Appendix E
California Coastal Commission LNG Siting Studies (Excerpts)

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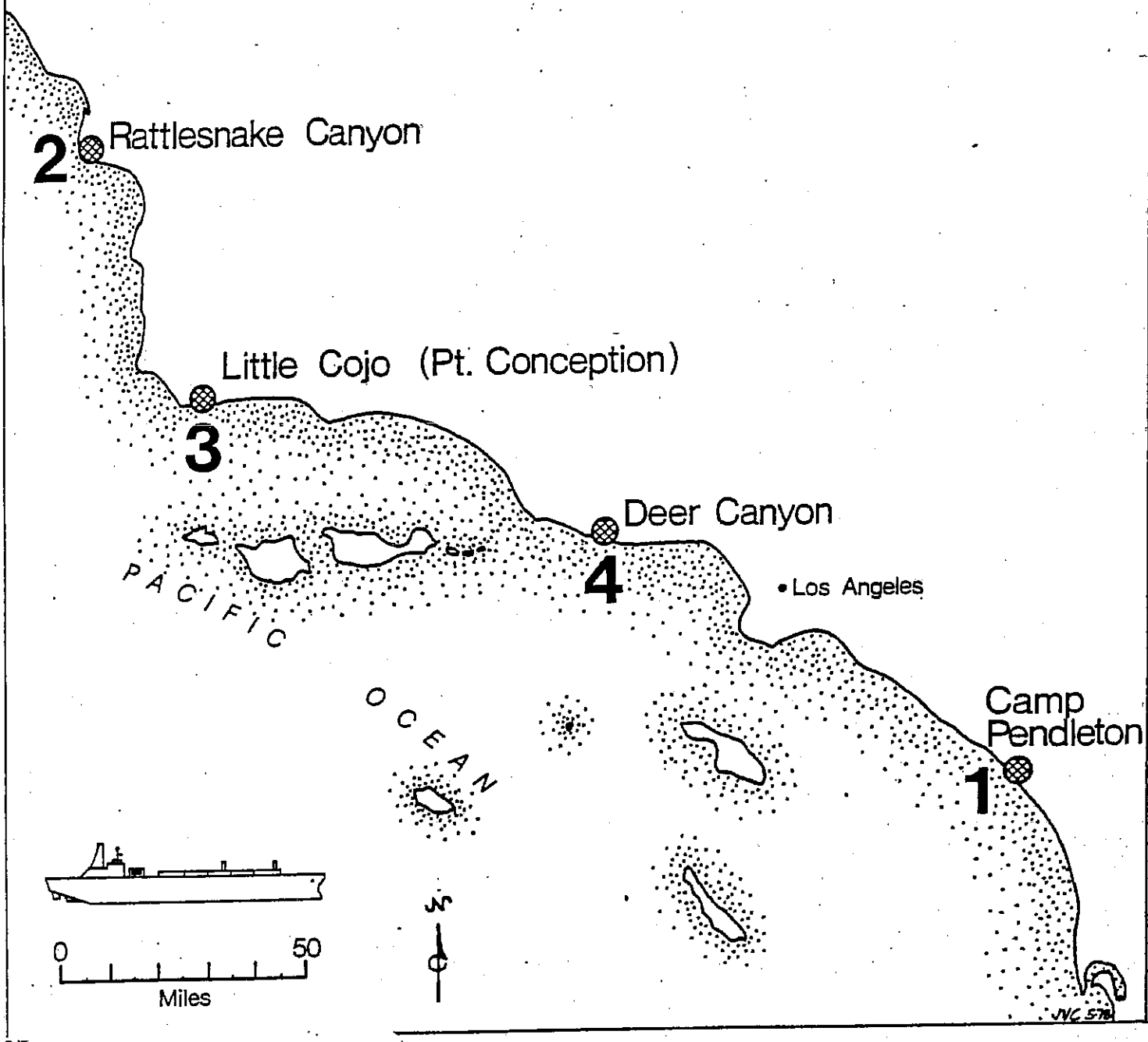
California Coastal Commission

Final Report Evaluating and Ranking LNG Terminal Sites

May 24, 1978



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Final report
evaluating and
ranking LNG

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Final report
evaluating and
ranking LNG
terminal sites

CALIFORNIA COASTAL COMMISSION
631 Howard Street, San Francisco 94105 — (415) 391-6800

FINAL REPORT EVALUATING AND RANKING LNG TERMINAL SITES

SUMMARY

On May 24, 1978, the California Coastal Commission adopted the following ranking of potential LNG terminal sites:

1. HORNO CANYON on Camp Pendleton in San Diego County where a terminal would have the least adverse impacts on coastal resources.

2. RATTLESNAKE CANYON in San Luis Obispo County.

3. LITTLE COJO near Point Conception in Santa Barbara County.

4. DEER CANYON in Ventura County where a terminal would have the most overall adverse impact on coastal resources.

The Commission eliminated a fifth site, at LAS VARAS in Santa Barbara County (Figure 1), due to the recently confirmed presence of a small active earthquake fault passing through the site. A similar fault has been identified at the LITTLE COJO site, which is nevertheless retained in the ranking because the LNG Terminal Act of 1977 requires that the Commission rank the site selected by Western LNG Terminal Associates in its application to the Public Utilities Commission (PUC).

The Commission also adopted thirty-one terms and conditions designed to minimize adverse LNG terminal impacts, at any of the sites, on recreation, natural resources, public views and other resources protected by the policies of the California Coastal Act of 1976. The Commission is required to submit a site ranking with recommended conditions to the PUC by May 31, 1978. The PUC must then reach a decision on whether a permit should be granted for construction and operation of an LNG terminal at one of the sites by July 31, 1978.

It has been difficult to identify possible onshore LNG terminal sites on the 1,100 mile long California coast. The Commission evaluated 82 possible sites, including 18 nominated by the public, and retained only five as potentially feasible sites for further study and ranking. Adverse wind, wave and fog conditions, nearby urban areas, earthquake faults and rugged land ruled out most of the coast for siting potentially hazardous LNG terminal operations. Seismic evaluations of the five sites resulted in discovering small active surface faults at two of them, and such faults may be found at the other sites after additional evaluation.

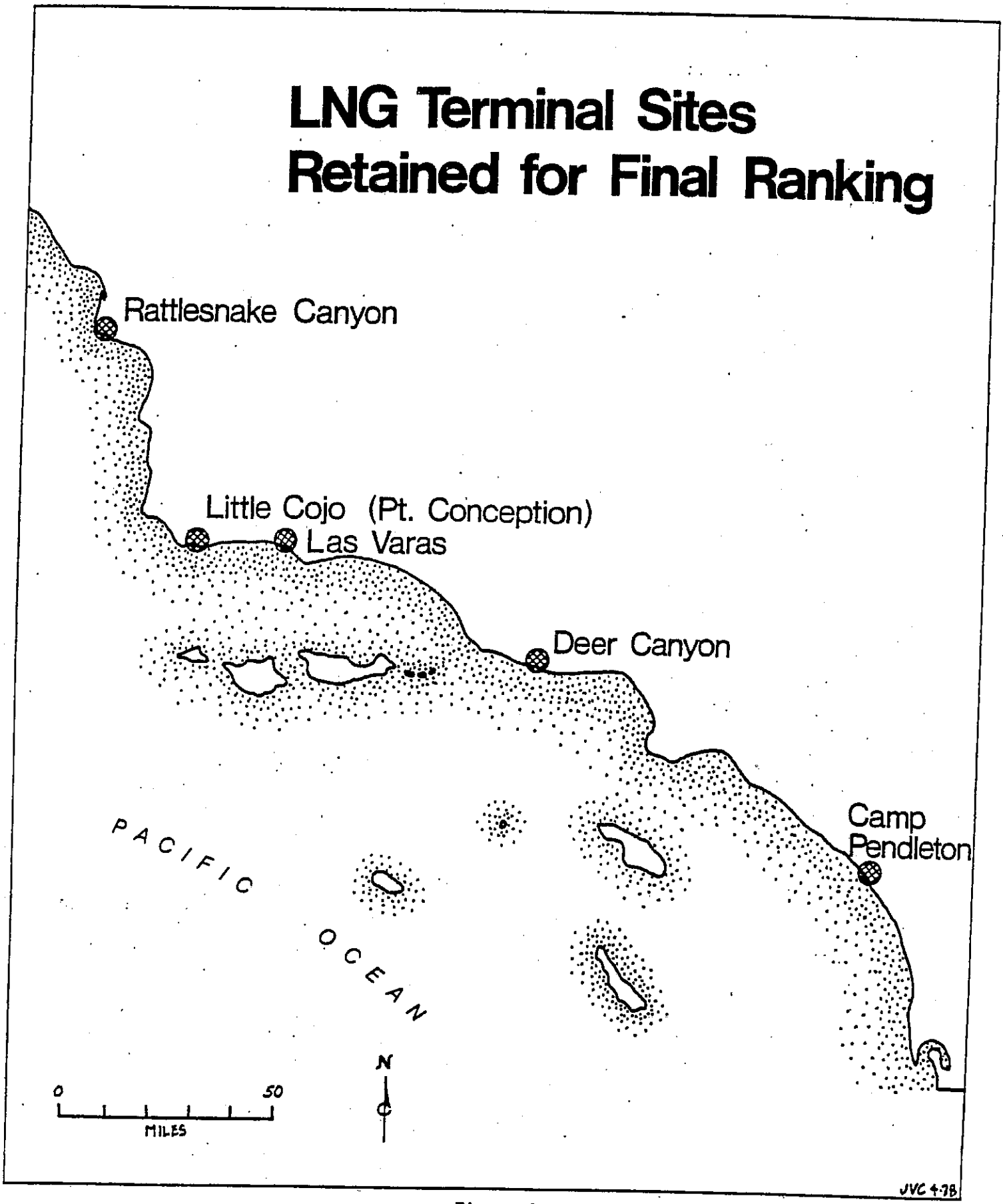

LNG Terminal Sites
Retained for Final Ranking
Rattlesnake Canyon
Little Cojo (Pt. Conception)
Las Varas
Deer Canyon
Camp
Pendleton
PACIFIC
OCEAN
N
0
50
MILES
JVC 4-78

Figure 1

The Commission contracted with a number of consultants to assist in technical evaluations of the sites, and correspondence has been received on the site ranking from many federal and state agencies, environmental groups, surfers, property owners, Western LNG Terminal Associates and other interested parties. The Commission held four public hearings in April near the sites to be ranked and received testimony from more than 150 groups and individuals. A final public hearing on this report was held in Los Angeles on May 15, 1978. The process established by the LNG Terminal Act for identifying, evaluating, and ranking sites by the Coastal Commission has been an open public process. The record contains over 2000 letters and reports commenting on all aspects of the site ranking process.

I. BACKGROUND

A. The Liquefied Natural Gas Terminal Act of 1977

Site Ranking. The Liquefied Natural Gas (LNG) Terminal Act of 1977 (SB 1081) requires the Coastal Commission to identify, evaluate, and rank remote onshore sites for a liquefied natural gas terminal and to submit a final site ranking to the Public Utilities Commission (PUC) by May 31, 1978. Section 5613 (a) states in part:

> "In ranking potential LNG terminal sites . . . the Coastal Commission shall base its ranking on an evaluation of the relative merit of each site and shall make findings, applying the policies, goals, and objectives of Chapter 3 (of the California Coastal Act of 1976)."

Western LNG Terminal Associates, a joint partnership of Pacific Gas and Electric Company and the Pacific Lighting Corporation, has applied to the PUC for approval to transport LNG to California and for a permit to construct and operate an LNG receiving terminal at Little Cojo (Point Conception) in Santa Barbara County. The LNG Terminal Act requires the Coastal Commission to include this site, selected by Western LNG Associates, in its ranking. The PUC, which has the sole state authority to approve an LNG terminal under the Act, must make a final decision on the application by July 31, 1978. Section 5631 (b) of the Act provides:

> "If the commission (PUC) issues a permit, the commission (PUC) shall issue a permit for construction and operation at the site designated as the highest ranked site pursuant to Section 5612 (by the Coastal Commission). However, the commission (PUC) may select a lower ranked site if it has determined with respect to each higher ranked site that it is not feasible to complete construction and commence operations of the terminal at such higher ranked site in sufficient time to prevent significant curtailment of high priority requirements for natural gas and that approval of the lower ranked site will significantly reduce such curtailment."

Conditions. The Coastal Commission must also recommend terms and conditions to ensure that the construction and operation of a terminal at any of the ranked sites would be in accordance with the Chapter 3 Coastal Act policies. The PUC is required by the LNG Terminal Act to impose the Coastal Commission's conditions unless a condition would delay terminal operation long enough to result in significant curtailment of high priority natural gas requirements, would adversely affect public health or safety, or was not based on substantial evidence.

Population Limits. The LNG Terminal Act requires that an LNG terminal authorized under the Act be located at a remote onshore site on the mainland coast. Because of the Legislature's concern about the safety of liquefied natural gas, the Act limits the numbers of permanent residents and workers near an approved LNG terminal. Section 5582 contains the following population requirements:

"1. Population density shall be not greater than an average of 10 persons per square mile for a distance of one mile outside the perimeter of the site on which the offloading, regasification, and storage facilities for LNG will be located.

2. Population density shall be not greater than an average of 60 persons per square mile for a distance of four miles outside the perimeter of the site on which the offloading, regasification, and storage facilities for LNG will be located."

These density requirements mean that no more than about 27 permanent residents or workers could be within a mile of the proposed terminal and no more than about 1800 within four miles. In addition, the Act requires that the terminal be located so that LNG tankers would not pass closer to areas of population density greater than those given above.

The Act authorizes the use of eminent domain powers by the applicants to create and maintain the low population density. Local and state agencies are required to maintain the low population density around an approved site.

B. Project Description as Proposed by Western LNG Terminal Associates

Purpose of the Project. On October 14, 1977, Western LNG Terminal Associates filed with the PUC an application for a terminal at Little Cojo. The proposed marine terminal would receive LNG transported by ships, unload and transfer the LNG into storage tanks, regasify it, and deliver natural gas into transmission pipelines. Approximately 193 LNG tanker arrivals a year from Indonesia and South Alaska are expected at the terminal.

Terminal Configuration. The LNG terminal will consist of an offshore dock connected by a trestle to onshore storage and gasification facilities (Figure 2).

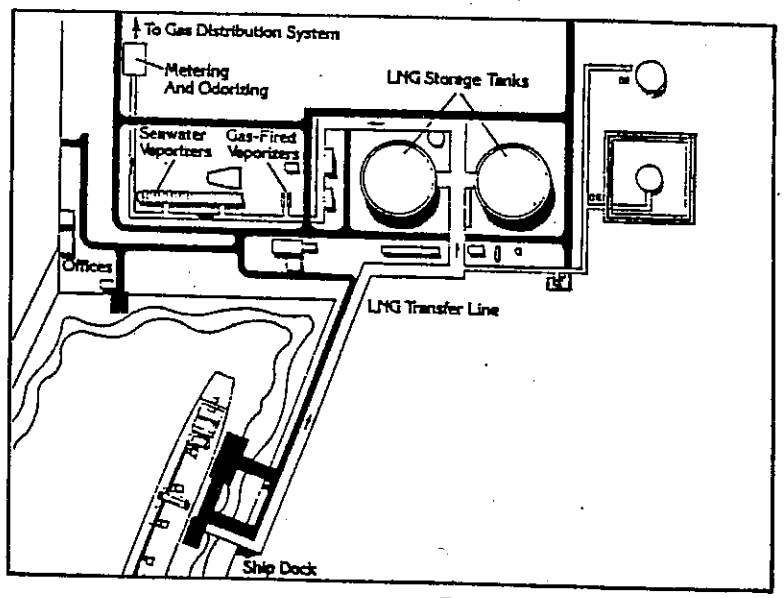
The applicant estimates an operating staff of 75 persons for continuous operation. Each of the steps in the process of receiving, storing, and gasifying the LNG received at the proposed site is summarized below.

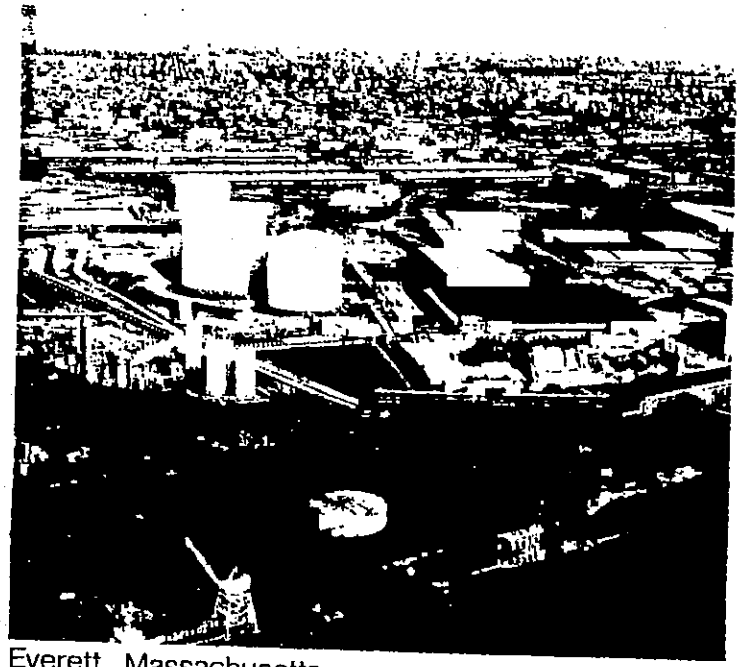
Marine Facilities. A berthing facility to handle one LNG vessel and support tug and line boats will be located at the end of a trestle in 50 feet of water. The trestle will carry a service roadway and necessary pipelines. The berthing facility, with a concrete deck approximately 40 feet above mean low low water, will consist of an unloading platform, a service platform, and a control tower.

The following pipelines will link the berthing facility, via the trestle, to onshore facilities:

- 32-inch diameter insulated cryogenic (very low temperature) pipeline for transfer of LNG to storage tanks

Typical LNG Receiving Terminals





Everett, Massachusetts

Nikiski, Alaska

Figure 2

- 10-inch diameter gas vapor return line from the tanks to ships
- pipeline for Bunker C fuel oil
- pipeline for diesel fuel
- pipeline for potable water

A small boat dock and mooring buoys will be located alongside the eastern side of the trestle to service three tugboats and one work boat. Buoys will also be available for use by line handling boats and by small craft as refuge in bad weather.

LNG Unloading. The LNG will be transferred from the berthing dock to onshore storage tanks in a 32-inch diameter insulated cryogenic pipeline attached to the trestle. Three tanks, each with a 550,000 barrel capacity, will store the LNG at its normal liquefied temperature of -260°F. Each tank, 240 feet in diameter and 145 feet high, will be built inside an earthen basin or concrete dike which could contain more than 100 percent of the tank capacity in the event of a leak.

LNG Gasification (Vaporization). Before entering the natural gas transmission system for distribution, the LNG must be gasified by raising its temperature to between 50°F and 75°F. Under full operation, 1.3 billion cubic feet per day (BCFD) of natural gas will be vaporized. The LNG is pumped from the storage tanks and revaporized in a heat exchange chamber using seawater as the heat source.

Seawater System. Seawater to vaporize the LNG is pumped from the ocean at a rate of about 160,000 gallons per minute. After warming the LNG, the seawater is returned to the sea by pipe at an approximate temperature 12°F less than at intake.

The 9-foot diameter intake will be located offshore in 30 feet of water. The 8-foot diameter outfall pipeline will extend further to 50 feet of water to prevent the cold discharge water from entering the intake. Both lines will be buried by at least three feet of cover on the ocean bottom, except through the surf zone, where six feet of cover will be used. Trenching, dredging, and possibly blasting will be required for construction. To prevent marine growth in the seawater system, chlorine will be injected and later converted with sulfur dioxide to a chloride before being discharged in the outfall pipe.

Bunker C Fuel Oil. Bunker fuel oil for LNG vessels will be brought to the site by tanker ship or barge and will be pumped through a bunker oil pipeline on the trestle to an onshore storage tank with a 100,000 barrel capacity. Bunkering will be accomplished by first rigging an oil spill containment boom around the LNG vessel and then pumping the oil from the onshore tank.

Electric Power. Electric power will be supplied by constructing transmission lines to the nearest adequate substation. Two standby gas turbines and batteries will provide emergency power when necessary.

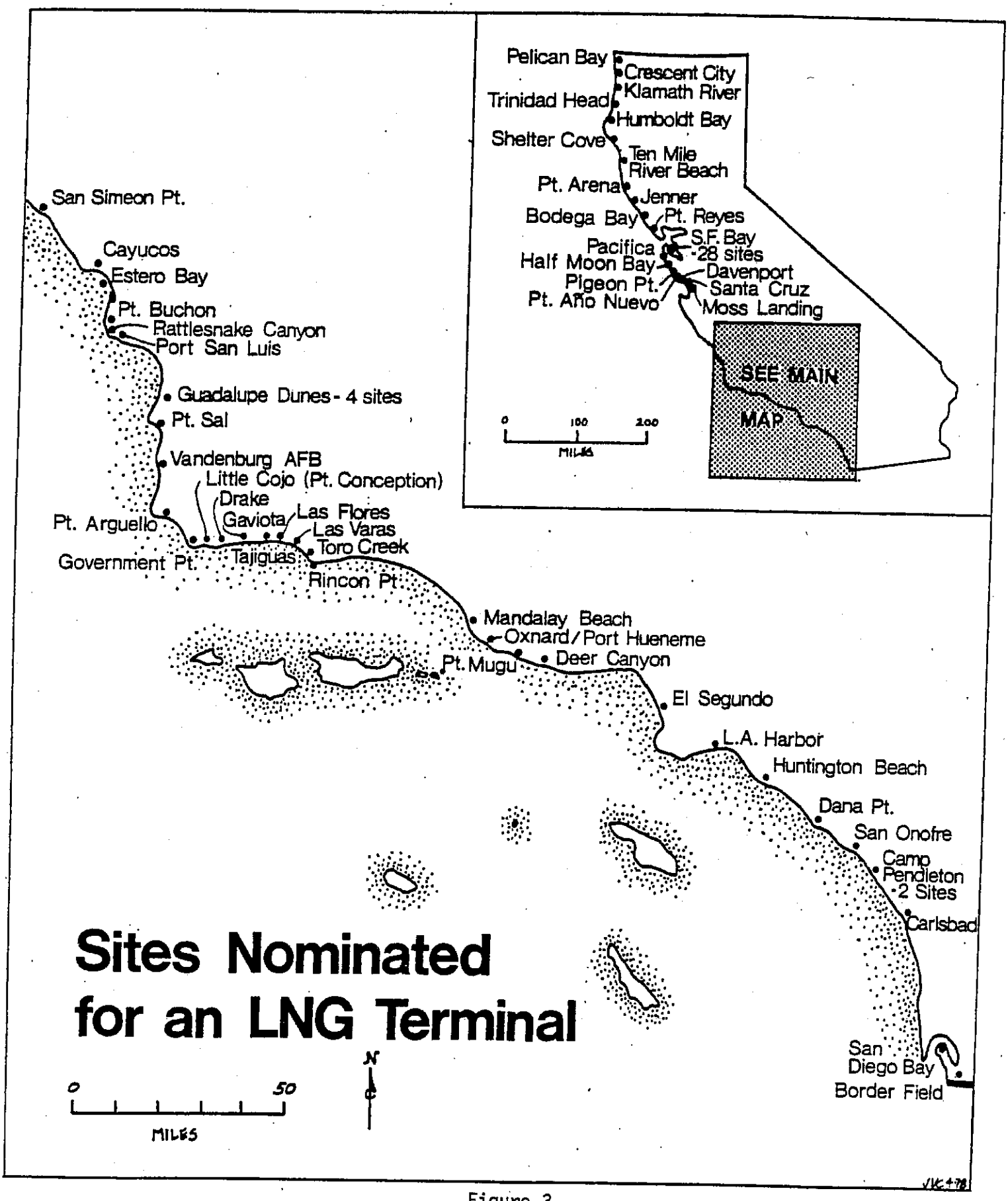

Sites Nominated for an LNG Terminal
San Simeon Pt.
Cayucos
Estero Bay
Pt. Buchon
Rattlesnake Canyon
Port San Luis
Guadalupe Dunes - 4 sites
Pt. Sal
Vandenburg AFB
Little Cojo (Pt. Conception)
Drake
Gaviota
Las Flores
Las Varas
Toro Creek
Pt. Arguello
Government Pt.
Tajiguas
Rincon Pt.
Mandalay Beach
Oxnard/Port Hueneme
Deer Canyon
Pt. Mugu
El Segundo
L.A. Harbor
Huntington Beach
Dana Pt.
San Onofre
Camp Pendleton - 2 Sites
Carlsbad
San Diego Bay
Border Field
0 50
MILES
N
Pelican Bay
Crescent City
Klamath River
Trinidad Head
Humboldt Bay
Shelter Cove
Ten Mile River Beach
Pt. Arena
Jenner
Bodega Bay
Pt. Reyes
S.F. Bay - 28 sites
Pacifica
Half Moon Bay
Davenport
Pigeon Pt.
Santa Cruz
Pt. Año Nuevo
Moss Landing
SEE MAIN MAP
0 100 200
MILES

Figure 3

Diesel Fuel. Diesel fuel for LNG vessels, tugs, launches, and emergency equipment will be transported to the site and stored in a 5,000-barrel onshore tank.

Water. Water will be provided from ground wells and the ocean. A pipeline on the trestle will provide potable water to the service platform. Plant water, to be stored in a 5,000 barrel tank, will come from wells. Fire control water will be pumped both from ground wells and the ocean and distributed throughout the plant.

Nitrogen. Nitrogen for purging the vessels' tanks and unloading arms of all LNG after unloading will be produced by an onsite air separation plant and delivered to a storage tank on the unloading dock by truck.

Sanitary Sewage. The facility will include a waste treatment unit. Treated effluent will be discharged in the seawater return system.

C. Previous Commission Actions

In October 1977 the Commission directed the staff to begin identifying and evaluating possible terminal sites. Letters were sent to hundreds of interested parties requesting nominations of mainland onshore sites to be evaulated, and 18 sites were nominated by the December 1, 1977 deadline. The staff used other LNG and oil terminal siting studies, topographic maps, and area visits to identify 64 additional sites for preliminary evaluation (Figure 3).

Project management and support was provided by the consulting firm of Rust and Weinstein of San Francisco. Pat Weinstein managed the study.

