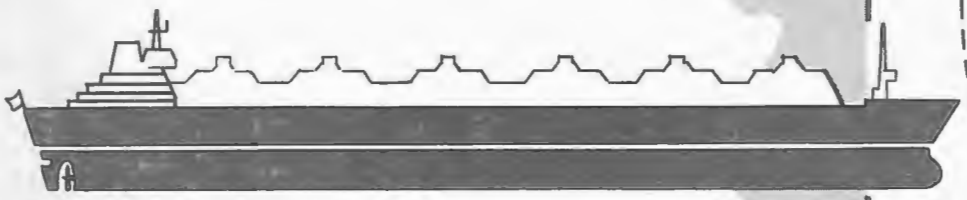
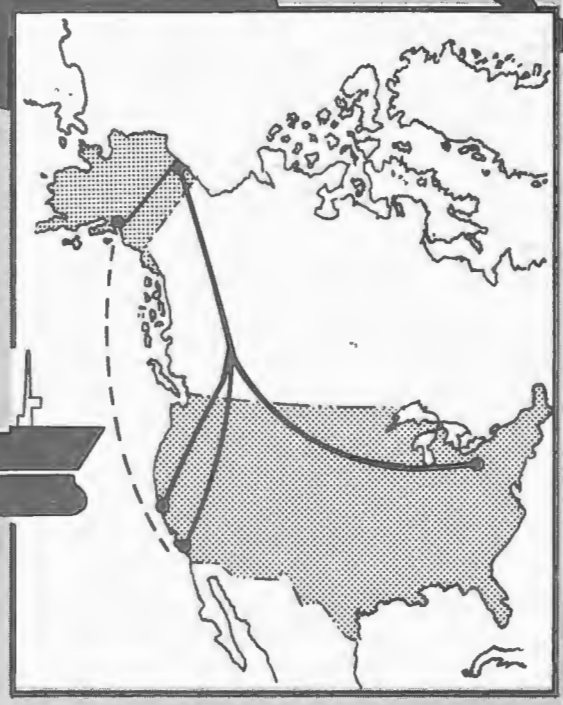
ALASKA NATURAL GAS TRANSPORTATION SYSTEMS

Final Environmental Impact Statement





FEDERAL POWER COMMISSION STAFF

VOL. III

WESTERN LNG
POINT CONCEPTION
TERMINAL

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FEDERAL POWER COMMISSION STAFF

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE ALASKAN ARCTIC NATURAL GAS TRANSPORTATION SYSTEMS

VOLUME III

WESTERN LNG TERMINAL COMPANY
Docket No. CP 75-83-1

APRIL 1976

The Federal Power Commission, pursuant to the Natural Gas Act, is authorized to issue certificates of public convenience and necessity for the construction and operation of natural gas facilities subject to its jurisdiction, on the conditions that:

> /a/ certificate shall be issued to any qualified applicant therefore, authorizing the whole or any part of the operation, sale, service, construction, extension, or acquisition covered by the application, if it is found that the applicant is able and willing properly to do the acts and to perform the service proposed and to conform to the provisions of the Act and the requirements, rules, and regulations of the Commission thereunder, and that the proposed service, sale, operation, construction, extension, or acquisition, to the extent authorized by the certificate, is or will be required by the present or future public convenience and necessity; otherwise such application shall be denied.

15 U.S.C. 717

The Commission shall have the power to attach to the issuance of the certificate and to the exercise of the rights granted thereunder such reasonable terms and conditions as the public convenience and necessity may require.

Section 1.6 of the Commission's Rules of Practice and Procedure allows any person alleging applicant's non compliance with such conditions to file a complaint noting the basis for such objection for the Commission's consideration.

18 C.F.R. §1.6 (1972).

Section 2.82(c) of the Commission's General Rules allow any person to file a petition to intervene on the basis of the staff draft environmental statement.

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* Note: The Sections in this TABLE OF CONTENTS which are typed in script have been adopted from the FPC's DEIS with appropriate changes as noted in the Comments and Responses (Volume IV). The Sections which are typed in regular block print are included in this volume of the FEIS.

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C. ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

1. Climate

The construction and operation of the pipeline and the LNG facility should have an insignificant impact upon the climatology of the region.

Wind speeds greater than 29 miles per hour occur 3.4 percent of the time at Point Conception. These occasional strong winds could hinder LNG tanker operations. Restricted visibility due to haze and fog, especially during the months of July through October could also restrict tanker operations. Visibility is reduced to one-half of a mile or less due to heavy fog 5 percent of the time in October, 4.6 percent in September, 3 percent in August, and 2.8 percent in July. Visibility reduction to 5 miles or less is at a maximum during these months also.

It is not expected that visibility conditions would have any significant effect on the operation of the proposed LNG tankers. However, conditions of restricted visibility would cause delays in the berthing operations depending on the extent of restricted visibility. Similarly, strong winds are infrequent and would not cause any significant delays to the tanker operations.

2.-3.-4. Topography, Geology and Soils

The proposed LNG terminal and its associated pipeline would have limited impact upon the topography and geology of the areas in which they would be located.

Impacts to the topography would be restricted to areas where grading would be required. Indirect impacts would be related to increases in erosion and mass movement which could cause local terrain modifications where the surface materials are prone to landsliding.

Direct modifications to the topography would occur within the boundaries of the terminal site where grading is expected to involve 2 million cubic yards of material. The two arroyos which now drain the southern part of the site would be filled in and the eastern slope of Canada del Cojo would be significantly altered as the proposed site is brought to grade.

Changes in the erosion regime of the site would constitute the greatest potential impact of the proposed facilities on the geology and soils of the area. The breakwater and the marine trestle would alter the existing pattern of longshore sediment transport. Possible effects include increased deposition to the west of the facilities and a decrease in sediment supply to the east. This would result in erosion of beaches to the east toward Santa Barbara.

The applicant has indicated that "of the 142.3-mile corridor, 70.5 miles or approximately 50 percent is in terrain that may require ridge cuts. . . ." This leveling of the ridge crests would be the major direct impact of construction on the topography along the Point Conception to Arvin pipeline segment. Where such extensive terrain modification takes place the resulting disequilibrium contours could not be easily maintained. This is especially true since most of the areas which might require ridge cutting are within regions of relatively high rainfall.

Due to the low relief over most of the 109-mile segment to Cajon there should be little alteration of the topography during construction. In those areas of significant relief within the Tehachapi Mountains and near Cajon there may be some grading but the proposed pipeline route does not generally follow ridge crests so that impact should be minimal.

Construction of the breakwater for the proposed small boat harbor would alter the offshore topography.

Removal of the natural vegetation at the proposed site and along the proposed pipeline route would increase the potential for erosion tremendously. Construction operations would also promote increased runoff by decreasing the surface permeability. This would result in increased erosion of areas on or adjacent to the right-of-way and plant area.

The proposed pipeline system would require the crossing of two permanent streams, the Santa Ynez River and the Sisquoc River. The former would not be significantly affected because the river normally carries moderate sediment loads. Sediment added to the Sisquoc River would be deposited within a relatively short distance because of the generally low flow. However, during periods of high water, increased amounts of sediment could reach gravel pit operations downstream.

All other streams which would be crossed are intermittent, so that increased sedimentation and turbidity may be avoided by proper scheduling of the construction, i.e., during the summer months.

In most of the areas traversed beyond MP 100 of the Point Conception to Arvin pipeline segment and all of the Arvin to Cajon pipeline segment, there would be little adverse effect in terms of increased sediment load. During the infrequent periods of sediment transport by water, the sediment load is naturally high and an additional increment would probably not be critical. It should be noted, however, that erosion within the pipeline right-of-way might be serious even if the additional sediment load in adjacent streams is not a cause for concern.

Water used for hydrostatic testing could have significant erosion impact if improperly released. In addition, such discharge upon the surface within the San Joaquin Valley or the Mojave Desert could create problems with the expansive and collapsible soils of these areas.

In addition to increasing the erosion potential, construction activity impairs the productivity of soils by distrubing the normal soil horizons and decreasing permeability by compaction.

Only about 4 percent of the proposed Arvin to Cajon route is within land now being cultivated. Due to the scarcity of water over most of the route, there is very little natural vegetation. The adverse impact of this localized reduction in natural and cultivated vegetation in the proposed Arvin to Cajon route should not be significant.

The proposed route between Point Conception and Arvin passes through agricultural land over 40 percent of its lenght. It also passes through the Los Padres National Forest. Much of this area is naturally productive and here the impact of consturction would be the removal of natural vegetation along the right-of-way leaving the potential for much erosion.

The only other impact to the geology is in terms of mineral resources. The proposed pipeline would pass through unconsolidated deposits over most of its length. These are important sources of construction materials. Although construction of the proposed facilities might mean that greater care would be required during future extraction of these materials, such operations would not be seriously hindered. There would be no impact upon subsurface mining or drilling from construction of the proposed facilities. Normal operation of the proposed facilities would have no impact upon the topography, geology, or soils of the area.

The geology of this region has more potential for serious impact upon the proposed facilities than vice versa. These hazards are discussed below.

Of the primary dangers due to earthquakes, ground shaking and ground displacement, the former is more of a problem for this proposed LNG terminal site. There are no known faults beneath the site, and the maximum probable events on the Santa Ynez fault(s) would not be anticipated to result in significant (greater than 1.5 feet) displacement at the site. It should be noted that the staff has no knowledge of any detailed foundation studies for this site. Such studies, provided for other sites proposed by the applicant, are essential to the determination of subsurface structures and a complete assessment of the geological risks at any site.

The proposed design ground level acceleration at the site may be affected by data obtained during foundation investigations. However, the input bedrock accelerations will not be dependent upon the results of onsite investigations unless, of course, a potentially active fault is discovered. Consequently, the level of bedrock shaking to be used in the LNG plant design procedure may be determined independently of such an investigation.

The maximum bedrock acceleration at the site would be in excess of 0.7g for the maximum probable event at either of the two closest portions of the Santa Ynez fault(s). The probable events on all the other identified onshore faults should not result in site accelerations in excess of 0.2g. A San Andreas fault event would probably result in 0.1g accelerations at the site with most of the transmitted energy occurring in long period vibration.

There are two avenues of approach to a determination of the maximum acceleration to be expected at Point Conception, a maximum credible earthquake for the Santa Barbara Channel Region (Magnitude 7.5) and/or the maximum earthquake to be expected on the closest fault (Magnitude 7.0-7.5). Using the regional approach, there is a probablility of about 10 percent that such an event could

shake the proposed site at a level of 0.6g within a period of 30 years. This assumes that an earthquake is equally likely anywhere within the region and that the maximum acceleration will occur during the event.

The regional approach is acceptable when no faults are known to exist near a site. In the present case, a significant active fault, the Santa Ynez (southern branch), is known to pass no more than 3 miles from the site and about 2 miles from the end of the proposed marine trestle. It is estimated by the environmental staff that a maximum probable event of 7.3 is appropriate for this active fault, and the (proposed) Seismic Safety Element of the Santa Barbara County General Plan uses 7.0 as the maximum probable earthquake that "could reasonably be expected to occur during a project life." Greensfelder (1974) has chosen 7.5 as the maximum expected earth quake on this fault. Depending upon the source reference using a fault (or epicenter)-to-site distance of 3 miles (4.8 km), the following site accelerations (g) are estimated.

SOURCE	MAGNITUDE		
	7.0	7.3	7.5
Davenport, 1972	0.66g	0.79g	0.93g
Greensfelder, 1974	0.63g	0.66g	0.67g
Schnabel and Seed, 1973	-	-	0.58g-0.78g
Page et al., 1972	0.55g	-	0.65g

It can be seen that the lowest value for peak bedrock acceleration beneath the site is 0.6g, regardless of the earthquake chosen. In fact, the values given by Page et al. are those which may be reached or exceeded 10 times; in other words, they are not necessarily peak values which would only be achieved once during the earthquake.

The applicant has indicated that the USGS has adopted a value of 0.5g to prevent collapse of drilling platforms in the channel. In addition, it should be noted that the design spectrum proposed by Fallgren (1974) for electrical facilities in this area is based on 0.5g. A maximum effective ground surface acceleration of 0.45g is the value upon which the design of underground portions of the TAPS pipeline is based. This acceration is for a generalized region in which magnitude 7.5 earthquakes may be expected. These three examples are regional guidelines, and no consideration is given to the proximity of faults.

Along the Point Conception to Arvin pipeline, horizontal accelerations of 0.7g could be experienced at each of 12 active or potentially active fault zones which would be traversed. Within the 12 zones, the proposed route crosses 19 mapped fault traces.

All of these are significant hazards to the proposed pipeline. From Arvin to Cajon, the proposed pipeline would cross on additional six fault traces, including two within the Garlock fault zone and one which is an extension of the Mirage Valley fault.

The applicant has indicated that the pipeline trench would be wide or shaped with sloping sides, to lift rather than sever the pipeline in the event of fault rupture. In addition, the material selected to fill the trench would have low cohesion and would be loosely packed so that it would deform, thereby reducing the stress transmitted to the pipeline. Such procedures would mitigate some of the seismic hazard to the pipeline. However, Bonilla (1970) notes that the maximum width of the main zone of faulting in strike-slip faults is less than 0.06 miles (about 330 ft.). And so a strike-slip fault capable of 6 feet of total displacement on the main fault would be able to exceed the pipeline design stress. There would be 15 fault traces within seven fault zones crossed by the pipelines from Pt. Conception to Cajon which could achieve this displacment. Five of these zones could conceivably experience ground displacements in excess of 3 feet in 120 feet which would presumably rupture the pipeline. Also, it is not inconceivable that the maximum probable event on the nearest portions of the San Andreas fault would cause rupture of the Arvin to Cajon pipeline. This assessment is based on the applicant's report that the proposed pipeline could accommodate displacement on the order of 1 foot in 120 feet of length before exceeding the design stress and that 1 to 3 feet of displacement could probably be accommodated without rupture.

In addition to the primary effects of earthquakes, the possible secondary effects include soil liquefaction, settlement/subsidence, mass wasting, tectonic subsidence and tsunamis.

When a soil liquefies it loses its ability to sustain a shear stress. It acts as a liquid and consequently may flow down very slight grades. Fortunately only soils which are granular, relatively unimodal and saturated are subject to liquefaction. Such soils must be removed or avoided during construction of important facilities in highly seismic areas.

An unconsolidated soil may settle into a more compact configuration when shaken. This may result in settlement of several feet depending upon the depth of the original deposit and the severity of the shaking. Proper foundation engineering can eliminate most of the problems associated with this phenomenon.

Various mass wasting processes including rock falls, landsliding and slumping may be triggered by shaking. Problem areas are not difficult to discover and avoid after proper geological studies.

Tectonic subsidence involves the vertical motion (up or down) of large portions of the surface due to readjustment of the earth's crust during and after an earthquake. As a result of the 1964 Prince William Sound earthquake in Alaska, an area of some 100,000 square miles changed elevation by as much as

33 feet. While such events are not common, there has been a similar event in California: Owens Valley, 1872 - 23 feet of vertical displacement with a similar horizontal offset. Vertical movement of this magnitude may occur in earthquakes of magnitude 8 or over. However, regional elevation changes would probably have negligible impact upon the proposed facilities due to the large area involved and the frequency with which such events apparently occur in California.

Tsunamis are long period waves formed by large-scale displacements of water. These displacements are generally due to vertical motion of a portion of the sea-floor along a fault although landsliding into bodies of water may cause waves of concern to local land areas. The proposed site is not likely to be subjected to the latter type of wave.

Close to the source of an earthquake induced tsunami, the maximum wave heights are experienced along a coast which parallels the fault, while at a distance refraction of the wave front may considerably alter the direction of the wave.

Faults whose activity might trigger tsunamis near the proposed site are located in the Santa Barbara Channel. The coast at the proposed Point Conception site is parallel to the probable generating faults and would experience the maximum locally generated waves. While no adverse effects would be expected at the onshore portion of the proposed facilities, the marine terminal would be vulnerable to wave forces. Furthermore, it is unlikely that there would be enough time to warn or remove a docked LNG tanker to a safe distance from the facilities before the wave arrived.

The major historical tsunami sources are near Chile, the Aleutian Island Arc, and Japan, although most of the rest of the Pacific Ocean border is a probable source. Houston and Garcia (1973) have performed analyses which indicate that a recurrence interval of 500 years is associated with a wave of no more than 13 feet at Santa Barbara, while the 100-year wave is expected to be 6.2 feet or less.

The Point Conception area would be expected to be relatively sheltered from tsunamis generated in the northern Pacific, but not those coming from the southern Pacific. It is expected that, in the event of a tsunami generated outside the offshore California

area, ample warning would be supplied by the U.S. Coast Guard.

Other geological hazards include floods, erosion, expansive soils, collapsing soils, subsidence, and volcanic activity. The proposed LNG site should not be subjected to flooding. Due to its elevation and the lack of a major drainage, the Point Conception site is extremely unlikely to be flooded.

Sheet erosion caused by storm runoff could be a problem at the proposed Point Conception site, however, proper grading and drainage of the site should be able to deal with this problem effectively.

Along the proposed pipeline route the western mountainous areas are the most likely to be affected by flooding. However, it is conceivable that this could be a problem along the entire route since flash flooding is not uncommon in the desert.

Soils containing appreciable quantities of the clay minerals kaolinite or montmorillonite are known as expansive soils. When exposed to water these soils may increase their volume substantially, moving retaining walls, lifting foundations, and adversely affecting the associated structures. Such soils must be identified and either removed or avoided.

The Montezuma clay on the southwest corner of the proposed site is expansive. Many of the soils crossed by the proposed Arvin to Cajon pipeline are highly expansive.

Collapsing soils, soils which are susceptible to hydrocompaction, are hard, dry, low density soils that compact when saturated with water. They are extremely common in the San Joaquin Valley, where they have posed severe construction problems, and probably exist in the Mojave Desert near its mountainous border.

The proposed Point Conception to Cajon pipeline crosses several areas in the San Joaquin Valley which have known problems with collapsing soils. It would be essential that the proposed pipeline be routed so that there would be no tendency for water to pond in subsidence-prone areas. Ideally this routing would be such that no natural drainage is intercepted or blocked (Curtin, 1973).

Non-tectonic subsidence may result from withdrawal of fluids (usually water or oil) from beneath the land surface. The Arvin-Maricopa area of the Southern San Joaquin Valley has experienced major subsidence due to groundwater withdrawal. Portions of Antelope Valley south of the proposed route have experienced subsidence also.

The proposed pipeline traverses the southern and eastern borders of the Arvin-Maricopa area. Subsidence along the route was no more than 7 feet during the period 1926 to 1970, and the current rate of subsidence is no more than 0.25 feet per year. Since the beginning of the current decade, when the state began to import irrigation water into the area, the rate of subsidence has leveled off. Even if the current rate continues over the life of the pipeline, it would not constitute a significant hazard to the pipeline.

There are no active volcanic centers in southern California. The last known activity occurred during Pleistocene time, but no extrusives as young as this are located within 50 miles of any of the proposed facilities. The Tertiary history of the southwestern U.S. records a steady movement of volcanic activity from west to east. Danger from volcanic activity appears to be remote at the proposed site.

5. Hydrology

a) LNG Site and Pipeline

The gathering of site specific pipeline route information regarding shorelines, streambanks, adjacent drainage areas, and areas subject to siltation and turbidity, as well as the selection of construction techniques to be employed at the affected areas, has not been completed by the applicant. Consequently, only generalized comments concerning anticipated hydrologic impacts can be made.

Construction of the proposed LNG facility could increase the sediment transported by the Canada del Cojo and, consequently, could increase the amount of sediment transported to the littoral zone.

Surface water conditions in the 11 basins that would be crossed vary substantially and therefore, the effect of additional debris produced by the pipeline construction would differ from stream to stream. In tributaries where sediment transport and turbidity are naturally low, the increase in sediment load due to construction could have a significant impact.

During periods of high water, sediment added to the Sisquoc River could increase sedimentation in several gravel pit operations. Construction activity along the Cuyama River could increase sedimentation in the Twitchell Reservoir. In the coastal drainages, pipeline construction would increase the amounts of sediments transported directly to the littoral zone.

The groundwater should only be affected in areas where the local water table is near the surface. It is highly probable that excavations at stream crossings would encounter the water table very near the surface of the alluvium if construction operations were conducted during the winter. This could necessitate dewatering the construction site which in turn would result in the lowering of the local water table and temporarily altering local groundwater flow.

Water tables along the proposed pipeline route which are close to the ground surface occur in the Santa Ynez River Basin, at stream crossings in the Southern San Joaquin drainage, at MP 14.2 of the Cajon Pass leg of the proposed pipeline, between MP 1.6 and 1.8 and MP 16.3 to 16.9 of the Cajon Pass segment, and the south end of Rogers Dry Lake. In the Rogers Dry Lake area, during periods of high winter runoff, inundation of the proposed pipeline route between MP 56.5 and 59.7 could occur.

Hydrostatic test water would be discharged either into catchments or into existing watershed areas and improper water disposal would result in increased erosion and sedimentation at and downstream of the discharge area.

Several water supply plans have been or are being studied by local, state, and Federal agencies for the Santa Maria-Sisquoc area. There would not be any direct conflicts between these plans and the proposed pipeline from Point Conception to Arvin. Other projects which have been or are being studied include the Lompoc Dam and Reservoir and the Salsipuedes Dam and Reservoir. The Lompoc reservoir would result from damming a portion of the Santa Ynez River and would result in inmundation of the pipeline in the vicinity of the proposed Santa Ynez River crossing. However, at present, due to problems with the overall project and insufficient support from the Santa Barbara County Water Agency to the Bureau of Reclamation , no action is being taken with respect to the project. It does not appear that the Salsipuede Dam and Reservoir project would have any direct effect on the proposed pipelines.

It is possible that future conflicts could develop if local water conveyance facilities are constructed in conjunction with the proposed extensions of the Coastal Branch of the California State Aqueduct. The environmental staff has made a recommendation concerning this matter.

b) Oceanographic Impacts

Facilities whose construction would effect the marine environment are the vaporization facilities, the pile-supported pier, a breakwater-protected small boat harbor, the intake and outfall portions of the heating water system, and a screenwell.

The vaporization facility would be close enough to the shoreline so that construction wastes, spills or leaks from this portion of the project could reach the sea via the Canada del Cojo as runoff. Construction and site preparation operations associated with the vaporization facility would result in increased erosion. This could increase turbidity in nearshore coastal waters. Offshore construction would further result in temporary increases in turbidity.

Trenching or dredging would be required in the surf zone for the construction of both the seawater intake and outfall structures. This could cause disturbance of low density sediments. The proposed breakwater could affect local circulation patterns and could locally affect the littoral transport of sediment in the nearshore zone. Increases in turbidity may be the result of changes in wave refraction caused by the breakwater and marine trestle.

Discharge of freshwater used for hydrostatic testing of the LNG storage tanks and any dewatering at the plant site would produce temporary impacts resulting from salinity and temperature differentials between the effluent and the receiving water.

A tanker or barge collision or grounding in the area of the plant site could release Bunker "C" fuel oil. The adverse effects would depend on spill size, spill location, and existing meterologic and oceanographic conditions.

The occurrence of waves at the marine terminal berthing area, which are beyond the range of 4 to 6 feet which can safely be accommodated by an LNG tanker at berth, would cause delays. However, it is expected that proper scheduling of the tanker arrivals would considerably alleviate any significant operational problems.

c) Cold Water Discharge

Under base load operations, approximately 300,000 gallons per minute (gpm) of water would be circulated through the seawater vaporization system. The water temperature would be depressed 12°F in the vaporizers. Acrolein would be added in 0.4 to 0.8 parts per million (ppm) concentrations for 4 to 6 hours per day to inhibit fouling by marine animals. The cooling water would be detoxified before discharge by the addition of sodium bisulfite.

A commercial preparation of acrolein (Betz Slimicide C-20) also contains hydroquinone to inhibit slow polymerization caused by air or oxygen.

Acrolein is highly reactive, and at a concentration of 1 ppm in distilled water, it has a half-life of 7 days. In a natural environment (e.g., the ocean), the half-life would presumably be shorter as a result of a greater mixing rate and the presence of organic matter with which acrolein would react.

The lethal or sublethal effects of acrolein on biota is believed to be due in part to the inhibition of enzyme activity. According to a Dames and Moore study conducted for the Pacific Alaska LNG Company, the 96-hour TL50 1/ @ 20°C of acrolein on killifish is 0.45 mg/L.

The U.S. Army Corpos of Engineers stated that acrolein is toxic to most fish species, including carp, at 3 ppm. Betz Laboratories indicated that, with respect to plant life, acrolein concentrations ranging between 1.5 and 7.5 ppm, depending upon water temperature (15°C - 87°C), killed Hydrodictyon, Cladophora, Spirogyra, Potamogeton, Zannichellia, Elodea, Callitriche, and Ceratophyllum.

The "Water Quality Control Plan, Ocean Waters of California" is the controlling regulatory document for treatment and discharge of waste water into the marine environment along the coast of California. The proposed seawater monitoring system would be designed to measure all discharge parameters specified by the California Regional Water Quality Control Board. The pertinent parameter relative to acrolein is the toxicity conentration. Current regulations indicate the toxicity concentration of a waste water discharge into the marine environment must not exceed 1.5 toxicity units (tu) 2/ more than 50 percent of the time and must not exceed 2.0 tu more than 10 percent of the time.

