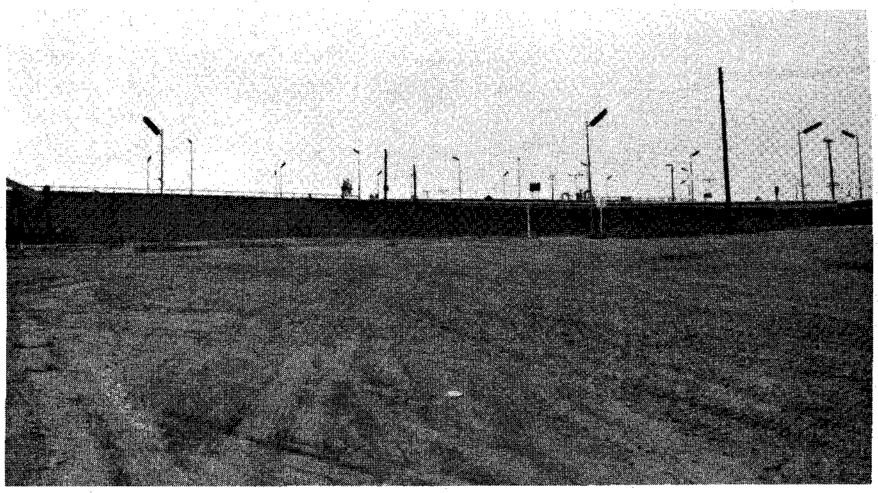
Alternative Supply Yard

3.6-5
Figure



Western portion of traffic loop looking southwest

Eastern portion of traffic loop looking southeast



Traffic loop looking southwest

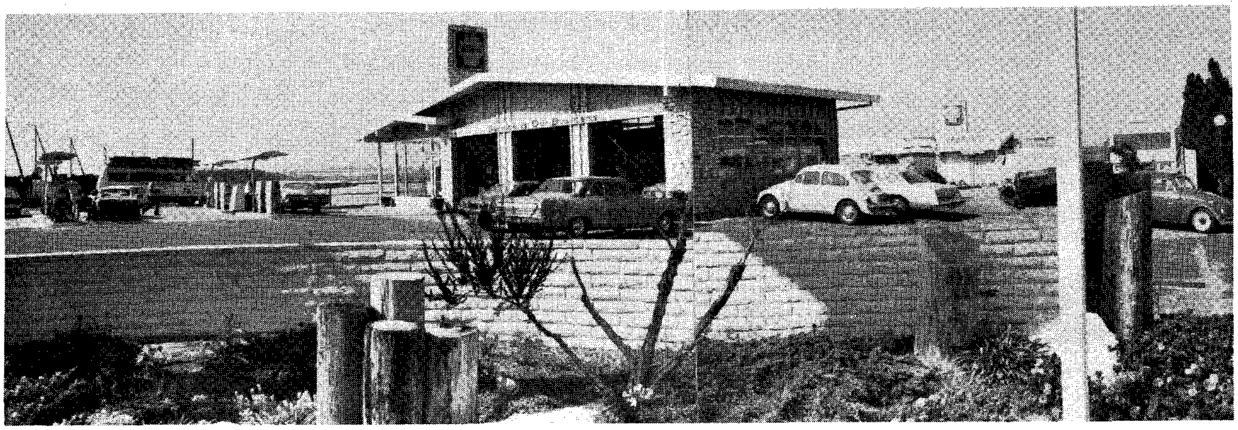
Proposed Crude Oil Distribution Site

3.6-6
Figure

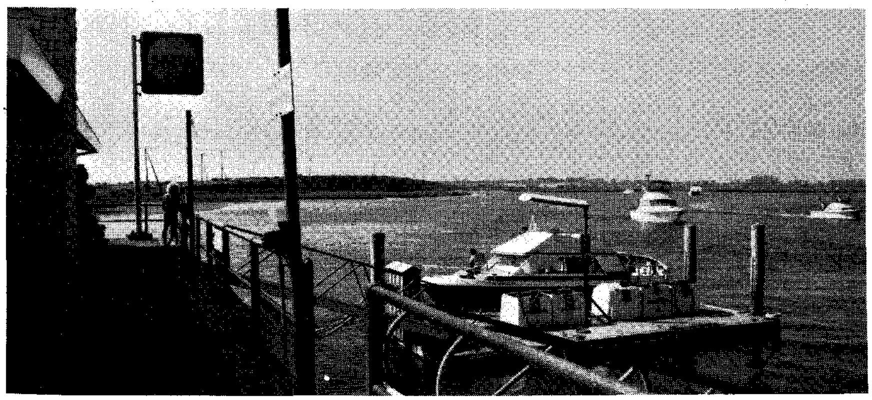
Chica Ecological Reserve and Huntington Harbour. The site is presently a combination automobile service station and a boat filling station and repair yard. The auto service station portion of the site can be viewed both from the north and the south along Pacific Coast Highway. The waterfront side is more readily viewed, as it can be seen from Pacific Coast Highway and from numerous points across the channel near Sunset Aquatic Park. It can also be seen from boats in the channel and in Sunset Bay (Figure 3.7-7). The view of this facility would be considered typical of a highly urbanized environment. The buildings on the site are of a low profile, and their appearances denote their functional uses. The site is clean and organized, and the portion fronting along Pacific Coast Highway is partially landscaped.

3.6.9.2 Facilities

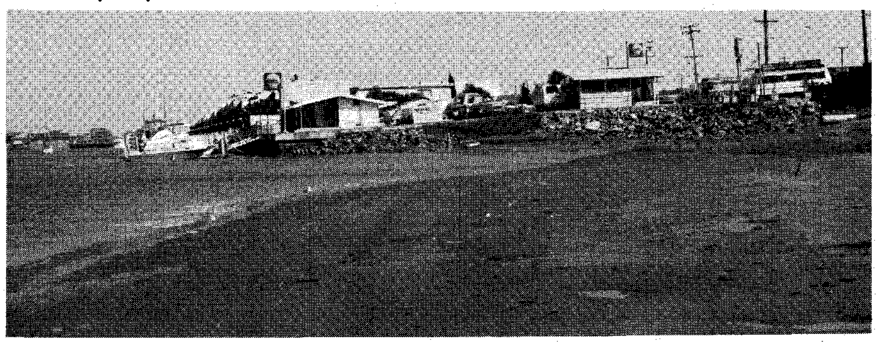