The Commission contracted with a number of consultants to evaluate whether an LNG terminal could be constructed and reliably operated at the sites being considered by the Commission and to evaluate potential terminal impacts at the sites. The major consultants include: John J. McMullen Associates evaluating site maritime factors including wind and wave conditions and navigational hazards; Woodward-Clyde Consultants for geotechnical site evaluations; H. J. Degenkolb and Associates for structural engineering analysis; the California Department of Fish and Game for identification of marine and terrestrial plant and wildlife resources; Madrone Associates for analysis of terminal impacts on natural resources; and the Army Corps of Engineers Waterways Experiment Station for wave calculations for the sites.

To determine which sites could legally be retained as feasible for the site ranking, the 82 sites were evaluated on the following criteria: population density, land and water site characteristics, maritime conditions, seismic safety, and coastal resources. A large number of the 82 sites failed to meet the strict population density requirements of the LNG Terminal Act. Other sites were too near earthquake faults, the soil conditions were not suitable for constructing an LNG terminal, or adverse wind and wave conditions would prevent safe berthing of LNG tankers too many days during the year. Given the rugged character and adverse wind, wave, and fog conditions on the northern California coast, the urban areas on the southern California coast, and the dense criss-crossing of major and minor earthquake faults in the coastal area, it was difficult to identify potentially feasible sites for an LNG terminal.

After public comments and a staff workshop on the evaluation criteria, the Commission held a public hearing and voted, on January 31, 1978, to retain 5 of the 82 sites for further study and ranking (Figure 1). The Commission's consultants then evaluated these five sites in detail to determine whether engineering and maritime factors were suitable, while additional information and opinions on the sites were submitted by local, state, and federal agencies, property owners, Western LNG Terminal Associates, the military, and other interested parties. These submissions, the consultants' reports, major correspondence and the staff reports are listed in Section VI, Substantive File Documents, and all documents are in the official Commission record on this project.

As required by the LNG Terminal Act, the Commission held public hearings on the site ranking in April 1978 in San Luis Obispo, Santa Barbara, the City of Port Hueneme, and Oceanside. These hearings followed staff public workshops in the four areas at which interested parties provided information and discussed the site ranking process.

The staff work on this project was done by Tom Tobin, John Grattan, Bill Johnson, Suzanne Rogalin, Jody Loeffler, Chris Garland, Donna Gara, and Jonathan Van Coops, under the direction of Energy Coordinator William Ahern.

II. TERMINAL SITE RANKING AND FINDINGS

A. Site Ranking

The Coastal Commission adopts the following ranking for possible LNG terminal sites. The sites are ranked in order, starting with the site where LNG terminal construction and operation would have the least adverse impacts on resources protected by the policies of the California Coastal Act of 1976 and ending with the site having the most adverse impacts:

1. HORNO CANYON on Camp Pendleton in San Diego County
2. RATTLESNAKE CANYON in San Luis Obispo County
3. LITTLE COJO near Point Conception in Santa Barbara County
4. DEER CANYON in Ventura County

The Commission removes the LAS VARAS site in Santa Barbara County from the ranking due to the recently confirmed presence of a small but active earthquake fault on the site. A similar fault has been detected on the LITTLE COJO site, and the Public Utilities Commission and federal Department of Energy may not be able to approve this site given this seismic problem. However, because this site was selected by the applicant Western LNG Terminal Associates and must be ranked by the Commission, it is retained in the ranking, recognizing that it too may be eliminated from the ranking by the PUC or Department of Energy.

B. Findings on Site Rankings

The Commission adopts the following findings and declarations:

1. The Coastal Commission Has a Limited Role in the LNG Project Decision. The LNG Terminal Act of 1977 deleted the Coastal Commission's permit authority over the construction and operation of California's first LNG terminal. Under the California Coastal Act of 1976, the Coastal Commission had the authority to approve or deny an application for an LNG terminal on the California coast. The LNG Terminal Act replaced the Commission's permitting authority with a more limited role, to determine by ranking, which possible LNG terminal sites would have the least adverse impacts on the objectives of the Coastal Act and to submit that ranking to the Public Utilities Commission (PUC). That Commission has the exclusive state authority to make the decision on whether to approve an LNG project, based on overall consideration of the public health, safety, and welfare. The LNG Terminal Act does not allow the Coastal Commission to make a finding that an LNG terminal is not needed or adversely affects public welfare and therefore should not be permitted.

The Commission recognizes that the project has national energy policy implications, and that the level of gas supply affects the State's

economy and environment. In reaching its final decision on the location of an LNG terminal, the PUC is the State agency which will weigh these other factors, and will represent the State of California in the federal proceedings on this project.

2. An LNG Terminal at Any Site Will Cause Serious Impacts to Coastal Resources. The Commission finds that after an evaluation of 82 potential LNG terminal sites along the 1,100 mile long California coast and after intensive evaluations of five of those sites, there is no possible remote onshore terminal site that would not cause major adverse impacts to natural marine and wildlife resources, public recreation areas, and other resources protected by the California Coastal Act of 1976. Conditions imposed on the construction and operation of a terminal at each site would help reduce, but will not eliminate, these adverse impacts. The marine environment in these remote coastal areas will be disturbed by massive construction activities, including trenching, blasting, and pile driving. Regular LNG tanker maneuverings, fuel oil deliveries, and tug and line boat activity will continuously intrude noise and activity into areas used by sea birds and mammals, including the California grey whales. Onshore, because all sites are remote and relatively undisturbed, an LNG terminal will alter the character of the area and disturb valuable wildlife populations. The Commission urges the Public Utilities Commission to give these adverse impacts heavy weight in its decision whether to approve the proposed LNG project.

3. The Safety of LNG Operations Remains Uncertain. Section 5552 of the LNG Terminal Act of 1977 states in part:

> "The Legislature further finds and declares that current uncertainties about the safety of liquefied natural gas require that the single terminal authorized by this chapter be located at a site remote from human population in order to provide the maximum possible protection to the public against the possibility of accident."

To implement this policy, the Act limits the population density within one and four miles of a terminal authorized under the Act. To further minimize risks from LNG terminal operations, the Act also requires the Public Utilities Commission to adopt regulations governing the safety and construction of an LNG terminal and to consult with the Division of Industrial Safety and the Energy Commission. At the federal level, the Department of Energy requires an LNG terminal operator to submit and receive approval of a Final Safety Analysis Report prior to operation of the terminal, and safety requirements of the U.S. Coast Guard, the Office of Pipeline Safety Operations, the Occupational Health and Safety Administration, and other federal agencies must also be met.

The Commission therefore finds that the major state consideration of the safety factors in LNG terminal siting, design, and operation has been addressed in the legislation and assigned to the PUC. Since the safety of LNG terminal and tanker operations is not within the Commission's legislative jurisdiction, only limited study was made of these safety issues and the possible consequences of LNG accidents to people, property and natural resources. However, the Commission has serious concerns about the adequacy of measures to prevent and to cope with LNG accidents and about the research undertaken so far to predict the consequences of LNG spills, fires, and vapor cloud dispersion (see Staff Notes). The Commission recognizes a decision on transporting LNG to California cannot wait until the completion of long term

research projects on LNG risks. The Commission therefore urges the PUC and Department of Energy, if they approve a terminal, to develop stringent safety regulations and a monitoring program to ensure that LNG risks to people and property are minimized, regardless of the "remoteness" of the terminal location. In addition, the Commission urges the Coast Guard to institute a program to inspect the LNG vessels for structural integrity and other safety risks for the life of the vessel.

4. The Basis for the Site Ranking Is the Heavy Weighting of Coastal Act Policies on Recreation, Public Access, Protection of Natural Resources, and Minimizing Adverse Development Impacts. The LNG Terminal Act requires the Commission to base its site ranking on findings applying the policies, goals, and objectives of Chapter 3 of the Coastal Act. Most of these policies provide for the protection and enhancement of public recreation opportunities and public access to and along the coast, for the protection of valuable marine and wildlife resources, and for minimizing adverse impacts of coastal developments on public views and the character of coastal areas. The Commission has given greatest weight to these policies in ranking the sites. Less weight has been given to the Coastal Act policies providing for consideration of terminal cost and safety differences at the sites. Although the LNG Terminal Act restricts the number of permanent residents and workers in the terminal area, the Commission finds that visitors, campers, and travelers within four miles of an LNG terminal and, to a lesser extent, people and property beyond four miles may also be at risk from LNG accidents. Therefore the "remoteness" of the sites from transients, permanent populations, and nuclear power plants has been considered in the site ranking.

5. Seismic Safety Considerations.

a. Seismic Siting Criteria. In December the Commission published criteria for evaluating possible sites for an LNG terminal. The seismic criterion stated that no site would be retained for the ranking if it were on or within 50 feet of an active earthquake fault. Public comment emphasized that this standard was not conservative enough. Although Nuclear Regulatory Commission seismic criteria for nuclear power plant siting are not directly applicable to LNG terminals, for purposes of comparison, the NRC does not license nuclear power plants that lie upon or are in close proximity to "capable" earthquake faults. These are defined as those with movement within the last 35,000 years or multiple movements within 500,000 years. The NRC generally considers as not suitable sites located within five miles of a surface capable fault longer than 1,000 feet. Draft regulations of the Department of Transportation's Office of Pipeline Safety Operations would also prohibit LNG terminal siting near a capable fault.

b. Seismic Safety Considerations Remove LAS VARAS from the Ranking. The Commission authorized its geologic consultants to trench the Las Varas site (Figures 4 and 5) to investigate a questionable surface feature. The trenches at that site confirmed the presence of a small thrust fault that apparently has moved approximately three feet at some time within the past 30,000 to 50,000 years. LNG storage tanks and other critical components at a terminal would be in close proximity to this relatively youthful fault (Figure 5). There is a very good possibility of similar and related geologic features on the site. Because of the possibility of future surface faulting at this site, and in spite of the low probability of a failure, the Commission has removed Las Varas from further consideration as an LNG terminal site to minimize risks to persons and property. This action is consistent with the siting criteria published in December.

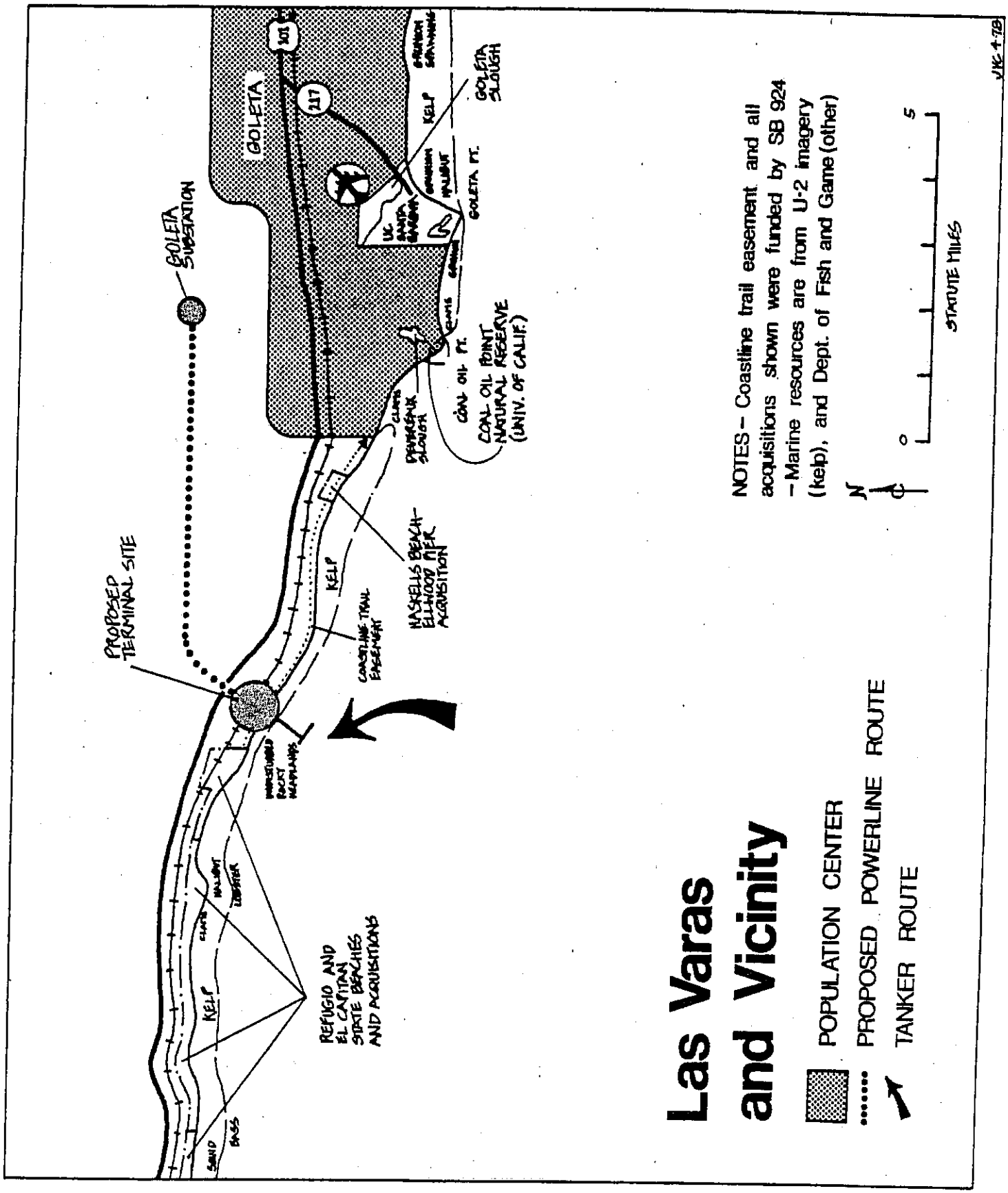

Las Varas
and Vicinity
POPULATION CENTER
PROPOSED POWERLINE ROUTE
TANKER ROUTE
NOTES – Coastline trail easement and all acquisitions shown were funded by SB 924
– Marine resources are from U-2 imagery (kelp), and Dept. of Fish and Game (other)
0
5
STATUTE MILES
GOLETA
101
217
GOLETA SLOUGH
GOLETA PT.
COAL OIL PT.
COAL OIL POINT NATURAL RESERVE (UNIV. OF CALIF.)
HASKELLS BEACH-ELLWOOD PER ACQUISITION
COASTLINE TRAIL EASEMENT
PROPOSED TERMINAL SITE
GOLETA SUBSTATION
REFUGIO AND EL CAPITAN STATE BEACHES AND ACQUISITIONS
KELP
SQUID
BASS
JKC 4-78

Figure 4

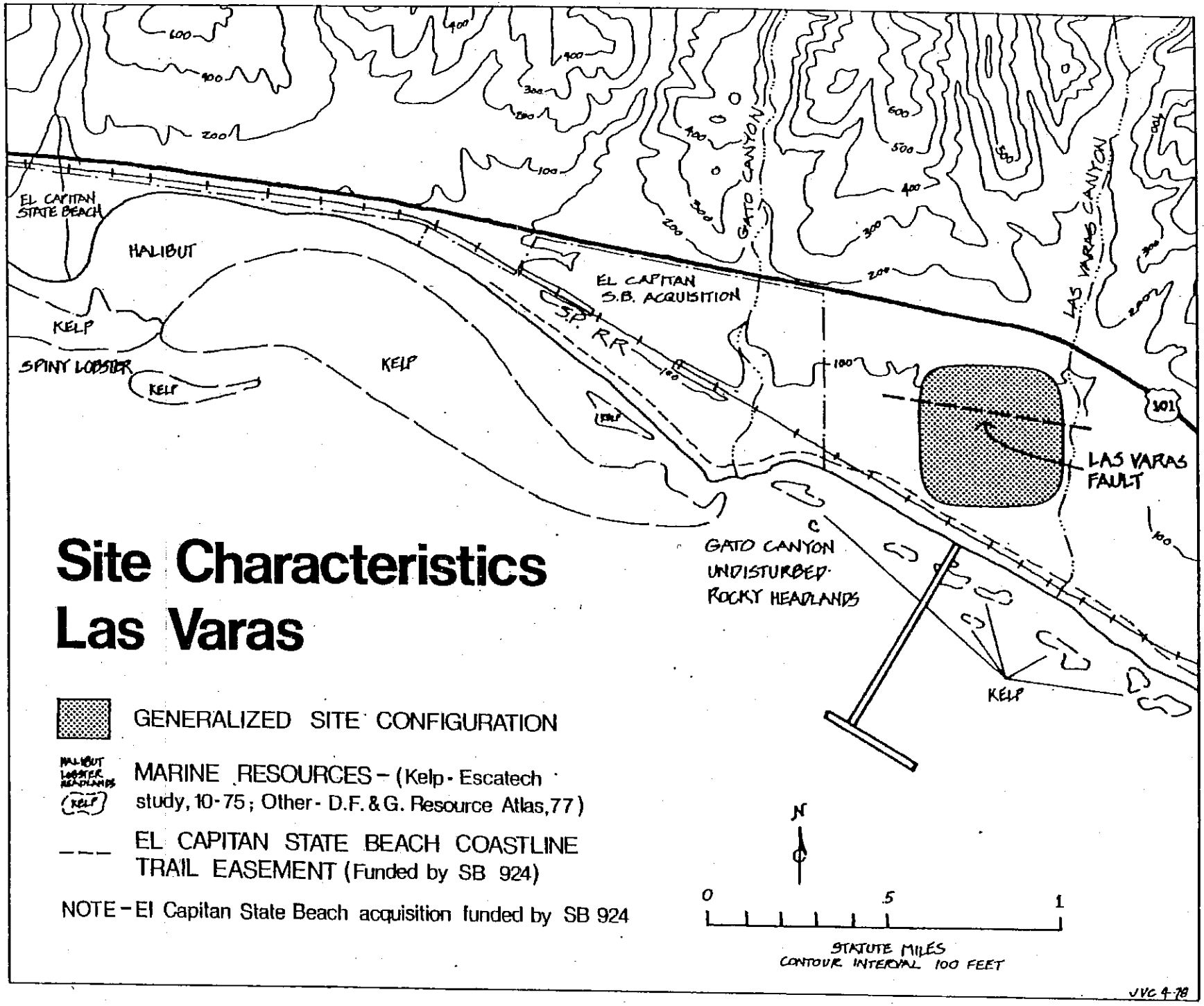

Site Characteristics
Las Varas
GENERALIZED SITE CONFIGURATION
MARINE RESOURCES – (Kelp - Escatech study, 10-75; Other - D.F. & G. Resource Atlas, 77)
EL CAPITAN STATE BEACH COASTLINE TRAIL EASEMENT (Funded by SB 924)
NOTE – El Capitan State Beach acquisition funded by SB 924
EL CAPITAN STATE BEACH
HALIBUT
KELP
SPINY LOBSTER
EL CAPITAN S.B. ACQUISITION
S.P. RR
GATO CANYON
LAS VARAS CANYON
LAS VARAS FAULT
GATO CANYON UNDISTURBED ROCKY HEADLANDS
101
N
0
.5
1
STATUTE MILES
CONTOUR INTERVAL 100 FEET
JVC 4-78

Figure 5

The removal of Las Varas from the ranking is done even though the Commission's own consultants believe that design features can minimize risks due to surface faulting. The Commission believes that it is not prudent to locate such a large and potentially hazardous industrial facility on a site with known recent faulting.

c. Little Cojo Must Be Ranked Despite Seismic Problems. Recent information presented by geologists employed by the Hollister Ranch, and confirmed by the Commission's consultants, indicates that the Little Cojo (Point Conception) site has a fault (Figure 11) similar to that found at Las Varas. Applying the same reasoning and caution which caused the Commission to remove Las Varas would also mean eliminating the Little Cojo site from further evaulation. However, the Liquefied Natural Gas Terminal Act of 1977 precludes that action. Since it is the applied-for site, it must be ranked by the Coastal Commission. If it were not for the requirements of the legislation, that specific site would no longer be considered.

Both the PUC and the federal Department of Energy (DOE) have requested Western LNG Terminal Associates to further evaluate the seismic hazards at the Little Cojo site. It is possible, after more evaluation, terminal design work, and possibly shifting the site away from the fault within the same siting area, that Western LNG Terminal Associates could convince the PUC and DOE that licensing a terminal at Little Cojo would be acceptable.

It is also possible that more detailed seismic evaluations, including trenching, at one of the other three sites, if approved, will discover small faults similar to those found at Las Varas and Little Cojo. If these common faults in California coastal areas are also discovered at other sites, and if there is an overriding need for an LNG terminal site, all the sites, including Las Varas and Little Cojo, should be reevaluated to select the one upon which design features can minimize the risks. However, authorization to construct an LNG terminal on a site with an active surface fault nearby would be a significant departure from currently accepted regulatory practice.

6. Adding Facilities to a Terminal. The Commission's maritime consultants indicate that if an approved terminal reaches the maximum gas delivery rate authorized under the LNG Terminal Act, 1.3 billion cubic feet per day, additions may be needed to the terminal to increase the reliability of LNG tanker berthing and unloading (see Staff Notes). Possible additions that might be considered would include a fourth LNG storage tank, second berth, or a breakwater to protect the berthing area. In this site ranking, the Commission is considering a breakwater only at the Rattlesnake Canyon site, and a breakwater at other sites, particularly Little Cojo, would lower the ranking of such site.

The three options for improving gas supply reliability that involve terminal additions are not part of any application. There is no clear State regulatory process for approving such additions after a permit is granted under the LNG Terminal Act of 1977. If proposals are made in the future to add facilities to a terminal, all alternatives and their degree of environmental damage should be evaluated. The Commission urges the legislature and the PUC to develop a review and approval process for terminal additions, and the Commission should have a major role in selecting an alternative and developing terms and conditions.

7. Horno Canyon on Camp Pendleton is Ranked First. The Commission ranks the Horno Canyon site on Camp Pendleton (Figures 6 and 7) first among the four sites because construction and operation of an LNG terminal there would have the least adverse effects on the objectives of Chapter 3 of the California Coastal Act of 1976. The basis for this ranking is that a Horno Canyon LNG terminal would have low adverse impacts on public access, recreation, and natural resources and would not be inconsistent with most of the development policies of the Act. It is ranked first despite statements from the Navy and Marine Corps that the site would not be available for an LNG terminal, because the military does not necessarily exercise final control over the use of federal property. Federal property is not subject to state authorized eminent domain proceedings. Consideration of national energy priorities and a federal LNG terminal siting policy to locate such terminals where they will be least damaging to the environment, however, could cause other officials in the executive branch, including the President, to make the land available.

The Commission recognizes that under both the federal Coastal Zone Management Act and the California Coastal Act the Commission does not regulate lands on the coast in federal ownership. However, the LNG Terminal Act of 1977 expressly states that the Commission shall study, evaluate, and rank "potential onshore sites for an LNG terminal" (Section 5611) and that "onshore" is defined as "any location on the mainland of California landward of the mean high tide line" (Section 5565). Thus the Act requires an evaluation of all potential sites regardless of site ownership, even though use of federal lands for a terminal would have to be a federal decision. Given the small number of feasible sites remaining after an evaluation of 82 sites, this has turned out to be a prudent legislative directive.

Public Access and Recreation. A Horno Canyon terminal would have more adverse impacts on coastal recreation and public access than a Rattlesnake Canyon or Little Cojo terminal and less adverse impacts than a terminal at Deer Canyon.

Public Access. The Horno Canyon site is owned and used by the U.S. Marines and is not open to the public. Visitors can reach it by walking south along the beach from San Onofre State Park, which extends to about a mile from the site, but Marine patrols prevent public use. Recommended conditions 1 and 18 would, at a minimum, preserve the existing public access in the area, and perhaps increase it.

Recreation. The terminal's 8700-foot long trestle would degrade the recreation experience for some visitors at San Onofre State Park, but the most heavily used area of the park, popular for surfing, is five miles from the site and is divided by the large San Onofre Nuclear Power Plant. Boating from Oceanside and San Clemente is popular in the area, and tanker operations could result in some restrictions on boating near the terminal. The Department of Parks and Recreation indicates that only a Rattlesnake Canyon terminal, of the other three sites, would cause less adverse recreation impacts than a Horno Canyon terminal. In fact, the Department did express hope that someday this last major block of undeveloped coastal property in Southern California, Camp Pendleton, might be a park (Exhibit 00502). Given the site's present use and lack of access, however, the Commission finds a Horno Canyon terminal would have a low adverse effect on public recreation opportunities if recommended conditions are imposed by the PUC.