1/ That concentration of a toxic substance in which 50 percent of the fish survive for 96 hours.

2/ Toxicity Concentration = measured in tu $\frac{100}{\text{96-hr Median Tolerance Limit}}$

The impact of accidental discharges of non-neutralized acrolein or of an accidental spill is difficult to assess in view of the lack of information about local oceanographic conditions and the proposed vaporizer design features. However, it could be assumed that a short duration discharge of non-neutralized acrolein at the proposed concentration would not have significant long-term impacts, but that a large spill could result in severe impacts.

The kinds of impacts of cold water on marine organisms are dependent on the difference of temperature between the effluent and the ambient water temperature. The extent of the impact depends on the size and shape of the plume. No studies on the biological effects of cooled seawater discharges are available for comparison with the proposed system. In addition, the location and design of the outfall has not been specified. Its location relative to biotic distribution, current patterns, and natural temperature distributions would have a significant effect on the resulting impacts. Until the location and design is specified, impact assessment can only be general.

Point Conception is regarded as a natural boundary between the colder water regimes of central and northern California and the warmer waters of southern California. At the boundary itself, the conditions can be expected to vary more than they do to either side; thus the biological community found at the boundary is a mixture of the northern and southern species.

Seven hundred and twenty-one species of vertebrates, invertebrates and algae known to or likely to occur at the Point Conception site were categorized by Dames and Moore (1974) on the basis of zoogeographic range data into northern, southern, and transitional groups. Approximately half (48.1 percent) of these species were determined to be in the Zone 1 (northern) group; 35.2 percent fell in the Zone II (transitional) group; and 16.7 percent formed the Zone III (southern) assemblage.

Dames and Moore (1974) indicated that Zone I species should be able to tolerate depressed water temperatures of the magnitudes experienced around the cold water outfall. Zone II species were expected to acclimate to the depressed temperatures in most instances and all species were expected to be able to survive outside of the -2°F isotherm. Zone III species were not expected to tolerate greatly depressed temperatures.

Physiological effects of cold on marine poikilotherms 1/ are primarily manifestations of reduced metabolic rate. One effect of this reduced metabolic rate is the reduction in growth rate of both larvae and adults. 2/ Another effect is the increased size of animals in cool water populations when compared to warm water population of the same species. 3/ As fecundity is directly correlated with size, increased size leads to greater fecundity. 4/

A permanent decrease in ambient temperature as opposed to short-term cooling may result in a restricted or absent reproductive period in those species where reproduction is cued by higher temperature or by longer periods of temperature above a certain level. Changing reproduction periods may affect food availability for larvae, juveniles, and adult fishes or invertebrates.

Maximum temperature stress is expected to occur during the winter when temperature minima prevail. Species could suffer sub-lethal or lethal temperature effects, resulting in reduced population size. Temperature stresses are also synergistic with high pollution levels, low dissolved oxygen, and fluctuations in salinity.

Another source of potential mortality resulting from the cooled water discharge is through mixing entrainment of plankton into the cooled plume.

According to Dames & Moore, the general effect of cooled water will be to force a change in the species composition of areas directly influenced by the effluent. The zone of affected species is expected to be within the -2°F isotherm. Within this zone the lowered temperature could reduce or eliminate the species with southern affinities or prevent successful reproduction of some species.

The "Water Quality Control Plan, Ocean Waters of California" (California Regional Water Quality Control Board, adopted July 6, 1972) is the controlling regulatory document for treatment and discharge of waste water into the marine environment along the coast of California. Treatment and discharge of effluents from the proposed LNG facilities would comply with regulations set forth in this document. Existing California Regional Water Quality Control Board regulations governing temperature differentials between the receiving water and the effluent do not apply to cold water discharges.

1/ Species whose internal temperatures generally correspond to environmental temperature.
2/ MacLaren, 1965, Scheltema, 1967; Loosanoff, and others 1951; Bullock, 1955.
3/ MacLaren, 1974; Bullock, 1955; Fox, 1939; Dehnel, 1955.
4/ Dehnel, 1955; MacLaren, 1974; Patel and Crisp, 1960.

6. Vegetation

a) LNG Site

Clearing, cutting, and filling activities would result in the removal of the majority of the vegetation on the 227-acre LNG site. The upper third of the site and the Canada del Cojo would remain unaffected, being located outside the site fence. It is estimated that about 90 percent of vegetation to be removed on the site is herbland,with the remainder mostly coastal sage scrub. The gullies on the site which contain a mixture of coastal sage and coastal bluff vegetation would be filled in. Of the 2 million cubic yards of material which would be cut from the proposed site, half would be used as fill on the site, while the other half would be disposed of at an off-site location not yet identified.

Construction of the four 10-foot diameter seawater lines would remove some coastal bluff and strand vegetation on the beach and cliffs in an estimated 100-foot wide path from the ocean to the coastal terrace above. The road from the proposed site to highway 101 near Gaviota would be widened, resulting in the clearing of an additional 26 acres of land, mainly herbland with smaller quantities of coastal sage and riparian woodland. The construction of water and electric lines leading to the proposed site would result in similar impacts.

Landscaping with trees, shrubs, and grass would offset part of the loss of primary productivity (production of plant material) on the site. The gaseous emissions from construction equipment and the proposed LNG facilities would not be in great enough concentrations to have a noticeable effect on vegetation in the vicinity of the proposed site.

Until the landscaping were completed, water runoff and erosion of the bare soil could lead to erosion of the soil beneath uncleared vegetation on the cliffs, beach, and the riparian areas.

b) Pipeline Routes

The construction of a 125-foot right-of-way for most of the 142.3-mile Point Conception to Arvin segment and a 100-foot right-of-way for the 108.9-mile Arvin to Cajon segment would necessitate the removal of all vegetation within these rights-of-way. Table 17 shows the distance in each community that would be traversed by the proposed route, and Table 24 shows the approximate quantity of land which would be disturbed in each community. Besides the 3,400.2 acres which would be cleared as rights-of-way, 1.5 acres of herbland

Table 24

APPROXIMATE AREA DISTURBED IN EACH VEGETATIONAL COMMUNITY BY THE PROPOSED RIGHT-OF-WAY
(Combined values for both segments, Point Conception to Arvin, and Arvin to Cajon)

	Community	Acres	Percent of Total Acreage
	Herbland	1,333.5	39.2
Shrubland	Coastal sage scrub	187.9	5.5
	Chaparral	129.4	3.8
Woodland	Oak Woodland	181.0	5.3
	Juniper Woodland	35.2	1.0
Desert	Saltbrush scrub	298.2	8.8
	Creosote bush	341.8	10.1
	Joshua tree	26.7	0.8
	Creosote and Joshua tree	181.8	5.4
	Mesquite-alkali sink	2.4	0.1
	Cultural	677.8	19.9
	Barren	4.5	0.1
		3,400.2	100.0

would be cleared for the Arvin metering station, 1.5 acres of abandoned farmland would be cleared for the Cajon metering station, and about 110 acres in undetermined areas would be cleared for temporary storage yards. Temporary dirt roads would be constructed to aid access to the proposed rights-of-way during construction, especially in the mountainous areas where there are no existing roads. The applicant has stated that the location and number of any access roads cannot be determined until final design plans are made.

The severity of impacts to vegetational communities would depend on the time of year during construction, specific construction and revegetation techniques, community type, previous disturbance, and topography.

Upon completion of construction, the proposed route would be seeded with native herbland flora. Ideally, the cleared land would undergo secondary ecological succession whereby a series of plant communities (pioneer stages) invade and succeed themselves, until a final stabilized or climax community is reached, identical to the original community. As is discussed below, the number of pioneer stages, the length of succession, and even the probability that a climax community would result vary for the different community types. Furthermore, other factors enter into the succession cycle which would prevent or delay successful revegetation back to the preconstruction state from occurring or would result in indirect impacts. These will be discussed following the description of succession for each community.

Farmland (comprising most of the 677.8 acres of cultural land), the small quantity of barren land, and herbland would suffer the least amount of impacts with respect to vegetation. Annual crops could regrow in the proposed right-of-way during the first complete growing season following completion of construction activities. The herbland in the first two biophysiographic provinces consists almost entirely of annual species of grasses and forbs which would probably revegetate during the first rainy season. A greater percentage of those forbs which grow best with little litter would appear in the right-of-way for several seasons until enough litter accumulates to favor the preconstruction mixture of grasses and forbs. The small quantities of marshland along the proposed route would take a similar duration of time to revegetate to the preconstruction state, unless drainage patterns were altered. If the latter occurred, water may be so reduced that only herbland would grow back, eliminating these valuable communities. The herbland in the vicinity of the Carrizo Plain-Temblor Range-San Joaquin Valley Province, which comprises the majority of the herbland along the route, contains a variety of small perennial shrubs along with annual herbs. The annual herbs would grow back in the manner described above, but the shrubs which dominate some areas of the herbland would take from

between 5 and 15 years to revegetate depending on the species.

The succession in disturbed chaparral communities has been well-documented. Annual forbs which are uncommon in mature chaparral would dominate the cleared areas for the first 3 to 4 years following construction. There would be many of these species with few individuals per species at first, with several species becoming dominant. Grasses would become more common and would take over by the fifth year. If the roots of major shrub species such as chamise, scrub oak, greenbark ceanothus, and mountain mahogany are still viable, they would start sprouting from the crowns; the sprouts would keep growing until shrubs once again dominate the area within 6 to 8 years, eventually forming a climax community in around 12 to 30 years following the clearing of the lands, assuming light browsing from deer. 1/, 2/, 3/

However, where the root crowns have been destroyed, shrub seeds which would be in the soil following land clearing would have to germinate and eventually grow to mature plants to complete the succession. Because chaparral is a fire-adapted community, the seeds of many annuals and perennials are not only resistant to high temperatures, but actually require heat and/or scarification (rupturing of the seed coat) for optimum germination. The perennial species known to require heat include bigpod ceanothus, greenbark ceanothus, and sugar bush. 4/, 5/ The mechanical clearing may result in seed scarification, thereby stimulating germination for some species. However, the lack of heat would delay the germination of other species and thus delay formation of a climax community. This would be a significant factor in chaparral in the first 45 miles of the route where the above-mentioned ceanothus species are among the dominant species. In this case, coastal sage scrub species may invade and keep out chaparral species for an indefinite amount of time.

In coastal sage scrub areas, a similar but shorter succession would take place, with an initial growth of annual herbs which dominate for several years until shrub species like California sagebrush and sage, which grow and mature faster than chaparral species, take over either from seed germination or root crown sprouting.

1/ Hanes, T.L. "Succession After Fire in the Chaparral of Southern California", 1970.
2/ Sweeney, J.R. Responses of Vegetation to Fire ..., 1956.
3/ Biswell, H.H. "Manipulation of Chamise Brush for Deer Range Improvement", 1961.
4/ Quick, C.R. and A.S. Quick, "Germination of Ceanothus Seeds" 1961.
5/ Wells, P.V. "Vegetation in Relation to Geology, Substratum, and Fire in the San Luis Opispo Quadrangle", 1962.

Well-developed oak woodland and riparian communities have a community structure similar to that of forests, with a ground layer of herbs, a shrub layer, and a tree canopy on top. Succession in these areas would consist of three stages: herbs, shrubs, and finally trees. In oak woodland, many of the shrubs, which are derived from chaparral, would form quickly as a result of sprouting from oak root crowns or stumps. It could take 100 years for a climax oak or riparian woodland to form. Oak woodland with an open canopy and no shrubs would also require as long or longer a period to completely revegetate. Coast live oak, buckeye, and sycamore are often over a century old; valley oak trees have been known to live up to 300 years. 1/

In juniper woodland, herbaceous growth would dominate the first several years following construction; understory shrubs, which are derived from chaparral and desert communities, would take roughly 5 to 10 years to become established. Slow growing junipers and pinyon pines would finally appear, but not be significant for at least several decades. Mature pinyons are often over 100 years old and have been known to be as old as 250 years. 1/

The desert communities are the most fragile of those along the proposed route. Potential impacts to the creosote bush communities have been well-documented in the article by Vasek et al. (1975) entitled "Effects of Pipeline Construction on Creosote Bush Scrub Vegetation of the Mojave Desert", which consisted of a study of a 12-year old natural gas pipeline. Where there is a fairly high vegetation production, mainly in moderately or gently sloping washes and fans, areas disturbed by construction would undergo a succession of communities leading to a climax community. Perennial herbs would come up during the first winter rains following completion of construction. Pioneer perennial shrubs which live for only several decades such as cheesebush and hop sage would quickly invade and become relatively abundant, probably within 5 to 10 years; these are normal components of slightly disturbed areas such as small washes, which are natural components of the desert. Climax species, mainly creosote bush and burrobush, would not become dominant over the pioneers until about 30 to 40 years following

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1/ Peattie, D.C., A Natural History of Western Trees, 1953.

construction. Mature creosote bush communities with maximum production would require one to two centuries to form. However, creosote bush communities in the proposed route which have subnormal features such as poor rocky soil and rainfall rate which is below average for the desert would not be expected to return to their preconstruction state for any discernable length of time. The pioneer species described above would probably dominate any vegetation which grows back in these subnormal areas with climax species being minor components or nonexistant. In the study, little or even no vegetation at all was found in parts of these subnormal areas after 12 years.

In the saltbush scrub and mesquite-alkali sink communities, a similar pattern of succession such as in creosote bush communities would occur, but the duration of time would be lessened to around several decades for the formation of mature climax communities. The understory vegetation in Joshua tree areas would take from several decades to over a century to revegetate, depending on whether it were composed of saltbush scrub or creosote bush. Replacement of mature Joshua trees could require 200 to 300 years due to slow growth and poor seed germination. 1/

In the Point Conception to Arvin segment, the proposed right-of-way follows ridges which, if too narrow, would have to be cut until sufficient construction work width is obtained. The exact ridges to be cut are unknown at this time, but they would be located in the hilly terrain between MP4.5 to 18, 22 to 68, 94 to 101, and 137 to 141. During the ridge cutting process, spoil dirt would be pushed over the sides of the ridges, thus burying vegetation downhill. Most annual plants would be eliminated by burial exceeding 2 to 3 inches or by mechanical damage to the root crown. Perennial herbs would survive deeper burial and more severe damage because they can resprout from buried parts. Coastal sage shrubs would be able to recover from burial up to about 1 foot and from severe mechanical damage. Chaparral species which can resprout, such as chamise and scrub oak, would recover from a burial of several feet, if some parts of the plant remain above the spoil or if the root crown and associated roots remain intact. Nonsprouting species could withstand burial of several feet of trunk, but would not recover from mechanical damage. Woodland

1/ Woodward-Envicon, Inc., Environmental Data Statement, A Natural Gas Pipeline, Nevada-California Border to Cajon, California, 1974.

trees, such as live and blue oaks, would recover from burial and mechanical damage slowly. Riparian trees are not quite as tolerant, but can recover from some burial and mechanical damage. The cleared ridges could serve as fuel or firebreaks to prevent the spread of a fire from one side of a mountain to the other. In the Los Padres National Forest, selective fuel breaks are part of an overall program to manage the forest and small portions of the clearings for the proposed route through Los Padres could be utilized as fuel breaks. 1/

Probably the most significant factor which would prevent successful revegetation of the rights-of-way and cause indirect environmental impacts would be erosion. The loss of the roots, aboveground parts of plants, and surface litter which normally retard runoff and hold the soil would accelerate water erosion of the soil and loosening of rock until a plant cover were reestablished. Increased runoff would result in increased erosion of areas downhill from the cleared land and a reduction in soil fertility in both locations. Lessened fertility could result in reduced plant productivity in these areas. The runoff with its load of debris could cause increased siltation in flowing streams, as discussed in the aquatic section. The applicant has proposed a variety of steps including trench breakers, burying of sand bags over the pipeline, diversion ditches, and reseeding of disturbed areas, all described in detail in the "Mitigating Measures" section, which should minimize erosion in the long run. Wind erosion could also be significant during periods of occasional strong winds when the soil is dry. Wind erosion is most severe in the desert, where it is more of a problem than water erosion. In addition, areas of high susceptibility to water erosion are found in about 9.7 miles of the first 61.5 miles of the Point Conception to Arvin route (the remaining part has not yet been evaluated) and about 3 miles of the Arvin to Cajon route. These areas have easily erodible substrate, thin soil, and steep slopes, where erosion could possibly remove so much soil that little vegetation could grow back.

1/ Los Padres National Forest Official, personal communication, 1975.

The sections of slopes where ridges were cut as previously described would end up devoid of vegetation where the excavated material pushed over the sides was the deepest. In southern California, these newly created slopes would not be stabilized fast enough by natural vegetation. The invading vegetation would tend to consist of weak shrubs and herbs rather than trees and woody shrubs which can form a dense canopy, strong roots and much litter to prevent soil erosion. Only reseeding and/or planting of young shrubs or trees on these slopes could stabilize the areas to insure the beginning of succession and minimize soil loss. Even with these methods, it has been shown that some erosion will take place, forming small gullies, but after about 15 years most of the once-bare land on the slopes had revegetated properly. 1/ Existing roads and rights-of-way on hills in the vicinity of the proposed route have long erosion scars on the slopes beneath them where proper revegetation did not take place.

The release of hydrostatic test water has the potential for erosion. Impoundment and allowing natural seepage and evaporation, controlling flow back to the original source, or use for irrigation are the ways which the applicant would minimize any harmful effects of the release of this water.

For time periods from several years up to many decades depending on the community, the constructed right-of-way and temporary access roads would be free of enough vegetation that they could be utilized as a road for four-wheel drive cars or off-road vehicles. Such usage might be illegal but would be difficult to monitor. It would inhibit revegetation and lead to increased access to previously undisturbed areas, with resultant impacts to ecosystems there whose magnitude could not be predicted. The Mojave Desert has become the scene of the most extensive off-road vehicle activities due to the relative openess of the area and proximity to the Los Angeles metropolitan area. In localized areas, the ecosystems have been moderately to severely damaged by these vehicles and their operations, especially in the vicinity of Baldy Mesa and scattered desert buttes, and similar damages could result from usage of the proposed right-of-way. 2/

1/ Horton, J.S., Trees and Shrubs for Erosion Control in Southern California Mountains, 1949.

2/ U.S. Bureau of Land Management, Environmental Analysis Record for Interim Critical Management Program for Recreational Vehicle Use of the California Desert, 1973.

The ditching and subsequent backfilling operations would result in the placement of the top layers of soil back in the ditch first with the less fertile layers on top. As a result, overall soil fertility would be reduced for two strips of land 4½ feet wide and 142.3 miles long for the two parallel pipelines from Point Conception to Arvin. An additional strip of land 4½ feet wide and 108.9 miles long from Arvin to Cajon would also be affected. This reduction in fertility is evident in crops growing above trenches in existing rights-of-way through agricultural areas; the crops tend to be somewhat smaller above the trench than those alongside it.

Construction would take place over a period of at least 12 months, rather than be limited to a specific time of year. The applicant has not stated whether construction activities would occur in different vegetational communities at different seasons. In the fire-sensitive communities, the danger of fires would be greatest in the dry season from about June through September. These communities, chaparral and associated coastal sage scrub and oak woodland, occur mainly in the Transverse Ranges Province (first 45 miles of the first segment; last 4.9 miles of the last segment) and the Southern Interior Coast Ranges Province (MP 45 to 65 of the first segment). Herbland is less susceptible to fire due to smaller accumulation of litter than in the shrubland and woodland communities. The desert communities could be cleared and trenched during any season without concern for fire since there is virtually no litter and the plants are spread out from one another. Construction during the rainy season which occurs in all provinces except for the Mojave Desert would, however, increase the severity of water erosion in the cleared areas.

c) Rare and Endangered Flora

There are 26 species of rare and endangered plant species which could be found along the proposed route, as shown in Appendix A. The occurrence of these species within the proposed right-of-way and other areas to be cleared is not known, but colonies of some of them would be expected to be encountered. It is doubtful if construction would result in the extinction of any of these species.

The annual rare and endangered species would be least affected by construction and could even benefit from vegetation clearing along the right-of-way. As discussed in the "Existing Environment" section, annuals are pioneer species whose abundance is stimulated by disturbance. However, disturbance of soil profiles could prevent the reestablishment of those species which have very specific soil requirements, mainly the rare and endangered plants: Scrophularia atrata; Carex obispoensis; Monardella palmeri; Hemizonia arida; and Puccinellia parishii.

7. Wildlife

a) LNG Terminal Site

The removal of most of the vegetation from the proposed site, and from an additional 26 acres necessary for road improvement would displace fauna through habitat destruction for as long as buildings, tanks, roads, and equipment occupy the site. This land would have an overall effect of slightly lowering the wildlife-carrying capacity of the general area for the life of the project. The road would probably become a permanent fixture in the area and thus would represent a permanent loss of habitat. The disposal of the 1 million cubic yards of excess material cut from the proposed site would result in the destruction of additional wildlife habitat if placed on land in a natural state. The introduction of trees onto the proposed site due to the planned landscaping would improve the wildlife variety on the site by providing habitat for tree-dwelling birds and mammals.

Short-term impacts from noise and dust during construction would scare away wildlife from the general vicinity of the proposed LNG site. Since construction of the LNG facilities would take over 3 years, those individuals scared away would probably leave permanently, migrating to similar habitats off the site. Their survival off the site would depend on the availability of suitable habitat and the carrying capacity in those habitats at the time of construction. In general, the population of a species can increase slightly above the carrying capacity of an area. Assuming the populations of animals in the Point Conception area are at the normal carrying capacities, some displaced wildlife could find other suitable habitats to feed and rest in. Birds would not be able to establish breeding territories. The number of these territories remains at a much more constant level than the overall number of individuals of a species; there are always "extra" individuals which do not breed. The green heron, black-crowned night heron, belted kingfisher, and band-tailed pigeon would have the most difficult time of all species in finding new habitat. These are confined to the riparian community around Canada del Cojo. Riparian communities occur only intermittently in the Point Conception area, and vacant habitat for these birds probably is rare or nonexistent.

The operation of the proposed facility would increase the noise levels in the project area. Although not yet measured, present levels are probably in the vicinity of 30 dB(A), typical of a natural community with no human disturbance. Expected operational levels on the property boundaries would be in the range of 60 to 65 dB(A), equivalent to the noise produced by slow-moving cars heard immediately adjacent to the road. At 1,000 feet from the boundaries, the levels would be in the range of 50 to 55 dB(A), equivalent to light auto traffic at 50 feet. During normal operations, noise would be emitted at a relatively constant rate for the life of the project. Unfortunately, little information is available concerning the effects on animals from the type of sound emitted by the proposed facilities. This noise source could generally be called constant and would not result in intense or impact type noise levels at the property boundaries. One general conclusion that can be drawn is that most animals would initially avoid areas around the proposed site due to increased noise levels but would adapt to these levels and possibly repopulate the area.

One study with Japanese quail showed that males separated from females increase the frequency of calls to their mates when there is an increase in noise levels similar to the increase expected due to the proposed project. 1/ This is an example of one species' response and adaptation to the masking effect of noise. This might be expected of other bird species--as noise increases, individuals wishing to verbally contact others would call more often or louder.

b) Pipeline Routes

i. Birds and Mammals

The major impacts on animals due to construction of the proposed rights-of-way would consist of loss of habitat, destruction of food sources, death to those animals which are unable to escape from construction equipment, and disturbance to breeding animals. Following construction, use of the proposed rights-of-way by off-road vehicles would represent a long-term impact.

1/ U.S. Environmental Protection Agency, Effects of Noise on Wildlife and Other Animals, 1971.

During construction activities, most animals would vacate the area near construction due to the increase in local noise and dust levels. Following completion of construction, most of the animal life would return to the area adjacent to the cleared rights-of-way and access roads. However, as discussed in the rare and endangered species section,many large raptors are extremely sensitive to noise and abandon their nests when disturbed by blasting or traffic during the breeding season. 1/ Due to the small amount of time required to construct any portion of the pipeline and the moderate increase in sound during that period, no long-term adverse effects from noise would be anticipated for any animals, wild or domestic, which do not vacate an area during pipeline construction.

Invertebrate fauna living under or on the surface would suffer the greatest impacts from trenching and clearing. With the exception of adult insects, they move slowly and would be unable to escape the disruption of the ground by clearing or trenching. These species would not suffer any long-term impacts due to their abundance and large reproductive potential.

Construction activities, especially trenching, would destroy small hibernating animals such as amphibians located within the proposed rights-of-way. Animals which sleep or rest in burrows such as small rodents, lizards, the desert tortoise, foxes, and badgers, would either be killed or would be forced to seek out suitable habitat in areas adjacent to the proposed rights-of-way or access roads.

Most rodents have relatively small territories, generally less than an acre. 2/ Most passerine birds in shrubland and woodland also have small territories. The impact on these animals would be severe because they would be forced to seek new territories due to the loss of habitat when vegetation is removed. The success that they would have in relocating would depend on

1/ U.S. Environmental Protection Agency, Effects of Noise on Wildlife and Other Animals, 1971.