The site designated for the proposed project's drilling and production platforms is presently open water. The closest mainland point to the platforms is Huntington Beach, some nine miles (14.4 km) away. However, between the site and portions of Huntington Beach there are two existing platforms, Eva and Emmy. In general, visibility in the entire southern coastal area is quite variable. Visibility in the early morning hours may be frequently less than one mile (1.6 km), due to fog, and may be less than three miles (4.8 km) in the afternoon, due to smoke and haze. However, based on a percentage of hourly observations where visibility was greater than ten miles, (16.1 km), this proposed project site could be visible on the horizon approximately 53 percent of the time. This condition would vary, depending upon the time of year. For example, in January the visibility factor could be as high as 67 percent (SCOSC, 1975).



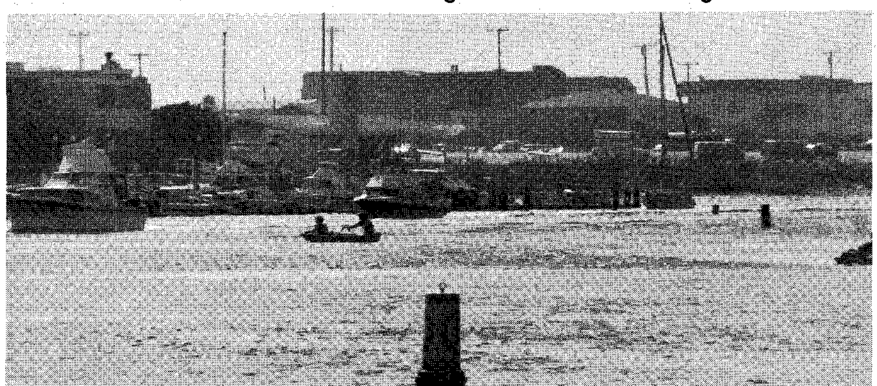
Auto filling station with boat marina in background looking northwest



Fuel pumps and Sunset Bay looking northwest



Boat marina and auto filling station looking east at low tide



Boat Marina looking southwest across Huntington Harbor Main Channel.

Crew Departure Site

3.6-7
Figure