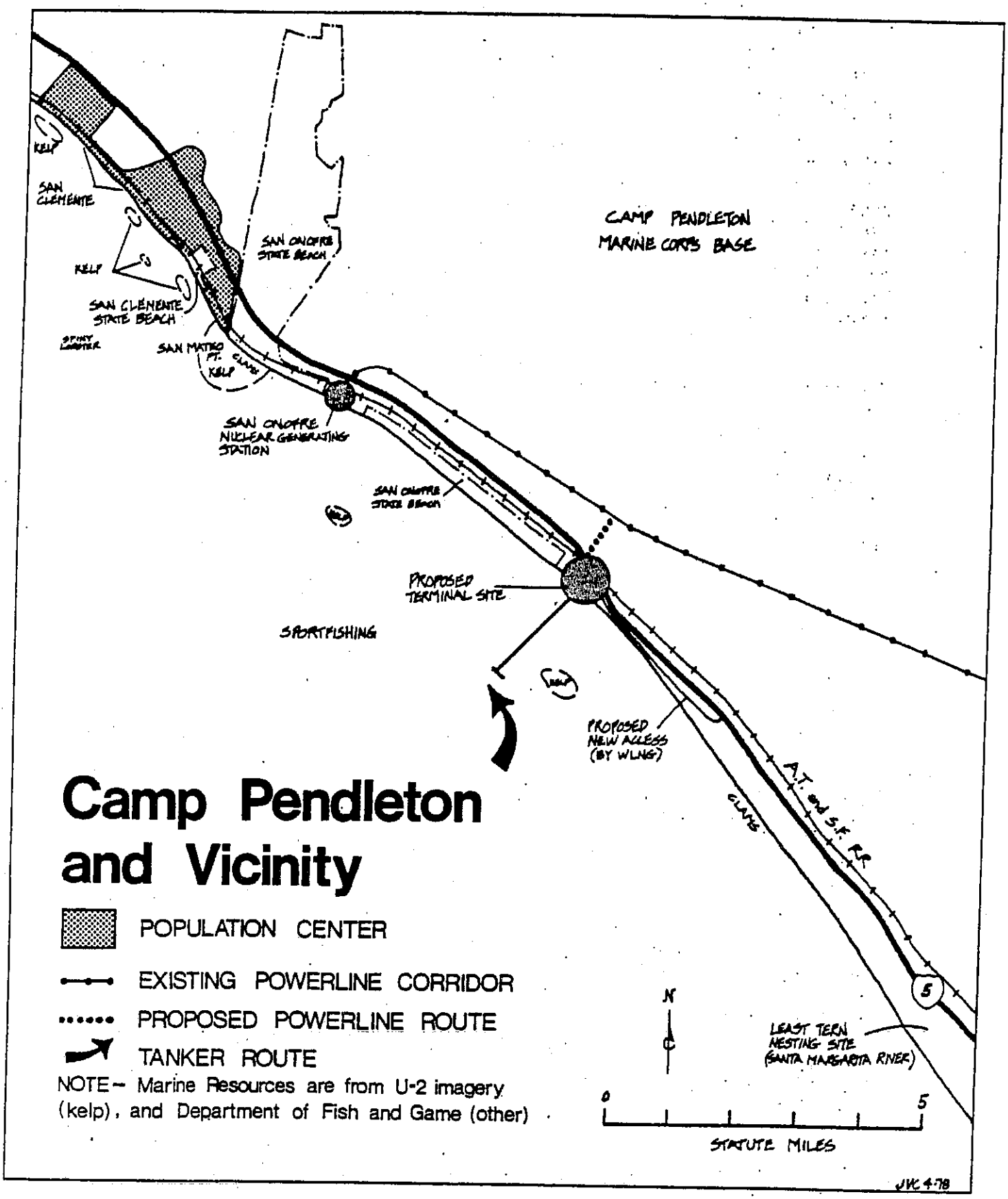

Camp Pendleton and Vicinity
POPULATION CENTER
EXISTING POWERLINE CORRIDOR
PROPOSED POWERLINE ROUTE
TANKER ROUTE
NOTE – Marine Resources are from U-2 imagery (kelp), and Department of Fish and Game (other)
CAMP PENDLETON MARINE CORPS BASE
SAN CLEMENTE
KELP
SAN CLEMENTE STATE BEACH
SAN ONOFRE STATE BEACH
SAN MATEO PT.
SAN ONOFRE NUCLEAR GENERATING STATION
SAN ONOFRE STATE BEACH
PROPOSED TERMINAL SITE
SPORTFISHING
PROPOSED NEW ACCESS (BY WLNG)
A.T. and S.F. R.R.
CLAMS
LEAST TERN NESTING SITE (SANTA MARGARITA RIVER)
N
0
5
STATUTE MILES
JVC 4-78

Figure 6

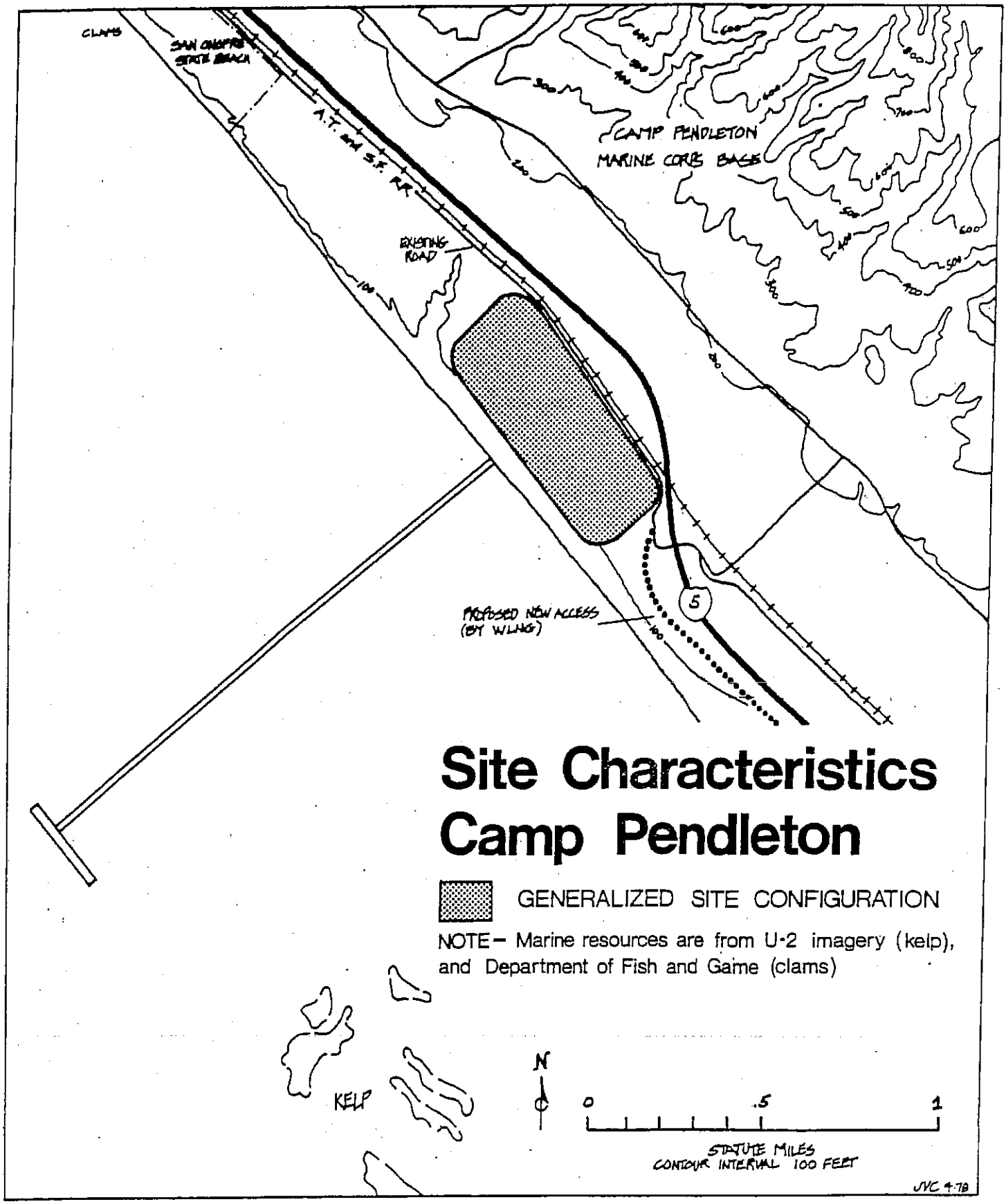

CLAMS
SAN ONOFRE STATE BEACH
A.T. and S.F. RR
CAMP PENDLETON
MARINE CORPS BASE
EXISTING ROAD
PROPOSED NEW ACCESS (BY WILNG)
5
Site Characteristics
Camp Pendleton
GENERALIZED SITE CONFIGURATION
NOTE – Marine resources are from U-2 imagery (kelp), and Department of Fish and Game (clams)
KELP
N
0
.5
1
STATUTE MILES
CONTOUR INTERVAL 100 FEET
JVC 4-78

Figure 7

Marine Environment and Land Resources.

Marine Resources. A Horno Canyon LNG terminal would have the least adverse impacts on marine resources protected by the policies of Article 4, Chapter 3 of the Coastal Act. The lack of suitable offshore rock or reef bottom prevents the offshore area from supporting more than intermittent kelp beds of comparatively low importance. Although the area supports very good commercial and sport fisheries, most of the species which are fished are not dependent on nearshore features, such as kelp beds or rocky reef areas, that would be affected by terminal construction and operation. The fishing catch per unit of effort is low. Therefore the Department of Fish and Game judged the adverse impacts on marine resources as less significant than at the other three sites (April 17, 1978 letter from Charles Fullerton to the Coastal Commission).

Land Resources. The onshore wildlife resources of the site, which consist of a natural coastal sage scrub community and are of low diversity and abundance, are common to the general area. Military activities, mainly vehicle travel over the site, have affected the scrub communities. The site is not presently inhabited by any rare or endangered species of animals or plants, although it is probably visited by the California brown pelican, an endangered species, and the white-tailed kite, a fully protected species. The area is of relatively low importance to marine bird and mammal populations, so the Department of Fish and Game has concluded that LNG facilities would have the least adverse impact on wildlife species of special concern than any other site.

Archaeological Resources. The State Historic Preservation Office indicates no cultural and archaeological resources are known to exist at the site (Exhibit 00774).

Land Use and Development Policies. The Camp Pendleton Marine Corps Base has helped to limit urban expansion into the largest remaining undeveloped coastal area in southern California. The Commission believes that open space is a desirable use of this 10½ miles coastline and its conclusions on the siting of an LNG terminal should not be viewed as encouraging other kinds of development. The requirements of the LNG Terminal Act could have the effect of limiting possible future development within four miles of the site. The 100-acre site constitutes less than .1% of the Camp Pendleton Marine Corps Base and is not used for military operations. Testimony by representatives of the U.S. Navy and Marine Corps indicates that a Horno Canyon LNG terminal would, however, conflict with amphibious military training exercises considered necessary to maintain national defense preparedness (see Staff Notes). The nearest beach at which amphibious landings take place is less than 2 miles south of the site, but the Navy indicates vessel maneuvers take place where the LNG terminal trestle would be located. In addition, the Marines operate airplane flight paths over the site. Therefore, if an LNG terminal is located at this Camp Pendleton site, vessel and aircraft maneuvering areas would probably have to be changed.

Public Services. The Horno Canyon site comes closest, given the population restrictions in the LNG Terminal Act, to meeting the coastal policy of locating new industrial development in areas of existing industrial facilities. The site is readily accessible by an existing highway and railroad, and public services, including emergency medical facilities, are nearby. Adequate electrical transmission lines are within a few thousand feet of the site.

Alteration of Natural Landforms. Little landform alteration would be required to prepare the fairly level site, although some minimal offsite disposal of dirt may be necessary.

Offshore construction would not require any reef removal or breakwater construction.

Public Views. The relatively undeveloped and open stretch of coast between the San Onofre Nuclear Power Plant and Oceanside provides a comparatively uninterrupted sweeping view of the ocean to the west and rolling hills to the east along heavily traveled Interstate 5. It provides visual relief from the highly developed Orange County and San Diego County coastal areas and, of the four sites, is viewed by the most people. Immediately adjacent to the southern boundary of the site is a scenic viewpoint on I5. A Horno Canyon terminal would intrude a major industrial facility in the middle of this stretch of coast. A terminal would be less visually incompatible with the imposition of condition 18, which requires partially undergrounded LNG storage tanks, but the 8,700-foot long trestel would be visible from much of the San Diego County coastal areas.

Weighing the different impacts on views to and along the coast at the different sites is complicated and subjective. While the view along Camp Pendleton's coastal terrace provides a sweeping vista for Interstate 5 drivers, the terrace itself is generally flat and not spectacular. By contrast, the view of the coastal terrace at Little Cojo is spectacular, with bays and curving bluffs along the shore, and ravines dropping to sandy beaches from the steep canyons of the Santa Ynez Mountains. However this Little Cojo view can be seen only by fortunate residents and visitors to the private Hollister and Bixby Ranches and those who can reach the offshore area by boat, while the Camp Pendleton view is seen by 60 to 80,000 drivers a day.

Remoteness. The risks to population concentrations associated with a Horno Canyon terminal seem roughly comparable to terminals at the other sites except at Little Cojo, the most distant site from urban areas. The nearest permanent population concentrations to Horno Canyon are at least ten miles away at Oceanside and San Clemente. Some Marine barracks may have to be relocated to meet population density standards within four miles of the site. As with the Rattlesnake Canyon site, and unlike the other two sites, a nuclear power plant is about five miles north of the site (see Staff Notes).

The Horno Canyon site provides the opportunity for LNG tanker traffic to travel outside the Santa Barbara Channel shipping lanes should the Coast Guard determine that such a route provides greater safety.

Cost. The Public Utilities Commission indicates that construction costs at Horno Canyon would be comparable to those at Little Cojo, which is currently estimated as costing about $475.5 million. Terminal construction at both sites would cost about $250-300 million less than at Rattlesnake and Deer Canyons. The Horno Canyon cost would be comparatively low because the site is on a level coastal terrace and no breakwater would be required.

8. Rattlesnake Canyon is Ranked Second. The Commission finds that the Rattlesnake Canyon site (Figures 8 and 9) would have the second least adverse impacts on the objectives of Chapter 3 Coastal Act policies. The basis for this ranking is that construction and operation of an LNG terminal at Rattlesnake Canyon would have the least adverse impacts on public access and recreation and would not be inconsistent with most of the development policies of the Act. It is ranked second, below Horno Canyon, primarily because of the adverse impacts on natural marine and wildlife resources, which are more diverse and abundant than at Horno Canyon and Deer Canyon, but less than at Little Cojo. Other adverse factors contributing to the second place ranking include major alteration of the offshore reef area by construction of a breakwater, an increased construction cost, according to the PUC, of about $350 million above the Horno Canyon cost, potential damage to archaeological resources, and the generally more severe fog, wind, and wave conditions. If the PUC approves this site instead of the first ranked Horno Canyon site, there would be an overall moderate increase in adverse impacts on Coastal Act objectives.

Public Access and Recreation. The Commission finds that adverse impacts of a Rattlesnake Canyon terminal on public access and recreation would be the least significant of the four sites.

Public Access. Public access to the area is prohibited by a PG&E guard station which provides security for the Diablo Canyon Nuclear Power Plant. While the other three sites have sandy beaches at the base of bluffs, the shore below the bluffs at this site is steep and rocky, without a beach, and inaccessible.

Recreation. The Department of Parks and Recreation concludes that, of the four sites, this site would be the least disruptive of existing park units and proposed development and acquisition. Montano de Oro State Park is 5½ miles north of the site, and Avila Beach State Park is about 2 miles southeast. The terminal would not be visible from either park or otherwise affect their use, with the exception of increased construction traffic on the Avila Road.

Marine Environment and Land Resources.

Marine Resources. The Department of Fish and Game concludes, and the Commission finds, that marine resources at Rattlesnake Canyon are very sensitive, second only to those at Little Cojo. The nearshore environment supports diverse and abundant marine life, although the repopulation of the area by the sea otter has depleted historic abalone and sea urchin fisheries. Some kelp is present, and the site area supports commercial and sport fisheries for finfish, especially rockfish. The area is important to marine birds and mammals since nesting and resting areas for cormorants, sea lions, and harbor seals are nearby, and these would be disturbed by construction activities and tanker operations offshore.

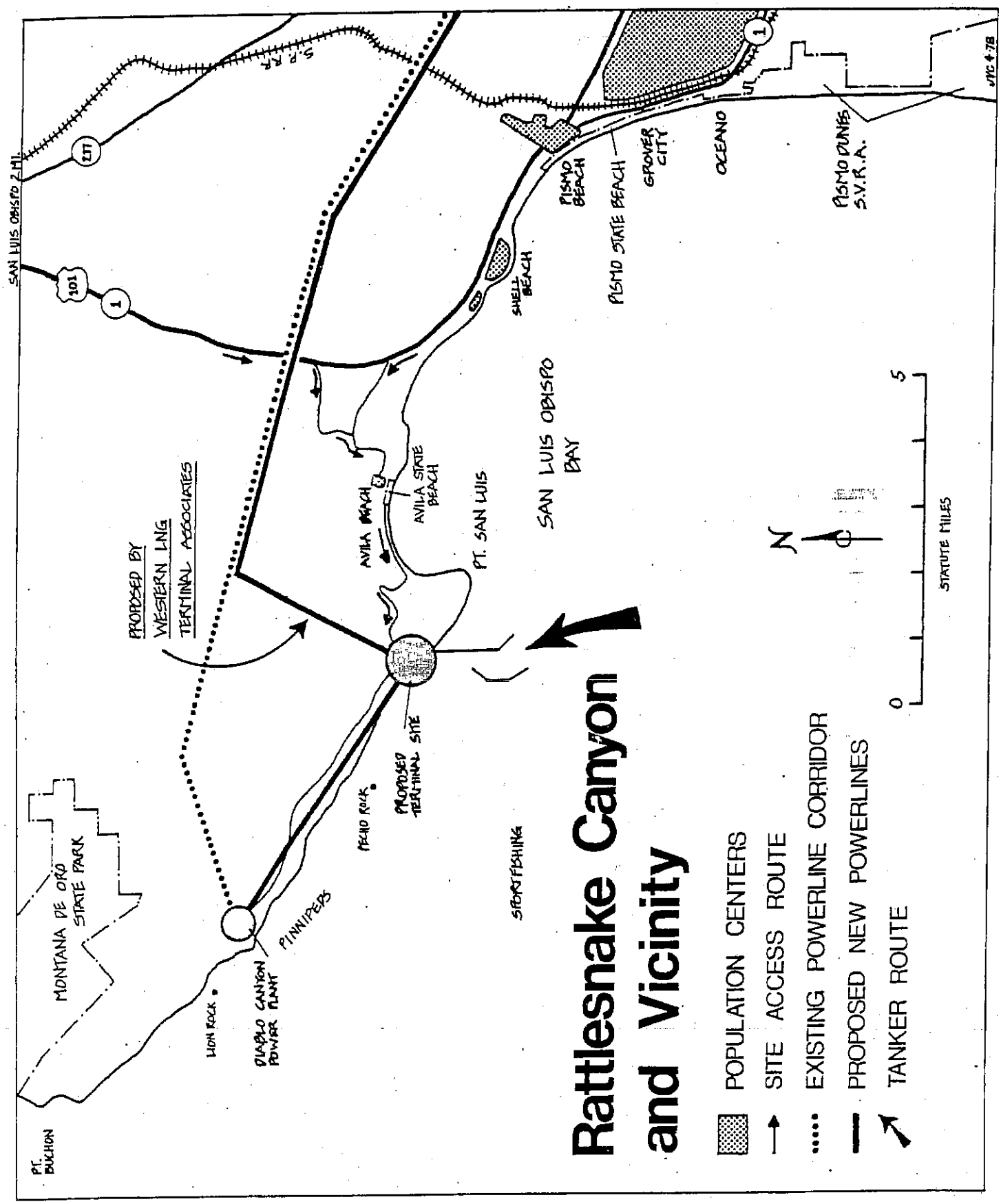

Rattlesnake Canyon and Vicinity
POPULATION CENTERS
SITE ACCESS ROUTE
EXISTING POWERLINE CORRIDOR
PROPOSED NEW POWERLINES
TANKER ROUTE
0
5
STATUTE MILES
N
SAN LUIS OBISPO BAY
PT. SAN LUIS
AVILA BEACH
AVILA STATE BEACH
SHELL BEACH
PISMO BEACH
PISMO STATE BEACH
GROVER CITY
OCEANO
PISMO DUNES S.V.R.A.
PROPOSED BY WESTERN LNG TERMINAL ASSOCIATES
PROPOSED TERMINAL SITE
PECHO ROCK
SPORTFISHING
PINNIPEDS
DIABLO CANYON POWER PLANT
LION ROCK
MONTANA DE ORO STATE PARK
PT. BUCHON
SAN LUIS OBISPO 2 MI.
S.P.R.R.
101
1
227
JVC 4-78

Figure 8

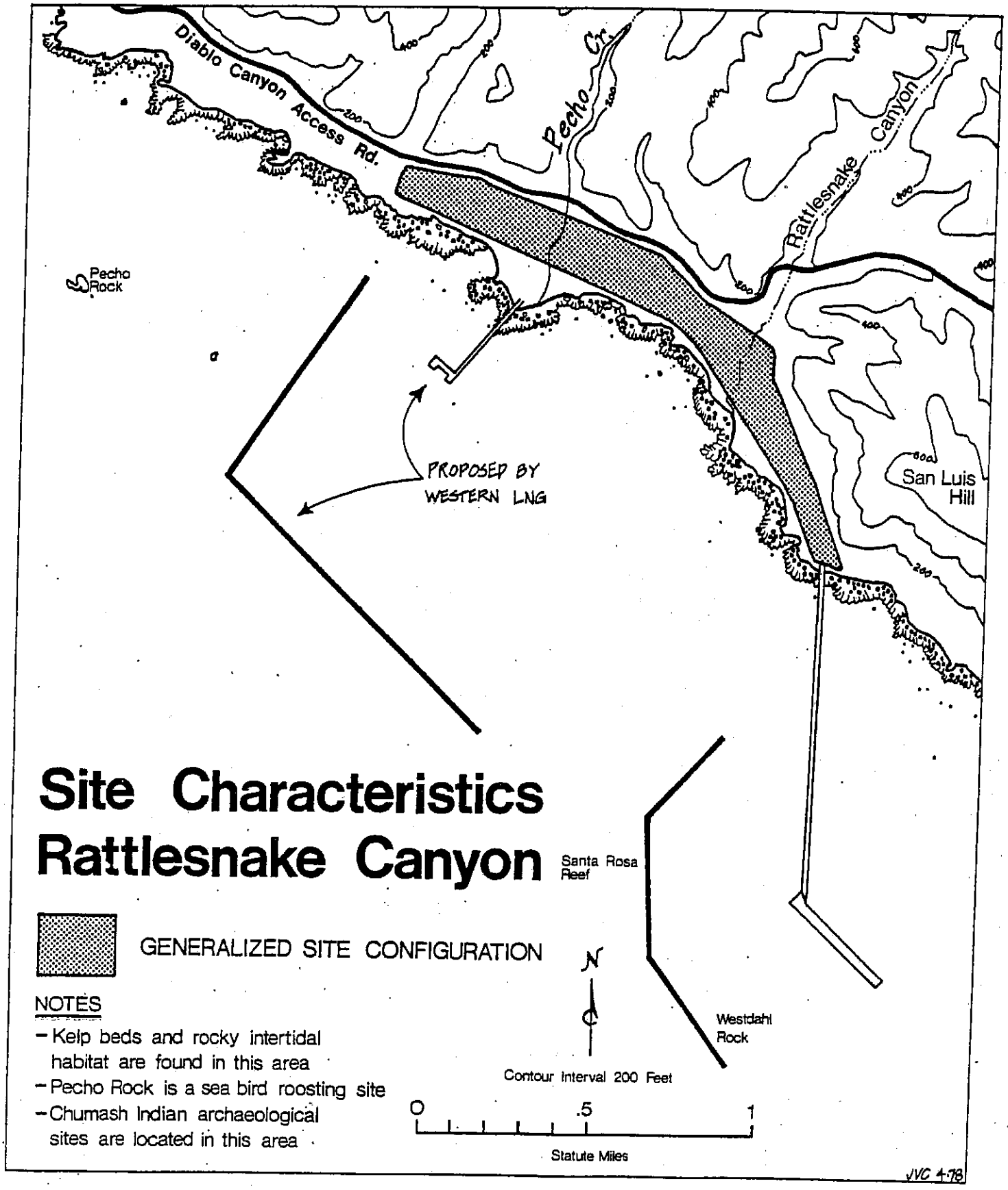

Diablo Canyon Access Rd.
Pecho Cr.
Rattlesnake Canyon
Pecho Rock
PROPOSED BY WESTERN LNG
San Luis Hill
Santa Rosa Reef
Westdahl Rock
Site Characteristics
Rattlesnake Canyon
GENERALIZED SITE CONFIGURATION
NOTES
- Kelp beds and rocky intertidal habitat are found in this area
- Pecho Rock is a sea bird roosting site
- Chumash Indian archaeological sites are located in this area
N
Contour Interval 200 Feet
0
.5
1
Statute Miles
JVC 4-78

Figure 9

Land Resources. The Department of Fish and Game concludes that adverse impacts on natural resources of a terminal at this site would be more significant, in general, than at Horno Canyon and Deer Canyon, and less significant than at Little Cojo. Onshore, the site itself is being cultivated for barley and snow peas, but a good riparian community of plants and animals along Pecho Creek would be unavoidably altered by construction. Introducing industrial activity onto this section of terrace in front of the grazed but relatively undeveloped Irish Hills would disturb the valuable long-term wildlife resources. While condition 7 would minimize disturbance to natural resources at this site, the major disturbance is due to the intrusion of industrial activity, with bright lights, noise, and equipment movements which cannot be prevented.

Archaeological Resources. The State Office of Historic Preservation considers this site the least preferred, because at least four Chumash archaeological sites listed on the National Register of Historic Places and a possible prehistoric period ceremonial shrine are located on the site (Exhibit 00774). This factor contributes to ranking this site below Horno Canyon, but it does not contribute in a major way to making it less adverse than Little Cojo or Deer Canyon, since those sites also have archaeological resources, though of somewhat less significance.

Land Use and Development Policies.

Character of the Area. The Rattlesnake Canyon site is on an isolated coastal terrace which is currently in agricultural use. Development plans have been discussed to take advantage of the scenic quality of the area. The character of this stretch of coast, however, has been altered by the construction of the Diablo Canyon nuclear power plant about four miles north of the site and the connecting transmission lines and access road.

Public Services. The availability of roads, utilities, and other facilities is a factor contributing to ranking Rattlesnake Canyon above Little Cojo and Deer Canyon. The coastal terrace area has already experienced a major construction project, the Diablo Canyon Nuclear Power Plant, and a barge terminal, heavy duty road, electric transmission line corridor, security fences, and other facilities are already in place to serve the site.

Alteration of Natural Landforms. Construction of a large 6,700-foot long breakwater offshore the site would be a significant alteration to the rocky nearshore area. The rock breakwater would go over Santa Rosa Reef to Westdahl Rock, and some blasting and removal of offshore rocks and reefs may be needed to insure safety for LNG tanker maneuvering. After construction, however, the Department of Fish and Game indicates that the effect of the breakwater on kelp, fish, and invertebrates would not be adverse, since the breakwater would provide substrate habitat for these organisms. Therefore the breakwater would be a major physical landform alteration but not necessarily a major natural resources habitat alteration; thus, this factor does not contribute to changing the second-place ranking of this site.

Construction onshore at the site itself would be possible with a nearly balanced cut and fill approach, minimizing the need for off-site removal of dirt by trucks.

Public Views. The site is not visible to the public because it is in the PG&E restricted area on the other side of the Irish Hills from Port San Luis and Avila Beach. This contributes to a high ranking for the site, although the trestle, breakwater, and LNG tanker operations would be visible from ten or more miles away at Pismo Beach and the recreation areas along the south half of San Luis Obispo Bay.