2/ Macmillen, R.E., "Population Ecology, Water Relations, and Social Behavior of a Southern California Semidesert Rodent Fauna," 1964.

the availability of suitable habitat and the carrying capacity of the area at the time of construction. As stated in the previous section, the populations of species in the areas adjacent to the cleared rights-of-way and access roads could increase slightly above the carrying capacity at that time to absorb some of those wildlife displaced by construction. Bird species absorbed into these areas would be able to feed and rest, but would not be able to establish breeding territories. Animal species not absorbed into new areas would perish.

The loss of habitat for all wildlife species would be most significant in areas where the particular habitat for certain species is extremely limited. In the Carrizo Plain-Temblor Range-San Joaquin Valley and the Tehachapi Mountains Provinces, riparian, juniper, and oak woodland occur in scattered separated areas, providing the only significant cover and breeding areas for wildlife species for many miles. These species include mammals such as skunks, mule deer, the pinyon mouse, Merriam chipmunk, and raccoon; and birds such as owls, hawks, the plain titmouse, and pinyon jay; most individuals of these species would probably not be able to find vacant habitat.

Although the populations of treee-dwelling species such as the western tree squirrel and various woodpeckers are reduced when trees are cleared from the land , the populations of species more adapted to open areas would increase. Among rodents, the clearing of vegetation in shrubland and oak woodland would create open areas more favorable to the California meadow mouse, a species confined to herbland. It would replace such common species confined to shrubland and woodland, such as the California pocket mouse, brush mouse, and California mouse,until sufficient revegetation of shrubs and trees takes place.

Clearing of vegetation in areas of shrubland and oak woodland could temporarily increase the populations of many wildlife species in these areas until the shrubs grow back again to their preconstruction size. The sprouts from root crowns of shrubs and the large quantity of herbs which are found several years after clearing are very valuable as food for wildlife.

Deer, jackrabbits, quail, and mourning doves have been observed to have increased populations following the clearing of shrubs. 1/ These are species which prefer open areas of brush, as opposed to solid closed shrubland.

No adverse effects on deer migration would be anticipated because mule deer along the proposed route do not form migratory herds. Game trails for a variety of species would be disrupted, but could be reestablished by the animals. Larger mammals may also establish trails along the proposed right-of-way following completion of construction.

Water catchments for wildlife use may exist along the proposed route in both the Los Padres National Forest and the Temblor National Cooperative Land and Wildlife Management area. The disruption by construction activities of natural water sources such as Buck Cove Spring and Clifford Spring could permanently reduce populations of deer and grain-eating birds such as California quail and mourning dove. The destruction or draining of any pools or marshes would result in the entire destruction of the populations of amphibians inhabiting them.

The proposed rights-of-way and any associated access roads could be utilized by off-road vehicles. They would scare away wildlife in the general area near the rights-of-way and access roads and would permanently reduce the carrying capacity for various species by preventing revegetation along these corridors. A 50 percent reduction in deer numbers has been noted in a one quarter mile wide corridor on each side of back-country roads in the states of Washington and Colorado; 2/ similar results would be expected due to construction of the proposed project. Many vehicles would be capable of traveling off the corridors, creating direct impacts themselves and leading to the formations of new vehicle trails. Where these vehicles would pass adjacent

1/ Biswell, H.H., Manipulation of Chamise Brush for Deer Range Improvement, 1961.

2/ U.S. Department of the Interior, Alaska Natural Gas Transportation System DEIS, 1975.

to water sources, some animals could be forced to find alternate sources. Inspection of the finished pipeline several times a year by land vehicles would also result in scaring away wildlife.

A total of 3,400 acres would be required for the proposed rights-of-way. However, this quantity would not represent the total wildlife habitat to be disrupted. The construction of access roads and the pushing of spoil dirt onto slopes below ridges which were cut would add an undeterminable acreage to this figure, as would the creation of any new trails from off-road vehicles. Erosion from the cleared areas on slopes below these areas and any increase in fires would also increase the total acreage disrupted.

ii. Freshwater Species

The effects of construction on the aquatic habitat would arise primarily from stream and river crossing and surface runoff from cleared areas. These effects would be temporary, and would be restricted to relatively small, downstream portions of the waterways, so that overall these areas should not be greatly affected.

The two major results of construction activity would consist of siltation and the release of chemicals previously bound in the soil. The general effect of siltation on the aquatic environment is to severely reduce both the kinds of organisms present and their population numbers.

As particulate matter settles to the stream bottom, it creates undesirable physical environments for the organisms normally present. These undesirable areas are created by the screening out of sunlight, changing of heat radiation, formation of a silt layer on the stream bottom, and release or introduction of organic materials or other substances, such as heavy metals, that may create toxic conditions. Eggs and larval stages of various organisms could be smothered; fish feeding would be hampered and spawning areas could be lost. Accumulation of sediment would cut off oxygen and food supplies to benthic organisms, and small pools used for breeding by certain aquatic organisms would be filled in and lost.

The proposed pipeline route would cross about 43 rivers, streams, washes, and arroyos, all of which are usually dry during some portion of the year (typically during summer months). Limited fish populations occur in the larger streams along the route, particularly the Santa Ynez River, Sisquoc River, and Cuyama River. Species found would be typical of warm water streams, such as bass, crappie, sunfish, catfish, and carp. Streams which flow to the ocean, particularly coastal streams, may contain intermittent runs of two (2) species of anadromous fish, steelhead trout and Pacific lamprey, during wet years. These runs would contain low numbers of anadromous fish and do not constitute a recreational (fishing) component of streams that would be crossed. Stocking of some streams for fishermen would also be responsible for the appearance of fish along the proposed route.

c) Marine Biota

The proposed facilities that would involve construction and operation-related impacts on the marine environment include the 4,600-foot long pile-supported trestle and pier terminating in a water depth of 60 feet (above MLLW); a breakwater-protected harbor for small boats, which would be located on the east side of the pier in approximately 20 feet (MLLW) of water; the intake and outfall structures for the heating seawater system; and a screenwell and fish return system.

i. Impacts from Construction Activities

The small boat harbor would consist of a rock breakwater which would be connected to the trestle via a roadway on top of the breakwater. The "U" configuration of the breakwater would be approximately 1,000 feet long. The boat harbor would be used as a construction dock during the LNG terminal construction phases. During plant operations, the harbor would shelter tugs, barges and other small craft. The height of the breakwater would be determined after meteorological and oceanographical study of the site has been conducted. The appropriate type of breakwater to be built at the site would be determined following model and resource studies. Regardless of the type of breakwater, floating marine construction equipment would be required. Hauling barges would transport the materials to the site and floating barge cranes would be used to place the materials.

Emplacement of the breakwater would cause an almost complete mortality of the slow-moving and sessile organisms, the infauna (organisms living in the substrate), and the benthic plants which are present at the site. The more abundant invertebrates in the immediate area which probably would not survive the breakwater

construction include abalone, hydroids, anemones, and several species of starfish. Less common invertebrates include sea urchins, rock crabs, and lobster. The area is on the nearshore edge of the kelp beds. Characteristic algae in this transition zone which would be destroyed include Macrocystis (giant kelp), Egregia (feather boa kelp), and possibly some Pterogophora (a brown algae).

Sediments suspended as a result of rock placement activities could have several detrimental impacts on organisms in the area immediately adjacent to the activity. Suspended particles can clog the filter feeding and respiratory mechanisms of many animals. Their eventual death can result from simple abrasion from sand particles. As the particles settle out of suspension, benthic organisms may be buried. The motile organisms such as fish would move from the construction area and avoid serious damage. Some of the sedentary or slow benthic organisms are adapted to shifts in seafloor materials, but their survival would depend on their mobility, and the rate and volume of settling material. With increasing distance from the breakwater, the possible effects described above would diminish. The applicant is presently conducting a 2-year oceanographic data collection and monitoring program offshore from the proposed LNG terminal site. This investigation should provide the baseline information necessary to begin finalization of the design specifications for the breakwater. The applicant has stated that the feasibility of a final plan would be verified by either analytical or physical modeling of refractor/ diffraction patterns of currents and waves due to the superimposition of the breakwater in the marine environment.

The impacts associated with installing the trestle pilings would be similar to those described above for the breakwater placement. The area of impact involved under each of the piles would be considerably less; however, due to the linear extent of the trestle, more habitat types and associated biological communities would be impacted. It is expected that the impacting of several small areas over the length of the trestle would not, in itself, constitute a significant threat to the populations of plants and animals in the vicinity of construction activities.

Boat and barge activities during construction would cause the loss of the kelp canopy in the vicinity of the breakwater and pier installations. The physical cutting of the kelp fronds would decrease primary productivity in the immediate area. However, the loss of kelp production may not be significant because frond regeneration is rapid and because increased

light penetration would allow increased phytoplanktonic production. Nutrients released from sediment disruption may, given sufficient oxygen, further increase primary production. In any case, the net short-term productivity change should not be significant.

Western has not supplied the staff with sufficient information on the design, location, and construction procedural aspects of the seawater intake-outfall system and the screenwell to be able to accurately assess the impacts which would be associated with this aspect of the proposed construction. However, the applicant has stated that dredging would be required in the surf zone in order to construct the intake and outfall structures. Such dredging would destroy habitats and organisms in the vicinity of the dredging operations. In addition, impacts from sediment movement and increased turbidity would be similar to those discussed in relation to the breakwater construction. Because the dredging would be in the surf zone, the organisms affected would include intertidal flora and fauna as opposed to neritic organisms. The significance of the impacts from constructing the intake-outfall structures is not known and it is the staff's opinion that any speculation on the significance of such impacts would be unfounded without more information on the structure design and construction procedures.

The applicant has indicated that the freshwater used for the hydrostatic testing of the LNG tanks and any water collected from dewatering at the plant site would be discharged into the marine environment. About 11.5 million gallons of test water would be required for each tank. If scheduling permits, the same water would be used to test all tanks. The applicant did not identify the techniques which would be used to discharge the test water, nor did it identify measures which would be taken to minimize adverse effects on the marine environment.

The discharge of at least 11.5 million gallons of water into the sea would locally reduce the salinity of the ocean water. The amount of salinity reduction and the size of the area affected would depend on the rate of discharge, the water current patterns, and the ultimate volume discharged. The impacts on the physical environment, such as habitat destruction, would depend on the discharge techniques used by Western. The impacts on the marine biota would also depend on the discharge techniques and on the organisms located in the area of reduced

salinity. Some organisms can move from the area. Others can close themselves off from their surroundings and thereby avoid the lower salinities. Some organisms can tolerate lower salinities for short durations while others cannot.

ii. Recovery from Construction Impacts

The breakwater would be installed early in the construction phases to allow the boat harbors use as a construction dock. During the lag between completion of the breakwater and startup of plant operation, the areas impacted by the breakwater construction would partially recover. A period of 2 to 5 years may be required before a biologically recovered (breeding) community is established. The breakwater would be a high-relief object, as would the trestle pilings, and would be able to support a greater abundance and diversity of organisms than in low-relief or sandy areas.

The breakwater would indirectly create a relatively low energy environment within the berthing area as a result of the breakwater induced changes in wave and current movement. Therefore, the creation of this breakwater habitat should lead to the development of a biotic assemblage characteristic of southern California's protected, rocky areas. On the seaward side of the breakwater, biotic communities typical of high-energy rocky areas should develop. However, should the cold water plume from the seawater outfall encroach on the breakwater, the communities developing on the breakwater could change. See the discussion of the cold water plume for additional information.

iii. Impacts from LNG Terminal Operation

Under base load operations, approximately 300,000 gpm of seawater would be circulated through the vaporization system. A screenwell and fish return system would prevent the passage of larger organisms and debris through the system. Most adult fish (depending on the screen mesh size) would be diverted through the fish return system. A biocide, acrolein, would be added to the seawater intake at an average rate of 0.6 parts

per million (ppm) for 4 to 6 hours per day to inhibit fouling of the system by marine organisms. The acrolein would be neutralized by a stoichiometric quantity of sodium bisulfite prior to discharge.

The entrainment system consists of a screenwell inside of the intake pipe, a trash rack, and traveling screens. The initial entrainment of organisms would kill most and stun some of the larger organisms. Those few larger organisms which move through the system unharmed could return to the sea through the screen wash system which would discharge into the surf zone. However, most of the organisms which are trapped by the screens and pass through the fish-return system would probably be injured. These organisms would not be expected to survive because they would be easy prey, and injured organisms often succumb to diseases. Even a surficial scratch can prove fatal through disease. Western has indicated that intake velocities at the traveling screens would be kept low to minimize damage to large marine life.

Marine birds that feed on dead or stunned fish would congregate near the discharge end of the return system. A group of fishes may congregate or reside at the mouth of the screen wash return to take advantage of partially immobilized animals. Such predation may be considered beneficial to the predators and may reduce the amount of detritus created by dead organisms washing into the sea.

It is anticipated that there would be nearly 100 percent mortality of plankton, eggs, and larvae which pass through the vaporizers. The temperature shock and mechanical abrasion alone would probably be sufficient to kill many species of plankton, and the intermittent addition of acrolein into the heating water would kill the remaining organisms prior to adding the sodium bisulfite as a neutralizer.

Due to the intermittent addition and neutralization of the acrolein, no significant effects of the biocide should occur in the open sea during normal operations of the plant. A system to stop and neutralize the acrolein input in the event of failure of the neutralizer addition system would be provided.

If accidentally spilled, the acrolein could enter the marine system and kill organisms in the area. The damage from such an accident would depend on the amount of acrolein spilled, location of the spill, and the effectiveness of emergency cleanup and neutralization procedures. Data from the producers of the neutralizing agent, sodium bisulfite, indicates that this solution, normally 35 percent by weight, has a pH of 4.0. Direct contact with such an acidic substance could be expected to cause discomfort and burns in both humans and marine organisms.

If contaminated with oil, drainage from the diked oil storage areas would be processed to remove the oil before being added to the holding pond. A small volume (not to exceed 5 gpm) of fresh cooling water from the utility and instrument air compressors may periodically be added to the holding tank. An average of 7.3 gpm of sanitary waste water from the combination of raw sewage and oil-contaminated drainage, which has been processed through activated sludge treatment and a chlorinater, would also be added to the holding pond. These discharges may be combined with the heating water return system or discharged directly into the ocean. No adverse effects would be expected to result from these minor additions.

When fuel firing is required, freshwater would be used in the heat exchange system. The amount of water needed to fill each of the three gas-fired peaking vaporizers would be about 6,000 gallons. During use of the peaking vaporizers, a total of about 15 gpm of pH 5.5 wastewater would be produced as a byproduct of the gas combustion. Prior to mixing in the holding pond with other LNG plant waste stream, this acidic water would be neutralized with sodium hydroxide. All holding pond wastes would be discharged through the seawater discharge system.

LNG tankers are constant draft ships. To maintain proper trim, an equivalent weight of seawater must be taken on board for each increment of LNG discharged at the terminal facilities. This process would be reversed at the LNG onloading facilities in Alaska where ballast water would be discharged as LNG is loaded. Ballast water may serve as a medium of transport for southern California planktonic marine organisms to the Alaskan LNG loading sites. Impact of ballast water uptake at the marine facilities is limited to the removal of plankton contained in the ballast water.

Diesel fuel and Bunker "C" fuel oil would be shipped by barge to the proposed site. Bunker "C" fuel oil would be onloaded to the LNG ships at the LNG unloading platform. The effects of oil spills on marine biota are varied and dependent on a number of parameters, including size of spill, type of oil, length of exposure time, oceanographic and meteorological conditions, and cleanup and containment operations.

Impacts can be decreased by effective operational procedures and containment and removal of any spilled oil. Cleanup or oil spill containment contingency plans would be developed for this site. Because of the lack of extensive rocky intertidal areas within the immediate site, it is expected that damage to the biota of this area would be minimal. However, damage would probably be severe to the biota which develop on the breakwater areas, as well as to the surface feeding marine birds known to occur in the site area.

iv. Potential Impacts on Commercial and Sport Fishing and Kelp Harvesting

California Department of Fish and Game commercial catch records for the years 1967 to 1972 show a total commercial catch during the 6-year period of 6,429,906 pounds from the four fish blocks in the Point Conception region. 1/ Fish Block 656 yielded the most poundage (58.1 percent) followed in decreasing order by Blocks 657, 658, and 643. Block 657 yielded 27.9 percent of the total of the four blocks. The taxa providing most of the commercial yield for Block 657 included Red abalone (60.2 percent of the block total).

Sport catch records (California Department of Fish and Game) indicated rock fish the most numerous fish (69.5 percent) of the total catch for Block 657 from 1967 to 1971. Block 657 yielded 4,931 fish (31.6 percent of the total from the four blocks) from 1968 to 1972.

Kelp is harvested year-round off the Canada del Cojo Barranca Honda coastline by Kelco, a commercial kelp processing company. Kelco leases kelp beds #31 and #32, which extend between Gaviota and Point Conception, from the State of California. These leases are nontransferrable, and Kelco has exclusive rights to harvest for a minimum of the next 5 years. Bed #32 which extends from Point Conception to approximately 4 miles east of the proposed LNG terminal site is ranked among the top five kelp producers on the California coast.

The construction of the mooring berths, the trestle, and the small craft facilities offshore from the terminal site would temporarily restrict offshore access to commercial fishers and kelp harvesters in local waters. An area of up to 380 acres (approximately .6 square miles) could be directly affected by small craft and work boat traffic supporting construction operations. As shown in Figure 6, the work period for constructing the marine facilities has been estimated at slightly more than 2 years. However, once the proposed facilities became operational, normal activities of the fishermen, abalone divers, and kelp harvesters should not be significantly affected.

Estimates of anticipated economic losses to Kelco as the result of the proposed construction and operation of the LNG facilities have not been calculated. However, before the applicant could cross these leases, it would be necessary to obtain right-of-way easements from the leaseholder, and, presumably, the applicant would be required to reimburse the leaseholder for any losses incurred as a result of the LNG project.

1/ Fish Block 657 is immediately offshore of the proposed LNG facility site and is bounded on the west by Block 658 and on the east by Block 656. Fish Block 643 is due north of Block 658. Block 657 encompasses an area of approximately 40 square miles.

Fishing operations could be hampered if limits are set on how close to the offshore facilities commercial fishing vessels are allowed. However, the staff is not aware of any proposals at this time which would restrict fishing vessel access to waters surrounding the trestle and berthing facilities. Abalone divers would be expected to suffer some economic losses due to the reduction in available seabottom area in and around the marine trestle and breakwater. Between 1967 and 1972, the abalone catch from Fish Block 657, which includes the project area, averaged 180,000 pounds annually. For the purpose of estimating the potential economic losses to local abalone fishermen, it was assumed that as much as 20 percent of the annual catch in Fish Block 657 (about 36,000 pounds) was landed locally and that 20 percent of that local catch (about 7,200 pounds) was taken from the proposed pier route. Using 40 cents per pound as the average price paid to the fishermen (Pinkas, 1974) and the 7,200 pounds per year harvest loss, the loss of abalone fishing grounds beneath the offshore facilities would result in an annual economic loss to local divers estimated at approximately $3,000 during operation of the LNG facility. Additionally, if it can be assumed that 20 percent of the abalone catch is landed in the locale of the marine trestle construction, then it can also be assumed that 20 percent or 36,000 pounds of abalone would be eliminated from the catch during the 2-year construction period. The economic losses to the abalone fishermen could be as high as $14,400 annually for each year of construction.

In assessing potential economic impacts from project implementation, it could be assumed that surface fishermen would not be significantly affected by the offshore facilities, since they pursue free swimming fish.

Western Terminal conducted interviews with some of the fishermen whose home port was Santa Barbara in 1974 and 1975 to help determine the potential economic impact on local fishermen. Based on those interviews and on a review of fish catch data for the California Department of Fish and Game's Fish Block 657, Western Terminal concluded that the construction and operation of the proposed LNG facilities would have a minimal economic impact on local commercial fishermen.

d) Rare, Endangered, or Protected Species

Impacts on rare, endangered, or protected species have the potential of being much more severe than those on common species. The elimination of only a few individuals of a rare population could tilt the balance toward extinction of that species.

The proposed route would involve construction through roughly 47 miles of habitat for the San Joaquin kit fox. With a 125-foot right-of-way to be cleared along this segment, a total of about 31 million square feet or about 1.1 square miles of fox habitat would be destroyed. This represents about 0.03 percent of the remaining fox habitat, or a reduction in carrying capacity for one fox, based on a maximum population density of one per square mile. 1/ Successful revegetation would make this a temporary impact lasting up to 15 years. Construction activities, especially trenching, could destroy kit foxes if inhabited dens are encountered. The abundance of vacant dens indicates that capturing and relocating foxes to prevent destruction from pipeline construction could be successful. 2/

No known Mojave ground squirrel population would be encountered by the proposed route, but it is possible that some presently unknown populations could be crossed. A small quantity of potential habitat in the desert would be destroyed. Based on its food requirements of plants such as cactus, saltgrass, Russian thistle, and saltbush, any reduction in carrying capacity should last no longer than a decade. 3/ Dormant species could be destroyed in their dens during the estivating period from August to March. This could be significant due to the limited number of these squirrels.

No impacts are anticipated on the California sea otter which at present ranges between Seaside and San Luis Obispo (approximately 150 miles of coastline). Sea otters are rarely sighted south of San Luis Obispo. Although the marine habitat of the LNG terminal site is suitable for sea otters, the amount of habitat affected is negligible in comparison to the total available habitat south of San Luis Obispo. Thus, the effect of the proposed LNG marine terminal would be negligible.

The ringtail would have a slightly reduced carrying capacity due to habitat destruction in various areas along the proposed route. Construction could kill some animals sleeping in dens during the day. These impacts are not significant because the ringtail is widespread, though uncommon, and not at all in danger of extinction.

1/ Laughrin, Lyndel, San Joaquin Kit Fox, Its Distribution and Abundance, 1970.

2/ Morell, Stephen, "Life History of the San Joaquin Kit Fox," 1972.

3/ Martin, A.C. et al., American Wildlife and Plants: A Guide to Wildlife Food Habits, 1951.

No impacts are anticipated on the California least tern and California brown pelican because no nesting colonies would be affected by construction or operation. The pelican would not be able to utilize the strand area of the proposed LNG site for resting while construction on the strand takes place, but would probably utilize nearby beaches until completion of construction.

Construction through herbland and small marshland areas of the San Joaquin Valley would further limit declining winter habitat of the sandhill crane in California, although no large marshes would be affected.

The California condor may be adversely affected by construction of the proposed Arvin to Cajon pipeline segment from approximately MP 4 to MP 9. This segment would traverse the proposed Tejon Ranch, critical habitat area for the California condor. 1/ If approved, this area would be a feeding and roosting sanctuary. Correspondence has been sent by the FPC staff to identify the area of the proposed pipeline construction to the Regional Director, Portland Office of the U.S. Fish and Wildlife Service, in compliance with Section 7 of the Endangered Species Act. With the exception of this segment between approximately MP 4 and MP 9, the environmental staff would recommend the proposed Arvin to Cajon pipeline route. At this time, the environmental staff would recommend an alternate route for the critical habitat segment mentioned above, pending an evaluation of potential impacts to the California condor by the U.S. Fish and Wildlife Service on the acceptability of the proposed construction. (See Section I, "Recommendations.")

No other impacts to the California condor would be anticipated due to the distance from the nesting sites and feeding areas. Potential use of pipeline construction access roads by off-road vehicles and subsequent human intrusion could bring activities nearer to existing nesting sites, but probably not close enough to cause nesting failure.

1/ Federal Register, Vol. 40, No. 242, December 16, 1975, Pages 58308-58310.

The American peregrine falcon would not be expected to be adversely affected by construction because of the lack of any nesting sites near any of the proposed facilities. Destruction of foraging habitat would occur, but would not be significant due to the wide range of this species.

Impacts could be severe to the prairie falcon if nesting sites were encountered during rights-of-way and access road construction. These activities would cause nesting failure of any nearby falcon pairs. Off-road vehicle use of the proposed rights-of-way and access roads would also cause nesting failure near any nests; this represents a more severe adverse impact than the pipeline construction due to the potential long-term nature of off-road vehicle use.

The southern bald eagle does not have any nesting sites in southern California, so no adverse impacts on this species are anticipated. Construction could benefit this species by creating cleared areas where, in and along the borders, small rodents could be more easily spotted by this predator.

Impacts to the white-tailed kite would not be significant because its population is presently increasing. Cleared rights-of-way through woodland and shrubland would open up feeding areas for this species, but clearing through woodland could also destroy some nests.

Construction would take place through several areas near populations of the blunt-nosed leopard lizard. Impacts would be severe if burrows with resting lizards were destroyed by trenching or clearing activities. Carrying capacity would be reduced for about 15 years until revegetation has occurred.

The desert tortoise is not as rare as the blunt-nosed leopard lizard, but would suffer moderate impacts if pipeline construction destroyed the shallow burrows where eggs are laid. Loss of vegetation would result in a reduced carrying capacity for 5 to 50 years. 1/

The Tehachapi slender salamander would probably not be harmed by the proposed project because its nearest occurrence is 5 miles from the proposed route. However, significant impact could occur if new populations are discovered which would be within the proposed right-of-way, since individual salamanders could be destroyed.

1/ U.S. Department of the Interior, Alaska Natural Gas Transportation System DEIS, 1975.