Remoteness. The site is similar in remoteness and potential risks to people and property as the Deer and Horno Canyon sites and less remote than Little Cojo. The Rattlesnake Canyon site itself is somewhat shielded from Port San Luis and Avila Beach by the Irish Hills, but San Luis Obispo Bay would have no such protection from an accident at the berthing facility. The number of people potentially at risk, including permanent residents and workers, visitors, campers, and recreators, seems roughly similar to the number around Deer and Horno Canyons, so this factor does not have a large impact on this site's ranking. As at Horno Canyon, a nuclear power plant is about four miles north of the site, and the Nuclear Regulatory Commission would have to find that LNG terminal operations at Rattlesnake Canyon pose acceptable risks to safe nuclear plant operation before permitting this major PG&E investment to produce electricity from nuclear reactions (see Staff Notes).

The LNG tanker route would not come within about 10 miles of populated areas, and the vessel traffic in the site area is relatively light.

Cost. Due to the need to construct a $175 million breakwater and a long cryogenic pipeline, the total construction cost of a terminal at this site, about $880 million according to the PUC, would be higher than that at Little Cojo or Horno Canyon and similar to that at Deer Canyon, where large amounts of earth would have to be moved to prepare the site.

9. Little Cojo near Point Conception is Ranked Third.

The Commission finds that, of the four sites, the Little Cojo site (Figures 10 and 11) would have the third least adverse effects on the objectives of Chapter 3 Coastal Act policies. This ranking does not take into account the recently confirmed presence of a potentially active earthquake fault on the site, because this fact would have caused the Commission to eliminate the site from consideration, as it does with Las Varas. But the LNG Terminal Act requires that the Little Cojo site be ranked. The basis for ranking this site third is that construction and operation of an LNG terminal at Little Cojo would have the most significant adverse impacts of the four sites on natural resources and the comparatively unspoiled character of a unique and remote coastal area especially

valued by surfers and fishermen. The views along this long, broad coastal terrace are spectacular. Little Cojo is ranked below Rattlesnake Canyon because it is more inconsistent with Coastal Act development policies and would have a greater adverse impact on natural resources. Little Cojo ranks above Deer Canyon primarily because Deer Canyon would affect far more recreational users of the area and the landform alteration would be significantly greater.

With conditions 23 through 28 which prohibit a seawater intake system and electric transmission lines at the site, require partial ingrounding of storage tanks, and provide for public access to the area, the overall adverse impacts of a terminal at this site would be moderately more severe than at the higher ranked Rattlesnake Canyon site, but slightly less severe than the lower ranked Deer Canyon site. If the PUC does not impose the specific conditions recommended for a terminal at Little Cojo, Little Cojo would be ranked fourth, with moderately more adverse impacts on Coastal Act objectives than Deer Canyon, which would then be ranked third.

Public Access and Recreation.

Public Access. Onshore public access to the site area is prevented by the locked gate policies of the Bixby and Hollister Ranches. Surfers, divers and fishermen reach the waters in front of the site using boats launched at Gaviota State Beach or elsewhere. If this site is selected for an LNG terminal, condition 25 would provide new public access to the area, and to that extent would further the Coastal Act objective of promoting public access to coastal areas.

Recreation. The Commission has received testimony and hundreds of letters from all over California and the world urging protection of the special surfing breaks off the Hollister Ranch. A "point break" at the west end of Little Cojo Bay is rated a "classic" break and one of the four best breaks in California, according to the Western Surfing Association. The construction of a trestle at this site and vessel operations would not necessarily prevent or directly interfere with surfing at Little Cojo, and if such interference does take place it would be substantially mitigated by condition 27 requiring construction of equivalent surfing breaks. But the presence of the 4600-foot long trestle would degrade the remote character of the Ranch surfing experience.

The area is also popular with sport and commercial fishermen, divers, and boaters. Heavy construction traffic could adversely affect Gaviota Beach State Park, where the Hollister access road connects to US 101.

Marine Environment and Land Resources.

Marine Resources. The Department of Fish and Game identifies the Point Conception marine environment as the most sensitive of the four sites because cold northerly waters and warmer southerly waters meet and mix there. Therefore the area is considered the limit for the ranges of 14 species of fish and 20 species of invertebrates, making the marine resources highly diverse. In addition, marine resources are particularly abundant in the area due to the upwelling of nutrient-laden colder waters. Commercial fishermen from Santa

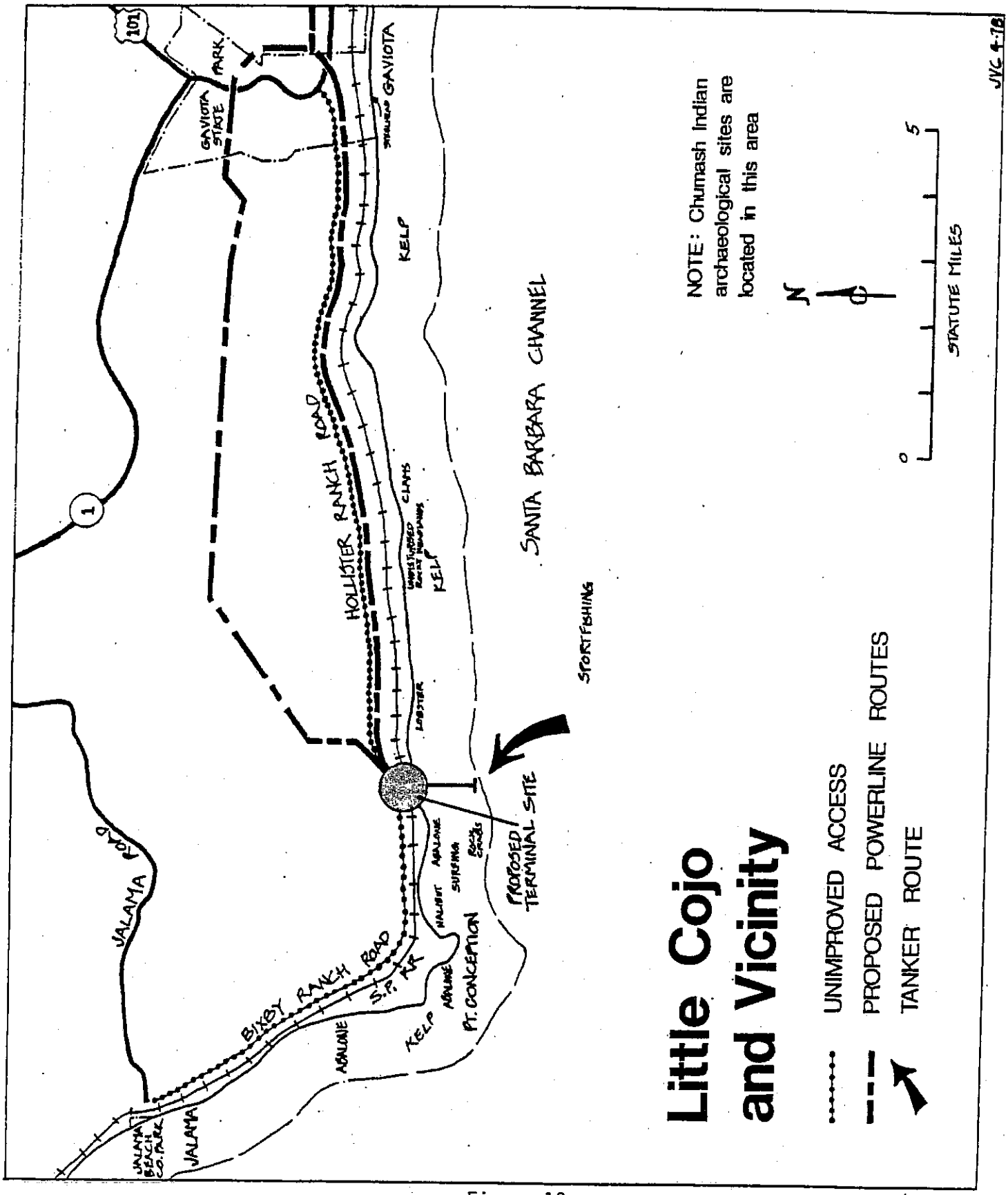

Little Cojo and Vicinity
UNIMPROVED ACCESS
PROPOSED POWERLINE ROUTES
TANKER ROUTE
NOTE: Chumash Indian archaeological sites are located in this area
N
0
5
STATUTE MILES
JVC 4-78
SANTA BARBARA CHANNEL
SPORTFISHING
PROPOSED TERMINAL SITE
HOLLISTER RANCH ROAD
BIXBY RANCH ROAD
JALAMA ROAD
JALAMA
JALAMA BEACH CO. PARK
GAVIOTA STATE PARK
GAVIOTA
KELP
CLAMS
LOBSTER
ABALONE
SURFING
ROCK CRABS
HALIBUT
PT. CONCEPTION
S.P. RR
101
1

Figure 10

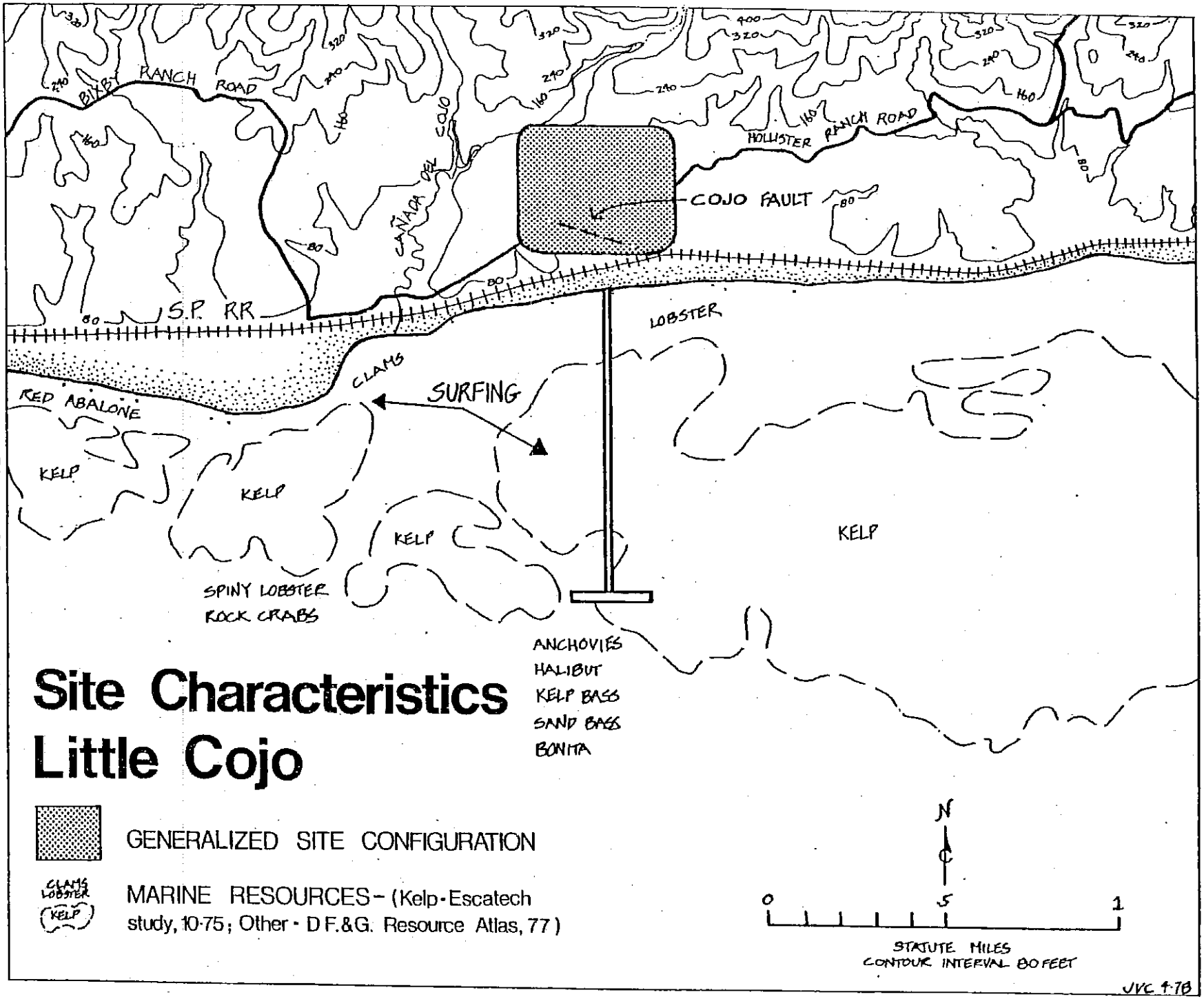

Site Characteristics
Little Cojo
GENERALIZED SITE CONFIGURATION
CLAMS
LOBSTER
KELP
MARINE RESOURCES - (Kelp - Escatech study, 10-75; Other - D F.&G. Resource Atlas, 77)
BIXBY RANCH ROAD
CAÑADA DEL COJO
HOLLISTER RANCH ROAD
COJO FAULT
S.P. RR
LOBSTER
CLAMS
SURFING
RED ABALONE
KELP
KELP
KELP
KELP
SPINY LOBSTER
ROCK CRABS
ANCHOVIES
HALIBUT
KELP BASS
SAND BASS
BONITA
N
0
.5
1
STATUTE MILES
CONTOUR INTERVAL 80 FEET
JVC 4-78

Figure 11

Barbara testified that the waters off Little Cojo provide one of their most productive fishing grounds. The largest and most productive kelp bed off California, bed #32, extends along the site. The kelp is commercially harvested under a 20-year lease from the Department of Fish and Game and also serves as a rich habitat for associated marine life. The area near the site, relatively undisturbed by human activity, is very important to marine birds and mammals. It is believed to be used as a staging area by California grey whales during their migrations along the California coast. Adverse impacts of terminal construction and operation at this site would be minimized by the imposition of conditions 23 and 28 prohibiting seawater LNG vaporizers and reducing damage to the kelp resource, but major adverse impacts would still be associated with the intrusion of industrial activity into the nearshore area, including tanker, tug, and line boat maneuvering, shipping fuel oil to the site, and lights and vehicles on the trestle.

Land Resources. The wildlife resources of the site itself, which is currently used for cattle grazing, are not significant, but because the large area around and inland of the site is relatively undeveloped and remote, the area in general, and particularly the foothills and canyons of the Santa Ynez Mountains, are important wildlife habitat. The area is especially valuable for birds, as large numbers of double-crested cormorants, black brants, and pink-footed shearwaters are observed near the site. The intrusion of large scale industrial activity into this remote site would, according to Fish and Game, cause greater damage to wildlife populations than would terminals at the three other sites.

Archaeological Resources. The State Historic Preservation Officer has stated that valuable Chumash archaeological resources are found in the site area. The proposed terminal site has been moved by the applicant to avoid some of these archaeological sites.

Land Use and Development Policies.

Character of the Area. A Little Cojo terminal would unavoidably be a major intrusion of an industrial facility and industrial activity on a unique area highly valued for natural resources. The entire stretch of coast from Gaviota around Point Conception to Jalama is the last major semi-wild coast left in Southern California. Its magnificent views and abundant wildlife make it a unique coastal expanse, lacking only in greater public use and enjoyment of the area. Hollister Ranch to the east has been subdivided into large parcels of approximately 100 acres. The lack of more extensive residential and commercial development for more than ten miles around the site and lack of public access has preserved this coastal area in a lightly developed state. Small-scale development near the site includes an unused oil storage tank and a buoy type marine oil terminal in Little Cojo Bay, and the Southern Pacific Railroad tracks along the top of the bluffs.

Public Services. As the most remote site, Little Cojo is also the most inconsistent with Coastal Act policies favoring locations near existing public services. The existing Hollister Ranch road would have to be substantially upgraded to handle construction workers

and equipment, the natural gas pipeline would have to pass through sensitive areas in new rights of way, and emergency services in the event of an accident are at least an hour away. The adverse impacts would be decreased by conditions 23 and 24, requiring onsite electricity generation to avoid new electric transmission lines and minimizing alterations caused by upgrading the Hollister Ranch road to the site.

Alteration of Natural Landforms. The alteration of natural landforms at the site would be minimal since the site is a comparatively level terrace. A breakwater at this site has not been proposed by the applicant, and the Commission has relied on the lack of a breakwater in ranking Little Cojo third. If a breakwater were a required feature of this site, the Commission would rank it fourth, after Deer Canyon.

Public Views. Since the public does not have easy access to the Point Conception area, a site at Little Cojo will not visually impact many people. On extremely clear days, however, the terminal and trestle would be visible from the Santa Barbara Channel coastline.

Remoteness. The Little Cojo site is by far the most remote from population concentrations, with the Santa Barbara area about 40 miles to the east and areas to the north shielded by the steep Santa Ynez Mountains. There are a few Hollister Ranch residents within four miles of the site, and there are no campers, travelers or other transients within ten miles except for occasional nearshore surfers, divers, boaters, and fishermen. The LNG tanker routes would also be the furthest from population concentrations, barely entering the Santa Barbara Channel, while tankers to Deer and Horno Canyons would traverse the entire Channel, and, at Rattlesnake Canyon, the outer part of San Luis Obispo Bay.

Cost. A Little Cojo terminal, estimated to cost about $475 million, would be comparable to one at Horno Canyon and less than one at Rattlesnake or Deer Canyons.

10. Deer Canyon is Ranked Fourth.

The Commission finds that an LNG terminal at Deer Canyon would have the most adverse impacts on Coastal Act policies of the four sites, and therefore ranks it last. The basis for this ranking is that the Deer Canyon site is inconsistent with Coastal Act development policies and is in a coastal area heavily used for recreation. The site is only slightly more objectionable than the third-ranked Little Cojo site, primarily because of the extensive land form alteration and the interference with public use of the coast. The only favorable aspects to having a terminal at this site is its minimal view impact by being located in a canyon and its less significant and valuable natural resources.

Public Access and Recreation.

Public Access. The Commission finds that of all four sites, Deer Canyon is the most inconsistent with Coastal Act policies protecting public use and enjoyment of the coast. Public access and recreational opportunities in the general area include two heavily-visited state parks, several camps, and the Pacific Coast Highway. Although the site itself is privately owned, public access to the inland canyon is possible for hiking and the beach is easily accessible just off the shoulder of the highway. It is part of a recreation area in the Santa Monica Mountains of increasing importance to the heavily populated Southern California urban areas. The construction traffic would cause heavy traffic conflicts on the narrow Pacific Coast Highway during times of peak use, and the construction noise and lights and activities would degrade the outdoor experience of the approximately two thousand children who use camps nearby during the summer and on weekends.

Recreation. Point Mugu Beach State Park extends to within 1¼ miles and Leo Carillo Beach State Park to within 2½ miles of the entrance to Deer Canyon. A terminal at this site would not directly impact the parks, but it would intrude on the recreational experience in an area presently untouched by industrial development. These impacts would be mitigated if the PUC imposes condition 31 requiring dedication of added coastal land for public use. The offshore area is used by sport fishermen, boater, and divers. The site is part of the proposed Santa Monica Mountains National Park.

Marine Environment and Land Resources.

Marine Resources. The marine resources offshore of the Deer Canyon site are judged by the Department of Fish and Game to be of less significance than the Little Cojo and Rattlesnake Canyon sites, but more significant than Horno Canyon. Offshore there is scattered kelp, and the area supports significant commercial and sport fisheries and recreational diving, but the fisheries are not dependent on near-shore kelp or reefs. The waters have been designated an Area of Special Biological Significance by the State Water Resources Control Board, but the Department of Fish and Game indicates that the marine resources at this site, while valuable, are less significant than those at Little Cojo or Rattlesnake Canyon. The site is along the migratory routes of California grey whales and some marine birds.

Land Resources. The wildlife and plants in Deer Canyon are more diverse and abundant than those at the other three sites since it is a coastal creek habitat that is relatively undisturbed. On the one hand, the presence of such wildlife and marine resources near the heavily populated Los Angeles area and the growing Oxnard Plain communities gives special value to these resources. On the other hand, the disturbance from the heavily traveled Pacific Coast Highway and popular parks and the approach of the residential development of northern Malibu detracts from the long-term significance of these wildlife populations. Therefore the Commission finds the adverse impacts on natural resources of a terminal at Deer Canyon would be moderate.

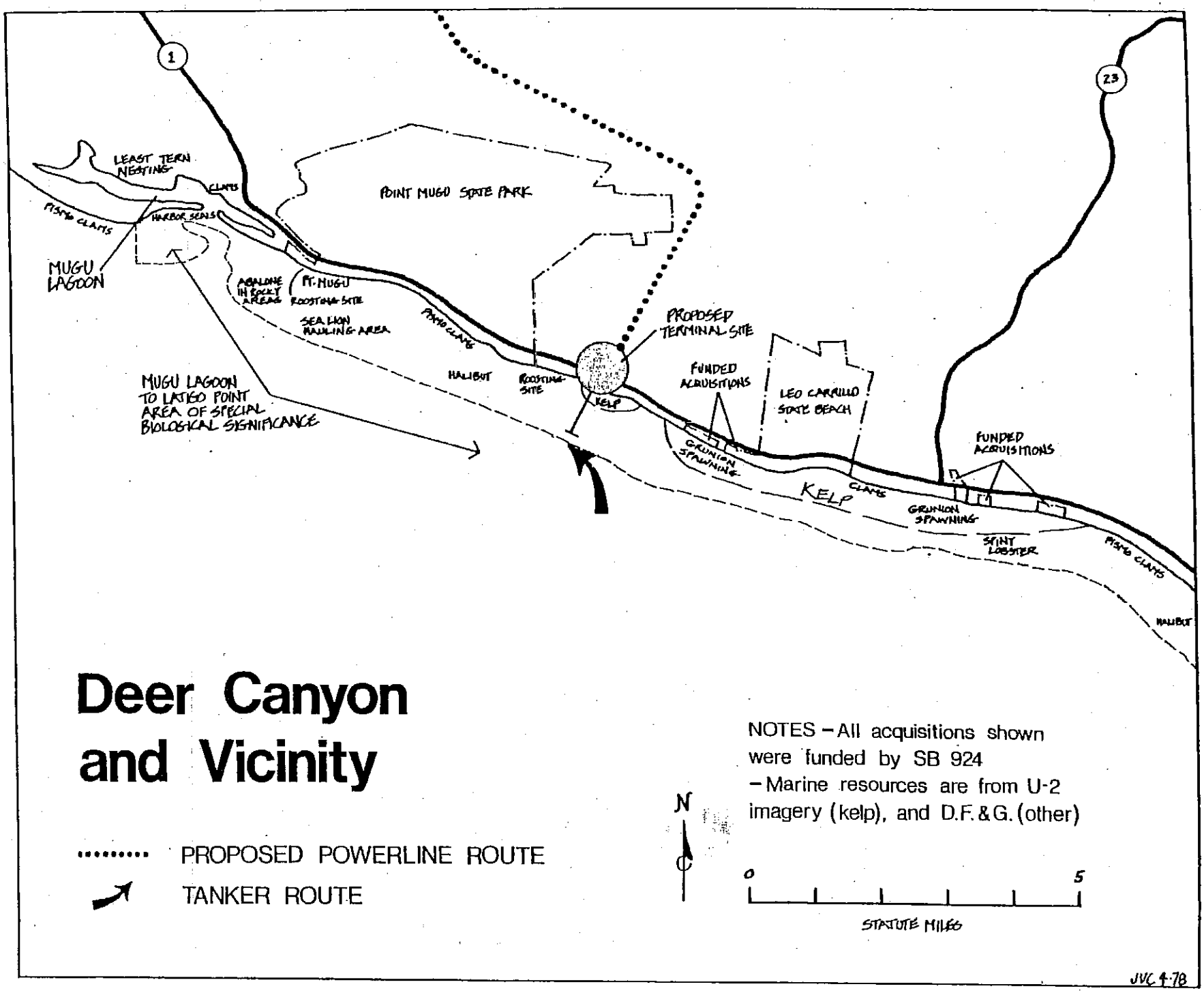

1
23
LEAST TERN NESTING
CLAMS
PISMO CLAMS
HARBOR SEALS
MUGU LAGOON
POINT MUGU STATE PARK
ABALONE IN ROCKY AREAS
PT. MUGU ROOSTING SITE
SEA LION HAULING AREA
PISMO CLAMS
HALIBUT
ROOSTING SITE
KELP
PROPOSED TERMINAL SITE
FUNDED ACQUISITIONS
LEO CARRILLO STATE BEACH
MUGU LAGOON TO LATIGO POINT AREA OF SPECIAL BIOLOGICAL SIGNIFICANCE
GRUNION SPAWNING
KELP
CLAMS
GRUNION SPAWNING
FUNDED ACQUISITIONS
SPINY LOBSTER
PISMO CLAMS
HALIBUT
Deer Canyon and Vicinity
PROPOSED POWERLINE ROUTE
TANKER ROUTE
N
NOTES – All acquisitions shown were funded by SB 924
– Marine resources are from U-2 imagery (kelp), and D.F.&G. (other)
0
5
STATUTE MILES
JVC 4-78

Figure 12

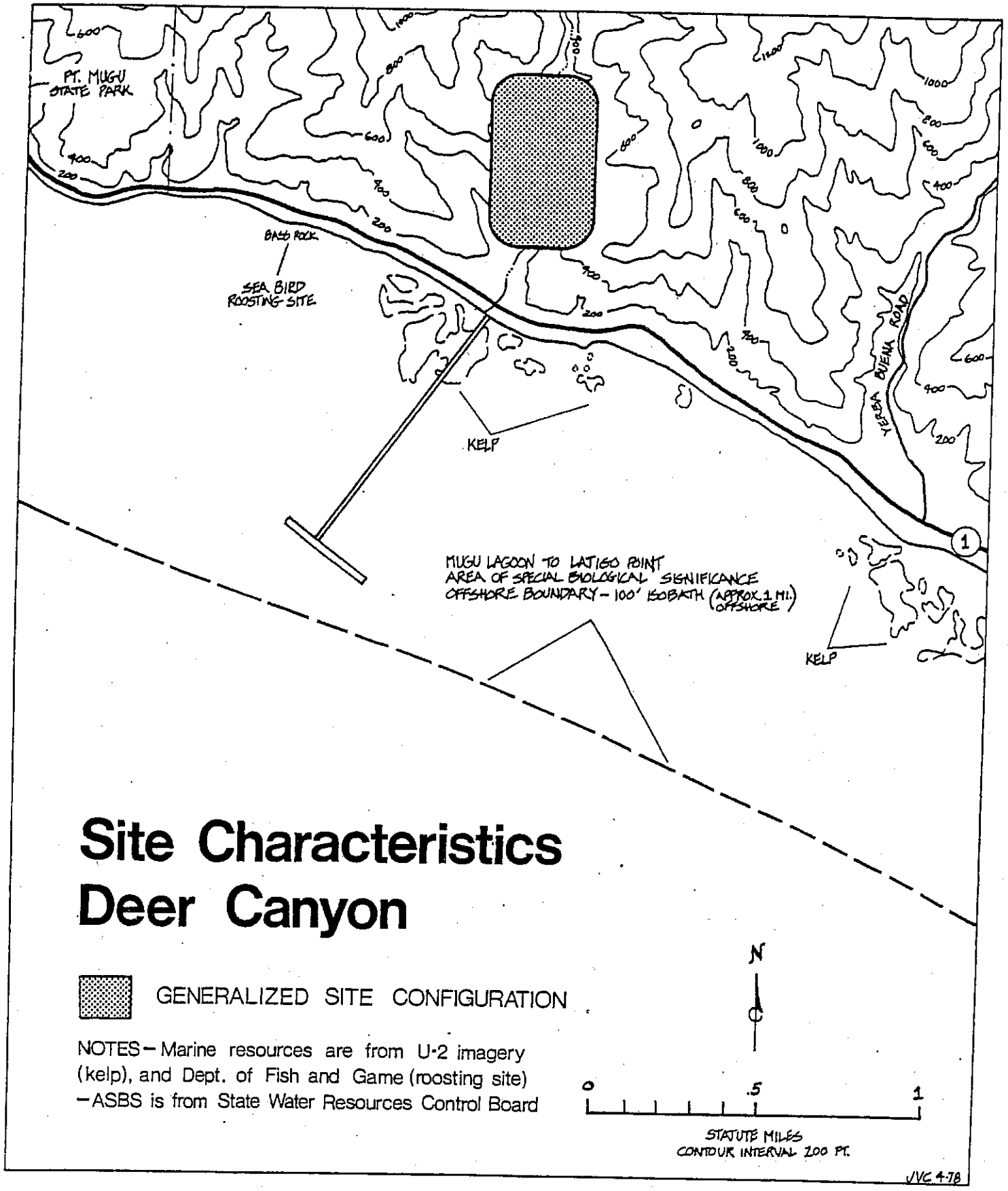

PT. MUGU STATE PARK
BASS ROCK
SEA BIRD ROOSTING SITE
KELP
MUGU LAGOON TO LATIGO POINT
AREA OF SPECIAL BIOLOGICAL SIGNIFICANCE
OFFSHORE BOUNDARY - 100' ISOBATH (APPROX. 1 MI. OFFSHORE)
KELP
YERBA BUENA ROAD
1
Site Characteristics
Deer Canyon
GENERALIZED SITE CONFIGURATION
NOTES - Marine resources are from U-2 imagery (kelp), and Dept. of Fish and Game (roosting site)
- ASBS is from State Water Resources Control Board
N
0
.5
1
STATUTE MILES
CONTOUR INTERVAL 200 FT.
JVC 4-78

Figure 13

Archaeological Resources. A Deer Canyon LNG terminal would have adverse impacts on archaeological resources. The Office of Historic Preservation indicates there may be at least eight Chumash archaeological sites in the site area and eight more nearby and that these resources are somewhat less significant than those at Little Cojo and Rattlesnake Canyon.