The three protected amphibians (southwestern toad, red-legged frog, and ensatina) are prevalent enough in California that construction would not endanger these species, although habitat and/or individuals may be destroyed.

e) Ecological Considerations

Plants, animals, and the nonliving parts of the environment all interact with themselves to form a functional system, an ecosystem, energy is transferred back and forth along various pathways as plants are eaten by animals which are eaten by other animals, which in turn die and decay to provide nutrients for plants. These relationships form a food web; one for chaparral is shown in Figure 37. The more stable an ecosystem is, the more resilient it is to outside changes. Ecosystems in areas of extreme climate such as the Mojave Desert, and successional stages of communities, are the least stable and have the least ability to absorb impacts. These tend to have lesser numbers of species than stable ecosystems such as climax chaparral communities. The destruction of plants by the various construction activities would cause a corresponding decrease in the animals which feed on them (primary consumers) and a decrease in the populations of secondary consumers which feed on these animals. Thus, the populations of some animals could be indirectly reduced due to the loss of habitat for the species they feed on. Figure 37 also illustrates how some predator may utilize alternate animal food sources if their usual ones are unavailable or reduced. This is more prevalent in stable ecosystems rather than unstable ones. The duration of time before the wildlife species composition and numbers return to that which existed before construction would depend on the degree and quality of revegetation. Accordingly, as discussed in the vegetational impacts section, this length of time would range from several years in herbland to over a century in desert communities; in some areas where succession leading to a climax community was prevented, the wildlife would remain impacted.

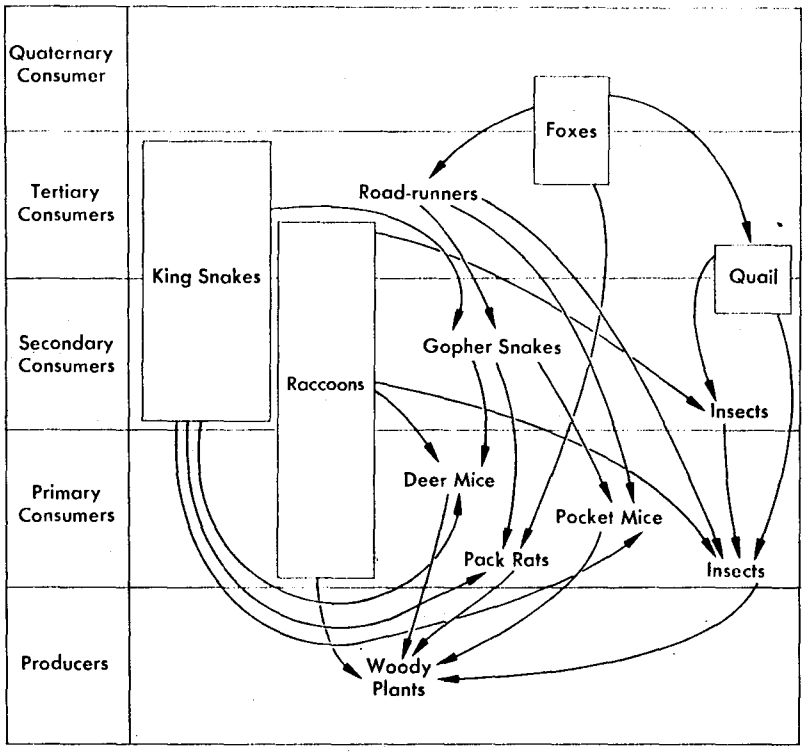

Figure 37. A Simplified Scheme of a Chaparral Food Web

With respect to disruption of natural ecosystems, the sum of all human actions or projects must be examined. A project such as the proposed Point Conception to Cajon pipelines could destroy small populations of rare plant or animal species or unusual ecosystems, and would also lower productivity of a variety of local ecosystems. These impacts represent an individual project. However, their true significance lies in the fact that they are only a portion of the synergistic effects of many unrelated projects, which over a long period of time can have a far more significant combined impact on the environment. For example, the gradual loss of natural communities would not only lead to extinction of rare animals, but would make now common animal species less and less common, until some of these species also become rare and eventually extinct. Rights-of-way occupy a considerable quantity of land. As of 1958, rights-of-way in the United States, for various utilities, comprised an area greater than that of the six New England states combined. 1/ In 1970, there were more than 1 million miles of natural gas pipeline alone whose rights-of-way occupied nearly 4 million acres. It is estimated that by 1990, there will be over 18 million acres of gas rights-of-way. 2/ The magnitude of these figures indicates that the selection of the most environmentally sound right-of-way routes, elimination of others by utilizing existing routes, and the adaptation of various mitigating measures by private industry and government agencies could significantly reduce the general trend in this country of lessened primary productivity, animal populations, community stability, and species variety.

1/ Frank Egler, "Science, Industry, and the Abuse of Rights-of-way," 1958.

2/ EDAW, Inc., Natural Gas Pipeline Right-of-way Study, 1974.

8. Socioeconomic Impacts

a) Construction of LNG Facilities

The local socioeconomic structure of Santa Barbara County would be significantly affected by several immediate and long-term impacts as a result of construction and operation of Western's proposed LNG facilities near Point Conception. The construction phase of the project would result in impacts which would place temporary demands on local housing, the local work force, construction contractors and suppliers, and related services. Long-term effects would be placed on housing, social and protective services, and potential industrial development as a result of operation of the proposed facilities.

During construction, the availability of housing facilities for the influx of workers would be the most immediate problem. Western anticipates that approximately 80 percent or 1,500 workers of the total peak period work force (1,800 workers) would be satisfied from the Santa Barbara County labor pool. Housing impacts could be substantial if enough workers were forced to relocate for the duration of the construction period. Many of these workers might commute from their homes on a daily basis but others might wish to relocate in temporary housing closer to the construction site. Those workers brought in from adjoining counties would probably maintain their distant residences and would commute on a weekly basis. They might choose to reside in local rental accommodations during the work week. Others brought in from outside the southern California area or those who would be associated with the project for a longer period of time would probably relocate their families in the regional area. Those who relocated would make use of rental accommodations or purchase permanent housing.

The magnitude of impact on available housing in the county would depend on where and when the demands would be placed. The larger communities of Goleta, Santa Barbara, Lompoc, and Santa Maria would usually have more housing available than the smaller communities such as Buellton, Solvang, and Santa Ynez. Accommodations become scarce and rates high with the influx of tourists during the summer season. The tourists are mainly concentrated in the Santa Barbara area. This situation may force workers to seek accommodations in the northern county motels, which may increase daily commuting distances and highway traffic.

The availability of rental housing units and trailer and camper parks is very low within the area. In 1970, the U.S. Census estimated that 2,175 vacant housing units were for rent in the county. This represented less than 2.5 percent of the

total existing units. Vacant housing for sale is even more scarce.

It is anticipated that workers would be able to obtain housing but not without difficulty since the housing supply will be scarce. The current lack of camper and trailer courts might result in pressures to develop new facilities or expand existing units. Despite the potential problems, impacts incurred on housing during the 3-year construction period would, for the most part, be temporary.

For the duration of construction (approximately 39 months), the expected increase in population as a result of the influx of workers is expected to be relatively small. However, urban services such as police and fire services, schools, hospitals, and public utilities would be affected to some degree by an increased burden.

Should the proposed project lead to the development of new residences and businesses, police and fire protection would be expected to expand. Law enforcement would be needed in areas where transient housing was erected, and an increase in traffic controls would be required, particularly along U.S. Highway 101.

The applicant has discussed the implementation of the proposed LNG terminal project with the Santa Barbara County Fire Department (SBCFD). Western would cooperate with the SBCFD to train the local firefighting personnel concerning all aspects of the proposed LNG facilities and the handling of the onsite firefighting equipment. A fire at the LNG terminal would not cause an automatic alarm at any of the nearby fire departments. Only in an extreme emergency situation or in the case of a fire outside the plant would the fire department be called. Local firemen would participate as backup to the plant operating personnel who would be specially trained and fully equipped to act immediately in the event of a fire within the area of the LNG facilities. In the event of an LNG accident which would threaten the railroads operations, the trainmaster at Lompoc, with whom communication is available at all times, would be contacted immediately and notified of any problem.

Should local law enforcement and fire protection services be inadequate, these departments would incur additional expenses to provide extra temporary support. However, these expenses might be offset by substantial tax revenues generated by construction activities to the county and other governmental recipients.

Since a majority of the workers will already be residents of the county area, the influx of new students would probably be minimal. However, if 300 highly skilled workers and families were brought into the area by Western during the construction period of the LNG terminal, it is possible that up to 600 new students could be added to the local school system. If these workers decided to reside in the towns nearest the proposed site, it is possible that some overcrowding in the schools could occur. Accessible hospital services in the cities of Lompoc, Solvang, Goleta, and Santa Barbara should be able to accommodate any required emergency service.

The purchase of necessary construction materials would be obtained from the nearest available source. The purchase of materials such as sand, gravel, and sandstone within Santa Barbara County would be an economic benefit to the local suppliers. Structural steel would be imported. The importation of construction materials by rail service would be an economic benefit to Southern Pacific Railroad. However, any rail traffic disruption caused by construction of the proposed railroad spur and trestle which would span the existing track could upset existing rail service. The railroads would be expected to take necessary steps to minimize inconvenience to their customers during these periods of interruption.

The expenditure of payroll money on large supplies of food and other necessary supplies would be a significant economic benefit to retail and wholesale establishments, but would be limited to the duration of the construction phase. The total construction payroll is estimated at $96 million, of which $73 million in disposable income would be made available. Approximately $61.3 million would be available to Santa Barbara County's economy over a 3-year period. The major categories of expenditures are shown in Table 25.

Expected sales tax revenue on the taxable portion of the disposable expenditures (approximately $34 million) is estimated at $2.04 million. A 1 percent revenue charge by the taxing cities and Santa Barbara County would gain $340,000 while the State of California would gain $1.7 million from a 5 percent sales tax revenue.

Building permit and plan-check fees which would be paid to Santa Barbara County would be based upon the value of construction and would represent approximately $890,000 in revenue. (See Table 26.)

TABLE 25

TERMINAL AND PIER CONSTRUCTION
PROJECTED EXPENDITURE OF DISPOSABLE
INCOME IN SANTA BARBARA COUNTY
(1974 Dollars in Millions)

Item	Typical Percent Allocation	Expenditures Resulting From Project Construction Wage Payments (38 months)
Food and Beverages	19.0	$11.65
Housing and Household Operating Expenses	19.0	11.65
Clothing and Shoes	7.5	4.6
Autos and Parts	7.5	4.6
Furniture and Household Equipment	7.0	4.3
Medical and Other Services	13.0	7.96
Other Uses (Including Savings)	27.0	16.56
TOTAL	100.0	$61.32

TABLE 26

TERMINAL AND PIER CONSTRUCTION
PERMIT AND PLAN CHECKING FEES
(Dollars in Millions)

Jurisdiction	Estimated Permit Value of Construction[2]	Building Permit and Plan Checking Fees[1]
County of Santa Barbara	$213	$0.890[3]
State of California surcharge	213	0.015[4]
		$0.905

[1]All fees rounded to the nearest thousand.

[2]All fees are based on direct field costs for the construction of the terminal and pier.

[3]Santa Barbara County Department of Public Works, 1974, Schedule of Building Permit Fees, Building Bulletin No. 3-74.

[4]Surcharge imposed by State of California Division of Mines and Geology for seismic instrumentation (State of California, Division of Mines and Geology, 1973).

Water which would be needed during the initial phases of construction would be transported to the construction site and stored. All storage tanks would be removed upon completion of the project. Electric power would be provided by either temporary fuel-powered generators located on the construction site or brought in on temporary connecting lines via Gaviota. Sanitary facilities would consist of portable chemical toilets and would be removed upon completion of the project.

Although public access by road is forbidden by the property owners of Hollister Ranch, a significant number of people use the beach and offshore resources for commercial and recreational use. Construction activities could cause minor economic losses in commercial fishing and kelp harvesting, because boats would have to avoid the immediate construction area. Such activites would produce noise and disruption of the water which might possibly result in smaller fish catches or would create an increased expenditure in time and fuel in order to fish elsewhere. Recreational boaters and surfers would have to avoid the construction area as well, thereby limiting recreational use near the Point Conception area.

Onshore, grazing activities would have to be terminated near the construction areas. This might result in minor economic loss. No field crops would be affected.

Due to the remote location, the site has limited exposure to the general public, but the presence of the facilities would significantly alter the visual aesthetic nature of the local area. For many years, the unchanged pastoral character of the area has been preserved. The introduction of a major industrial LNG facility would drastically alter this existing state. Not only would the site facilities be visible from the Hollister Ranch area, but the many commercial and recreational boaters who use the area would be subjected to the visual impact of the onshore and marine facilities. Traffic congestion and dust would be generated and would be visually disruptive elements to the residents of the Hollister Ranch and to the people using the Gaviota State Beach Park access road.

b) Operation of LNG Facilities

Operation of the proposed LNG facility would require an estimated operating staff of 80 persons who would be receiving a gross annual payroll of approximately $1.415 million. This gross annual payroll would contribute approximately $1.08 million in disposable income per year within Santa Barbara

County, since it is expected that all the personnel employed in operating and maintaining the facilities would be permanent residents of the county. Over a 20-year economic life period, approximately $21.6 million would be contributed to the economic base of the county.

It is anticipated that the majority of the operating personnel would be recruited from Santa Barbara County, but some employees might be drawn from neighboring counties. Population growth within the county, related to the operation of this project, is expected to be minimal. The potential impact on the available housing supply should also be minimal.

Urban services such as police and fire protection would have to be expanded to the extent that any new residences associated with employed personnel would have to be protected. This should not be significant. While costs for additional protective services would increase, public revenue from the LNG facility property taxes would compensate for any increased expenditures.

The electric power requirements of the LNG facility would be quite extensive and would necessitate the expansion of the Goleta substation and transmission lines to the project site. However, SCE would not have to increase its generating capacity. The proposed 66 kv transmission line would extend for 35 miles from Goleta and would require a right-of-way 150 feet wide. Up to one-half acre of land would be required for the expansion of the Goleta substation. The estimated cost for these new electrical facilities is between $3 million and $5 million, and Western has stated that it would bear the cost of expansion.

Water supply for the LNG plant would be from onsite wells or via pipeline from an outside source. Sewage treatment requirements would be met by onsite facilities. An onsite sewage treatment plant would handle the estimated 4,900 gallons per day of sanitary wastes.

Upon completion of construction, the total estimated value of the facility would be $375.5 million. The ad valorem (property) taxes on the completed facility should add $10.1 million annually to the revenue of the county, districts, and agencies sharing the tax dollar. The accrured property taxes would account for the principal beneficial economic impact upon the county. Table 27 shows the breakdown of revenue beneficiaries.

TABLE 27

PROJECTED ANNUAL AD VALOREM (PROPERTY) TAXES
ON COMPLETED TERMINAL AND PIER 1/

(in millions of dollars; excludes land)

Estimated Plant	$ 301.4
Investment Interest during Construction	74.1
Upon Completion	375.5
Assessed	93.9
Valuation (25%)	
Property Tax Rate (In-County Distribution Schedule)	
General County of Santa Barbara	$ 3.3102
County Fire Protection District	.6147
Schools	6.3895
Other	.4897
Total Tax Rate	$10.8041
Annual Property Tax Revenue to:	
General County of Santa Barbara	$ 3.108
County Fire Protection District	.577
Schools	6.000
Other	.460
Total	$10.145

1/ Calculations based on FY 1975-76 property tax rates; rate per $100 of assessed valuation. Tax Rate Area 94-009., $10.8041.

Operation of the facility would require no relocation of residences or businesses. Access to the beach areas is presently restricted along the privately owned road from Gaviota. There is no public area along the entire road, and consequently beach use is low.

c) Construction of Pipelines

Construction of the proposed gas pipelines from Point Conception to Arvin and from Arvin to Cajon would have several immediate short-term impacts on the socioeconomic structure of the counties which would be traversed.

However, one significant long-term impact would be the restriction upon building any permanent structures within the rights-of-way corridors. Construction activities would cause short-term, minor economic losses in agricultural areas. Grazing activities which would be disrupted would have to be relocated or terminated, which could involve some economic cost. Crop cultivation schedules would be similarly disrupted. Upon completion of the construction phase, land previously used for agriculture would be restored to its original use and appearance. However, the rights-of-way in forested areas, particularly in the Los Padres and San Bernardino National Forests, would be kept clear.

The pipeline routes which have been selected would avoid residential and commercial areas and would not result in any displacements or relocations of families or businesses. The easements for the pipeline rights-of-way through Federal and private property would be acquired by Western. For the Point Conception to Arvin segment of pipeline, approximately 114.5 miles of private land and 27.8 miles of Federal land would be traversed. The Arvin to Cajon segment would require crossing approximately 85.7 miles of private land and 23.2 miles of Federal land.

Construction of the 142.3-mile long Point Conception to Arvin pipelines would require a peak work force of 700 personnel including laborers, craftsmen, and supervisors. The 108.9-mile long Arvin to Cajon pipeline would require a peak construction work force of 225. The proposed pipelines would traverse parts of Santa Barbara, San Luis Obispo, Kern, San Bernardino, and Los Angeles Counties.

Western has estimated that approximately 25 percent, or 230 of the total pipeline construction force of 925, would be recruited from Kern, San Luis Obispo, and San Bernardino counties. The remaining 75 percent, or about 700, of the work force would be recruited from Santa Barbara and Los Angeles Counties and from other areas outside the region.

The pipeline construction phase for both segments of pipelines would extend for a period of 12 months. It is foreseeable that pipeline construction would have a beneficial short-term impact on regional employment. This impact would be reflected in a slight percentage decrease in the unemployed civilian work force in the regional areas, particularly for construction workers. Secondary employment in commercial activities might increase to support construction-related activities. However, this economic growth would be short-term, and business activities would more than likely return to their preconstruction stage. The impact of the available project-related positions on a state and national level would be negligible.

It is expected that since most construction workers would be drawn from existing county labor pools, the workers would probably commute daily to the construction site when it is relatively close to home. Transient accommodations would be sought as construction activities move beyond reasonable commuting distances. Relocation of families is not expected to be a widespread occurrence because of the mobility required of pipeline workers and the relatively short length of the pipeline routes. Permanent homes would most likely be maintained and temporary accommodations; in close proximity to the pipeline route, would be sought on a weekly or monthly basis. The migratory work force would place demands on local transient accommodations, however, no problems are foreseen in obtaining adequate, temporary rental units for individual workers. Many communities located in close proximity to the pipeline routes have many motels and hotels. In addition, mobile homes and camper parks are available, and it is expected that some workers would rely on such transient housing. Overall, the construction phase for the two segments of pipeline should have no significant long-term impact on the existing housing characteristics of the communities situated in close proximity to the pipeline corridor.

The wages paid to the 700 workers for the Point Conception to Arvin segment of pipeline is estimated at $26 million for a 12-month period and would primarily be distributed in Santa Barbara, San Luis Obispo, and Kern Counties. For the Arvin to Cajon segment of pipeline construction, the required 225 workers would be paid $9.6 million in wages over a 12-month period. A substantial portion of these payrolls would be spent in communities along the pipeline route. The disposable income, calculated at 76 percent of the gross annual construction payroll, would be $19.8 million for the Point Conception to Arvin pipeline and the Arvin to Cajon pipeline payroll would yield approximately $7.29 million in disposable income. (See Tables 28 and 29.) In addition to lodging, workers would purchase goods and services necessary for their daily needs and recreational desires. Economic benefits stemming from the purchase of goods and services would be limited by the short duration of construction in any one area, but the expenditures would stimulate the local economy and temporarily increase employment in service-oriented businesses.

Although the construction personnel would infuse new money into the local economies, it is unlikely that any businesses would suffer from overexpansion. Increased income, general sales, and excise taxes would provide a beneficial short-term impact in the state and communities throughout the project areas.

Building permit and plan check fees which would be paid to the traversed counties are based on the value of construction. These fees would represent an increased impact upon county revenues. Table 30 outlines the fees which would be generated in Santa Barbara, San Luis Obispo, and Kern Counties. No information is available for the Arvin to Cajon pipeline through Kern, Los Angeles, and San Bernardino Counties.

d) Operation of Pipelines

The operation of the proposed Point Conception to Arvin pipelines and the Arvin to Cajon pipeline would require a total of seven persons. A staff of this size would have an insignificant impact on the labor force and employment, population and housing, and urban services of the counties crossed by both routes. Employee payroll would have little affect on the counties' income profiles.

The completed gas transmission facilities from Point Conception to Arvin would have an estimated value of $258 million. Property taxes based on $248 million (excludes interest

TABLE 28

POINT CONCEPTION TO ARVIN PIPELINE
ECONOMIC BENEFITS OF CONSTRUCTION PAYROLL
(1974 Dollars in Millions)

		Counties			
		Santa Barbara	San Luis Obispo	Kern	3-County Total
Gross Construction Payroll		$10.0	$7.1	$8.9	$26.0
Disposable Income (at 76%)		7.6	5.4	6.8	19.8
Expenditures of Disposable Income:					
Food and beverages	19.0%	1.44	1.03	1.29	3.76
Housing and household operating expenses	19.0%	1.44	1.03	1.29	3.76
Clothing and shoes	7.5%	0.57	0.40	0.51	1.48
Auto and parts	7.5%	0.57	0.40	0.51	1.48
Furniture and household equipment	7.0%	0.53	0.38	0.48	1.39
Medical and other services	13.0%	0.99	0.70	0.88	2.57
Other uses (including savings)	27.0%	2.06	1.46	1.84	5.36
Total	100.0%	$7.60	$5.40	$6.80	$19.80
Taxable Retail Sales[1]		4.3	3.2	4.0	11.5
New Sales Tax Revenue					
Counties and Cities therein (1%)		0.043	0.032	0.040	0.115
State of California (5%)		0.215	0.160	0.200	0.575
Total (6%)		0.258	0.192	0.240	0.690

[1]Ratios of taxable retail sales to disposable income range between 0.555 and 0.587, based on data from the following sources:

Kern County Board of Trade, 1973

Santa Barbara Chamber of Commerce, no date.

TABLE 29

ARVIN TO CAJON PIPELINE
ECONOMIC BENEFITS OF CONSTRUCTION PAYROLL

(1974 $ in millions)

		Counties			3-County
		Kern	Los Angeles	San Bernardino	Total
Gross Construction Payroll		$5.37	$1.25	$2.98	$9.60
Disposable Income (at 76%)		4.08	0.95	2.26	7.29
Expenditures of Disposable Income:					
Food and beverages	19.0%	0.78	0.18	0.43	1.39
Housing and Household Operating Expenses	19.0%	0.78	0.18	0.43	1.39
Clothing and shoes	7.5%	0.31	0.07	0.17	0.55
Auto and parts	7.5%	0.31	0.07	0.17	0.55
Furniture and household equipment	7.0%	0.29	0.07	0.16	0.52
Medical and other services	13.0%	0.53	0.12	0.29	0.94
Other uses (including savings)	27.0%	1.08	0.26	0.61	1.95
Total	100.0%	$4.08	$0.95	$2.26	$7.29
Taxable Retail Sales[1]		2.57	0.51	1.38	4.46
New Sales Tax Revenue					
Counties and Cities therein (1%)		0.026	0.005	0.014	0.045
State of California (5%)		0.129	0.026	0.069	0.224
Total (6%)		0.155	0.031	0.083	0.269

[1] Ratios of taxable retail sales to disposable income are 0.536 (Los Angeles County), 0.612 (San Bernardino County), and 0.631 (Kern County), based on data from pp. 46 and 95 in the California County Fact Book, 1974 (County Supervisors Association of California, 1974).

TABLE 30

POINT CONCEPTION TO ARVIN PIPELINE
PERMIT AND PLAN CHECKING FEES

	Counties			
	Santa Barbara	San Luis Obispo	Kern	Combined Impact
Permit value of construction within county (dollars in millions)	65.8	46.1	58.1	170.0
Project permit and plan checking fees	$269,000[1]	$77,000[2]	$104,000[3]	$450,000
Permit and plan checking fees as a percent of 1972-73 license and permit revenue	42%	35%	16%	30%
State of California surcharge[4]	--	--	--	$ 12,000
Total Fees (County and State)				$462,000

[1]Santa Barbara County Department of Public Works, 1974.

[2]San Luis Obispo County, no date.

[3]Kern County, 1973.

[4]Surcharge imposed by California Division of Mines and Geology for seismic instrumentation. Reference: State of California Division of Mines and Geology, 1973.

during construction) would add more than $5.9 million annually to the counties, agencies, and districts involved. (See Table 31) The Arvin to Cajon pipeline would have an estimated value of $86.9 million. Property taxes based on $83.6 million (excludes interest during construction) would add more than $2.3 million annually within Kern, Los Angeles, and San Bernardino Counties as shown in Table 32.

Once in operation, agricultural activities could resume, creating little adverse economic effects upon existing crop planting or grazing activities. However, it is not known whether any orchards would be removed within the Arvin to Cajon right-of-way. If orchard removal is unavoidable, affected growers would suffer from a reduction in crop yield. This impact might be minimized if the applicant were to allow growers to replant certain varieties of fruit trees with shallow root systems. Even in this case, depending upon the age of the trees replanted, the fruit bearing stage might not be achieved for a significant time period. If orchard replanting is not feasible, then the grower would suffer from potential economic loss for the duration of pipeline operation. Construction of permanent structures within the rights-of-way would be prohibited.

TABLE 31

POINT CONCEPTION TO ARVIN PIPELINE
PROJECTED ANNUAL AD VALOREM (PROPERTY)
TAXES ON COMPLETED FACILITY
(Excludes Land and Interest During Construction)

	Santa Barbara	San Luis Obispo	Kern	Combined 3-County Impact
Estimated value upon completion of project facilities within county (dollars in millions)	$ 96.1	$ 67.2	$ 84.7	$ 248
Assessed valuation at 25% of the above item (dollars in millions)	$ 24	$ 16.8	$ 21.2	$ 62
Average county tax rate per $100 of assessed valuation	$ 10.00±	$ 10.05	$ 10.48	$ ---
Ad valorem (property) tax revenue to counties, agencies, and districts (dollars in thousands)	$2,400	$1,690	$2,220	$6,309

TABLE 32
ARVIN TO CAJON PIPELINE
PROJECTED ANNUAL AD VALOREM (PROPERTY)
TAXES ON COMPLETED FACILITIES

(Excludes Land and Interest During Construction)

	Counties			Combined 3-County Impact
	Kern	Los Angeles	San Bernardino	
Estimated value upon completion of project facilities within county ($ mil)[1]	$ 46.7	$ 10.9	$ 26	$ 83.6
Assessed valuation at 25% of the above item ($ mil)	$ 11.6	$ 2.7	$ 6.5	$ 20.8
Average county tax rate per $100 of assessed valuation	$ 10.83	$ 11.97	$11.62	----
Ad valorem (property) tax revenue to counties, agencies, and districts ($ thousands)	$1,256	$ 323	$ 755	$2,334

[1]Based on 1974 construction dollars.

9. Land Use and Recreation

a) LNG Facility

c. Onshore Construction

Construction of the proposed Point Conception LNG terminal would have immediate and long-term effects on present and future land use in Santa Barbara County. Cumulative effects would be substantial, because the project would involve the installtion of a major industrial facility in a primary rural agricultural area.

Presently, the proposed site and the local area are zoned 100-AL-O (Limited Agricultural), and the existing land uses are consistent with this zoning. The Limited Agricultural designation would allow oil-related development with county approval, a spot rezoning, and a conditional use permit. The construction of the LNG terminal would represent a major change in land use policy, which presently recommends open space and/or grazing land uses for the site and other properties located along the coast from Point Conception to Gaviota. The proposed LNG terminal would represent a direct conflict with use of the land with respect to development of the Hollister Ranch parcels which would border the LNG site to the north and extend for many miles to the east (See Figures 34-A,B, and C.) The proposed LNG facility would be visible from many areas of those parcels of land.

The adjoining property to the north and east of the property owned by SCE is held by the Hollister Ranch Corporation. As discussed in the "Existing Land Use" section, the Hollister Ranch has been divided into 135 parcels, each a minimum of 100 acres, which are being sold as exclusive home sites. This land is not considered a subdivision opportunity. The Hollister Ranch is one of the last of the large coastal ranches available for private ownership. Each parcel is purchased subject to a grazing lease, because the ranch is operated as a working cattle ranch.

The construction of the LNG facility would introduce major industrial development into an area of agricultural preserve. The isolated impact at the construction site would be relatively low in juxtaposition to the impacts which would be incurred by the south coast region, as a whole, in relation to future industrial development.

As a result of the construction of the storage tanks and regasification facilities, grazing activities would be terminated on the project site, and a total of 227 acres of open land would be converted to industrial use for the life of the project. The cryogenic LNG transfer line would be constructed between the offshore LNG berthing facilities and the regasification facilities. This transfer line would cross Southern Pacific Railroad's track atop a trestle. Rail service might experience minimal localized interference as a result of construction activity near the railroad right-of-way. In addition, temporary disturbance to rail traffic could occur from the construction of a railroad spur adjacent to the existing tracks. This spur would be utilized to offload construction materials. The large quantities of required equipment and materials would be stored near the immediate construction site.

The ingress and egress of vehicular traffic, generated by commuting workers, and the movement of large trucks and construction equipment to the construction site would have a significant impact on the local traffic patterns for the duration of the construction period.

The principal access to the proposed LNG site is along a private road through the Hollister Ranch. This road extends west from U.S. Highway 101 at Gaviota Beach along the coastline, and it is a winding, single-lane and partially developed road. An alternate site access route could be developed northwest of Point Conception. The Jalama Beach Road, a public road, intersects Highway 1 between Lompoc and U.S. 101. This road also follows a winding, narrow route through the foothills of the Santa Ynez Mountains to the Jalama Beach State Park.

Because this route is much steeper and more winding than the coastal access route, widening of this road would be more impractical.

If access is permitted along the private road from Gaviota Beach through the Hollister Ranch, all construction traffic would be funneled onto it. The road would require extensive preparation. Widening the road to provide two-lane access would involve the use of approximately 26 acres of land. Heavy traffic congestion and its localized impact would occur at the Gaviota Beach at-grade intersection with U.S. 101 during the morning and afternoon peak traffic periods. Current traffic counts are not available for this private road. However, based on the low population density of this area and the strict use restrictions which are applied, the average daily traffic count is estimated to be less than 100. Although the number of people presently using this road is small, the overall effect of widening would be great, considering the conditions of the existing roadway.

Beyond the immediate site and access area, the construction phase of the project could induce some significant land use changes. The influx of construction workers to the region might require the development of transient housing facilities such as motels, trailer parks, and rental units. A small demand for residential housing might develop. The expansion of housing facilities would be accompanied by a demand for improved commercial and social services. This cumulative growth would significantly influence the urbanization rate of a primarily rural area.

ii. Offshore Construction

Construction of the marine facilities would have a direct, conflicting impact on recreational and commercial use of the offshore areas. The construction activities associated with the installation of the docking facilities and trestle on approximately 31 acres of leased state subtidal land would impose temporary localized restrictions on any vessel using the area. Commercial fishing boats in the area would have to exercise caution to avoid interfering with construction activities and to avoid any possible collisions or damage to trawling

equipment such as nets and otter boards. Recreational vessels would also run the risk of collision with barges and other construction vessels. Kelp harvesting would also be excluded within the immediate vicinity of construction.

Within the inshore areas, where recreational use is more significant, several impacts would occur. Any swimming, scuba diving, surfing, and other beach-related activities would be eliminated.

c. Onshore Operation

Operation of the proposed project would have significant impacts on land use on a temporary and long-term basis. Approximately 101 acres of a total of 227 acres which Western would purchase would be converted to an industrial use from an agricultural and open space use. Grazing activities would be excluded from the site area, and the operation of the proposed LNG facility would have impacts on neighboring land uses, particularly in the Hollister Ranch area.

The purpose of the 100-acre minimum size of the parcels of land which are being sold for ranching and estate development is to help preserve the exclusive, rural nature of the area. The operation of the LNG facility would disrupt the seclusion that the homeowners desire and would significantly change the low density character of the area. The coastal view would be marred, thereby affecting the aesthetic nature of the area as well as adversely affecting property values at the Hollister Ranch. The visual quality of the existing environment is an important asset to the county.

The shoreline that extends from Jalama to Gaviota Beach is some of the most scenic in the county. The development of a designated scenic corridor would be dependent on the design and development of a shoreline drive. The proposed LNG terminal would degrade the quality and effect of such a plan along the coastal terrace. This impact would affect not only the present residents of the Hollister Ranch area but would affect the general public who would gain visual access all along the scenic corridor.

The trestle which would connect the offshore LNG berthing facility with the plant site would impact a small section of public beach where the trestle would cross the shoreline. This would be a minor impact, because access to the beach in the site area is restricted. Access for those using the beach would be available to either side of the trestle, however, access to the trestle itself would be prohibited.

Vehicle traffic and circulation patterns would be affected as a result of the additional traffic generated by approximately 98 commuting workers and by the supply trucks which would service the vaporization site and ship stores. This impact would primarily affect ingress and egress traffic along the access road to the site, but would not be a significant impact on the volume of traffic on U.S. 101.

The most critical land use impacts that might result from this project are the cumulative effects and development implications which would concern future county and south coast land use. Land use development and related trends are controversial issues with the people of Santa Barbara County. Decisions relating to residential development and particularly petroleum production and processing have for some time agitated county concern. The 1968 sale of Outer Continental Shelf (OCS) leases increased petroleum exploration activity in the Santa Barbara Channel. In January 1969, a major blowout and oil spill along the public beaches was costly environmentally as well as in tangible economic losses to the community. Subsequently, a 5-year moratorium was imposed on all new drilling on existing state tideland leases. The moratorium was lifted in December 1973.

With renewed impetus, exploration and development of petroleum products has again proceeded. Exxon Pipeline Company of California proposed to construct and operate an offshore production platform and onshore treatment facilities in Las Flores Canyon. Public disfavor with the County Board of Supervisors 3-2 decision in favor of the project brought the controversial matter to a county referendum vote in May 1975. The final results of the referendum marginally favored the development of Exxon's facilities and emphasized the growing polarization on the subject between local citizens.

Residential developments have not progressed as rapidly as in other areas of southern California. In 1970, the proposed subdivision of El Capitan Ranch was defeated by a county referendum vote. Clearly, the formidable ramifications of industrial and residential development in Santa Barbara County are given much attention. The direction taken for county land use will depend greatly on an evaluation of state and county needs and their compatibility with the County General Plan.

iv. Offshore Operation

Operation of the marine facilities could present a hazard to commercial and recreational boaters who venture too near the facilities. Commercial fishermen and kelp harvesters would have to avoid the immediate area. The presence of the marine facilities might affect recreational surfing. The local beach immediately adjoining the proposed LNG site, Cojo Reef, has been ranked by the Western Surfing Association (1974) as "Fair." Cojo Point, west of the site, is considered "Classic"; Lefts and Rights, east of Barranca Honda and Gato, is rated "Good." 1/

There would be significant impact on traffic in the Santa Barbara Channel due to the large number of LNG ships traveling to the Point Conception site. The number of ship arrivals per year would depend on the capacity of the ships used. To meet the 2,806 million mmcfd rate, 308 ship arrivals per year using 165,000-cubic meter capacity ships would be required.

1/ Classic - often an internationally known location that has been surfed for many years, receiving a great deal of publicity in both the general media and surf publications; and, as such, playing a key role in the heritage and history of the sport of surfing in California. In addition, a surf break with waves whose potential to size, quality and frequency in relation to other surf spots makes it a unique surfing resource.
Good - Frequently provides waves of excellent size and quality.
Fair - Provides waves of lesser frequency and/or size and quality (Western Surfing Association, 1974).

b) Pipeline Routes

i. Pipeline Construction

Construction of the twin 42-inch pipelines from the Point Conception LNG facility to the proposed pressure regulating station at MP 133 would require a minimum 125-foot wide right-of-way. From MP 133, an additional 9.2 miles of 42-inch pipeline would be constructed which would extend north to the Arvin metering station. This 9.2 miles of pipeline would require a 100-foot wide right-of-way during construction. These rights-of-way would extend for a total length of 142.3 miles and would traverse leased and purchased easements in Santa Barbara, San Luis Obispo, and Kern Counties.

During the construction phase a total of approximately 2,272 acres of land along the right-of-way would be cleared as work space for the pipeline construction. After installation of the pipeline, a permanent 75-foot right-of-way or approximately 1,294 acres would be retained.

In Santa Barbara County approximately 55.5 miles (or 841 acres) would be disturbed during construction. Approximately 48.6 miles of the route would cross private land holdings and 6.9 miles would cross U.S. Forest Service lands (Los Padres National Forest). The entire route through this county is zoned with various designations for agricultural use. These categories include AL - Limited Agriculture, U - Unlimited Agriculture, and AG - General Agriculture. With the exception of the AL zoning, mineral production and processing is allowed in addition to agricultural use. In any area zoned AL or where the route would approach within 1,000 feet of such an area, a conditional use permit would be required.

In San Luis Obispo County, the pipeline route would disturb 27.8 miles of private lands or 421 acres, 6.5 miles of U.S. Forest Service lands or 99 acres, and 4.6 miles of Bureau of Land Management lands or 70 acres. The zoned areas through which the pipeline would cross permit a wide variety of land uses. Therefore, no zoning changes would be required.

Currently, the land use allows the operation of public utility or public service buildings and structures for uses related to water, power, gas, and telephone transmission, storage, and generating facilities.

Approximately 47.9 miles of the pipeline route would be contained within the county limits of Kern County. Of this total, 36.1 miles of right-of-way land is privately owned and 2.6 miles is under the jurisdiction of the Bureau of Land Management. The land ownership of the remaining 9.2 miles of right-of-way has not yet been determined. The entire route in this county is zoned for exclusive agriculture, which permits oil and gas production and pipeline construction.

The second segment of the proposed pipeline would extend for 108.9 miles from the Arvin metering station in Kern County through Los Angeles County to the Cajon Station in San Bernardino County. This route would require a 100-foot wide cleared right-of-way. The pipeline construction would disturb a total of 1,330 acres, of which 10 acres would be occupied by temporary storage yards for pipe, construction materials, and equipment.

Unlike the first segment of the pipeline which crosses a significant amount of cultivated land, the Arvin to Cajon segment would encounter open space land use for approximately 95 percent of the proposed route. The open space uses include naturally vegetated land, grazing land, and undeveloped subdivided land.

The 100-foot wide pipeline right-of-way would affect 60.9 miles of land or 738 acres in Kern County. A 5-acre parcel would be leveled for storage purposes and an additional 1.5 acres would be graded near Arvin for a metering station. Approximately 48.6 miles of the route would traverse privately owned land, and the remaining 12.3 miles would cross Federally owned land within Edwards Air Force Base.

Zoning along the Kern County portion of the route is the most diverse as compared to the rest of the route to Cajon. Areas zoned for agricultural, estate, suburban residential,

and general manufacturing would be encountered. None of these zoning categories would preclude the installation and operation of public utility facilities including gas transmission pipelines. Approval for the 12.3 miles of pipeline right-of-way across Edwards AFB must be obtained from the Base Commander and various Federal agencies in Washington, D.C.

The proposed right-of-way in Los Angeles County would account for 14.2 miles (or 172 acres) of the pipeline route to Cajon. Private and Federal lands would each account for 7.1 miles of the route. No zoning changes would be required because the route passes through areas of open space and light agricultural activity. The 7.1 miles of right-of-way through Edwards AFB would require the same approvals as discussed in the previous paragraph.

From Los Angeles County, the pipeline route would cross into and terminate in San Bernardino County. The corridor would extend for 33.8 miles and would affect 410 acres. A 5-acre site would be selected and cleared for a storage yard and 1.5 acres would be utilized for a metering station at Adelanto. The first 31 miles would cross a combination of Bureau of Land Management and private lands. The final 2.8 miles are within the San Bernardino National Forest. The areas of contact are zoned for desert living, light agricultural, and rural residential, and these areas do not preclude the construction of gas transmission pipelines.

Pipeline construction activities for the entire 251.2 miles of proposed pipeline construction would primarily occur in rural, unpopulated areas. Residential developments along the route are relatively scarce. Agricultural use of the land would incur significant impacts along the Point Conception to Arvin pipeline segment. Pipeline construction activities would result in the disruption of existing agricultural uses encountered along the entire length of the proposed pipeline. Farm equipment access across the right-of-way might also be hindered. Livestock grazing would be temporarily eliminated near the right-of-way areas, and crop planting and harvesting schedules would be disrupted. Recultivation of these agricultura areas could not resume until after the termination of the

construction phase. If orchard crossings were unavoidable, fruit trees occupying the right-of-way would be removed, thus reducing the fruit bearing potential of the land.

The residents of the Hollister Ranch, which adjoins the proposed LNG site, would be subjected to an increase in traffic along their private residential road. Pipeline construction would parallel the coastal bluffs and increased dust and noise levels would discourage recreational use along these bluffs. Cattle grazing would have to be temporarily terminated near construction activities.

In Santa Barbara and San Luis Obispo Counties, where the pipeline route would pass through Los Padres National Forest, recreational impacts might occur. Hiking, camping, horseback riding, fishing, swimming, and other recreational uses are common in the more rugged portions of the forest area. Construction noise and dust would temporarily discourage recreational use near pipeline construction activity.

Where the proposed route would cross thickly vegetated or tree covered slopes, a "tunnel effect" would be created. Potential beneficial use of these areas could be made as fire breaks, ecotones for fauna use in foraging, or recreational uses such as hiking and horseback riding.

Minimal impact to traffic on major thoroughfares and frequently used streets and roads would occur. All road and railroad crossings would be bored and cased to minimize disruption of traffic flow. Temporary delays could be experienced at these road or railroads due to the crossing of construction equipment.

In all areas along the pipeline routes from Point Conception to Arvin and from Arvin to Cajon where trails, and dirt or gravel roads are encountered, temporary detours and interruption of vehicle traffic would occur because these roads would be open-cut.

The California Aqueduct and the Los Angeles Aqueduct would each be crossed once by the pipeline easement. The pipeline would span the waterway above the main channels. Construction should not affect the flow of water at either site, and no construction related impacts are expected.

ii. Pipeline Operation

Once the pipeline had been installed, the right-of-way would be properly revegetated with native grass or cultivated crops. Restoration activities should allow the land to revert to its previous or other appropriate uses immediately following construction. A restriction on the construction of permanent structures would be imposed within the right-of-way. Land use would be restricted in areas where aboveground facilities would be situated. The visual impact of the right-of-way would be significant in the forested areas, where trees would continually be cleared away for the life of the pipeline project.

Maintenance operations should have a minor impact on land use. Vehicle traffic associated with pipeline inspection should not have a significant impact on local traffic patterns. Access roads would be maintained in the mountainous regions near Tehachapi and Cajon. This may result in increased disturbance to wildlife.

10. Impacts of Construction on Archaeological and Historical Resources

An analysis of the impacts of construction on archaeological resources is limited by several factors. First, the precise alignment of the pipeline has yet to be determined. Prior to construction, the applicant would survey a 2-mile wide corridor in order to provide the best alignment alternatives. Second, the existing data on known or potential archaeological resources are of variable quality, with archaeological reports often differing in format, methodology, descriptive precision and in the qualification of the reporters themselves. Third and most important, no comprehensive field survey has been performed for the pipeline corridor, hence the actual numbers and locations of archaeological resources present cannot be known.

While it is impossible to define with any precision the impacts of pipeline construction on southern California archaeology, what can be discussed is the nature of the impacts that can be expected. The impacts associated with construction would be both direct and indirect. Direct impacts would arise from the actual construction of the pipeline and its associated facilities; the right-of-way, access roads, metering station, the LNG facilities and terminal, equipment yards and work areas. The proposed right-of-way would be 125 feet wide. The right-of-way and support facility sites would be cleared and graded. The pipeline trench would be 54 inches wide and from 60 to 80 inches deep. Machines would be used to dig the ditch except in rocky areas where blasting would take place. In such cases sites that would otherwise be outside the area of direct impact might be damaged. Additional sites might be damaged at borrow areas where gravel and rock would be mined for construction.

Indirect impacts would arise from activities outside the actual construction of the pipeline. Foremost among these would be a greater incidence of souvenir collecting by construction workers at archaeological sites. Other indirect impacts could come about through soil erosion or chemical alterations in soils which would affect the integrity of archaeological sites.

Forty known sites have been located within the 2-mile wide pipeline corridor at the LNG plant site and offshore tanker facilities. The possibility exists that a large percentage of these, along with uncounted potential sites, would be disturbed by pipeline construction. Staff has identified those known sites and areas of probable site concentration that would be affected by the pipeline (See Section B.11 and Appendix B.) Of principal concern here is the location of the LNG facilities at Point Conception, which would impact large Chumash village sites. Also endangered by these facilities would be several underwater sites. Another area of concern is the Cajon terminus for the pipeline, where 14 sites located in Crowder Canyon would be endangered by the construction activities at the proposed regulating and metering station.

A survey of the National Register of Historic Places indicates that no National Register properties would be affected by the proposed pipeline. The Los Alamos Ranch House near Los Alamos, California, would be about 1½ miles west of the pipeline, and no impacts are expected. In addition, it is not expected that any impacts would occur to the state landmarks which have been identified.

11. Air and Noise Quality

a) Air Quality

Gas-fired peaking vaporizers and trim heaters would emit small amounts of nitrogen oxides, carbon dioxide, and sulfur to the ambient air. The standby peaking vaporizers would use gas from the plant as fuel.

Emissions from the gas-fired vaporizers operating intermittently at maximum capacity should be approximately 0.06 - 0.12 lbs./MMBtu for NO_x and 0.0007 lb./MMBtu for SO_x. For trim heaters whose averaging firing rate is 200 MMBtu/hr, NO_x emissions are approximately 0.13-0.18 lb./MMBtu and 0.0009 lb/MMBtu for SO_x, therefore nitrogen oxides are of primary concern. Although these emissions would comply with appropriate emission regulations, the percentage increase above baseline ambient concentrations of pollutants in the Point Conception area appears to be large. These units, however, would be designed to minimize the formation of nitrogen oxides during operation.

To estimate the maximum impact of the operation of the LNG facility on air quality both maximum emission rates and worst meteorological conditions were assumed. Emissions were assumed to emanate from an altitude equal to the stack height plus the plume rise (caused by plume buoyancy and momentum). At combustion temperatures, the formation of NO is thermodynamically favored over the formation of NO_2. Thus, in order to compute the annual average NO_2 contribution from the operations of the LNG facility, the effective NO_2 emission rate is equated to the total NO_x emission rate. The resulting annual average concentrations are less than 0.001 ppm, even with all sources operating full time. Thus, the annual average effect of nitrogen dioxide emission is less than 2 percent of the Federal standard (0.05 ppm).

Again using the Turner method (1969), for the combined sources, a conservative estimate for the worst 1-hour concentration is 0.06 ppm, occuring when all sources are operating and there is a strong sea breeze. With the more

frequently occurring meteorological conditions (stability classes C and D), the worst 1 hour concentration is estimated at approximately 0.02 ppm. Therefore, the short term standard would not be exceeded unless the background concentration at Point Conception is greater than 0.23 ppm.

Since California has a 1-hour standard for SO2, it became necessary to calculate the maximum ground level SO_2 concentration resulting from the operation of ships boilers. The resulting absolute maximum 1-hour concentration would be approximately 830 ug/m^3 occurring during extremely rare meteorological conditions. This concentration is well below the 1-hour standard of 1310 ug/m^3.

During the construction phase, there would be some additional vehicular emissions due to the influx of additional workers into the area, but this increase should have an insignificant impact upon the ambient air quality of the region.

In addition, localized short-term fugitive dust would occur as a result of construction activities and movements of equipment.

b) Noise Quality

Noise sources at construction sites are very complex. Noise levels are a function of the numbers and types of equipment being used, operations being performed, and size of the construction area.

All valves and metering devices will be buried, which will muffle noise levels normally associated with the operation of the proposed pipeline. Noise levels should attenuate to ambient levels within several hundred feet of these facilities, or within the confines of the right-of-way and the fence surrounding the metering station.

The proposed pipeline will not have compressor stations, which are the major noise source in any gas transmission system.

12. Impact on Local Utilities

Western has estimated that the electrical power system required during the construction period would be required to supply an average electrical load of 5,000 kw. This system would probably operate on a 50 percent load factor during the 8-hour construction day, with about 600 kw/hr. needed for night lighting.

The electric power for construction would either be generated onsite with diesel generators or provided to the site through temporary connections from SCE's (kv) system in Gaviota. The jobsite is approximately 16 miles from Gaviota. If installed, the temporary connection would be removed after the facility has been completed, and a higher capacity permanent electric transmission line from Goleta would take its place.

The electrical power requirements of the completed Point Conception LNG plant would necessitate some utility expansion at SCE's 220-66 kv Goleta substation. The permanent electric transmission line would have a 66 kv capacity and would be 35 miles long.

Preliminary planning by SCE indicates that no expansion of its generating capacity would be required to meet the power requirements. The cost of the substation expansion and transmission line from the substation to the plant site has been estimated to be between $3 million and $5 million. Western LNG stated that it would bear the cost of the expansion as part of its facility expense. Rights-of-way for the 66-kv transmission line would have to be acquired. A typical right-of-way for the power line is 150 feet wide. An additional land area of up to one-half acre would be required for the expansion of the Goleta substation.

Comparing the estimated LNG plant load of 39,100 kw with the 1973 SCE Santa Barbara district average load of 96,150 kw indicates that the electrical requirements of the LNG plant

would increase the SCE service district average load by slightly more than 40 percent. As stated in Section B.12 of this report, the SCE generating plants in western Ventura County produce most of the power load in the Ventura-Santa Barbara region. The combined average power loads of the Santa Barbara district and the Ventura district totaled 291,940 kw in 1973. The Point Conception LNG plant load would increase this regional total by about 13.4 percent.

The applicant has estimated the freshwater requirements for construction activities as provided below:

a. Sprinkling Water - for dust control and abatement: 30-50,000 gallons per day (gpd) for approximately 8 months per year.

b. Hydrostatic Test Water - for LNG storage tanks. Testing of the tanks would require approximately 11.5 million gallons if the same water could be reused for each tank. Water for the tests would be required at a rate of approximately 800,000 gpd.

c. Potable Water - for chemical flush toilets and field offices: approximately 10,000 gpd.

d. Concrete Mix Water - for structures and foundations: 2,500,000 gallons. Peak rate requirements would be approximately 100,000 gpd during the construction of the foundations for the LNG storage tanks. This operation would take place between the 5th and 20th month of construction.