Land and Development Policies.

Character of Area. Deer Canyon is part of the closest undeveloped coastal area to the Los Angeles urban area. Although residential development of the greater Malibu area now extends to about four miles from the site, there is no industrial development on this mountainous stretch of the coast.

Public Services. A terminal at the Deer Canyon site would be inconsistent with Coastal Act policies favoring locations near existing development. Although road access exists, Highway 1 would be severely disrupted during the construction period. Electrical transmission lines would be brought in over the Santa Monica Mountains in new rights-of-way and emergency services are a long distance away.

Alteration of Natural Landforms. Preparing this site for construction would be a major earthmoving job involving filling the Canyon bottom areas with material cut from the ridges and canyon slopes. With condition 30, the extent of this earthmoving in the Canyon would be minimized, but even if it is fifteen million cubic yards to be filled and cut, the now natural canyon and small intermittent creek would be massively altered. Nevertheless, the Commission generally tries to minimize even small grading associated with building single family homes in the scenic Santa Monica Mountains, and this massive alteration contributes to the low fourth place ranking for this site.

Public Views. This stretch of the Pacific Coast Highway has special scenic value, since the Santa Monica Mountains drop down to the ocean here and there are many unobstructed views of the sea. The trestle and its road and cryogenic pipeline would cross over or under the Pacific Coast Highway, which can be heavily used on weekends and holidays for recreational driving. The terminal site itself would be sheltered inside the Canyon, but the trestle and associated activities would be noticeable from Point Mugu Beach State Park to the west and Leo Carrillo Beach State Park and the County line surfing area to the east.

Remoteness. The site compares to Horno and Rattlesnake Canyons in the number of people potentially at risk from LNG accidents. Such populations would include campers at the children's camps and State Parks and travelers on Pacific Coast Highway. Tankers to the site would traverse the Santa Barbara Channel.

Cost. Due to the large amount of earth moving required to prepare this site, terminal construction costs would be about $250 million higher than at the Little Cojo or Horno Canyon terminals. While this factor is given less weight by the Commission, it contributes to the low fourth place ranking for Deer Canyon.

11. Summary of Differences between Ranked Sites.

The Commission finds that a simple numerical ranking of the four possible LNG terminal sites does not adequately indicate the differences in coastal resource impacts between the sites. Although the Public Utilities Commission may select a lower ranked site only if it determines that to do otherwise would result in significant natural gas curtailments in California, the Coastal Commission believes the public and other state and federal agencies should be aware of how much more desirable one site is over another.

Based on its evaluation of the four ranked sites, as conditioned, the Commission finds that the differences between the Horno Canyon, Rattlesnake Canyon, and Little Cojo sites are not minor or small.

The Horno Canyon site is on the Camp Pendleton Marine Corps Base and public use of the area is prevented by Marine patrols. The marine and terrestrial resources are not unique and are ranked the least significant by the Department of Fish and Game. There are no known archaeological resources in the area. The site is readily accessible by an existing highway and railroad, and public services are nearby. Little landform alteration would be required since the site is nearly level. The principal effect of a facility at this location would be upon the scenic quality of this last remaining large open space between urbanizing San Diego and Orange Counties. Overall, construction and operation of a terminal at this site would cause the least adverse impacts on the resources protected by the Coastal Act.

The Rattlesnake Canyon site is also unavailable to the public due to security measures for the Diablo Canyon nuclear power plant and is also readily accessible by an existing road, with public services nearby. In other respects, however, the Rattlesnake Canyon site would be significantly worse than siting an LNG terminal at Horno Canyon. The marine resources at Rattlesnake Canyon are very rich and abundant, and breakwater construction would (at least temporarily) disturb this habitat. The effect of the seawater system on the marine biota is greatly reduced by the Commission's condition that warm discharge water from the nuclear power plant be used. Making use of the nuclear discharge water, however, requires a long pipeline which would add to the disturbance of the terrestrial wildlife. Therefore the impact on natural resources is much greater at Rattlesnake Canyon than at Horno Canyon. Unlike the Horno Canyon site, valuable arcaheological resources are found at Rattlesnake Canyon which would be difficult to avoid during construction. The Rattlesanke Canyon site is not served by rail, and equipment would have to be brought in by barge to Port San Luis and on Avila Road. These impacts contribute to the Commission's finding that considerably more adverse impacts will occur at the Rattlesnake Canyon site than at first-ranked Horno Canyon.

The Little Cojo site has many of the same disadvantages as Rattlesnake Canyon, but it is located remote from public services in an even more sensitive marine environment. As with the Horno and Rattlesnake Canyon sites, public access to the onshore area of the site is not now possible, but the marine life off Little Cojo is considered the most unique, abundant, and diverse of all the sites by the Department of Fish and Game. The marine environment in the Point Conception area is the most valuable because cold northerly waters and warmer southerly waters meet and mix there, making it the range limit for 14 species of fish and 20 species of invertebrates. In addition, Kelp Bed 23 is one of the most productive in the state and is a rich habitat for marine life. Condition 22 prohibiting seawater vaporizers would reduce the terminal's impact

but tanker, tug and line boat maneuvering, shipping fuel oil to the site, and operating a terminal with its associated noise and lights would cause continuing and permanent disruption of this sensitive habitat. Unlike either the Horno or Rattlesnake sites, a terminal at the Little Cojo site would result in major changes to the character of the last major semi-wild coast left in Southern California. The site is located on a wide, sweeping, open coastal terrace providing a striking panorama which stretches ten miles to the east and three to the west.

As with the Rattlesnake Canyon site, valuable archaeological resources are found in the Little Cojo area, which also has religious significance to Native Americans, and these resources would be difficult to avoid during construction, despite relocation of the terminal. The surfing breaks off Little Cojo are widely recognized as classic breaks providing a remote surfing experience. Although the Little Cojo site has some advantages over the Rattlesnake Canyon site because it does not require a breakwater as currently designed, would be more remote and cost less, a terminal at this site would be more inconsistent with the development policies of the Coastal Act and would have greater adverse impact on natural resources. The Commission finds, therefore, that the Little Cojo site is clearly less desirable than Rattlesnake Canyon; but, as conditioned, the difference between Little Cojo and Rattlesnake is not as great as between Horno Canyon and Rattlesnake Canyon.

The Deer Canyon site would have major adverse impacts on nearly all coastal resource categories, including recreation, views, highway capacity for recreation and access, marine and terrestrial natural resources, and the natural canyon landform. The marine resources offshore among scattered kelp, while less valuable than those at Little Cojo, are considerably more diverse and abundant than at Horno Canyon, and the offshore area is a designated Area of Special Biological Significance. The site, with a cryogenic pipeline crossing Pacific Coast Highway, is between two heavily used State parks, and construction activities and traffic would seriously interfere with recreational use of the Coast Highway. Massive changes to the Canyon bottom and its riparian habitat would be unavoidable since level construction pads would have to be built, filling in the Canyon to the 400 and 600 foot elevations. However, after construction period disruptions finish, a terminal would be mostly out of public view inside the Canyon and the long run adverse impact on the character of the Deer Canyon coastal area would not be as severe as at Little Cojo. Therefore, the Commission finds that the difference in adverse impacts between the Little Cojo site, as conditioned, and Deer Canyon would not be major overall and would be similar to that between Rattlesnake and Little Cojo.

The recommended conditions are necessary to minimize and mitigate the adverse environmental impacts of a terminal at all four sites. In general, the conditions make all the sites more suitable and would not change the ranking, except for the site specific conditions recommended for the Little Cojo site. If the PUC does permit the seawater intake system, new above-ground electric transmission lines and full use of an upgraded road and if the PUC does not mitigate adverse impacts on surfing and wildlife, or, if a breakwater were to be included as part of the project, then the overall adverse impacts of a terminal at this site would be so substantial that the Commission would have ranked it last, below Deer Canyon.

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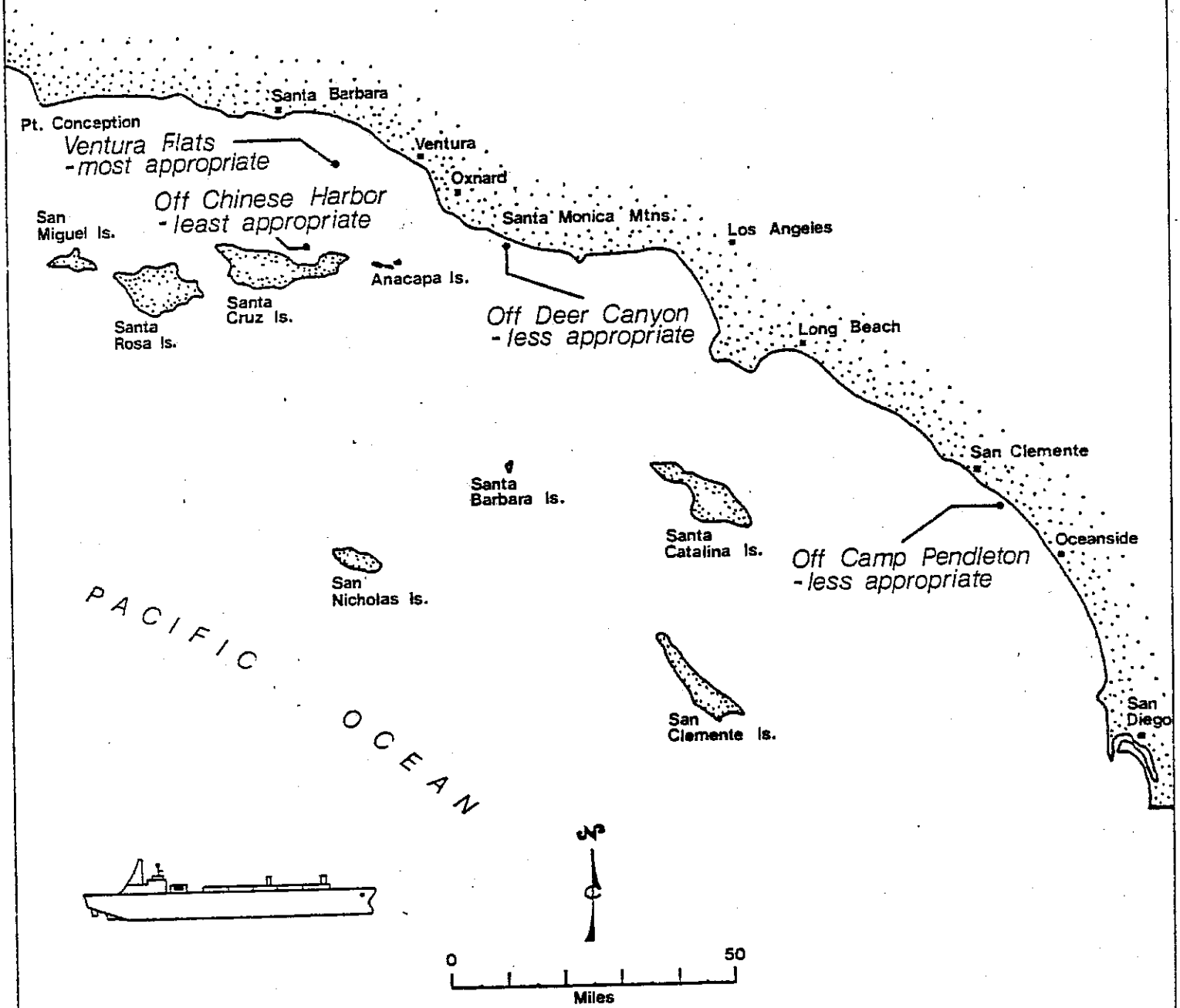
California Coastal Commission

Offshore LNG Terminal Study

September 15, 1978



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Note: The Appendices are presented in a separate volume available on request at the Commission's San Francisco office.

OFFSHORE LNG TERMINAL STUDY

SUMMARY AND MAJOR CONCLUSIONS

Introduction

This report presents Coastal Commission conclusions on potential offshore LNG terminal sites and types of terminals. The LNG Terminal Act of 1977 requires the Commission to present its judgment to the Governor, Legislature, Energy Commission, and Public Utilities Commission on the most appropriate sites for an LNG terminal offshore the California mainland and the most appropriate type or types of LNG terminals that could be located on such sites.

Study Approach

The Commission contracted with three designer-builder engineering firms to develop conceptual designs for one floating and two sea bottom-supported offshore LNG terminals at three specific sites offshore California. These designs permitted credible conceptual engineering and environmental evaluations of specific type terminals on actual potential offshore sites. At the same time, staff and consultants screened the entire California offshore area for zones where it might be feasible to site a terminal because of favorable winds, waves, water depths, and other factors. Seven zones off Southern California survived this initial screening. These zones have been evaluated with respect to terminal engineering problems, operational reliability in delivering gas to California, public safety, adverse impacts on marine and coastal resources, conflicts with existing recreational, military and other uses of offshore areas, terminal system cost, and the problems and time that could face obtaining required approvals and starting terminal operation.

Copies of the staff draft of this document were distributed in July 1978 to over 700 interested persons, including State and Federal agency staff, members of the gas transportation and offshore construction industries, and the general public, with a request for written or oral comment. During August, public nontechnical workshops on the study were held near the proposed sites and a technical workshop was held in Los Angeles to inform the public and answer questions. The Commission then held a public hearing on the study on August 15, 1978. Final revisions of the study were adopted by the Commission on September 5, 1978.

Relation of the Onshore Site Ranking to This Study

On May 24, 1978 the Coastal Commission adopted a ranking of four potential mainland onshore LNG terminal sites and transmitted that ranking to the Public Utilities Commission. The LNG Terminal Act requires the Commission to base that ranking on the policies of the California Coastal Act of 1976, whose most important policies protect public access and recreation along the coast, natural marine and onshore plant and wildlife resources, and the scenic quality of California's coastal areas. The issues of when a terminal could be put into operation or whether a site would be readily available for a terminal were given low

weight in the onshore site ranking, because the Act requires the PUC to analyze these issues. In this offshore LNG terminal study, however, the Coastal Commission must evaluate all aspects of offshore sites and terminals to judge overall "appropriateness." These aspects include site availability and likely opposition to terminal approvals, engineering feasibility and problems, safety, and cost, in addition to the impacts on objectives of the Coastal Act. After evaluating these aspects for sixteen combinations of sites and types of LNG terminals, one offshore site, with a floating type LNG terminal, seems to be "most appropriate."

The Most Appropriate Site

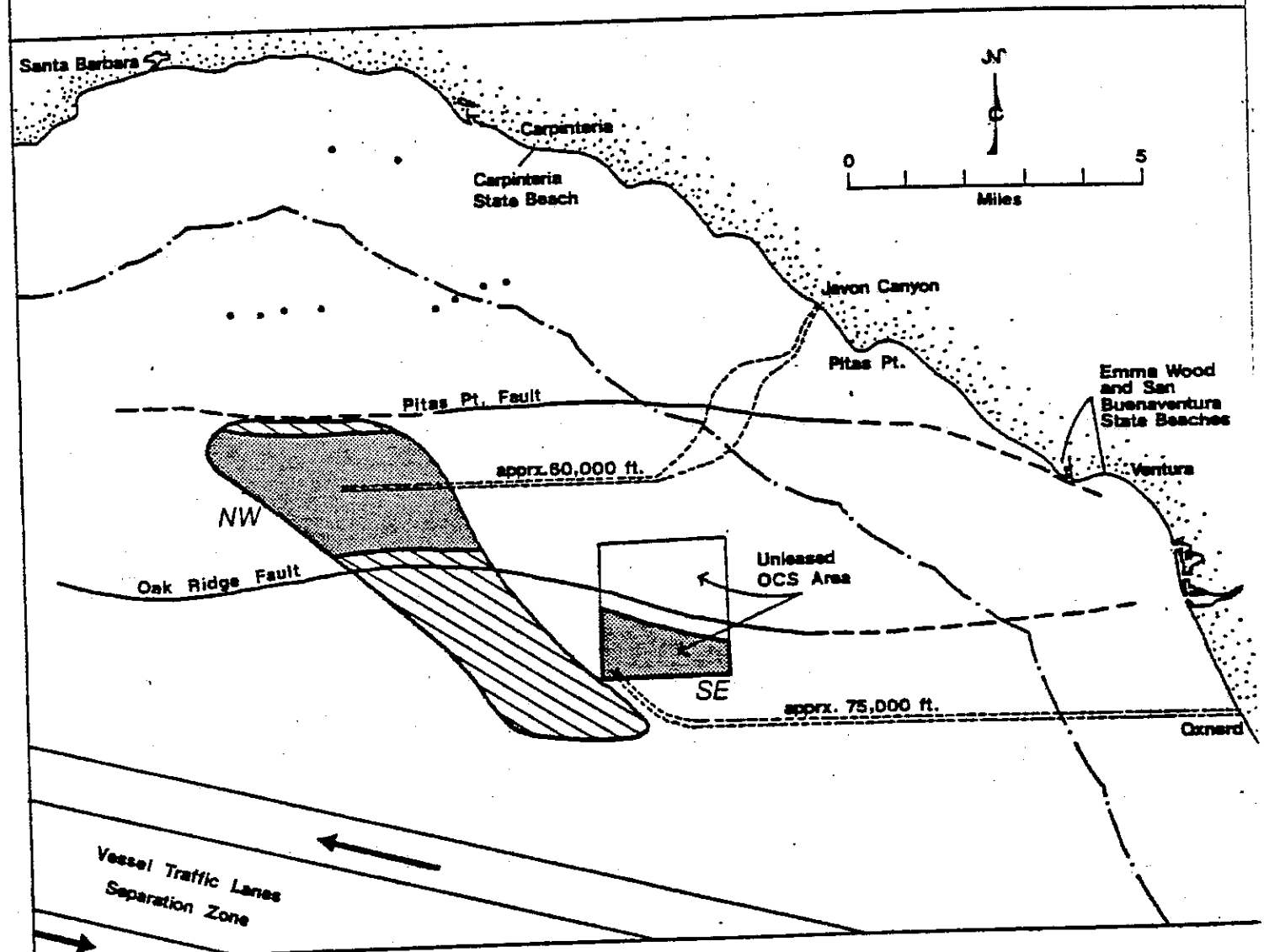
The most appropriate siting area for a liquefied natural gas (LNG) terminal off the shoreline of California appears to be in international waters of the southeast part of Ventura Flats. This area is more than 8 miles from the mainland in the eastern Santa Barbara Channel (Figure 1). Only the floating type of offshore LNG terminal of either the barge or semi-submersible type could be placed with confidence in this area because it is not dependent on favorable seismic and soil conditions of the sea bottom (Figure 2). Flexible moorings would connect the terminal to the sea bottom, but it would be supported by water and thus protected from earthquake shaking. A subsea bottom-supported terminal would also be appropriate on the site if foundation conditions are proven adequate.

Because of the site's distance from shore, a floating LNG terminal on the southeast Ventura Flats would have minimal adverse impacts on sensitive marine resources and public recreation along the coast. It would be visible on clear days from about 25 miles of coastline, but it would look like a large tanker and would be beyond the ten offshore oil production platforms in the area. Another advantage is that there would be a comparatively short underwater gas pipeline to the Oxnard area that would not cross major earthquake faults.

However, the LNG storage and LNG tanker operations of any offshore LNG terminal, even 8 miles from shore, would pose risks to public safety if an accident were to result in a large unconfined spill of LNG. Since Ventura, the closest urban area, is about 12 miles away, there would be a substantial safety zone. If a floating LNG terminal is proposed for this site, special safety measures should be taken relating to vessel controls, emergency anchors, availability of large tugs, and other equipment and operations to minimize risks of collisions and to insure that a floating terminal could not approach shore.

While southeast Ventura Flats has not been leased to oil companies for petroleum development, the area is under the jurisdiction of the federal government and there is no federal legislation at present enabling siting of an LNG terminal on the federal outer continental shelf (OCS). Congress is considering such

Ventura Flats



Refined Site Zone

Original Site Zone

Pipeline Route

Territorial Seas - 3 mile limit

Oil Drilling Platforms

Fault, dashed where inferred

(from Woodward-Clyde)

Dept. of Fish and Game resource information:

- Ventura Flats is heavily fished by purse seiners which make significant catches of northern anchovies.
- Brown pelicans and harbor seals feed in the site zone area.
- Grey whales pass through the site zone area during their migration period.

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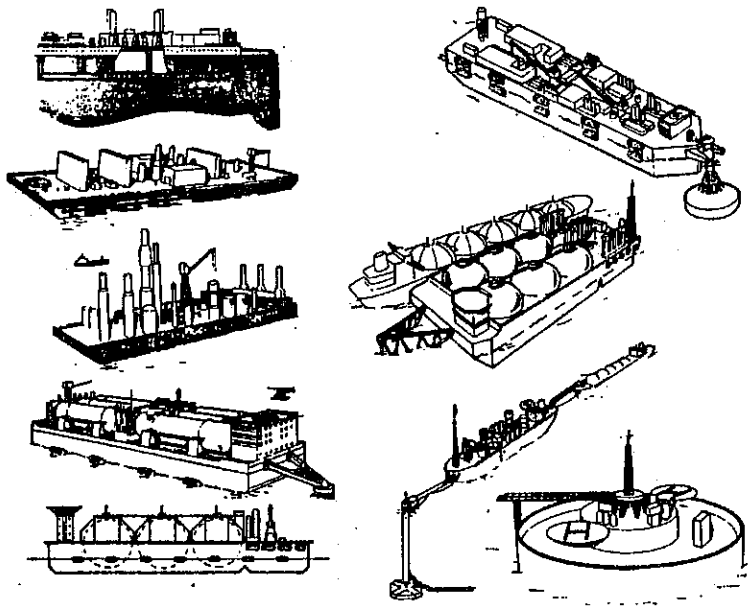
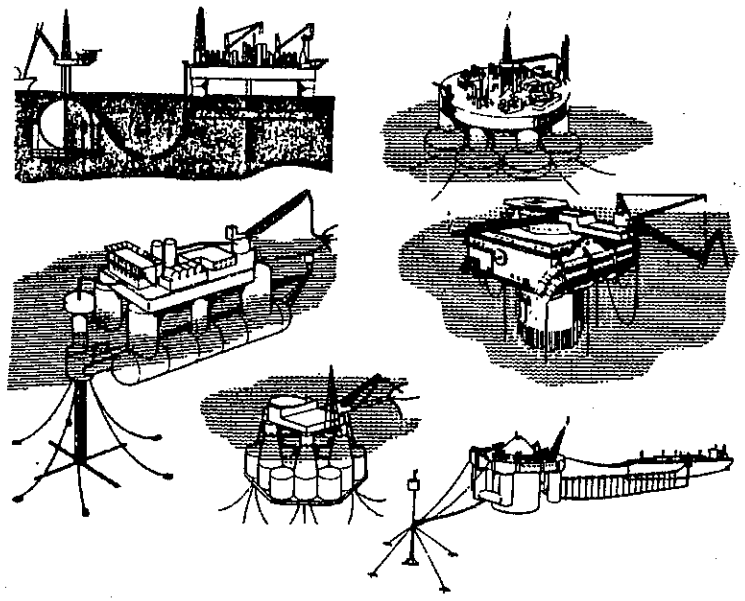
Figure 1

Types of Floating LNG Terminals and Moorings

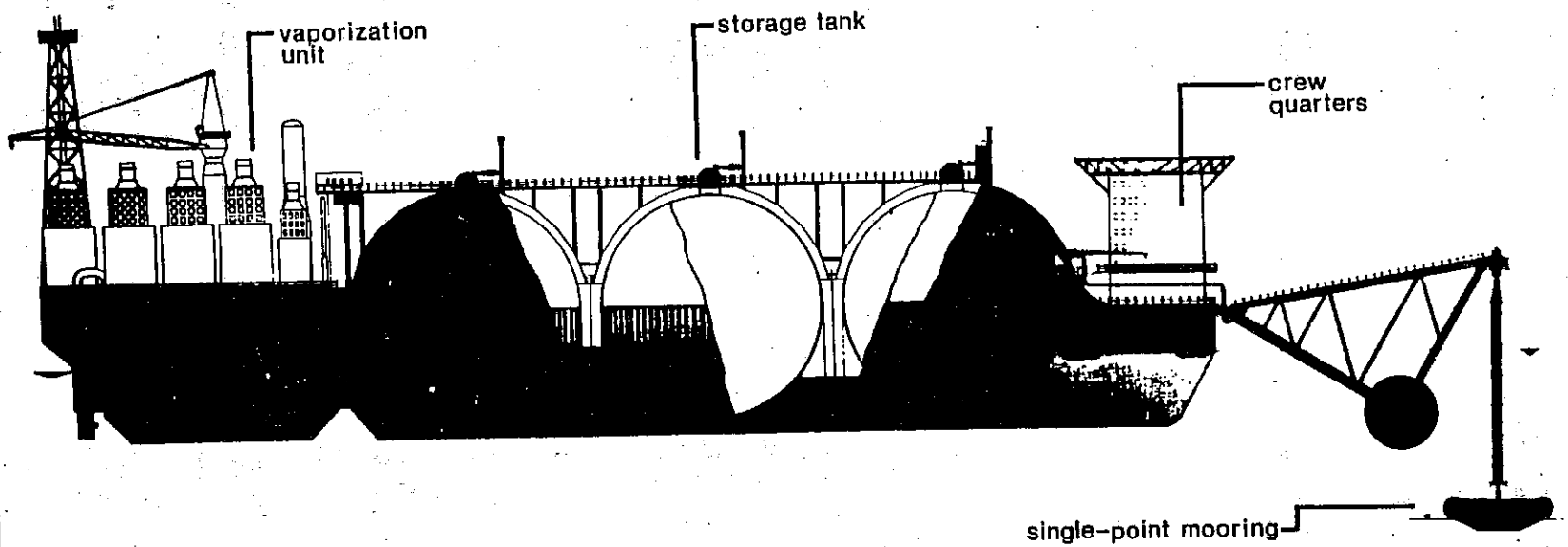


Surface floating terminals.