The domestic sanitation system at the LNG facility would discharge an estimated 4,900 gpd of sewage into a sanitary sewage treatment system located on the plant site. No sewerage utilities would be affected by this project.

Water for fire protection would be provided by freshwater stored in an onsite 160,000-barrel storage tank with a seawater backup. There would also be a seawater pump at the marine facilities.

Western LNG has not determined what sources of freshwater are available to meet the water requirements for construction and for normal operations of the LNG terminal. The applicant is considering constructing onsite water wells if there is sufficient usable water on the site. The alternative to onsite wells is to bring water to the site via pipeline. As of August 1975, Western LNG had conducted no specific investigation of this alternate possibility. As noted in the section on existing utilities, a water moratorium presently is in effect in the project area. If local utilities import water from the State Water Project, then it is possible that the moratorium could be lifted and water made available to users, including Western LNG, who presently are not supplied by the existing water utilities.

There are insufficient groundwater hydrologic data available to determine whether enough freshwater is available at the site to meet the terminal's freshwater requirements.

The fuel gas required for operating the trim heaters, gas-fired vaporizers, and other equipment would be supplied from regasified LNG. Therefore, existing supplies of natural gas that have been committed to consumer markets would not be affected. Western LNG has estimated that the fuel gas requirements would be approximately 2,400 billion Btu's per year for plant operations. Assuming a thermal value of 1,160 Btu's per cubic foot of fuel gas, the use of gas-fired equipment as proposed would preempt the use by the general consumer of approximately 2.068 million Mcf of gas each year of terminal operations.

13. Analysis of Public Safety

a) Introduction

The most significant hazard that could occur during the operation of the proposed LNG terminals would be the formation of a combustible vapor cloud and its subsequent dispersion and drift downwind into populated areas. The vapor cloud would be formed as the result of a spill of LNG. The larger the spill, the larger the vapor cloud and the further it could travel downwind over populated areas. A spill could occur over water from an LNG ship collision, or over either land or water from a rupture of an LNG storage tank.

Although there is little actual experience with the hazards to the public from LNG import terminals, there are data available from experiments involving small LNG spills and analytical techniques for calculating vapor dispersion and drift. There is also available the accident experience involving the marine transportation and land-based storage of other flammable liquids. This material has been used in the analysis given here. Some of the properties of liquid methane, which is the major component of LNG, are given in Table 33.

Table 33

Selected Properties of Liquid Methane

Molecular wt. = 16.0 gm/mol
Density of gas @0°C = 0.717 gm/liter = 0.045 lb/ft^3
Density of gas @112°K = 1.75 gm/liter = 0.11 lb/ft^3
Density of liquid @109°K = 415 gm/liter = 25.9 lb/ft^3
Boiling point = 112°K = -161°C = -260°F
Heat of vaporization = 138 cal/gm = 248 BTU/lb

b) California Terminals

In order to assess the risk of casualties to people on shore from a large spill of LNG on water, the FPC staff has performed an analysis which is provided in Appendix C of this EIS.[1/] The results of this analysis indicate that there is little difference between the three proposed terminals in terms of the probability of fatality per person per year. This analysis was based on equal numbers of LNG tanker deliveries per year to the three proposed terminals.

1/ Appendix C has been expanded to discuss areas of concern raised in comments to the DEIS.

In terms of the risk from LNG compared to that from other voluntary risks normally encountered in daily life, the analysis dicates that LNG risks, to people onshore, from ship accidents are mparable in magnitude to those from fire and electrocution. ese appear to be acceptable risks for LNG importation by ship.

This risk assessment is based on a model of LNG plume behavior .ven in Attachment 1 to Appendix C. This model assumes that, for ırge spills of LNG on water, the fire hazard area is confined ıssentially to the area covered by the plume and that when the ıpor plume warms to positive buoyancy and lifts uniformly off the ıter the fire hazard at ground level ceases to exist. For the ırgest LNG spill investigated, the spill would have to occur closer ıan 7000 feet to shore before the safety of the public ashore ɔuld be threatened by the ignitable vapor cloud. This model is alid for all meteorological conditions for plume travel, but assumed lat terrain.

In order to study the effect of a massive LNG spill from storage anks on shore, a plume analysis was performed for the FPC by eteorology Research, Inc. (MRI).

MRI assumed a 2,000,000-barrel spill from storage tanks at ɔint Conception, Oxnard, and Los Angeles Harbor, California. Com- utations were made on seasonal and annual bases of the Lower Flam- able Limit (LFL) for each site using its climatology (winds, temper- ture, stability). One analysis considered the LNG-water interactions sing a Gaussian diffusion model under the neutral stability condi- ions. Another LFL analysis was made considering both land and water nteractions with LNG and using the MRI three-dimensional diffusion odel which includes terrain and soil characteristics. The MRI land- ater model provides the most accurate results and the most signifi- ant indication of differences between sites.

Table 34 shows the downwind distances to reach one LFL derived rom these models. Table 35 shows the standard deviations associated ith these values of LFL for the Gaussian model. The MRI model esults in longer distances to reach the LFL. The reasons are: (1) he virtual-point concept is based on data from a relatively warmer loud than the LNG, the latter being very cold compared to the ambient tmosphere; (2) the σ_z for LNG dispersion should be smaller than hose based on data from clouds from hot stacks; (3) the Gaussian odel does not take into account terrain features or variations of eteorological parameters such as the wind.

TABLE 34

DOWNWIND DISTANCE TO REACH ONE LFL
FOR GAUSSIAN AND MRI DIFFUSION MODELS (km)

Continuous Release	Wind speed (m/s)	Point Conception			Oxnard			Los Angeles Harbor		
		Gaussian	MRI		Gaussian	MRI		Gaussian	MRI	
			Water	Land-Water		Water	Land-Water		Water	Land-Water
	2.24	9.13	9.65	12.0	9.13	9.65	12.73	9.13	9.65	12.5
Summer										
	3.91	4.65	6.50	11.5						
	3.86				4.71	6.25	11.8			
	3.66							5.04	7.20	11.5
Winter										
	3.09	6.22	7.60	11.0						
	4.74				3.65	3.90	7.75			
	2.78							7.06	8.0	10.5
Annual	4.90	3.47								
	4.20				4.22					
	3.90							4.68		

TABLE 35

VALUES OF σ_y AND σ_z (m) FOR GAUSSIAN DIFFUSION MODEL FOR "D" STABILITY

			Point Conception		Oxnard		Los Angeles Harbor	
			σ_y	σ_z	σ_y	σ_z	σ_y	σ_z
Continuous Release	5 mph (2.24 m/s)		1360	128	1360	128	1360	128
	Summer	3.91	1160	84.9				
	(m/sec)	3.86			1170	85.5		
		3.66					1180	89.1
	Winter	3.09	1230	101				
	(m/sec)	4.74			1120	72.7		
		2.78					1270	109
	Annual							
	(m/sec)	4.90	1110	71.1				
		4.20			1150	80.0		
		3.90					1170	85.0

For Point Conception, the effect on the wind field distributions of the 12.2 m (40 ft) drop from the proposed site to the beach below was considered in the MRI model. The resulting LFL distance was 12.0 km (7 miles), as compared to 12.5 km when flat terrain is assumed. The lower LFL is due to the higher average wind speeds at the higher (40 ft) level, which causes the plume to make contact with the ground sooner and at a shorter distance from the spill. For the other two proposed sites at Oxnard and Los Angeles Harbor, such terrain effects are found to be negligible, resulting in distances to one LFL equal to those given in Table 34.

MRI did not perform a risk assessment of casualties from these plumes. The risk assessment performed by staff (Appendix C) indicates that the probability of plume ignition over a populated area reaches a value close to unity about one mile inland from shore. Thus, longer plumes may not exist over a populated area.

H. ALTERNATIVES TO THE PROPOSED ACTION

This section discusses the alternatives to implementing the proposed project. These alternatives include:

1) Alternate Pipeline Routes
2) Alternate West Coast LNG Sites
3) The Alternate of No Action
4) Alternate Modes and Systems
5) Alternate Sources of Energy
6) Energy Conservation

Alternatives 1, 2, and 3 are covered on the following pages. The discussion of alternatives 4, 5, and 6 is adopted by reference from the U. S. Department of the Interior's Final Environmental Impact Statement issued in March 1976 for the Alaskan Natural Gas Transportation System.

1. Alternate Pipeline Routes

a) Introduction

This section explores the advantages and disadvantages of alternate pipeline routes which could be used to transport natural gas from the applicant's proposed LNG terminal site at Point Conception to nearby major pipeline distribution facilities for subsequent distribution within California and other parts of the United States.

The location of the proposed pipeline to deliver gas from the proposed Point Conception LNG terminal was limited by the location of the existing pipelines which would receive the gas. According to the applicant, the proposed route was chosen on the basis of the following criteria:

1. Shortest practicable route which meets all other criteria.
2. Avoid rocky, rough terrain where possible to lower construction costs.
3. Follow other utilities, roads and rights-of-way where possible.
4. Choose a route which will not cause undue erosion problems in years to come in order to lower maintenance costs.

Since gas would be sent both north to central California and south to Los Angeles, it is the staff's opinion that a route connecting with the Pacific Gas and Electric pipelines which go through Arvin would clearly be the most environmentally sound route. The applicant's proposal for a route to Arvin is shown in Figure 40 which also shows the existing gas pipelines in southern California which would be used to transport gas north and south. No pipelines would have to be constructed to serve the middle and northern California areas because gas would be taken into a 16-inch Pacific Lighting Service Company (PLSC) pipeline about 10 miles from Point Conception and into a 34-inch PLSC pipeline about 10 miles southwest of Arvin which would deliver gas to these areas.

Several existing rights-of-way, owned by PLSC and Pacific Gas and Electric Company (PGE) could be paralleled from Arvin to Cajon thus reducing the required right-of-way width.

b) Point Conception to Arvin Alternatives

Several alternative routes described below are possible between MP 39 and 104. Table 38 contrasts environmental characteristics of these alternatives with the proposed segment between these mileposts.

i. Alternative A

Alternative A, shown in Figures 41 and 42, was considered by the applicant. It would deviate from the proposed route at MP 39 by continuing to follow Tepusquet Road down Tepusquet Canyon, then would leave the road and traverse one-half mile of mountain sides and ridges, and rejoin the road down Buckhorn Canyon. After about 1½ miles, the alternate segments would turn to the right to parallel Highway 166 for about 10 miles following the Cuyama River until the alternative joins the remainder of the proposed route at MP 56. As shown in Table 38, the main advantages of this route over the proposed segment are that there would be a small decrease in the number of possible ridges which would have to be cut during construction and that an additional 16 miles of existing right-of-way (road) would be paralleled. However, large sidecuts would have to be made alongside Tepusquet Road,

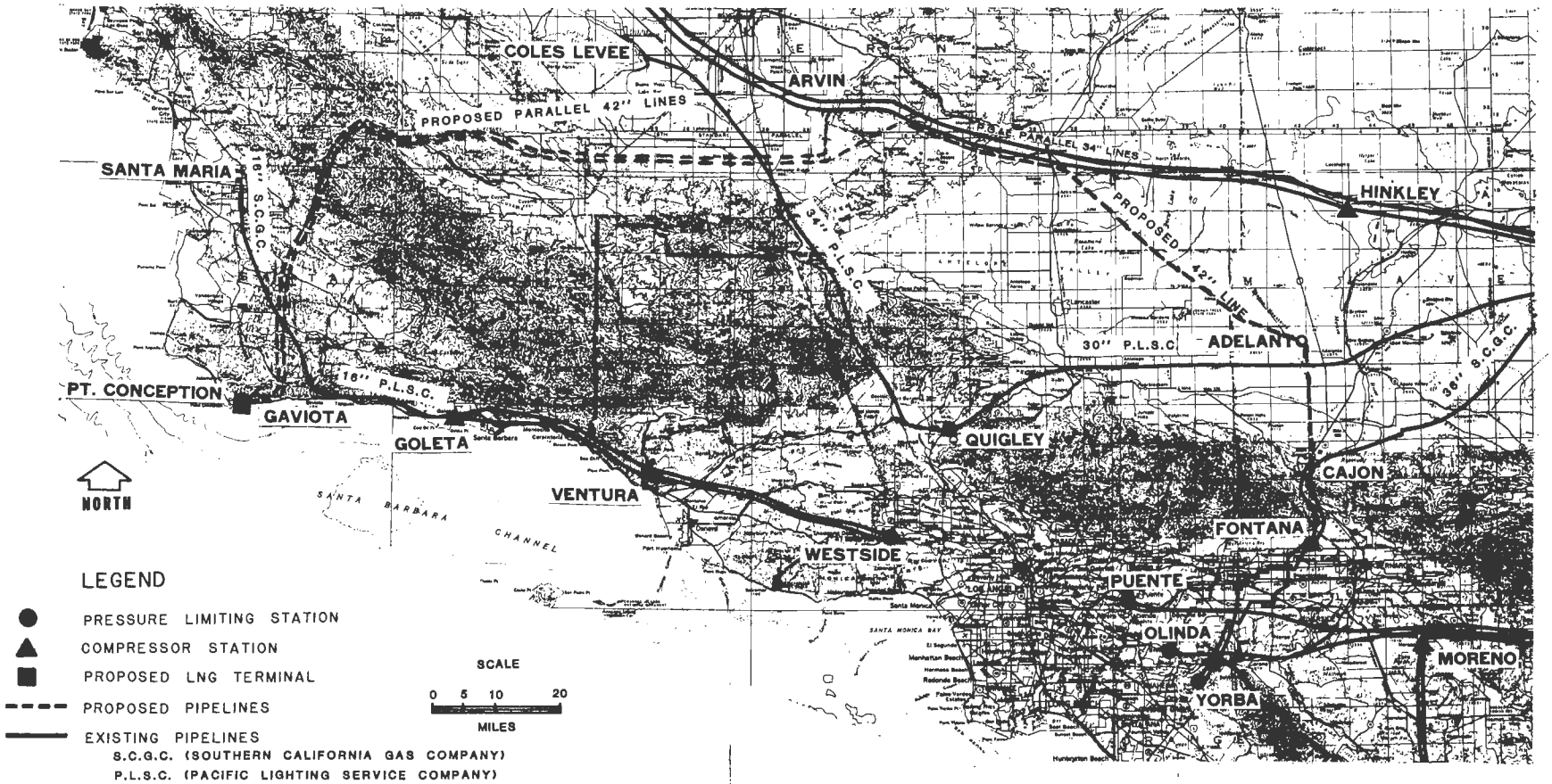

Figure 40. Existing Pipelines in Southern California and Proposed Pipelines from Point Conception

Table 38

ENVIRONMENTAL CHARACTERISTICS OF ALTERNATIVE AND PROPOSED PIPELINE ROUTES BETWEEN MILEPOSTS 39 AND 104

	Proposed Segment	Alternative A	Alternative B
Pipeline Length	65 miles	65 miles (last 48 miles follows same route as proposed route)	68 miles (first 6 miles follows same route as proposed route)
Use of Existing Rights-of-Way	Parallels 5 miles of road on the Elkhorn Plain	16 of the first 17 miles parallel road; parallel 5 miles of road on the Elkhorn Plain	Highway 166 is paralleled for about 56 miles; existing gas pipeline is paralleled for about 6 miles
Construction of New Access Roads	Unspecified number required	Unspecified number required	Probably none required
Major River Crossings	One crossing of the Cuyama River	One crossing of the Cuyama River	Approximately one dozen crossings of the Cuyama River
Ridge Cutting	Various ridges between mileposts 39-68 and 94-101	Same as proposed route except that no ridges would be cut for the first 6 miles of this alternative	Various ridges along the first 6 miles and the last approximately 10 miles of this segment
Erosion Potential	Mostly moderate to high; low in the Carrizo Plain and Elkhorn Plain.	Mostly moderate to high; low in the Carrizo Plain and Elkhorn Plain	Mostly low
Seismicity	This route would traverse a tectonically active region. Several active and potentially active faults including the San Andreas Fault.	Same as the proposed route	A somewhat smaller quantity of faults would be crossed, but potential seismic activity along this route would not be significantly less than that for the proposed route.
Existing Land Use	Open space, grazing, recreation	Open space, grazing, recreation	Open space, grazing, recreation

Table 38 (Cont'd)

ENVIRONMENTAL CHARACTERISTICS OF ALTERNATIVE AND PROPOSED PIPELINE ROUTES BETWEEN MILEPOSTS 39 and 104

	Proposed Segment	Alternative A	Alternative B
Archaeology	Low potential for major finds. Small finds probable.	Low potential for major finds. Small finds slightly more probable than for proposed route due to closer proximity to a stream.	Low potential for major finds. Probability of small finds greater than the other routes due to close proximity to Cuyama River. However, previous disturbance by highway construction minimizes the probability of finds.
Natural Communities	About 50 percent semidesert herbland, 20 percent chaparral-coastal sage-woodland, 25 percent agriculture, 5 percent herbland	Similar to above except that an additional 3 miles of oak woodland would be crossed.	Mostly herbland with almost no semidesert herbland. Quantities of other communities less than above. An additional type, basin sagebrush riparian vegetation, is encountered along the Cuyama River. However, most of this alternative route along the Cuyama has already been disturbed by highway construction.
Rare, Endangered, and Protected Species	Crosses areas utilized for breeding and feeding by the rare and endangered San Joaquin kit fox and blunt-nosed leopard lizard; and by the protected ringtail, white-tailed kite, southwestern toad, red-legged frog and ensatina. Crosses feeding areas used by the rare and endangered California least tern, brown pelican, California condor, American peregrine falcon, and southern bald eagle; and by the protected sandhill crane.	Same as the proposed route	Avoids areas utilized by the San Joaquin kit fox, blunt-nosed leopard lizard, California least tern, and brown pelican; remainder of species the same.

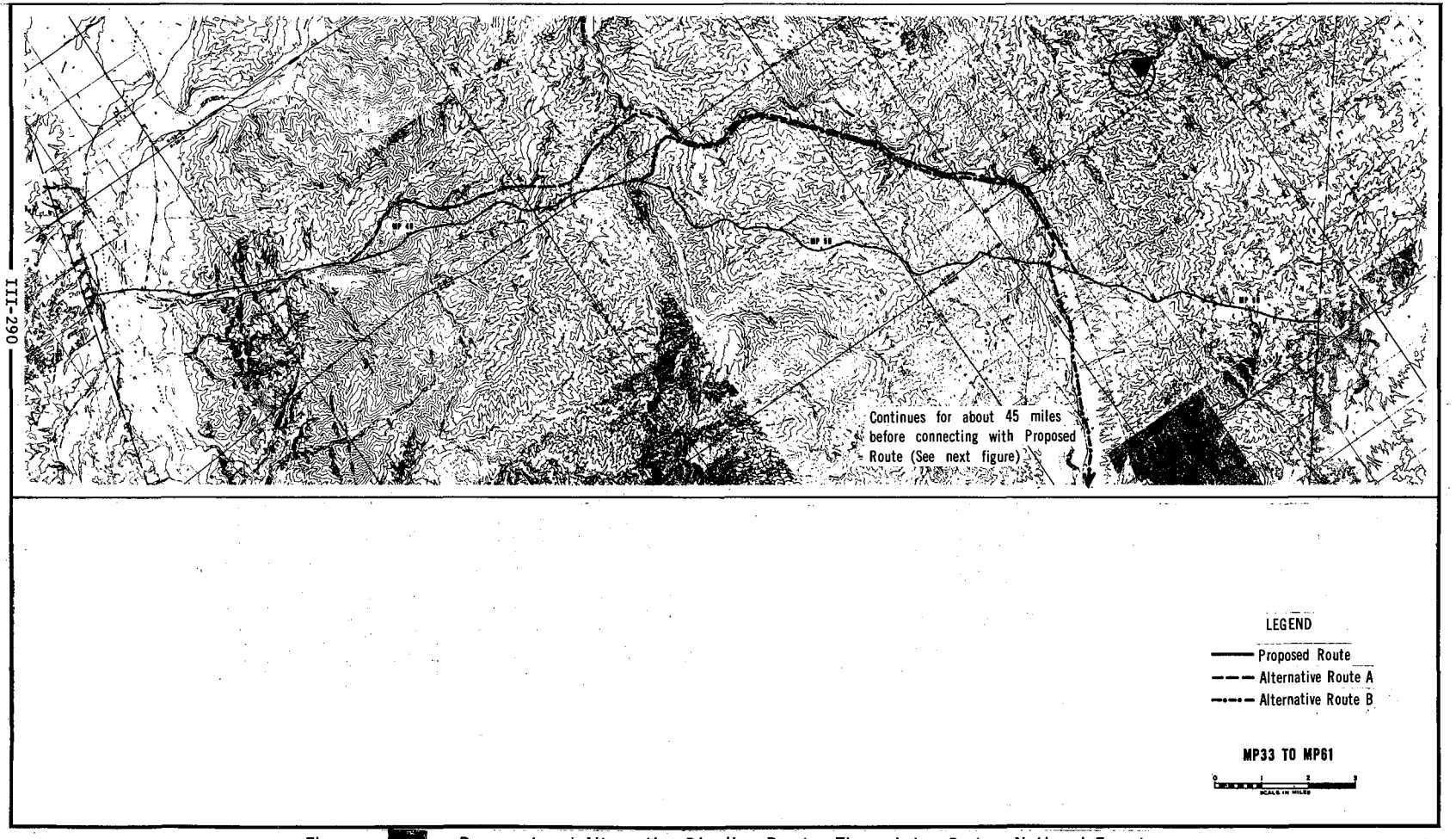

Figure [redacted] Proposed and Alternative Pipeline Routes Through Los Padres National Forest

Figure [redacted] Proposed and Alternative Pipeline Routes from Point Conception

removing oak woodland which grows up to the edge of the road in most places. This cancels out the advantages of paralleling the road; more woodland would be removed than in the proposed route. The applicant rejected this alternative because of the necessity of sidehill cuts along both Tepusquet Road and Highway 166. The FPC staff agrees that the canyons which Tepusquet Road follows would be too narrow for this part of Alternative A to be an improvement over the proposed route.

ii. Alternative B

Alternative B, shown in Figures 41 and 42, represents an alternative segment considered by the FPC staff as a result of field inspections conducted by staffs of the FPC and the Los Padres National Forest. While Tepusquet Road is rather narrow, Highway 166 has just been rebuilt and widened and follows a much straighter path than the original highway as it parallels the Cuyama River. Alternative B would leave the proposed route at around MP 46 and travel nearly due north until it reaches Highway 166. Whereas Alternative A would leave the highway after about 10 miles to rejoin the proposed route, Alternative B would continue to follow the highway for approximately 40 miles. This alternative would branch away from the highway and would follow two existing pipelines until joining Western's proposed route at around milepost 102. The river valley widens fairly quickly into what is mostly herbland, with basin sagebrush riparian vegetation near the river. As shown in Table 38 and Figure 42, there are many advantages to this alternate segment. It would avoid most of the up and down crossings of ridges and hills of the Sierra Madres in Los Padres National Forest and avoid the steeper parts of the Caliente Range. The overall mileage would be reduced because more flat terrain would be utilized. Where the Cuyama River Valley is somewhat narrow at the beginning of the alternative segment, additional side cuts would have to be made in the hills alongside Highway 166. This would not be a significant impact because these hills have already been cut for the road construction; natural vegetation has already been cleared from them. No access roads would be required due to the close proximity to the highway. Alternative B would avoid traversing the Carrizo Plain and the small remainder of habitat for the rare San Joaquin kit fox and the endangered blunt-nosed leopard lizard. This route

could easily be routed somewhat to the north in the vicinity of the towns of New Cuyama and Cuyama to avoid these populated areas. The only disadvantage of this alternative is that the Cuyama River would have to be crossed about one dozen times, creating potential turbidity problems. These problems would be avoided if the crossings were accomplished in the summer when the river is dry. Furthermore, the river is normally quite turbid when it is flowing. The FPC and Los Padres National Forest staffs agreed that an alternative route following the Cuyama River would be more desirable than the proposed segment. (See Section I, "Recommendations.")

iii. Alternative C

An alternative route for the Point Conception to Arvin right-of-way was also considered in the Tejon Hills near the end of the proposed route and is discussed as Alternative C.

Alternative C, shown in Figure 43, , was suggested by the applicant as an alternative for the last 9.2 miles before the proposed Arvin metering station. The proposed segment would traverse the uncultivated Tejon Hills, an "area of significant botanic communities" already described in Section 6 of the "Description of the Existing Environment." The alternative route would traverse almost entirely flat, cultivated areas and cross a drainage canal, following roads and an existing pipeline; only the last three-quarter mile, all cultivated, would cross the Tejon Hills. Considering these differences, the alternative route is more acceptable than the proposed route. (See Section I, "Recommendations.")

c) Arvin to Cajon Alternatives

Two alternative routes to the 108.9 mile Arvin to Cajon route are described below. Table 39 compares environmental characteristics of these alternatives with the proposed route. Figure 44 shows the location of these alternatives.

i. Alternative D

Alternative D traverses the same route as the proposed pipeline route through the Tehachapi Mountains and across the western Mojave Desert to Highway 14 south of the City of Mojave. At this point, Alternative D proceeds eastward, paralleling two 34-inch PGE pipelines along State Highway 466 to Four Corners (intersection of State Highways 466 and 395). The route then turns in

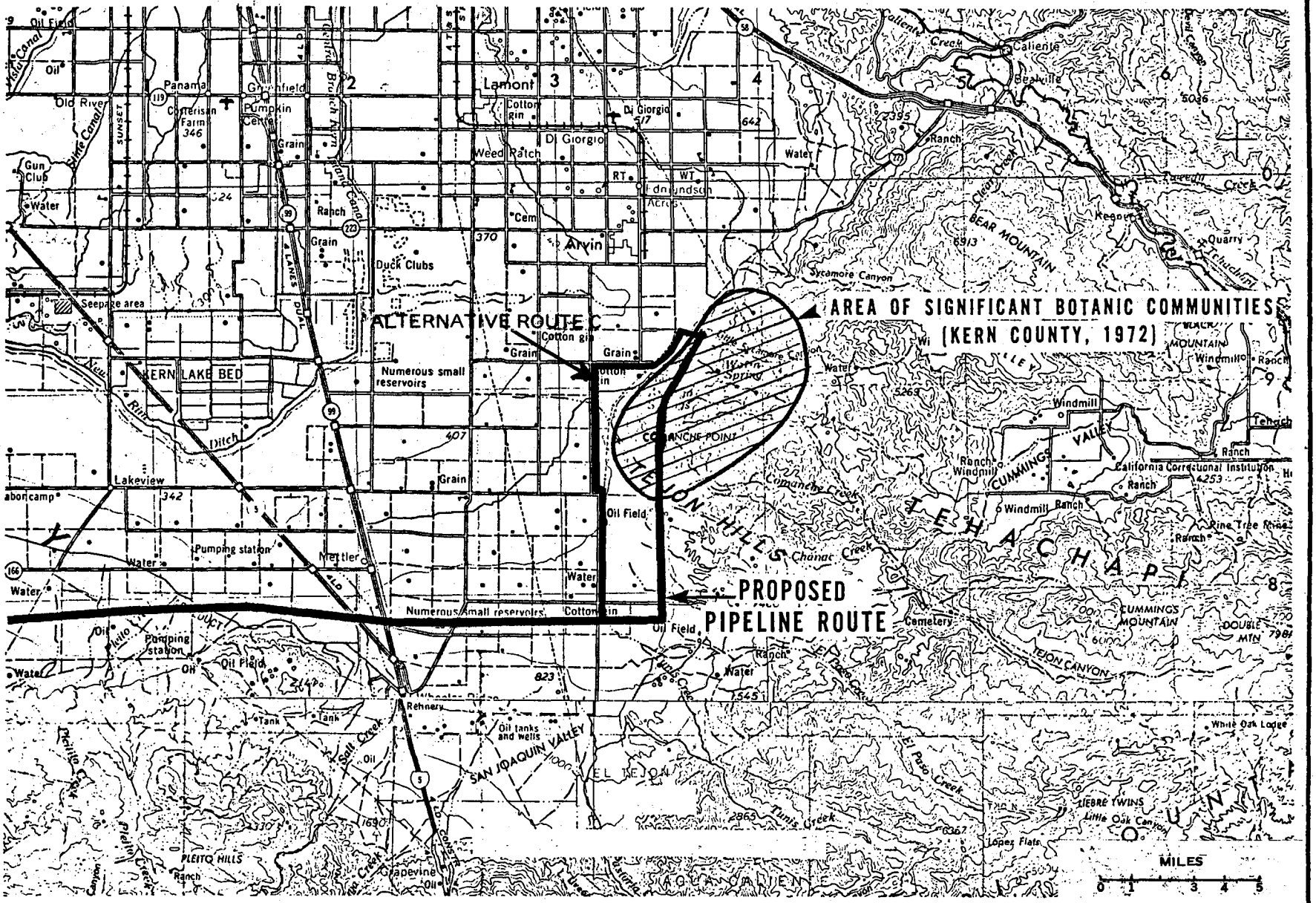

Figure 43. Proposed and Alternative Routes Near Arvin

TABLE 39

ENVIRONMENTAL CHARACTERISTICS OF THE PROPOSED PIPELINE ROUTES FROM ARVIN TO CAJON

	Proposed Route	Alternative D	Alternative E
Pipeline Length	108.9 miles	123 miles	110 miles
Use of Existing Rights-of-Way	Parallels about 20 miles of existing pipeline, 5 miles of railroad, and 9 miles of road rights-of-way. (31 percent of the route.)	Parallels about 51 miles of existing pipeline and 35 miles of road rights-of-way. (70 percent of the route.)	Parallels about 54 miles of existing pipeline and 6 miles of road rights-of-way. (55 percent of the route.)
Total Acres Disturbed (Assuming the width of a new right-of-way is reduced from 100 to 75 feet where it parallels an existing right-of-way.)	1,225 acres	1,358 acres	1,158 acres
Construction of New Access Roads	None required	None required	Unspecified number required in Tehachapi Mountains
Significant Stream Crossings	One crossing of Tejon Creek and two crossings of Chanac Creek; both are intermittent.	Same as proposed route.	One crossing each of Little Rock Wash and Big Rock Wash; both are intermittent, but have more rainy seasons.
Ridge Cutting	None	None	Some required in the Tehachapi Mountains.
Erosion Potential	Moderate to high for alternating portions of the first 30 miles and last 7 miles; low for the rest of the route.	Same as proposed route.	Moderate to high for most of the first 18 miles; moderate for a few portions for the 20 mile distance from Fairmont to Palmdale; moderate to high for portions of the last 7 miles; low for the rest of the route.
Seismicity	Traverses a tectonically active region. Four active and potentially active faults would be crossed: Spring fault, an unnamed fault north of Bear Mountain, Garlock fault, and Mirage Valley fault.	Traverses a tectonically active region. Five active and potentially active faults would be crossed: Spring fault, the unnamed fault north of Bear Mountain, Garlock fault, Spring fault and Blake Ranch fault. (Two or three breaks from Spring fault would actually be crossed.) The number of nearby earthquake epicenters is similar to that of the proposed route.	Traverses a tectonically active region. Three active and potentially active faults would be crossed: Spring fault, Garlock fault and San Andreas fault. (Several associated fault breaks as well as the main section of the San Andreas fault would actually be crossed.) This alternative is closer to a number of earthquake epicenters near the San Andreas fault (which is closely paralleled) than either of the above routes.

TABLE 39 (Cont'd)

ENVIRONMENTAL CHARACTERISTICS OF THE PROPOSED PIPELINE ROUTES FROM ARVIN TO CAJON

	Proposed Route	Alternative D	Alternative E
Land Use	5 miles utilized for crops. Most of the first 25 miles utilized for grazing and residential development. The remainder of the route is open space with a few small residential areas along the last 40 miles.	Same as proposed route, but is close to major highways for most of the route. More small roads would be crossed and temporarily closed to traffic.	Thirty-five miles utilized for crops and poultry. More small residential development than the other two routes. More small roads would be crossed and temporarily closed than either of the other two routes.
Archaeology	Fair possibility of significant sites in El Tejon Valley along the first ten miles where three villages and two camps are known in the vicinity of the proposed route; low probability of significant sites for remainder of route. Smaller finds possible for first 30 miles between MP 50 to 70.	Similar to proposed route but probability of archaeological finds after MP 40 is somewhat less due to proximity to existing rights-of-way.	Avoids El Tejon Valley. Smaller finds possible along crossing of the Tehachapi Mountains; probability of finds for remainder of route lower than the other two routes due to greater human disturbance.
Natural Communities	75 percent desert communities, 20 percent herbland, 3 percent juniper woodland, 1 percent oak woodland, 1 percent chaparral.	Similar to proposed route, but sharing many more existing rights-of-way lessens degree of disturbance from construction.	More chaparral, oak woodland, and juniper would be traversed than in proposed route; less desert would be crossed. The 11-mile crossing of the Tehachapi Mountains, comprised of oak woodland and chaparral is excellent wildlife habitat and is little disturbed by human activity. The section of this alternative through the desert shares existing rights-of-way along most of the route thus lessening the degree of disturbance from construction. This section of the Mojave is in a much less natural state than that for the other two routes due to much human disturbance.
Rare, Endangered or Protected Species	Eight species feed and breed along the proposed route: the rare or endangered Mojave ground squirrel and Techachapi slender salamander; and the protected ringtail, white-tail kite, desert tortoise, southwestern toad, ensatina, and red-legged frog. Three species only feed along the proposed route: the rare and endangered American peregrine falcon, the southern bald eagle, and the California Condor. The proposed pipeline would traverse a proposing feeding and roosting sancturary for the rare and endangered California condor between approximately MP 4 and MP 9.	Similar to the proposed route except that while the proposed route would come within 3.5 miles of one of the remaining four Mojave ground squirrel populations, this alternative would traverse two of the remaining populations.	This alternative avoids areas inhabited by the Mojave ground squirrel and the Tehachapi slender salamander. However the route would traverse the proposed Tejon Ranch California condor critical habitat area for approximately 7 miles.

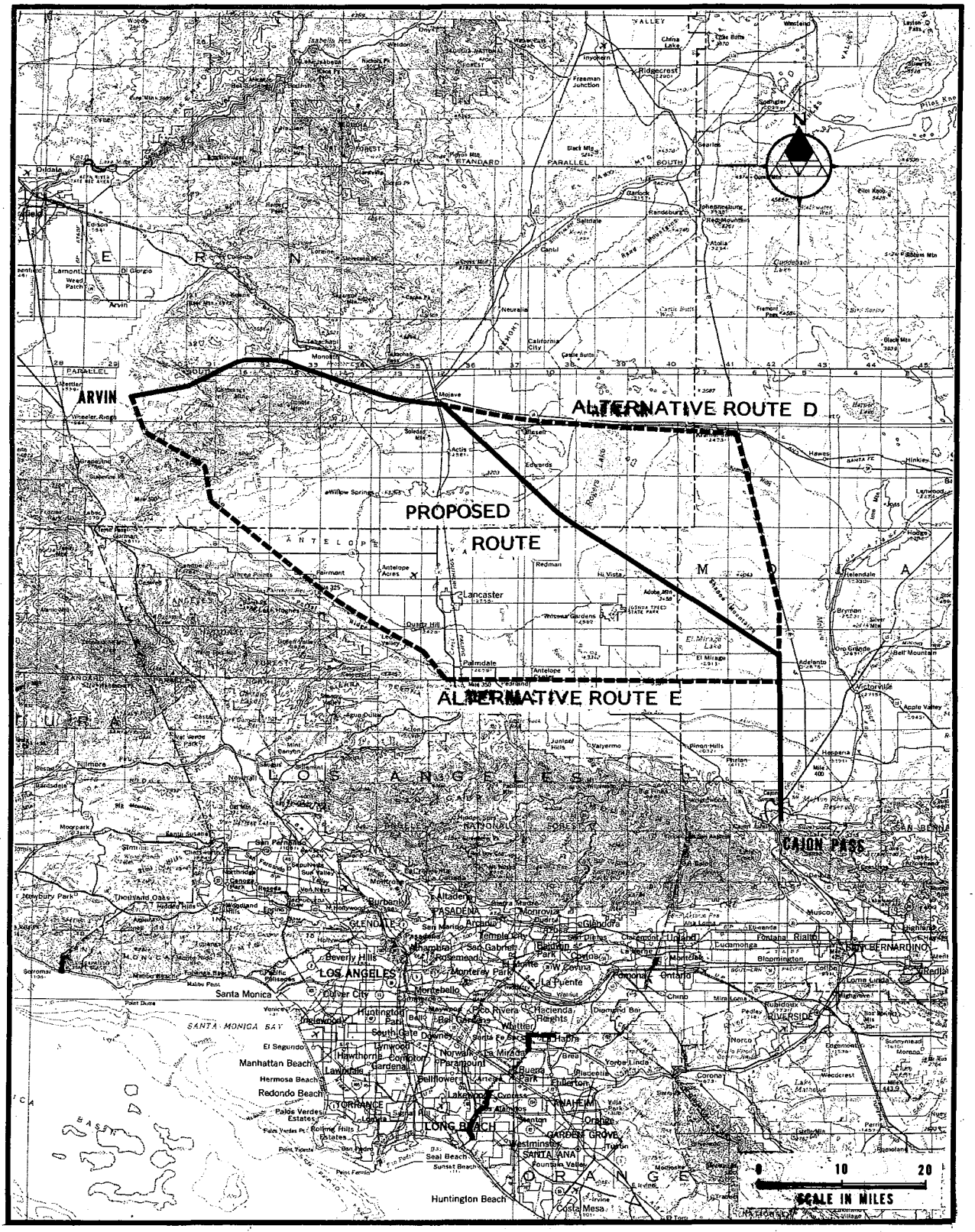

Figure 44. Proposed and Alternative Pipeline Routes, Arvin to Cajon

a southeastward direction, generally running parallel to State Highway 395, to the Adelanto metering station. The route then would follow Western's proposed route to the terminus at Cajon.

As shown in Table 39, the major advantage of Alternative D consists of an increase in the length of existing rights-of-way to be paralleled (shared). This would decrease the potential for off-road vehicle use of the proposed route.

There are two major disadvantages of this alternative compared to the proposed route. The first is that about 24 more miles of pipeline would have to be constructed, resulting in the disturbance of 133 more acres, despite the increase in shared right-of-way. Two, this alternative passes through half of the remaining Mojave squirrel habitat. The staff believes that the proposed route is more acceptable than Alternative D if appropriate steps are taken to prevent or minimize the use of the proposed route by off-road vehicles and pending an environmental determination by the U.S. Fish and Wildlife Service concerning the segment of the proposed route from approximately MP 4 to MP 9 which traverses a proposed feeding and roosting area of the California condor. 1/

ii. Alternative E

Alternative E would leave the proposed regulating station near the proposed Point Conception to Arvin pipeline route and would cross the Tehachapi Mountains in a southeasterly direction. The alternative would traverse the western portion of Antelope Valley, cross the Los Angeles Aqueduct, and continue in a southeasterly direction to Palmdale. From Palmdale, the route would proceed due east to the Adelanto metering station following an existing 30-inch pipeline right-of-way. The route would then follow the same right-of-way corridor as the proposed route to the terminus at Cajon.

As shown in Table 39, there are several major advantages of Alternative E. More existing rights-of-way would be shared, resulting in the disturbance of 67 acres less than the proposed route. The portion of the Mojave Desert through which this alternative would traverse has been disturbed to a greater degree than the proposed route. Finally, the habitats of two rare and endangered species would be avoided.

1/ A discussion of the potential conflict with the proposed condor feeding and roosting santuary is presented in Section C.7 of the FEIS under impacts to rare, endangered or protected species.

Alternative E also has several significant disadvantages. New access roads would have to be constructed and some ridges would have to be cleared, unlike the proposed route. The potential for erosion and earthquake disturbance to the pipeline would be greater for this alternative. Wildlife habitat which is more productive than any along the proposed route would be crossed. In addition, the pipeline route would also traverse the proposed Tejon Ranch California condor critical habitat area for approximately 7 miles. The environmental staff feels that the proposed route is more acceptable than Alternative E if appropriate mitigating steps are taken regarding rare and endangered species and pending an environmental determination by the U.S. Fish and Wildlife Service concerning the segment of the proposed Arvin to Cajon route from approximately MP 4 to MP 9. (See Section I, "Recommendations".)

2. Alternative West Coast LNG Sites

a) Introduction

The development of natural gas liquefaction facilities and associated marine LNG transportation facilities in the area of the Pacific Ocean requires that receiving terminals for the storage and regasification of LNG be developed on the west coast of the United States, and that the resulting gas be distributed for use throughout the lower 48 states. In view of the concerns for human safety, project success and environmental protection applicable to the proposed west coast LNG terminals, the staff has undertaken an extensive siting study for these terminals. The staff with the assistance of an outside consultant, Intersea Research Corporation, conducted a regional and subregional analysis of the United States west coast, evaluating locations on the level of a site specific analysis. 1/ The specific sites that were analyzed were chosen on the basis of material submitted by the applicant and the results of outside consultants.

b) LNG Terminal Siting Criteria

The following discussion provides detailed descriptions of the physical criteria that were applied to formulate the evaluations and ratings of each potential site as to its ability to accommodate the proposed project. Wherever possible, actual maximum or minimum limits of acceptability have been assigned in the definitions of the criteria, and both general and specific requirements are included in the definition. In many instances, however, the subjectivity of the criteria or the number of off-setting factors involved would not permit the assignation of such limits. In these instances, the criteria are presented solely on a general, subjective basis.

An ideal site would meet or exceed all the requirements established in the criteria; however, it should be realized that the possibility of locating such a site is remote. Therefore, the terminal site considered most suitable for development would be the one whose physical characteristics correspond most closely to the requirements set forth in the criteria.

1/ Intersea Research Corporation was contracted by the FPC to conduct a study of "Alternative Sites for Alaskan Related LNG Facilities on the West Coast of the Contiguous United States", which was submitted to the FPC in final form in September 1975. Additional information pertaining to this study is contained in forthcoming sections of this report.

i. Topographic Conditions

The potential site should satisfy certain topographic requirements which have been imposed to insure the integrity of the plant and to minimize preconstruction site preparation.

The slope of the site should be minimal so as to avoid the need for additional booster pumps and appurtenant equipment used to circulate seawater for cooling purposes, but should still permit adequate site drainage. Poorly drained sites could increase the potential for the disruption of groundwater regimes as well as increase construction costs.

The site should have few topographic irregularities such as hills, valleys, or terraces to preclude extensive preconstruction site preparation. The presence of large topographic irregularities or sites which would require excavation into the bases of mountains would necessitate the hauling of large quantities of spoil material and the consequent development of spoil disposal sites which would increase costs as well as increase the potential for additional adverse impacts.

ii. Foundation Conditions

Foundation conditions at the site should be such that adequate stability would be provided during both static and dynamic conditions.

Soils should be dense and granular to provide strength and well graded for resistance to settlement.

If bedrock is present, it should be relatively close to the surface in order to preclude high tension pile loads, but at a sufficient depth to avoid interference with preconstruction site preparation.

iii. Seismic Considerations

The plant site should not be located on or adjacent to any active fault zones which could jeopardize the structural integrity of the facility through ground movement or other related events which could accompany a major seismic disturbance.

The soils at the site should not be subject to liquefaction during seismic events and should retain their foundation stability under dynamic stress.

The site should not be located in or near areas where unstable submarine slopes could undergo sliding during seismic events. The potential for subaqueous landsliding infers a high potential for developing destructive waves of local origin.

The site should not indicate a potential for extensive shoreline damage from seismic sea waves of either local or distant origin. Areas with past histories of shoreline damage could pose a threat to the integrity of a marine terminal and/or storage facility.

iv. Atmospheric Conditions

The plant site should be relatively well sheltered and should permit safe and economical year-round operation with minimum periods of down-time resulting from adverse climatic conditions.

Winds exceeding a velocity of 30 miles per hour should have a low frequency of occurrence and be of short duration. High winds could hinder LNG carrier maneuvering, and wind loads imposed upon the mooring lines or on the fendering system could require a ship to vacate its berth. (The mooring system at each berth would be designed to hold an LNG carrier in winds up to 60 miles per hour.)

Periods of reduced visibility resulting from fog and/or precipitation should also have a low frequency of occurrence and minimal persistence. Extended or frequent periods of reduced visibility could increase the risk of ship accidents (collisions, groundings, etc.) or require temporary suspension of docking or loading procedures.

v. Oceanographic Conditions

The site should offer as much protection as possible from exposure to waves and currents of magnitudes which could hinder safe operation of LNG tankers.

Swell heights in excess of 4 feet should have a low frequency of occurrence at the site. Wave action could cause ship movement at the berth and increase the potential for hull and berth damage.

vi. Distance to Deep Water

The minimum acceptable water depth at the berth at mean lower low water should be 47 feet in areas not susceptible to wave action. Areas exposed to wave action should have a 50 to 60-foot water depth at the berth to accommodate increased vertical ship movements. The distance from the berths to the shore should be as short as possible to reduce both costs and revaporization problems that would be associated with a long cryogenic transfer line. Modern technology would allow for a transfer line approximately 2 to 2.5 miles long before revaporization problems would be encountered.

vii. Navigational Suitability

The nature and configuration of the approach channel should be such that navigation would not be hampered at any time.

The size of the approach channel should be three times the beam of the ship when traffic is limited to one-way movement and six times the beam of the ship when two-way traffic is operating. Minimum channel depths should be 47 feet in areas sheltered from waves and 50 to 60 feet in areas subject to wave action. All turns along the channel should be gradual and should not require any unsafe maneuvers.

Areas with minimal amounts of vessel traffic congestion would be preferable. In areas where there is a moderate to heavy concentration of vessels, traffic patterns should be well defined.

Areas in which established traffic safety systems are in service should be utilized whenever possible. The systems generally consist of two separation lanes, with each lane used for traffic moving in a single direction, with a buffer zone between the lanes.

The land bordering the areas in which the LNG carriers would maneuver should be well-marked or capable of being marked with lighted aids to navigation.

viii. Anchorage Suitability

At least one area suitable for anchoring the LNG carriers should be available in the vicinity of the marine terminal site.

The bottom conditions at the anchorage area should be firm enough to provide good holding power, and the water depth should not exceed 200 feet.

The anchorage area should be away from vessel maneuvering areas or channels and should be of sufficient size to permit the ship to swing with the wind or current.

ix. Land Use Conflicts

The proposed site should not be located where conflicts would arise between operation of the proposed project and existing, planned, or potential land uses on or near the proposed site, including commercial, recreational, or conservation-oriented activities.

x. Seawater Exchange System

The criteria used to evaluate each site include a determination as to whether a seawater exchange system could be effectuated between the proposed LNG facility and existing power generating stations. Although this criteria was not applied in a manner which resulted in the acceptance or rejection of a specific site in the initial elimination process, the large number of existing power generating stations on the west coast that issue heated effluents seemed to dictate that such an exchange system should be considered in the analysis of alternate terminal sites. In the final site selection process, the potential for a seawater exchange system was given considerable weight.

c) FPC Consultant Site Analysis

For the purpose of aiding the staff in its evaluation of the proposed and alternative sites presented by the applicant, as well as providing additional potential LNG sites, Intersea Research Corporation (Intersea) was contracted by the FPC to conduct a study of alternate LNG terminal sites on the west coast of the contiguous United States. Intersea examined a total of 47 potential sites, of which 7 were previously identified by the applicant in its filing to the FPC. The following excerpts from the final report indicate the scope of the study and the method of approach:

EVALUATION OF SITES

General Discussion

An initial list of 47 locations along the western coast of the United States was compiled using the criteria in Table 1. Through various processes of elimination, the sites were narrowed to seven locations which were to be analyzed in more detail. Of the seven sites seriously considered for a possible LNG facility, three have been identified previously by Western LNG Terminal Company and four are alternatives presented for the first time. The four alternatives consist of Drake, Mandalay Beach, and San Onofre along the southern California coast; and Port Angeles in the Strait of Juan de Fuca, State of Washington.

Port Angeles is more of a generic alternative than a specific site. All previous studies have considered only southern California as the southern terminus for Alaskan-related LNG. Port Angeles is being listed here as an example site for the Pacific Northwest United States in general. There are many possible locations in the Puget Sound area of Washington and Columbia River area of Oregon which might be feasible for LNG facilities.

To properly evaluate the more widely accepted southern California sites, the Port Angeles site has been presented not so much as a viable alternative to southern California localities, but as an option as another area for the southern terminus for Alaskan-related LNG. It is apparent that the Pacific Northwest area could not develop a pipeline system soon enough to meet the present schedule and quantity of LNG proposed to be delivered to the west coast of the continental U.S. However, if the present timetable were delayed so that such pipeline development could take place, this area might be considered a feasible alternative.

Table 1

Basic Criteria For LNG Facility

Ship

Up to 165,000 m^3 with 40' draft
Approximately 425 arrivals per year

Marine Site

Offloading pier, to 55 ft. water depth in open water and 45' water depth in bay
Waves: 4' - berthing
6' - operation
Winds: 30 knots - berthing
40 knots - operating

Land Site

Storage 2-4 tanks -- 550,000 barrels each
Acres - 100-200
Cryogenic pipeline length (ship to storage) -- 2-2.5 miles

Results

The initial list of 47 potential locations was examined with representatives from all members of the research team present. Obvious conditions such as high percentage of facility downtime related to weather; restrictive water depths; navigation hazards; seismicity and foundation problems; endangered species; serious conflicts with the General Plan of an area; and human resources with regard to the safety element, eliminated 31 of the locations. All sites considered are listed in Table 44 and Figure 43. The remaining 16 sites were studied to a greater extent for factors which might be limiting to the development of an LNG facility. This examination revealed that 9 of the 16 sites are not desirable for development (Table 45).

The seven remaining candidate sites were rated to obtain an order of priority for each individual site. Table 46 is a summary of the four alternative sites discussed in detail in this report. Each site was rated with respect to individual subjects. Following this, a summary was compiled based on the specific data. The final results rate San Onofre as the most viable alternative site, followed by Mandalay Beach and Drake, respectively.