Semi-submersible terminals.

Fig. 2A



Floating Barge LNG Terminal

designed by Moss Rosenberg

Fig. 2B

legislation at present; no serious opposition has yet appeared, so prospects for passage seem favorable. Nevertheless, the lack of both a federal and state regulatory process for approving an offshore LNG terminal creates considerable uncertainty as to the full time it might take to obtain required approvals. If there is general support at all levels of government and limited opposition, it would take about 6 to 8 years to put a floating LNG terminal into operation on Ventura Flats from the time application preparation starts. This time estimate is optimistic. Given the experience of other major energy project applications, the time to approval could stretch out indefinitely. The total construction cost in 1978 dollars for a complete floating terminal and underwater and onshore pipeline connections to the California gas distribution system is estimated at about $500 million. A floating type terminal would be built in a shipyard and towed to the offshore site, minimizing adverse environmental impacts of terminal construction. California has shipyards and drydock sites where the terminal structure could be built, but no LNG carriers have yet been built in the State. In order to avoid any question of their accuracy, the illustrative time and cost estimates in this study are based upon quotes by experienced out-of-State builders.

Site Screening and Geotechnical Problems

The other possible offshore LNG terminal siting areas and the bottom-supported types of offshore LNG terminals all have serious problems or disadvantages that make them less appropriate or unacceptable. After screening out most of the California offshore area because of unacceptable wind and wave conditions, infeasible water depths for a pipeline to shore, nearness to population concentrations, and conflicts with other uses of offshore areas, seven areas were selected for further evaluation: Ventura Flats, offshore Camp Pendleton, offshore Deer Canyon, three areas on or offshore Santa Cruz Island called Chinese Harbor, San Pedro Point, and Smugglers Cove, and one area at Santa Rosa Island called Bechers Bay (Figure 3). Terminal designs for sites on the two islands would be the same as designs for mainland onshore terminals. In the water areas both floating and bottom-supported type LNG terminals were evaluated.

There are a number of types of bottom-supported LNG terminal designs including shallow water designs and designs with the LNG storage underwater (Figure 4). Unlike a floating terminal, such rigid offshore terminals would have the advantage of stability while a tanker berths alongside, and the gas pipeline connections to the sea bottom would be more reliable. But because they are supported by the sea bottom, they are susceptible to earthquake shaking. They require special water depths and sea bottom characteristics.

This dependence on favorable sea bottom conditions is a major disadvantage because an LNG terminal would be both a potentially hazardous facility and a critical facility to the State's energy supply. Coastal California and the offshore areas are seismically active (Figure 5), and this activity means that extensive seismic evaluations would have to be conducted and a number of federal and state regulatory agencies would have to be convinced that earthquakes and other geotechnical factors present acceptable risks to the terminal before any bottom-supported offshore LNG terminal could be approved. The seismic evaluations of the seven offshore areas indicate that geotechnical factors severely limit where a bottom-supported offshore LNG terminal can be sited.

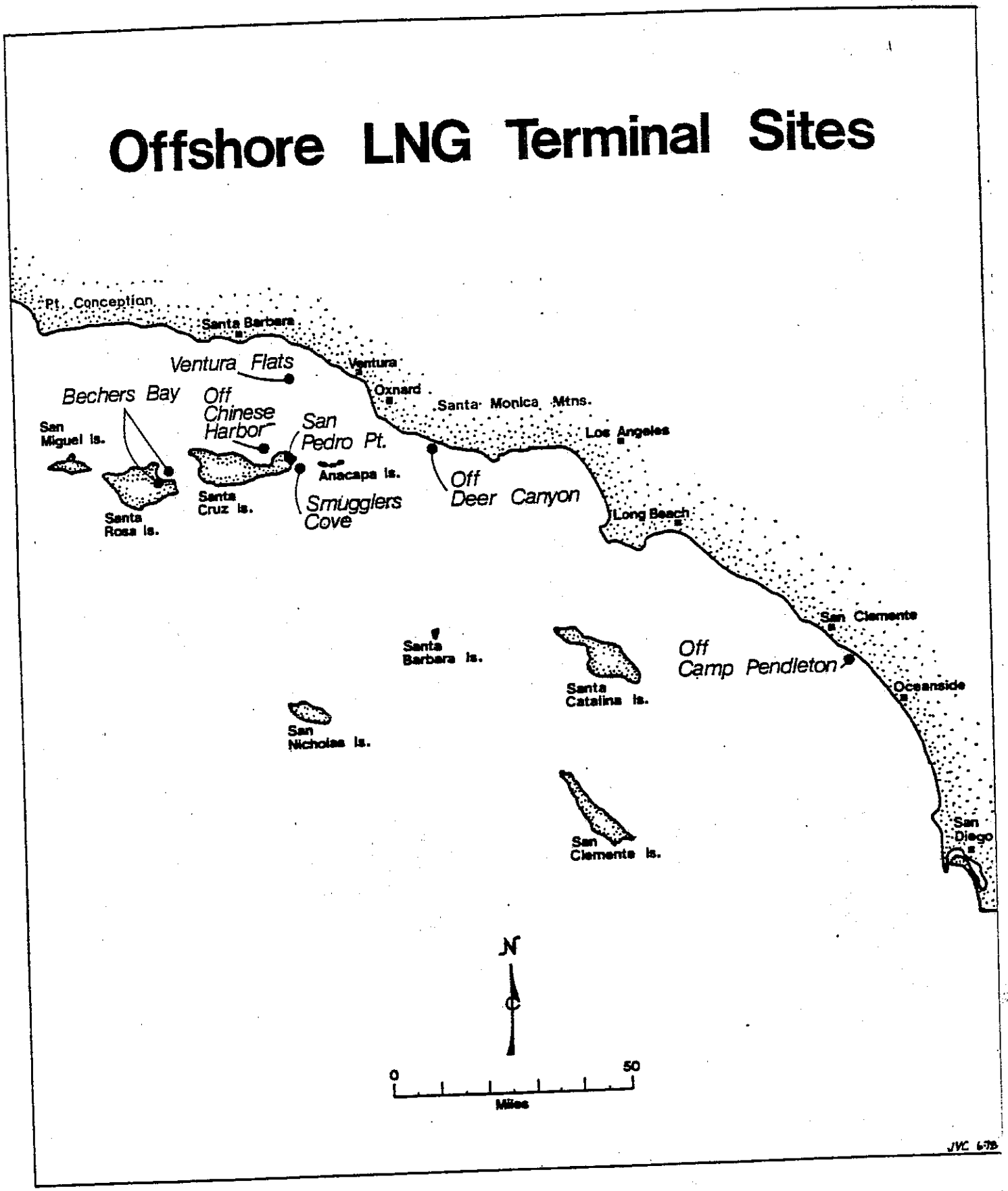

Offshore LNG Terminal Sites
Pt. Conception
Santa Barbara
Ventura Flats
Ventura
Oxnard
Santa Monica Mtns.
Los Angeles
Bechers Bay
Off Chinese Harbor
San Pedro Pt.
San Miguel Is.
Santa Rosa Is.
Santa Cruz Is.
Anacapa Is.
Smugglers Cove
Off Deer Canyon
Long Beach
San Clemente
Santa Barbara Is.
Santa Catalina Is.
Off Camp Pendleton
Oceanside
San Nicholas Is.
San Clemente Is.
San Diego
N
0
50
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Figure 3

Types of Bottom Supported Offshore LNG Terminals

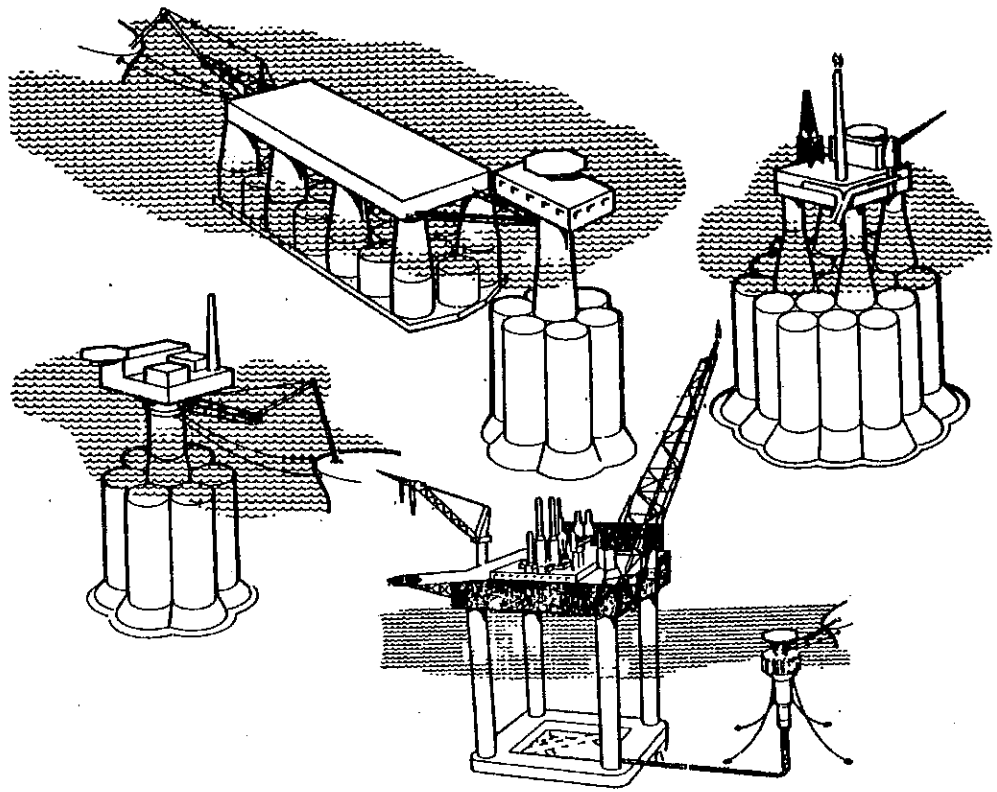

Figure 4

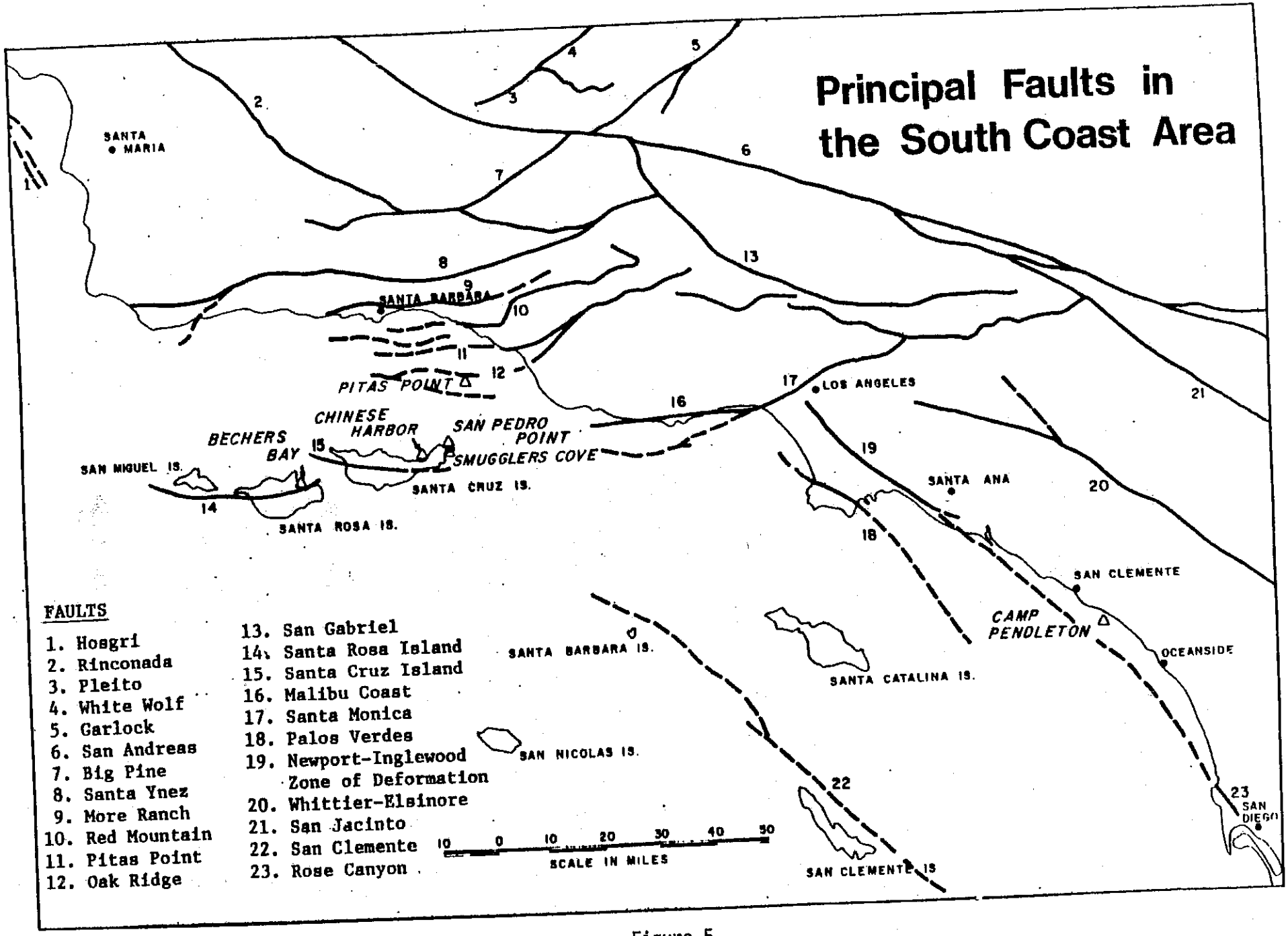
Principal Faults in the South Coast Area
SANTA MARIA
SANTA BARBARA
PITAS POINT
CHINESE HARBOR
SAN PEDRO POINT
BECHERS BAY
SMUGGLERS COVE
SAN MIGUEL IS.
SANTA CRUZ IS.
SANTA ROSA IS.
LOS ANGELES
SANTA ANA
SAN CLEMENTE
CAMP PENDLETON
OCEANSIDE
SAN DIEGO
SANTA CATALINA IS.
SANTA BARBARA IS.
SAN NICOLAS IS.
SAN CLEMENTE IS.
FAULTS
1. Hosgri
2. Rinconada
3. Pleito
4. White Wolf
5. Garlock
6. San Andreas
7. Big Pine
8. Santa Ynez
9. More Ranch
10. Red Mountain
11. Pitas Point
12. Oak Ridge
13. San Gabriel
14. Santa Rosa Island
15. Santa Cruz Island
16. Malibu Coast
17. Santa Monica
18. Palos Verdes
19. Newport-Inglewood Zone of Deformation
20. Whittier-Elsinore
21. San Jacinto
22. San Clemente
23. Rose Canyon
10 0 10 20 30 40 50
SCALE IN MILES

Figure 5

The evaluations provide moderate confidence that a bottom-supported terminal could safely and reliably be built on a part of the northwest section of Ventura Flats and off Camp Pendleton. Even there much more evaluation would be needed, and there would be the serious uncertainty of discovery of added faults anytime during the permitting process or during terminal operation. Thus the major advantage of a floating terminal over other onshore or offshore terminals is that only the base of the mooring system, and not other critical components, is susceptible to significant earthquake forces.[1]

Site Evaluations

The site evaluations show many other factors that make the seven sites other than southeast Ventura Flats less appropriate or unacceptable. The major factors in the evaluations are listed in Table 1. They include (1) confidence in the feasibility of terminal and pipeline construction and in reliable tanker berthing and pipeline operation, (2) public safety, (3) conflicts with recreation, petroleum development and military uses of offshore areas, (4) adverse impacts on marine and coastal resources, (5) cost, and (6) the time it could take to put a terminal into operation. A summary of these evaluations is presented in Table 1.

Ventura Flats. The southeast portion of Ventura Flats, centered 12 miles west of Port Hueneme and eight miles from the nearest land, is judged the most appropriate site. Of the terminal types evaluated, a floating terminal is definitely appropriate for the site and a subsea bottom-supported terminal may be appropriate if the sea bottom can be shown to provide a secure foundation for such a tall, massive structure.

Either a floating or subsea bottom-supported terminal would be feasible but less appropriate on the northwest part of Ventura Flats. The area has already been leased to oil companies by the Interior Department and there may be an oil field there, the underwater gas pipeline to shore would have to cross over the Pitas Point earthquake fault, and the route for the pipeline onshore would be especially damaging to environmental resources since it must traverse coastal and interior canyons (Figure 1).

Offshore Deer Canyon. A floating terminal about one mile off Deer Canyon (Figure 6) would also be feasible but less appropriate because it would intrude on the recreational experience at popular Leo Carillo and Point Mugu State Parks and at the coastal part of the Santa Monica Mountains, which are proposed for national park status. It seems unlikely that the public safety aspects of such a terminal would be acceptable. It would be about 5 miles from the Point Mugu Naval Pacific Missile Test Center and the homes of northern Malibu, while within 4 miles are heavily used parks, children's camps, and the Pacific Coast

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[1] Vertical earthquake forces are transmitted to floating structures but are estimated to be considerably smaller than the wave slamming forces for which such structures are routinely designed. Horizontal earthquake forces are "decoupled" from floating, flexibly moored structures.

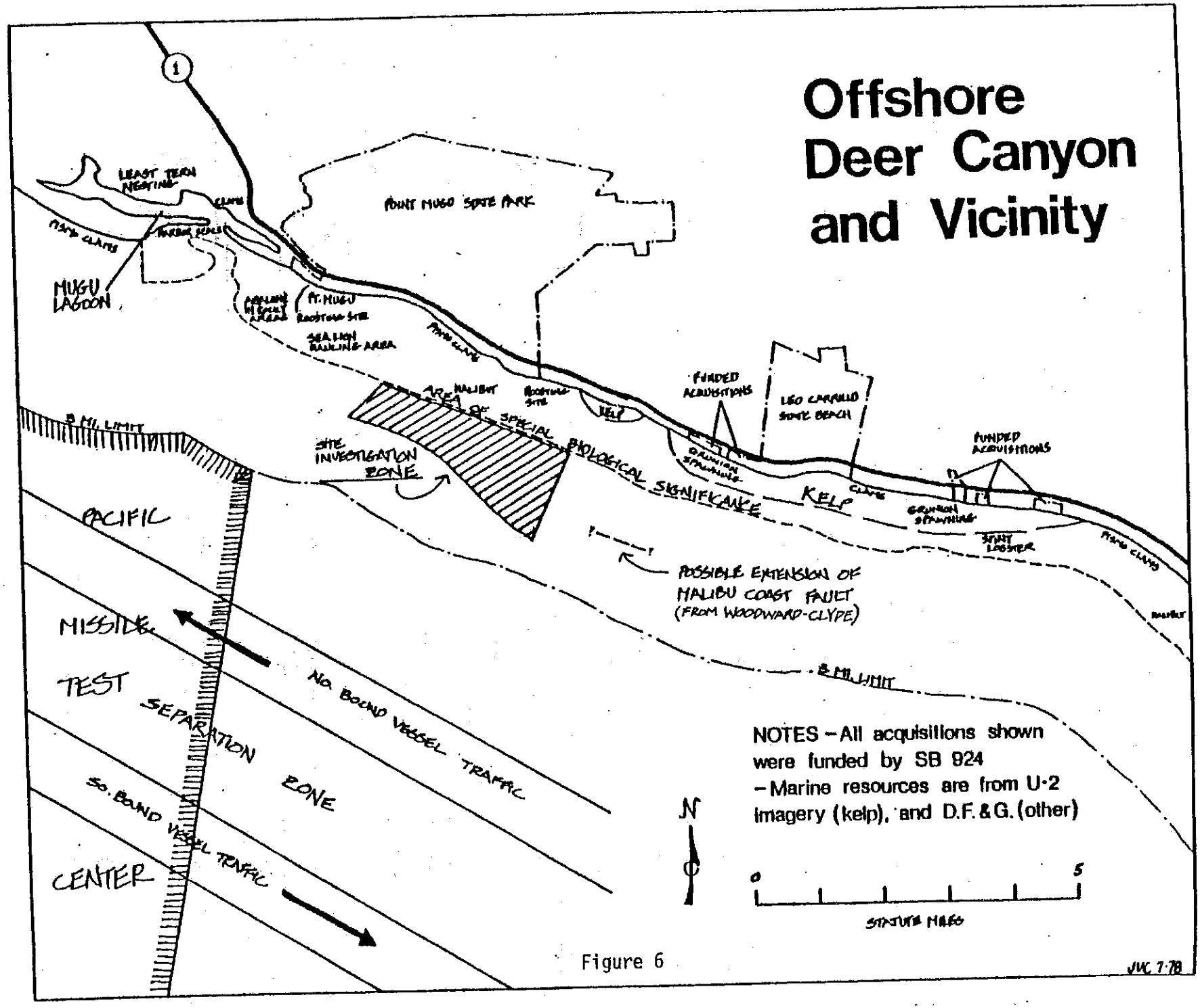

Offshore
Deer Canyon
and Vicinity
LEAST TERN NESTING
CLAMS
PISMO CLAMS
MUGU LAGOON
POINT MUGU STATE PARK
PT. MUGU
ROOSTING SITE
SEA LION HAULING AREA
PISMO CLAMS
HALIBUT
AREA OF SPECIAL BIOLOGICAL SIGNIFICANCE
ROOSTING SITE
KELP
FUNDED ACQUISITIONS
LEO CARRILLO STATE BEACH
GRUNION SPAWNING
CLAMS
FUNDED ACQUISITIONS
GRUNION SPAWNING
SPINY LOBSTER
PISMO CLAMS
HALIBUT
SITE INVESTIGATION ZONE
POSSIBLE EXTENSION OF MALIBU COAST FAULT (FROM WOODWARD-CLYPE)
3 MI. LIMIT
3 MI. LIMIT
PACIFIC
MISSILE
TEST
CENTER
SEPARATION ZONE
NO. BOUND VESSEL TRAFFIC
SO. BOUND VESSEL TRAFFIC
NOTES – All acquisitions shown were funded by SB 924
– Marine resources are from U-2 imagery (kelp), and D.F.&G. (other)
N
0
5
STATUTE MILES
JVC 7-78

Figure 6

ABLE 1: Summary of Site Evaluations

	Ventura Flats SE		Ventura Flats NW		Off Deer Canyon	Off Camp Pendleton	
	Floating	Subsea	Floating	Subsea	Floating	Floating	Shallow Bottom
Confidence in Construction Feasibility With Respect to Geotechnical (Mainly Seismic) Factors							
--Terminal	High	Low	High	Medium	High	High	Medium
--Pipeline	High	High	High	High	Low	High	High
Confidence in Reliability of Operations							
--Berthing (weather)	92%	96%	92%	96%	97%	98%	94%
--Pipeline (seismic)	High	High	Medium	Medium	High	High	High
Public Safety							
--Distance to nearest 1,000 people	12 mi	12 mi	9 mi	9 mi	4-6 mi	7 mi	5.5 mi
--Activity nearby (3 mi)	Sparse	Sparse	Sparse	Sparse	Moderate	Intense	Intense
--Critical facilities	None	None	None	None	Pt. Mugu, 4 mi	San Onofre Nuclear Power Plant, 4 mi	
Use Conflicts							
--Recreational conflicts	None	None	None	None	Substantial	Moderate	Substantial
--Petroleum leases	None	Leased	Leased	Leased	Partly	None	None
--Military conflicts	None	None	None	None	Small	Substantial	
Adverse Marine and Coastal Resource Impacts							
--Fishing	Moderate		Moderate		Moderate	Small	Small
--Special species	Some disturbance		Some disturbance		Some dis.	Small	Small
--Compatibility	Acceptable		Acceptable		Very poor	Poor	Poor
--Construction	Small	Small	Small	Small	Small	Small	Substantial
--Onshore pipeline	Small	Small	Severe	Severe	Substantial	Small	Small
Cost, ± 20% (1977-78 dollars)	$489m	$552m	$507m	$570m	$454m	$414m	$431m
Timing to Operation							
--Minimum time to operation	6-7 yr	7-8 yr	6-7 yr	7-8 yr	6½ yr	6½ yr	8 yr
--Likely opposition	Moderate		Substantial		Severe	Extreme	Extreme
Preliminary Overall Judgment	Most appropriate	Appropriate if feasible	Less appropriate	Less appropriate	Less appropriate	Less appropriate	Less appropriate

Box represents serious constraint

Off Chinese Harbor		Off Smugglers Cove		On San Pedro Point	Off Bechers Bay		Onshore Bechers Bay
Floating	Subsea	Floating	Shallow Bottom		Floating	Shallow Bottom	
High	Low	High	Low	Low	High	Low	Low
Probable, but not demonstrated					Questionable		
96%	97%	97%	96%	96%	94%	95%	95%
Medium	Medium	Medium	Medium	Medium	Low	Low	Low
24 mi	24 mi	23 mi	23 mi	21 mi	30 mi	30 mi	30 mi
Sparse	Sparse	Moderate	Moderate	Moderate	Sparse	Sparse	Sparse
None	None	None	None	None	None	None	None
Moderate	Moderate	Severe	Severe	Severe	Substantial		Substantial
None	None	None	None	None	None	None	None
Small	Small	Substantial		None	Substantial		Substantial
Moderate	Moderate	Severe	Severe	Severe	Severe	Severe	Severe
Substantial		Severe	Severe	Severe	Severe	Severe	Severe
Very Poor		Unacceptable		Unacceptable	Unacceptable		Unacceptable
Small	Small	Small	Substantial	Severe	Small	Substantial	Severe
Small	Small	Small	Small	Small	Small	Small	Small
$565	$628	$524	$545		$659	$680	
6½ yr	7 yr	No realistic figure					
Severe	Severe	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Barely acceptable		Not acceptable		Not acceptable	Not acceptable		Not acceptable

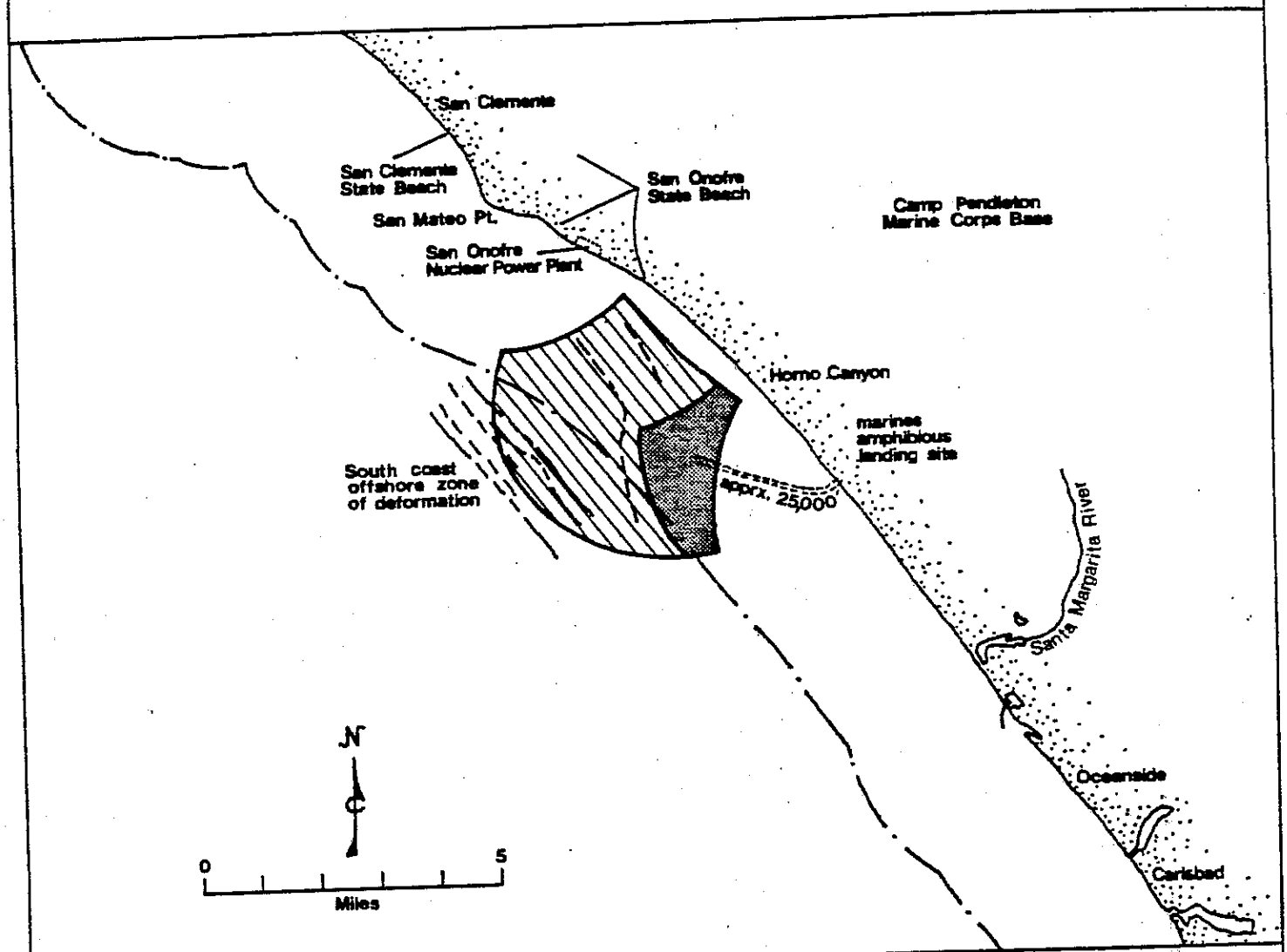
Highway. The advantage of this site is that it is within the three mile limit of State jurisdiction so no new federal legislation would be required to approve such a terminal. But strong opposition to this site would be likely and State approval, requiring both new legislation and application approval, seems highly doubtful. This site should be further considered only if an overwhelming need for LNG is shown and there are no other siting alternatives.

Offshore Camp Pendleton. Both a floating and shallow water bottom-supported type LNG terminal appear feasible off Camp Pendleton (Figure 7), but the geotechnical evaluations which found added traces of possible earthquake faults indicate only medium confidence that the bottom-supported type terminal could be sited there. Public safety problems would be serious since the LNG storage would be offshore and the terminal would be about 7 miles from San Clemente, 4 miles from Marine Corps barracks, and about 4 miles from the San Onofre Nuclear Power Plant. The site area, 1½ to 3 miles offshore, would be visible from San Onofre State Park, Interstate 5, and a long stretch of the San Diego County coast. The site's major advantage, as with the onshore site at Horno Canyon ranked first by the Coastal Commission among four onshore sites, would be the small adverse impact on marine biological resources. This site is less appropriate than Ventura Flats since strong opposition to its use for an LNG terminal could be expected from the U.S. Navy and Marine Corps, which operate amphibious warfare training exercises in the area.

Channel Islands. All the sites on or near the two Santa Barbara Channel Islands, Santa Cruz and Santa Rosa (Figure 8), present severe conflicts with the policies of the California Coastal Act of 1976. The Nature Conservancy is acquiring most of Santa Cruz Island for preservation of the valuable and unique terrestrial and marine life on the lightly disturbed island. All the islands are used by sensitive sea birds and marine mammals whose breeding and living would be seriously impacted by the noise, ship activity, construction activity and other aspects of an LNG terminal even 3 miles from shore. The waters around the islands are designated an Area of Special Biological Significance by the State Water Resources Control Board and are under study for designation as a National Marine Sanctuary. The islands are proposed for national park status.
In addition to these serious disadvantages, the Santa Barbara Channel Island sites present severe geotechnical and other engineering problems both for terminal construction and for the required long underwater gas pipeline to shore.

Only a small part of the Off Chinese Harbor site area (Figure 9) just inside 3 miles from the Santa Cruz Island shore can be considered barely acceptable. A floating type terminal appears to be feasible at this site, but it should only be considered if added remoteness from urban areas is required. The site is about 24 miles across the Santa Barbara Channel from Ventura. An underwater gas pipeline from the site to shore would have to be laid from special barges in water as deep as 770 feet. This depth plus possibly unfavorable bottom currents and other conditions could pose serious problems to pipeline construction and reliability.

Offshore Camp Pendleton



Refined Site Zone

Original Site Zone

Pipeline Route

Territorial Seas - 3 mile limit

Fault, dashed where inferred (from Woodward-Clyde)

Dept. of Fish and Game resource information:

- Sportfishing occurs in the site zone area.
- Brown pelicans are sighted in the area but do not nest locally.
- Least terns nest at the Santa Margarita rivermouth.

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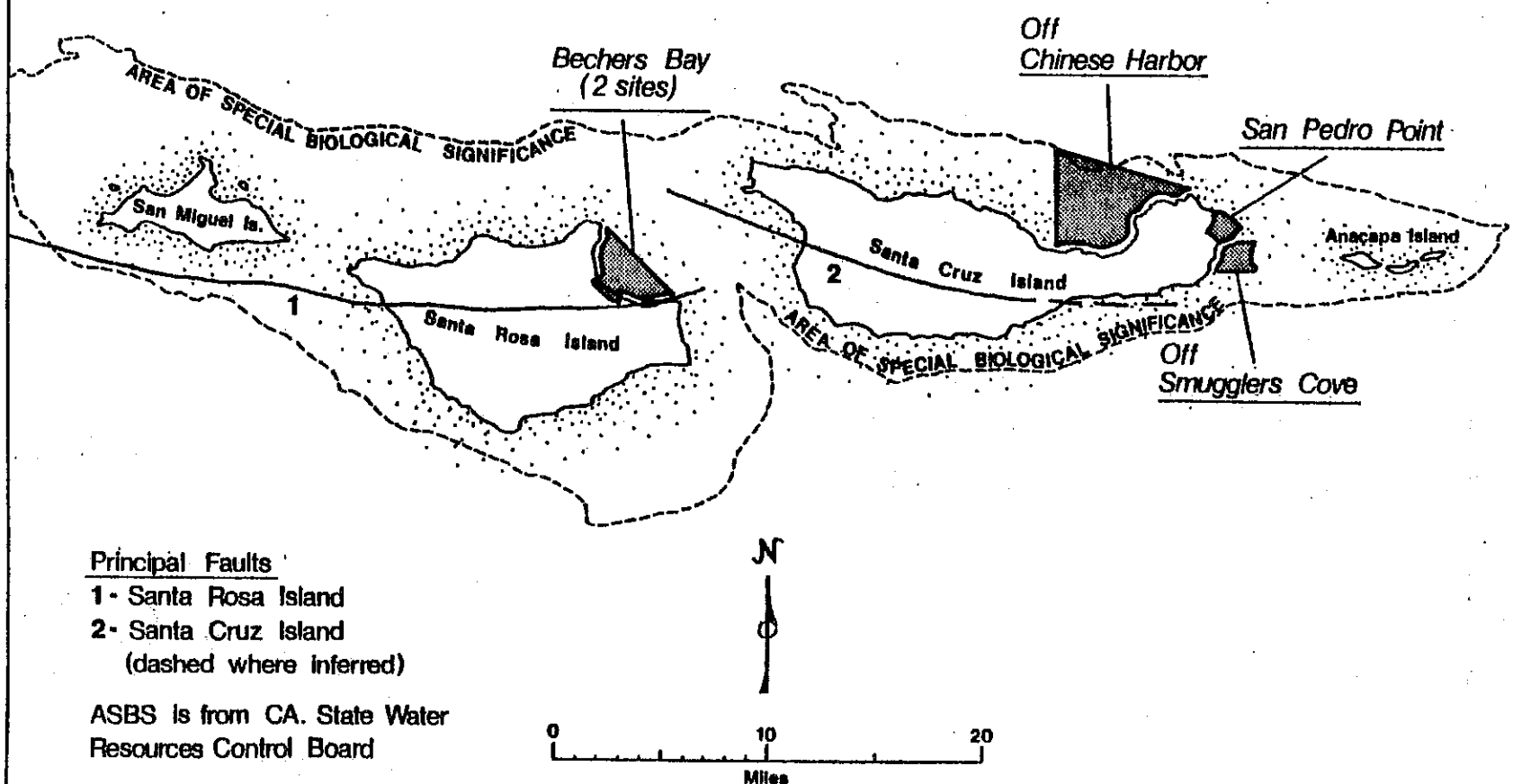
Figure 7

Site Investigation Zones

Channel Islands Area



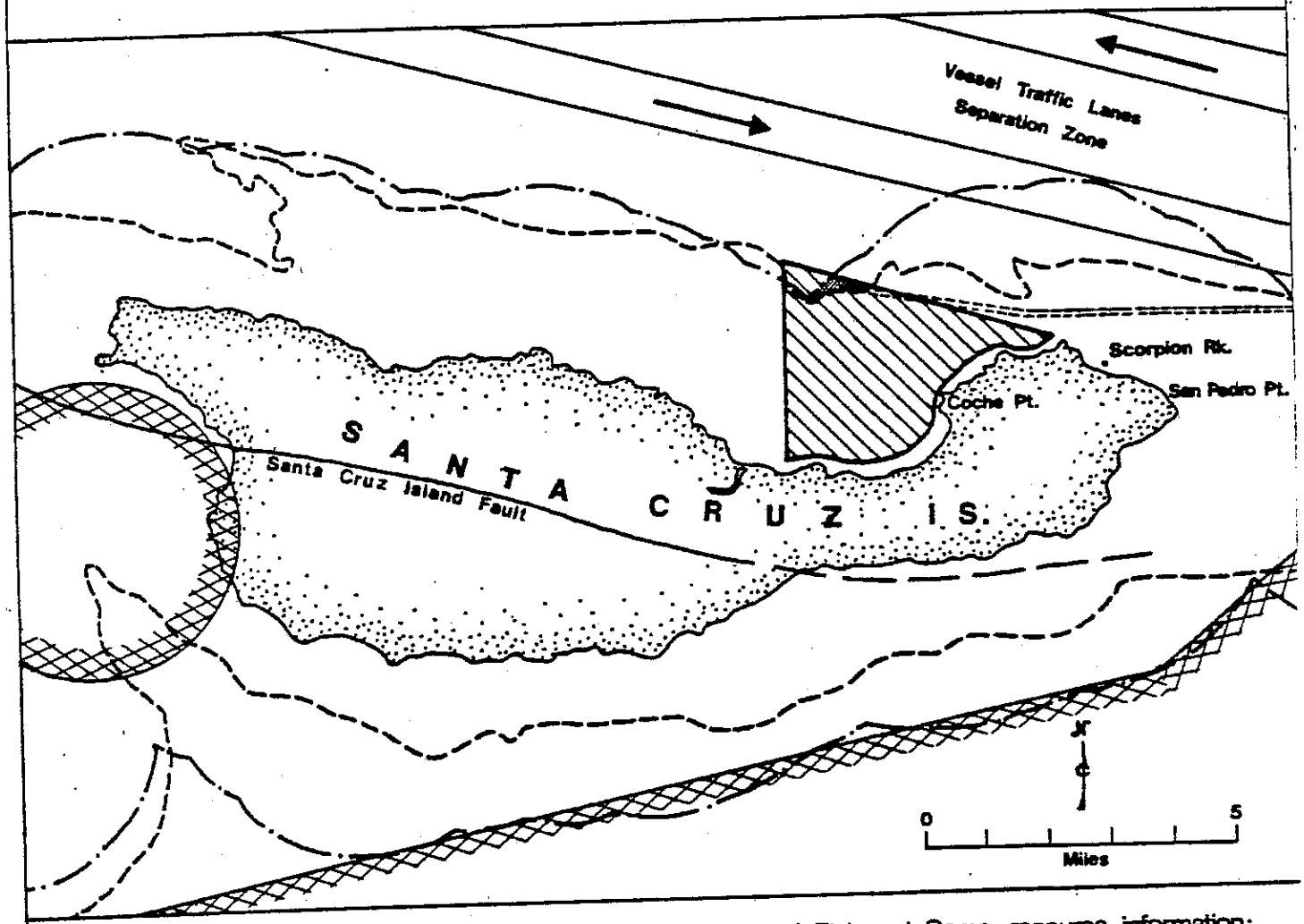
Principal Faults
1 - Santa Rosa Island
2 - Santa Cruz Island
(dashed where inferred)

ASBS is from CA. State Water Resources Control Board

Figure 8

JVC 6/78

Offshore Chinese Harbor



Refined Site Zone

Original Site Zone

Pipeline Route

Area of Special Biological Significance (seaward boundary - 300 foot isobath)

Territorial Seas - 3 mile limit

Military Operation Area (Pacific Missile Test Center)

Fault, dashed where inferred (from Woodward-Clyde)

Dept. of Fish and Game resource information:

- Scorpion Rock is the second most important seabird colony and supports one of the two brown pelican colonies in the Islands.
- Coche Pt. is a haulout and pupping area for harbor seals.
- Sport and commercial fishing occur within the site zone area.
- The local terrestrial environment supports rare, endangered, and endemic species of plants.

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Figure 9

I. BACKGROUND

A. The Liquefied Natural Gas Terminal Act of 1977

The Liquefied Natural Gas (LNG) Terminal Act of 1977 requires the California Coastal Commission to evaluate potential LNG terminal sites which are offshore from the California mainland, and to submit a final report by September 16, 1978 to the Governor, the Legislature, the Public Utilities Commission (PUC), and the Energy Commission. Section 5650 of the Act states in part:

> " . . . the coastal commission shall complete a final study of potential offshore sites and types of terminals for such sites. Such study shall indicate the most appropriate offshore terminal site or sites, in the coastal commission's judgment, together with the most appropriate type or types of terminals for each such site."

The LNG Terminal Act does not establish a procedure for, or authorize, the granting of a permit to construct and operate an offshore LNG terminal. The Act states that California's first LNG terminal, if permitted by the PUC, shall be on the California mainland. The Coastal Commission recently completed an evaluation and ranking of potential onshore sites and submitted a final report to the PUC, as required by the Act, on May 31, 1978.[1]

During the 1977 legislative deliberations on the LNG Terminal Act, a number of parties raised the possibility that an offshore terminal might have significant advantages over an onshore terminal. The potential advantages cited include decreased safety risks to onshore populations, minimization of conflicts with residential and recreational use of the coast, and decreased adverse environmental impacts. Prior studies had concluded an offshore LNG terminal would be technically feasible but could take a number of years longer to put

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[1] Copies of the Final Report Evaluating and Ranking Onshore LNG Terminal Sites, adopted by the Coastal Commission May 24, are available from the Commission's San Francisco office.

into operation than an onshore terminal.[2] There was no time during the deliberations, however, to develop detailed assessments of locating an LNG terminal offshore, and therefore the legislation established a procedure for reaching a decision on a permit for a mainland onshore site by July 31, 1978 and for a Coastal Commission study of offshore alternatives.

The Coastal Commission's final offshore LNG report could be used to guide the siting of a second LNG terminal in California, or, if the PUC determines an LNG terminal is not needed until the late 1980s, to assist selection of the most appropriate site from both onshore and offshore alternatives. In order for California's first LNG terminal to be located offshore, however, the LNG Terminal Act would have to be amended by the Legislature.

B. Description of Possible Offshore Terminal Facilities

Background

While there are many operating onshore LNG receiving terminals throughout the world, and presently two in the United States, no offshore LNG terminals have yet been constructed, except on islands. One terminal is being built on Elba Island in the Savannah River, Georgia, while an LNG receiving terminal is operating on the man-made Canvey Island close to shore in the English Channel. From experience with the existing onshore terminals and similar energy facilities designed primarily for oil development, several possible designs for offshore LNG terminals have been proposed by major engineering companies. These include terminals floating on the water and anchored to the ocean floor and terminals supported by the ocean bottom. Regardless of terminal design, however, any offshore terminal would perform the same function as terminals located onshore: to receive LNG transported by ships, unload and transfer the LNG into storage tanks, regasify it, and deliver natural gas via underwater pipelines to California's gas transmission system. Because cryogenic pipelines able to carry LNG at -260° cannot be built more than a few miles long without serious heat gain problems, an offshore terminal would have to send the regasified LNG to shore as natural gas, so all terminal functions, including LNG storage and regasification, would have to take place at the offshore terminal. With a mainland onshore terminal,

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[2] Fairchild Stratos Division, Offshore LNG Receiving Terminal Project, 3 volumes and supplement to volume 2, prepared for Western LNG Terminal Company, Manhattan Beach 1977. Report No. 4-76153. See also:

Atlantis Scientific, Feasibility Study: Offshore Siting of LNG Facilities, 1976.

Marcus, Henry S. and John H. Larson, Offshore Liquefied Natural Gas Terminals, prepared for the U.S. Department of Transportation Center for Transportation Studies, M.I.T., Cambridge, October, 1977.

R and D Associates, Offshore LNG Terminal Study, prepared for Western LNG Terminal Company, Los Angeles, 1976.

the LNG is unloaded from a tanker at the end of a trestle and transferred in a short cryogenic pipeline to storage on land until it is regasified and delivered to the gas transmission system (Figure I-1).

C. LNG Terminal Components and Performance Requirements for This Study

The LNG terminal evaluated here has the same general facilities and performance as the terminal proposed by Western LNG Terminal Associates for the Little Cojo site near Point Conception.

LNG Unloading. Once the LNG tanker has moored beside the terminal, the LNG will be transferred to the terminal's storage tanks. This study has assumed the tanks would have a capacity similar to the onshore terminal proposed by Western LNG Terminal Associates or about 1.65 million barrels. This is approximately equal to the LNG carried by two of the largest existing LNG tankers. The insulated storage tanks will keep the LNG at its normal liquefied temperature of -260°F.

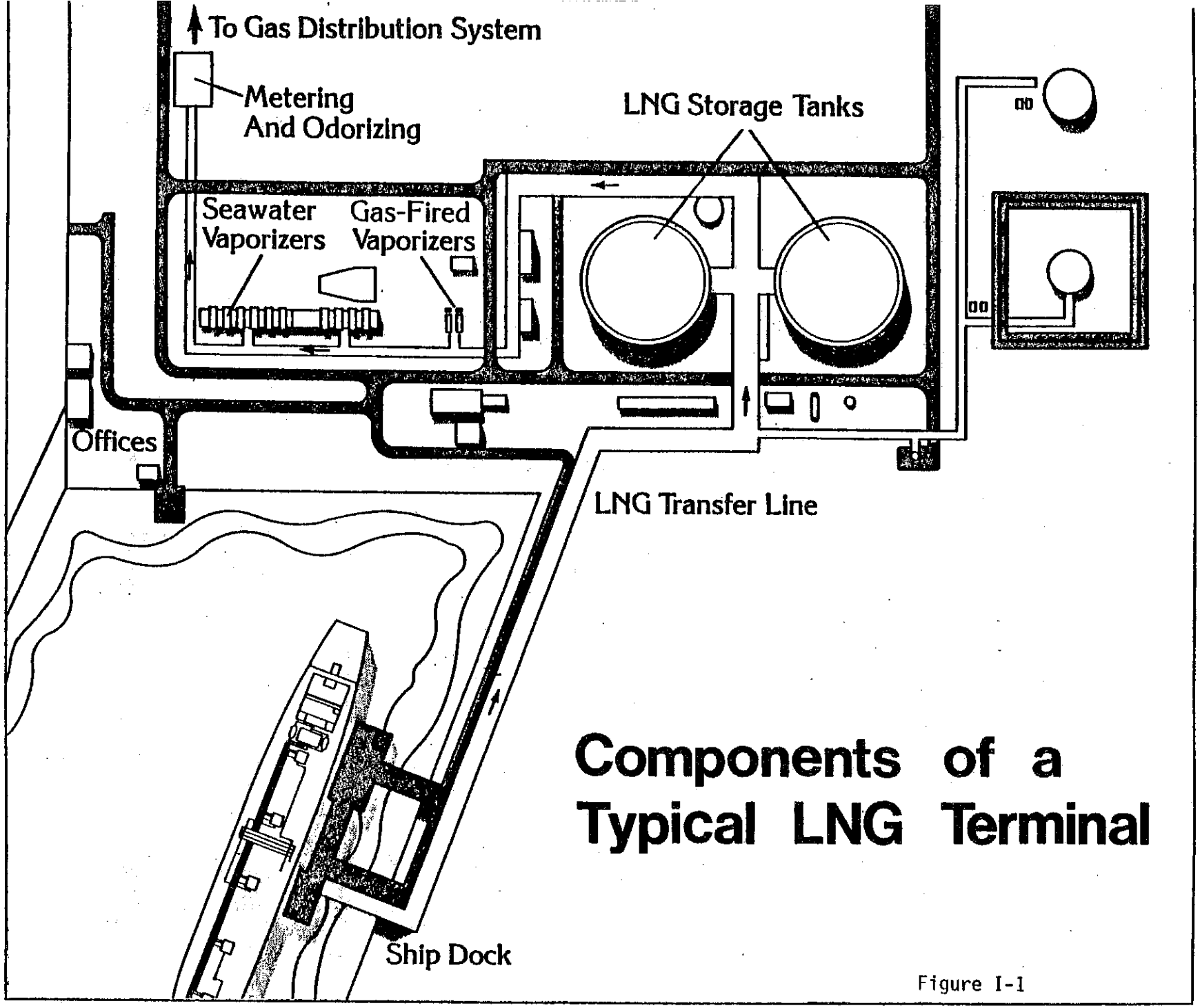
LNG Gasification (Vaporization). Before entering the natural gas transmission system for distribution, the LNG must be gasified and warmed to at least 40°F. The LNG is pumped from the storage tanks and revaporized in a heat exchange chamber using seawater or burning gas as the heat source. Under full operation 1.3 billion cubic feet per day (BCFD) of natural gas will be vaporized.

Seawater System. Seawater to vaporize the LNG is pumped from the ocean at a rate of about 100,000 to 200,000 gallons per minute. After warming the LNG the cooled seawater is returned to the ocean at a temperature about 10° to 12°F lower than at intake. Some form of biocide may be required to prevent marine growth in the seawater system.

Natural Gas Pipeline. Once the LNG has been pressurized, the natural gas is gasified and sent into two parallel underwater natural gas transmission lines. Except where special protection is needed, the pipelines would be on the surface of the ocean floor until they approached the surf zone of the shore, where they would be buried by several feet of cover. The pipelines would remain underground until reaching the most feasible point of connection to California's main gas distribution pipelines. The offshore pipeline distances from evaluated offshore sites vary from 1 to 60 miles, and the onland pipeline distances from shore to the distribution lines vary from 30 to 100 miles.

Bunker C Fuel Oil. Bunker fuel oil for LNG vessels will be brought to the terminal by tanker ship or barge and will be pumped into an oil storage tank. The number of bunker fuel deliveries needed will depend on the capacity of the storage, but approximately four shipments a month are estimated.

Electric Power. Electric power is needed at the terminal to operate the pumps for the seawater system, the LNG unloading process and natural gas send-out, as well as for normal low-voltage power needs. Electricity can be imported by cable to sites near shore or generated by natural gas turbines run with the terminal's vaporized LNG.



Components of a Typical LNG Terminal

Figure I-1

Other Storage. The terminal will store and transfer diesel fuel, fresh water, liquid nitrogen, provisions, and sanitary waste to LNG ships or service barges.

Operating Personnel. The terminal would require an operational work force of 50-75 employees, who will either live in quarters at the facility or commute by boat.

Tug Boats. Arriving LNG tankers will probably require assistance from tugs when making their approach to the terminal. Tugs would probably be based at a mainland California port and steam to the terminal when tankers are due to arrive.

Terminal Design Alternatives

Since no offshore facility has yet been built at an open ocean site, no one design has been universally accepted as the most feasible, reliable or economical. To evaluate and review various possible terminal concepts, the Commission contracted with three terminal design-construction firms for illustrative design work with estimates of construction cost and timing. The three illustrative terminal designs represent the three major structural approaches possible for offshore energy facilities at ocean (not island) sites: floating terminals, bottom-supported terminals in which the storage tanks extend above the water surface, and subsea bottom-supported terminals in which the tanks are completely under water. The final design could combine desirable features of more than one type studied.

D. Previous Commission Actions and Study Approach

In October 1977 the Commission directed the staff to begin an evaluation of possible offshore LNG terminal sites and of different terminal concepts. The basic study approach was to (1) identify major types of offshore LNG terminal designs and their siting requirements; (2) apply those siting requirements to the California offshore area to identify possible suitable siting areas; (3) develop performance standards and criteria for offshore LNG terminals; (4) contract for site-specific illustrative designs of three different types of offshore LNG terminals; (5) evaluate those designs with respect to the standards and criteria; (6) evaluate and judge the remaining suitable siting areas and the types of terminals that could feasibly be placed on them; and (7) assess the time needed for approval of offshore LNG terminals by presenting the site-specific illustrative designs to regulatory agencies for their reactions. This approach and the initial identification of terminal siting requirements and offshore California areas that might be suitable for LNG terminals were presented in the February 1, 1978 staff report, "California Offshore LNG Terminal Study, Interim Report."

To manage and support this special study, the Commission contracted with the consulting firm of Rust and Weinstein, Inc. of San Francisco, with Ted Rust as project manager. The Commission also retained consultants to evaluate the site areas: John J. McMullen Associates in Oxnard for evaluating maritime factors including wind and wave conditions and navigational hazards; Woodward-Clyde Consultants in Orange for geotechnical evaluations; H. J. Degenkolb and Associates

for structural engineering analysis; the California Department of Fish and Game for identification of marine and terrestrial plant and wildlife resources; Madrone Associates for analysis of terminal impacts on natural resources; the U.S. Army Corps of Engineers Waterways Experiment Station for wave calculations; and PBQ&D, Inc. for pipeline routes and feasibility; and Alan Magary for editorial consultation. The site conditions are analyzed in Section III, and the supporting consultant reports are summarized in Apendices A through D.

To enable site-specific evaluations of actual LNG terminal designs, the Commission contracted with three design-construction firms for illustrative designs of three different terminal types at three sites. General Dynamics was selected to develop design work for its floating barge terminal concept; Preload-Dravo for its concrete, shallow-water bottom-supported concept; and Norwegian Contractors for its concrete, deep-water bottom-supported concept called "Condeep." These three designs were selected after reviewing proposals from twelve firms. The design studies are evaluated in Section IV and summarized in Appendices G, H, and I.

Since there are no state or federal design standards for offshore LNG terminals, the Commission staff and consultants developed preliminary design criteria, relying heavily on existing standards for other offshore facilities such as ships and oil platforms, but raising the required level of overall safety to one more appropriate for such a large, critical, and potentially hazardous facility. The Commission's consultants in this area, who also helped evaluate the design studies, included Wesson and Associates for safety and fire prevention design criteria; John J. McMullen Associates in New York for maritime and LNG systems criteria; Woodward-Clyde Consultants in Houston for seismic design criteria; PBQ&D, Inc., for critical review of LNG terminal cost studies; Dr. Ben Gerwick, Jr., for structural design criteria; and Maurice V. Scherb for general technical review. These criteria, presented in Appendix F, are recommended as a point of departure for future regulation of LNG terminal design.

The following section presents the terminal and site evaluations and the major conclusions, while Section III provides information and evaluation of the offshore terminal siting zones that were identified in February 1978. Section IV evaluates the three different types of offshore LNG terminals and evaluates their advantages and disadvantages. The regulatory requirements for approval of an offshore LNG terminal at the different sites and the approval prospects, including expected time to terminal operation, are discussed in Section V.

The staff work on this project was done by Brian Baird, Dona Gara, Chris Garland, John Grattan, Bill Johnson, Jody Loeffler, Suzanne Rogalin, Tom Tobin, and Jonathan Van Coops, under the general direction of Energy Coordinator William Ahern.

II. SITE AND TERMINAL EVALUATIONS AND CONCLUSIONS

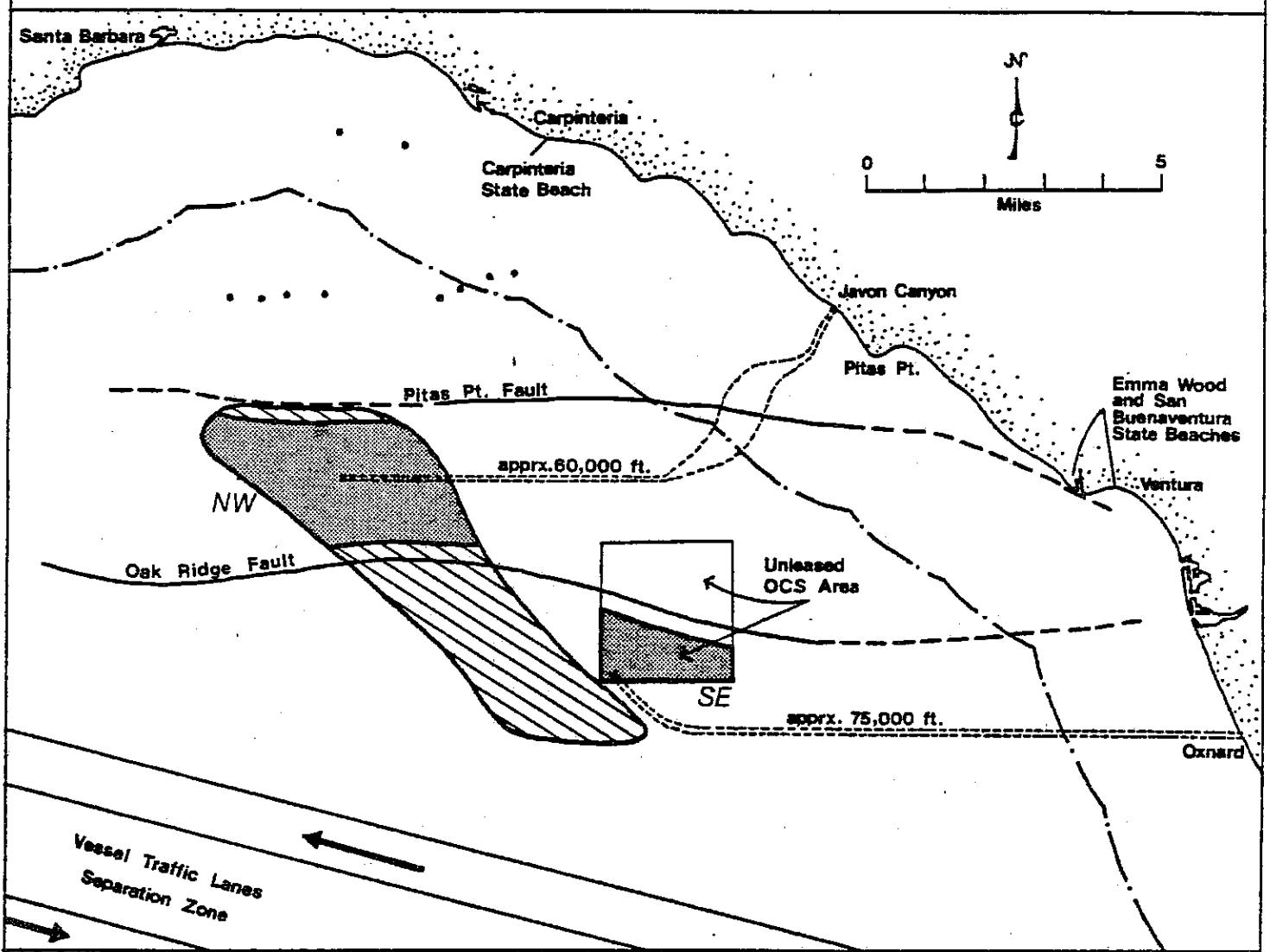
A. Major Conclusions

The most appropriate offshore LNG terminal siting area is the southeast part of the Ventura Flats zone, 12 miles southwest of Ventura in the eastern Santa Barbara Channel, with an underwater pipeline landfall at Oxnard (Figure II-1). A floating type LNG terminal could feasibly be placed in this siting area, but the feasibility of a bottom-supported design there has not been demonstrated. A floating terminal on this site would have small to moderate adverse impacts on marine and coastal resources, but these would be less severe than at any other offshore site investigated by the Coastal Commission. The total construction cost in 1978 dollars of an LNG terminal on southeast Ventura Flats, with connecting subsea and overland pipelines, would cost between $400 and $600 million. If there were strong political, financial and technical support, a terminal there could be in operation in as little as six years from the decision to prepare an application. However, any strong opposition or unforseen technical problems could stretch the approval process many years, since numerous safety, energy, and environmental agencies would have to grant approvals, and both new federal and state legislation would be needed to enable overall terminal approval. The terminal site is on the federally owned outer continental shelf beyond the state's three mile from shore jurisdiction.

Three other siting zones are feasible and acceptable for siting an offshore LNG terminal, but each is substantially less appropriate than Ventura Flats. These three are: 1½-3 miles offshore Camp Pendleton, one mile off Deer Canyon in Ventura County, and approximately three miles offshore Chinese Harbor at Santa Cruz Island (Figure II-2). Other potential siting areas near and on the Santa Barbara Channel Islands are unacceptable. In general, the two zones within three miles of the mainland, off Camp Pendleton and off Deer Canyon, present serious conflicts with recreational and military use of coastal areas. The zones near the Santa Barbara Channel Islands have the substantial disadvantage of being near the valuable and sensitive marine mammal and sea bird breeding areas on these relatively undisturbed islands. They are also difficult to reach with a subsea gas pipeline from shore due to the deep water and severe bottom conditions in the Channel.

The floating type of LNG terminal can be sited at all four acceptable siting zones because its feasibility and approval do not depend strongly on favorable seismic and sea bottom conditions. Only the base of the mooring system for a floating terminal is supported by and attached to the sea bottom (Figure II-2). While this is a critical element of the terminal, it represents only 2% of its cost and can be repaired if damaged by earthquake shaking or subsea landslides or other forces. The floating terminal itself would be supported by the water, and the water surface conditions are generally benign in the site areas that were selected.

Ventura Flats



Refined Site Zone

Original Site Zone

Pipeline Route

Territorial Seas - 3 mile limit

Oil Drilling Platforms

Fault, dashed where inferred

(from Woodward-Clyde)

Dept. of Fish and Game resource information:

- Ventura Flats is heavily fished by purse seiners which make significant catches of northern anchovies.
- Brown pelicans and harbor seals feed in the site zone area.
- Grey whales pass through the site zone area during their migration period.

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Figure II-1

Acceptable Offshore LNG Terminal Sites

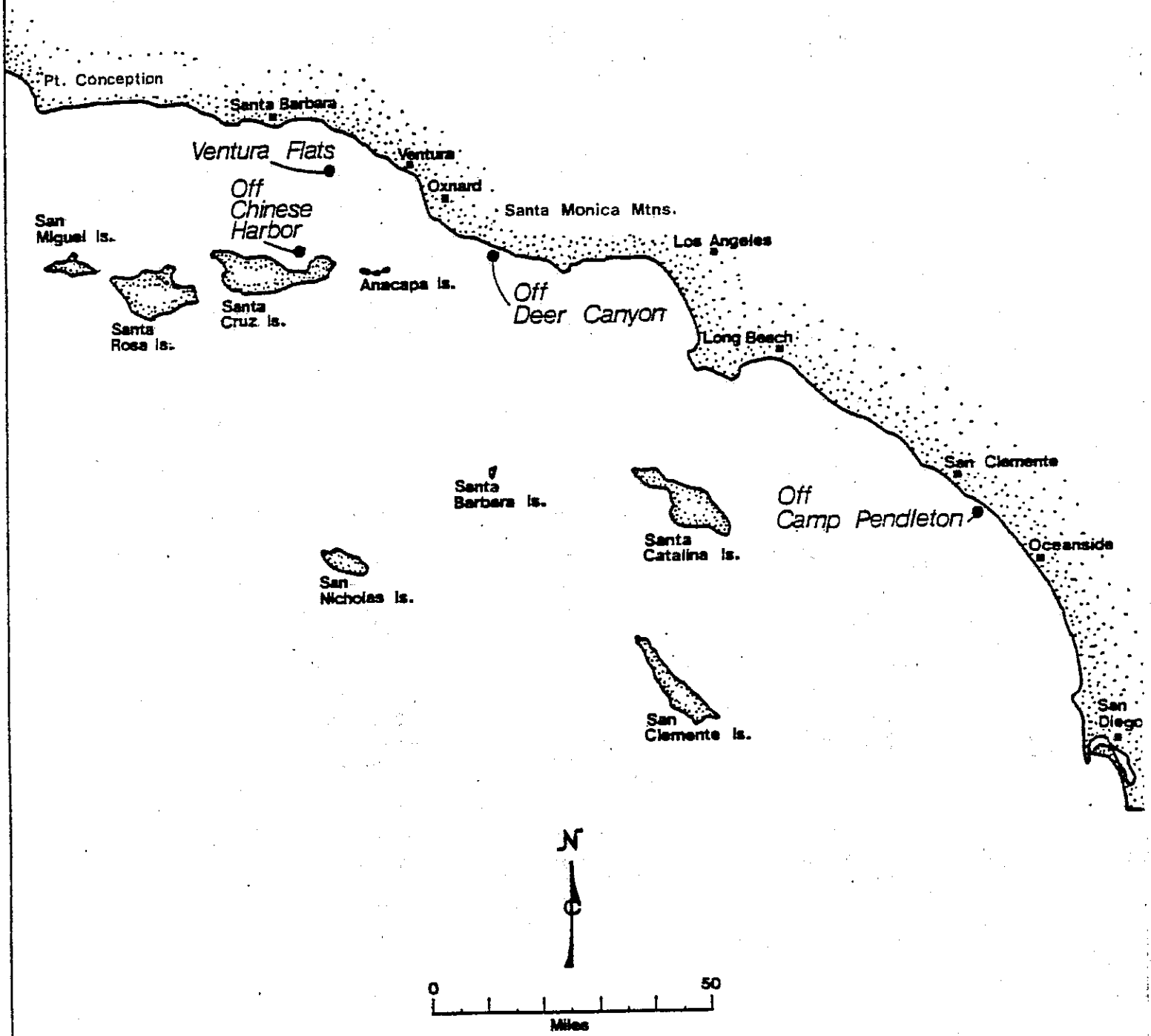

Figure II-2

On the other hand, sea bottom characteristics for supporting large critical facilities off California are generally demanding. The continental shelf is criss-crossed by numerous known and unknown earthquake faults (Figure 5). Much of the sea bottom is steep with unstable slopes. While initial evaluations indicate the shallow water bottom-supported type terminal may be feasible off Camp Pendleton and the deep water bottom-supported type on northwest Ventura Flats and off Chinese Harbor, there would be uncertainty about geotechnical feasibility and regulatory approvals, until an applicant has conducted extensive site and design-specific geotechnical evaluations and carried the burden of proof that a bottom-supported terminal could be safely and reliably built and operated.

The bottom-supported type offshore terminal should not be removed from further consideration, however, because it presents some advantages over the floating type. With floating terminals, both the terminal and the LNG tanker would move in response to wind and waves, creating large relative motions that could make LNG tanker berthing and unloading difficult. In addition, because a floating terminal would experience vertical and horizontal motions in the water, the gas pipeline to the sea bottom would have to swivel. While these motions can be accommodated in floating terminal designs, the bottom-supported type terminal provides a stable unloading berth for tankers and a rigid pipeline connection to the seafloor, enabling greater simplicity and reliability in the terminal system.

B. Initial Site Selection

Selection of feasible sites for an offshore LNG terminal has been just as difficult as locating possible onshore terminal sites. The most difficult siting constraint results from the need to connect any offshore terminal to the mainland with a large, high-pressure gas transmission pipeline. Such a pipeline can be installed reliably in ocean depths only to about 750 feet and, as shown in Figure II-3, this limit prevents use of most waters more than a few miles offshore. It also requires fairly gentle bottom topography. The offshore southern California bathymetry contains many basins as deep as 3,000 feet and much rugged terrain. A second major siting constraint is the generally hostile wind, wave and swell environment at offshore areas north of Point Conception. Wind, waves and fog can be frequent and severe off much of the coast, making marine operations more hazardous and less reliable. Applying the technical constraints of wind and wave conditions, areas offshore central and northern California between Point Conception and the Oregon border were eliminated from serious consideration. In addition, military operations, ship traffic, the presence of valuable marine and coastal resources and other factors limit the number of California offshore areas where a terminal could be built.

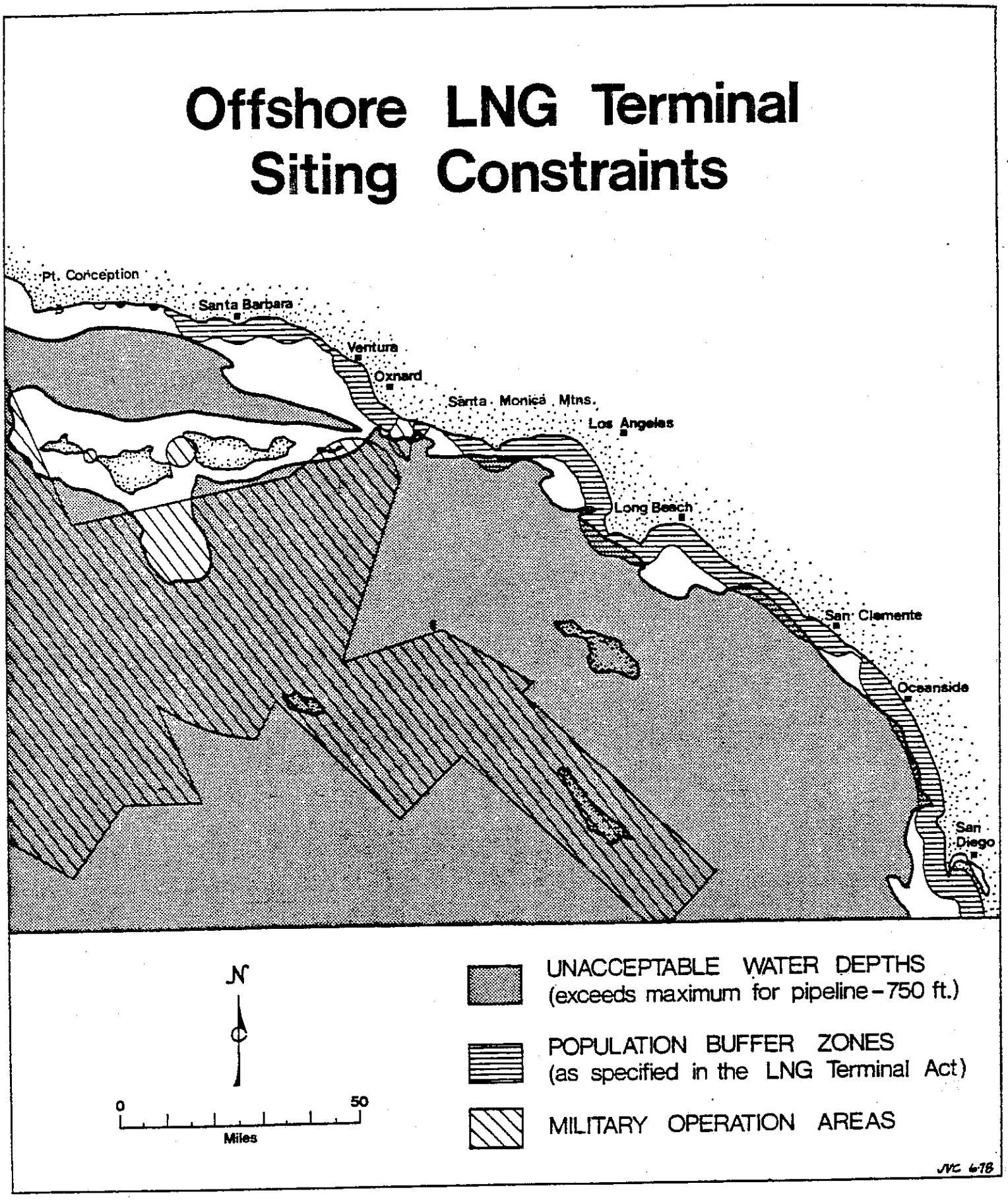
Offshore LNG Terminal
Siting Constraints
Pt. Conception
Santa Barbara
Ventura
Oxnard
Santa Monica Mtns.
Los Angeles
Long Beach
San Clemente
Oceanside
San Diego
N
0
50
Miles
UNACCEPTABLE WATER DEPTHS
(exceeds maximum for pipeline-750 ft.)
POPULATION BUFFER ZONES
(as specified in the LNG Terminal Act)
MILITARY OPERATION AREAS
JVC 6-78

Figure II-3

The limitation on ocean depths greater than 750 feet eliminates virtually all of the offshore area more than five miles from the mainland coast, with the exception of the Santa Barbara Channel Islands.[1] The islands are "linked" to the mainland by ocean depths of about 750 feet across the eastern end of the Channel. This connection is present because the Channel Islands are the underwater extension of the onshore Santa Monica Mountains range.

Although the LNG Terminal Act establishes population density requirements for the siting of an onshore LNG terminal to ensure a remote site, no guidance was given on population criteria for possible offshore sites. Siting an offshore facility closer to populated areas than allowed for onshore sites, however, would be inconsistent with legislative intent. Therefore, those offshore areas within four miles of about 1,800 permanent residents or workers were eliminated from consideration.

Military operations pose some potential problems to siting an offshore LNG terminal. Hundreds of square miles immediately south of the Channel Islands and two areas in the island chain are within the critical test ranges of the U.S. Navy's Point Mugu Pacific Missile Test Center. Possible sites off the southern part of the Channel Islands were dropped from serious consideration because of this conflict and the availability of other sites elsewhere around the islands.

As shown in Figure II-4, only a few offshore areas remain as feasible locations after these major siting constraints are applied. Three areas, offshore from Los Angeles, Long Beach and San Diego, were eliminated from further consideration due to the large population concentrations just beyond four miles and the vessel traffic in the area. From the remaining feasible areas, seven site "zones" were selected for extensive review by staff and consultants. Zones, as opposed to specific sites, were chosen to allow for flexibility in future siting after detailed evaluation of bottom conditions, seismic characteristics, possible terminal designs, and other factors. The seven site zones selected were:

Zones	Facility Types Considered
(1) Ventura Flats, eastern Santa Barbara Channel	Floating, Subsea Bottom-Supported
(2) Off Deer Canyon, Ventura County	Floating

[1] Deeper pipelaying techniques are being developed. The same basic siting constraints would apply, however, even if this limit were doubled.

Zones	Facility Types Considered
(3) Off Camp Pendleton San Diego County	Floating, Shallow Bottom-Supported
(4) Smugglers Cove, off Santa Cruz Island	Floating, Shallow Bottom-Supported
(5) San Pedro Point, on Santa Cruz Island	On-island
(6) Chinese Harbor, off Santa Cruz Island	Floating, Shallow and Subsea Bottom-Supported
(7) Bechers Bay, Santa Rosa Island	Floating, Shallow Bottom-Supported, On-island

Parts of the nearshore area off Santa Barbara County, both off Pitas Point and at the western end of the Channel also meet the population and wind and wave requirements. But these offshore sites within three miles of shore were not retained for further evaluation early in this year because there appeared to be at least two feasible onshore sites for an LNG terminal, Little Cojo and Las Varas. There seemed to be no advantage in siting a nearshore terminal in the water where onshore sites were available and appeared more desirable. However, now that seismic problems have eliminated Las Varas and affected approvability of the Little Cojo onshore site, there could be advantages with a floating terminal since it would be decoupled from the most serious seismic forces. On the other hand, any offshore LNG terminal near the mainland in the western Santa Barbara Channel would conflict with the valuable marine and recreational resources present there.

C. Evaluation of Sites and Terminals

The basis for the conclusions is the evaluation of 16 site and terminal type combinations with respect to engineering feasibility, public safety, conflicts with current uses of offshore areas, adverse environmental impacts, cost, and time expected for approvals and construction. In ranking possible onshore LNG terminal sites, the Coastal Commission was required to base its ranking on the policies and goals of the California Coastal Act of 1976. In applying these policies the Commission gave heavy weight to policies protecting public access and recreation along the coast, marine and terrestrial natural resources, and the unique and scenic character of remote coastal areas. The Commission also considered public safety and terminal cost in the ranking. Sites such as the Las Varas site were removed from the ranking when information on seismic

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