Port Angeles is included in this summary only to evaluate how it would compare to southern California sites. In general, it is concluded that with the exception of transmission pipeline considerations, the Port Angeles area meets the criteria for an LNG facility. A more detailed study likely would show that this conclusion also applies to other sites in the Pacific Northwest.

The same set of criteria used to rate the alternative sites alone was then applied to form a rating list considering both the alternative sites and the sites identified by Western LNG Terminal Company. Data used

Table 44

Initial Sites Selected For Potential LNG Facilities Along the West Coast of the U.S.

		(Latitude)
Washington		
	Strait of Juan de Fuca/Puget Sound - Port Angeles	(48°10')
2	Grays Harbor	(47°00')
Oregon		
	Columbia River	(46°10')
1	Necanicum River	(46°00')
1	Tillamook Head	(45°56') to Yaquina Bay (44°37')
1	Yaquina Bay to Umpqua River	(43°40') - Newport (44°37')
2	Coos Bay	(43°20')
1	Cape Arago	(43°18') to Coquille Point (43°05')
1	Port Orford	(42°45')
1	Sisters Rocks	(42°36') to Cape Sebastian (42°20')
1	Chetco River	(42°02')
California		
1	Pelican Bay	(41°51')
1	Crescent City	(41°45')
1	Klamath River	(41°32')
1	Trinidad Head	(41°05')
2	Humboldt Bay	(40°45')
1	Pt. Delgada (Shelter Cove)	(40°00')
1	Ten Mile River Beach	(39°30')
1	Pt. Arena	(39°00')
1	Jenner	(38°27')
1	Bodega Bay	(38°15')
1	Pt. Reyes	(38°00'
	San Francisco Bay - Hunters Point	(37°44')
1	Pacifica	(37°38')
1	Pt. Montara	(37°32') to San Gregorio (37°20') including Half Moon Bay (37°30')
1	Pigeon Pt.	(37°11')
1	Pt. Ano Nuevo	(37°07')
3	Santa Cruz	(36°57')
1	Moss Landing	(36°49')
	Estero Bay	(35°26')
	San Luis Obispo Bay	(35°10')
	Point Conception	(34°30')
	Drake	(34°28')
	Gaviota	(34°27')
	Santa Barbara	(34°25') to Oxnard (34°08') - Mandalay Beach (34°12')
	Oxnard	(34°08')
	Port Hueneme	(34°08')
	El Segundo	(33°55')

[1]Open coast sites where operations would be severely limited by waves.
[2]Navigation and water depth restrictions.
[3]Marginal land available or/and topographically unsuitable.

Table 44 (continued)

California (continued)

	L.A. Harbor (33°45')
3	Long Beach Harbor (33°40')
3	Huntington Beach (33°37')
3	Dana Point (33°27')
	San Onofre (33°22')
	Carlsbad (33°08')
2/3	San Diego Bay (32°40')
	Border Field (32°35')
4	Channel Islands (Santa Rosa)

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[1]Open coast sites where operations would be severely limited by waves.

[2]Navigation and water depth restrictions.

[3]Marginal land available or/and topographically unsuitable.

[4]Water depth too great for transmission pipeline routing to mainland.

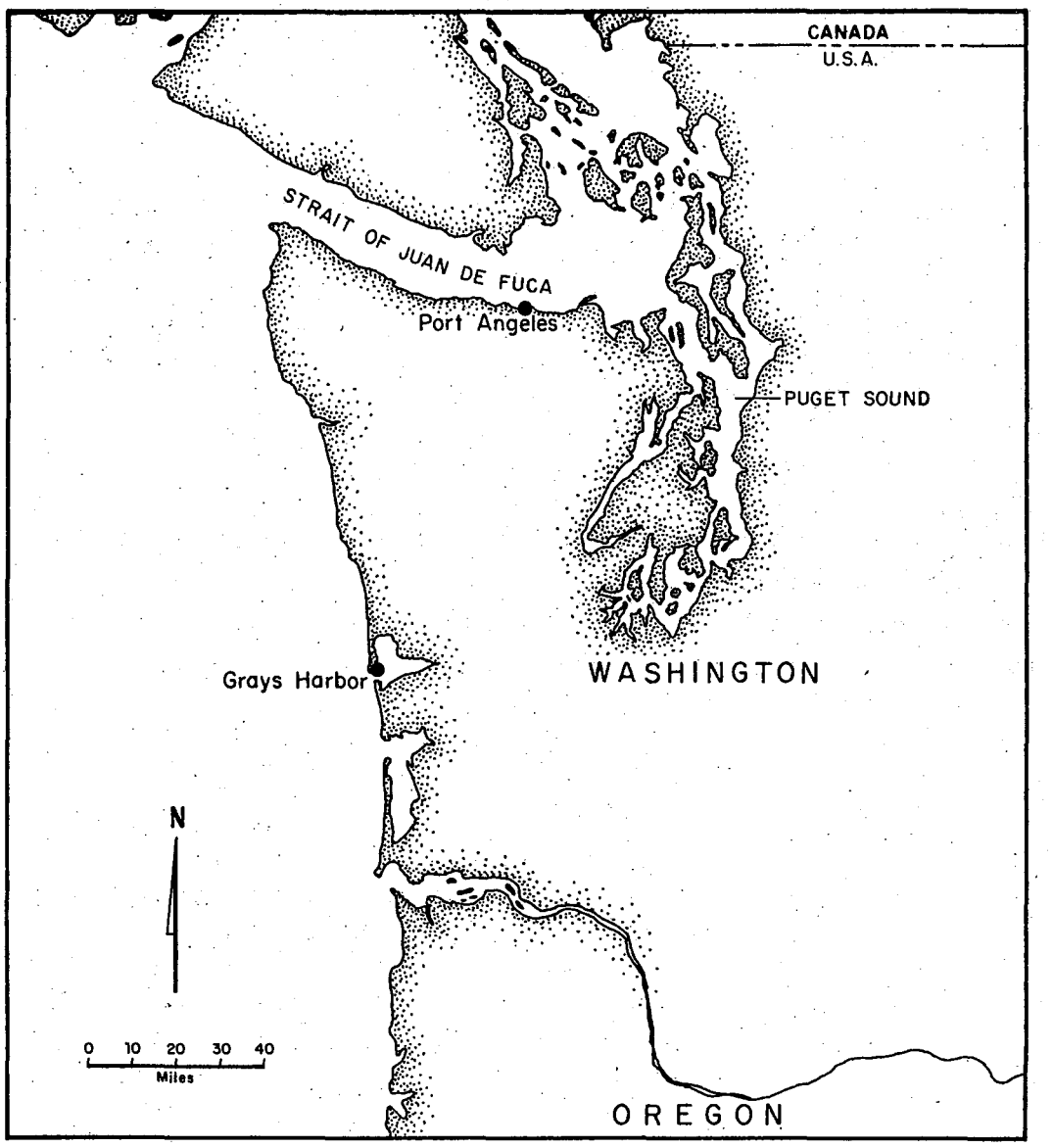

Figure 43a.
Location of initial sites listed in Table 44 in Washington.

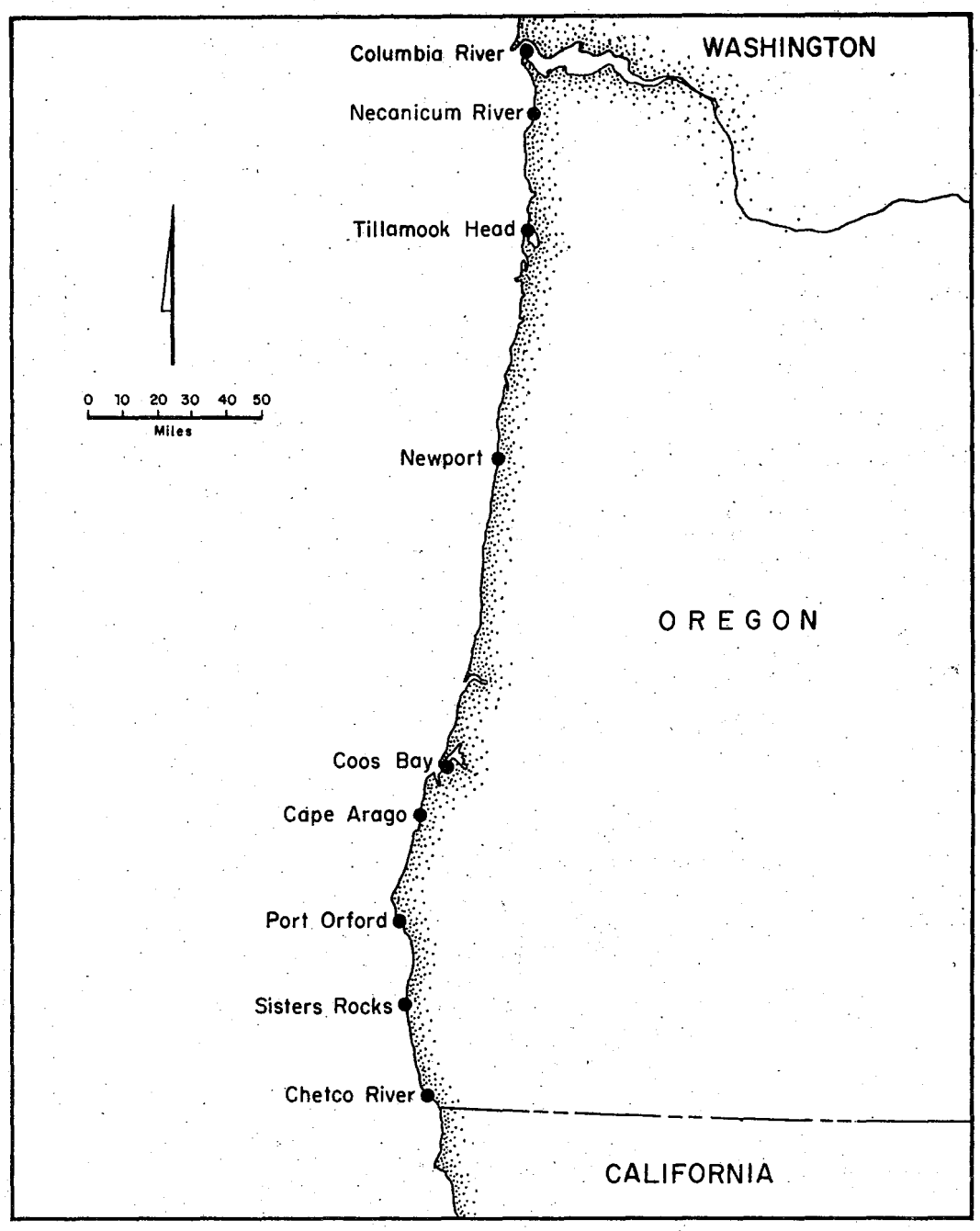

Figure 43b.
Location of initial sites listed in Table 44 in Oregon.

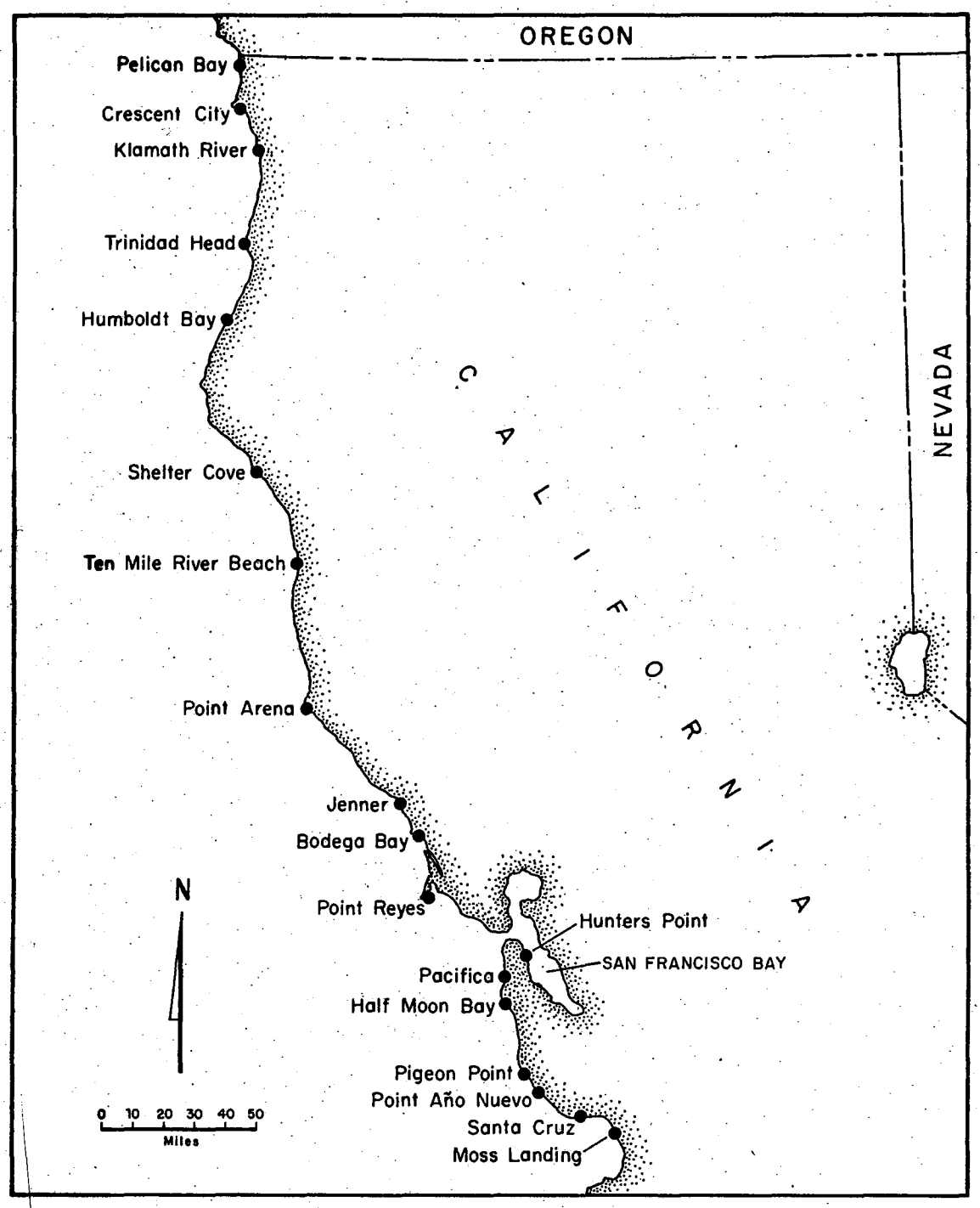

Figure 43c.
Location of initial sites listed in Table 44 in northern California.

Table 45

Potential LNG Sites Remaining After Initial Elimination Process

Site (Latitude)	Comments
Port Angeles (48°10')	Pipelines connecting other states are not adequate for amount of LNG scheduled to arrive at present. Could be developed with sufficient lead time. Selected as alternative for further study.
Columbia River (46°10')	Possible flooding and limited area of required water depth to handle large number of LNG cargo ships. Same pipeline problems as Port Angeles. Could be developed with adequate lead time. Rejected as serious alternative at this time.
Hunters Point (37°44')	Presently inactive Navy shipyard which is regarded as important resource in event of national emergency. Without converting shipyard facilities there may be insufficient land available; some land of marginal foundation conditions. Industrial development at Hunters Point or any other locations in San Francisco Bay would involve lengthy negotiations with local governmental agencies; subject to strict local regulations; would be controversial and time consuming with no reasonable certainty of concluding a satisfactory negotiation for LNG facility. Rejected as serious alternative.
Estero Bay (35°20')	Standard Oil Company of California presently has active refinery in the area. Weather downtime at LNG terminal would be fairly high but possibly not prohibitive. Land available for LNG facility is presently used as primitive tourist facilities; negotiations would be controversial and time consuming. Inadequate pipelines to interstate transmission systems. Rejected as serious alternative.
San Luis Obispo Bay (35°20')	Weather downtime higher than Estero Bay and possibly prohibitive; tsunamis could be problem. Land available presently used for tourist facilities; negotiations would be controversial and time consuming. Inadequate pipelines to interstate transmission systems. Rejected as serious alternative.

Table 45 (continued)

Site (Latitude)	Comments
Point Conception (34°30')	Low operational downtime; expected opposition from local governmental agencies. Area seismically active. Low human population density. Land availability good. Selected as alternative for further study.
Drake (34°28')	Low operational downtime. Conflict with present land use; expected opposition from local governmental agencies. Area seismically active. Low human population density. Desired water depth near shore. Selected as alternative for further study.
Gaviota (34°27')	Marginal space to development LNG facility; only available area would meet with extreme controversy. Entire area designated as open space by County of Santa Barbara and California Coastal Commission. Rejected as serious alternative.
Mandalay Beach (34°12')	Continental shelf relatively flat over one mile offshore to desired water depth. Area seismically active; possibly prone to liquefication. Good land use agreement. Ecologically appealing with nearby power plant. Selected as alternative for further study.
Oxnard (34°08')	Near Pacific Missile Range; area seismically active but less so than sites directly north. Excellent land use agreement. Ecologically appearling with nearby power plant. Selected as alternative for further study.
Port Hueneme (34°08')	Initial concept too time consuming with long cryogenic offloading to storage. Land site would be suitable for future expansion of Oxnard facility. Rejected offshore facility; accepted land facility as option to Oxnard.
El Segundo (33°55')	Heavily industrialized area; many oil refineries in the immediate vicinity. Only land available could cause long cryogenic pipeline to be buried parallel to and under major street. Distance marginal to pump seawater without upsetting ecosystem. Near large population center. Rejected as serious alternative.
Los Angeles Harbor (33°45')	Industrialized area; near large population center. Much ship traffic in area. Terrestrial biological impact minimal. Excellent pipeline routing. Selected as alternative for further study.

Table 45 (continued)

Site (Latitude)	Comments
San Onofre (32°22')	Near nuclear generating station; land presently part of U.S.M.C. Camp Pendleton and could be obtained through proper channels. Navigation would have to coordinate with U.S. Marines concerning offshore maneuvers. Offloading facility about one mile offshore. Low human population density. Ecologically appealing with nearby power plant. Pipeline routing and topographic factors good. Selected as alternative for further study.
Carlsbad (33°08')	Two possible onshore locations using same marine facility: (1) inland site -- would create long cryogenic pipeline and seawater exchange system that probably would be prohibitive; (2) Lagoon site -- nesting area for endangered species (Least Tern); all lagoon development opposed to California Coastal Commission Plan. LNG facility would conflict with present Master Plan of Carlsbad. Much residential development now occurring in lagoonal area. Rejected as suitable alternative.
Border Field (32°35')	Near Tijuana Slough -- an area set aside by San Diego as a natural preserve; area where many rare or endangered species frequent. Development of the Slough as recreational area has been rejected by local agencies. Cryogenic pipeline would be extremely controversial. Rejected as suitable alternative.

Table 46

Summary of Alternative Sites For Alaskan-Related LNG Facilities

Site	Site Topography	Geologic Factors	Meteorology & Oceanography	Navigation	Marine Ecology	Terrestrial Biology	Land Use & Human Population	Pipeline	Summary
Drake	3	3	3	3	3	3	4	3	3
Mandalay	1	4	2	2	2	2	2	2	2
San Onofre	2	1	1	1	1	1	3	1	1
Port Angeles	*	2	4	4	4	*	1	4	**

*Study without specific site prohibited evaluation of Port Angeles with respect to these items.

**Port Angeles not rated as alternate to southern California sites.

to evaluate the three western sites were obtained from published and unpublished reports related to the areas and from Docket Number CP 75-83. Again, Port Angeles was not considered in the final rating as it represents an alternative to the concept of a southern LNG terminus rather than a specific option to the southern California sites (Table 47).

The unweighted summary given in Table 47 rates Los Angeles Harbor 17 points, Oxnard 18 points, and San Onofre 19 points or nearly equal in relative merit as alternate sites. However, the relatively strong negative factors due to geologic conditions at Mandalay Beach and the element of population density near Los Angeles Harbor should be given consideration as to their weight in the overall evaluation process.

Consideration was given to the relative influence which the eight major project factors could potentially have on the long-term impact of the proposed project. In the professional judgment of the evaluation team these factors cannot be rated quantitatively on an absolute scale. There is substantial rationale, however, to rate them relative to each other in the same manner that sites have been rated under the individual factors.

A grouped weighting of the factors is used here based on the following four criteria:

Weighting Factor	Remarks
1	Localized effect, low local and regional impact probably limited to construction costs.
2	Localized effect, potentially high impact for short duration, low regional importance.
3	Continued threat of impact to the marine and pipeline transportation operations. Appropriate engineering design and operating procedures minimize this threat.
4	Threat of major impact which has regional implication as well as high impact on local site.

Table 47

Summary of Potential Sites For Alaskan-Related LNG Facilities

Site	Site Topography	Geological Factors	Meteorology & Oceanography	Navigation	Marine Ecology	Terrestrial Biology	Land Use & Human Population	Pipeline	Summary
Point Conception	5	4	6	6	6	5	4	6	42
Drake	6	5	5	5	5	6	5	5	42
Mandalay	2	6*	4	4	4	4	2	4	30
Oxnard	1	2	3	3	2	3	1	3	18
L.A. Harbor	3	3	1	1	1	1	6	1	17
San Onofre	4	1	2**	2	3	2	3	2	19

*Liquefaction may be possible during strong ground shaking.

**Waves at San Onofre are worse than all other sites, however, they still are considered to be minimal for downtime due to weather.

On the basis of these criteria the eight project factors or characteristics have been assigned relative weights in rank order as follows:

Site Factor	Weight Factor
Site Topography	1
Marine Ecology and Terrestrial Biology	2
Meteorology and Oceanography, Navigation, and Pipeline	3
Geological Factors and Land Use and Human Population	4

The latter category could in some projects be considered a GO - NO GO type of limitation. The characteristics of the proposed project do not indicate that there is a GO - NO GO element in the case of the final sites which have been evaluated here.

The results of the weighted rating analysis are given in Table 48. The weighted rating results in the same group of three sites having higher priority than the others. Within the higher priority group, however, Los Angeles Harbor ranks third instead of first. Oxnard retains its second place rating, and the San Onofre area becomes first. Mandalay maintains its intermediate rating of fourth place while Drake and Point Conception are rated equally in last position.

The proximity of the nuclear generating station to the possible sites at San Onofre raises the question of interdependence of risk relative to the two facilities. The basis for the weighted rating presented here is that the LNG facility would be designed to meet the safety standards applicable to construction, maintenance and long-term operation independently of the generating station and that the generating station is also so designed.

Table 48

Weighted Ratings of Potential Sites for Alaskan-Related LNG Facilities

Weighting Factors	1	4	3	3	2	2	4	3		
Site	Site Topography	Geological Factors	Meteorology & Oceanography	Navigation	Marine Ecology	Terrestrial Biology	Land Use & Human Population	Pipeline	Weighted Summary	Priority List
Point Conception	5	16	18	18	12	10	16	18	113	5
Drake	6	20	15	15	10	12	20	15	113	5
Mandalay	2	24	12	12	8	8	8	12	86	4
Oxnard	1	8	9	9	4	6	4	9	50	2
L.A. Harbor	3	12	3	3	2	2	24	3	52	3
San Onofre	4	4	6	6	6	4	12	6	48	1

d) FPC Staff Site Analysis

The staff's presentation of alternative sites consists of an analysis of 10 specific locations along the coast of California. Of these 10 sites, 7 have been identified and studied by the applicant in its application to the FPC (Oxnard, Point Conception, Los Angeles, Port Hueneme, El Segundo, Carlsbad, Border Field), and three have been presented by Intersea (Drake, Mandalay, San Onofre). The locations of the 10 sites are shown in Figure 45. The contract proposal submitted to the FPC by Intersea, however, does contain an analysis of all 10 of the aforementioned locations.

The initial symbolic criteria ratings that were applied to each site are shown in Figure 46. 1/The results of this rating system indicate that 5 of the 10 sites analyzed were found to be acceptable in terms of meeting the basic physical requirements of the proposed project. Each acceptable site has been subjected to a more detailed review which includes an analysis of the existing environmental sensitivities and the potential impacts that could result from terminal development at each site. The results of this review are presented in subsequent sections of this report. The remaining five sites have been rejected from further consideration as potential terminal sites, the primary reasons for which are discussed in the following section.

i. Sites Rejected From Further Study

Los Angeles

The Los Angeles site is located on a landfill on Terminal Island which is within the jurisdiction of the Los Angeles Harbor Department. Directly beneath the site is the Palos Verdes Hills fault zone. This feature is at least 56 miles long. At the site, it is at least 4,200 feet wide and exhibits approximately 5,000 feet of vertical displacement. 2/ Emery, 1960, implies it is part of a system of faults about 100 miles long.

To date, there has been no attempt to determine recurrence intervals on the Palos Verdes Hills fault. During the past 4 years, monitoring of earth tremor activity by UCLA has indicated that approximately two events of magnitude 3 to 4 occur on this fault each year. Although this is consistent with seismicity equivalent to the Los Angeles Basin as a whole it is certainly not sufficient to quantitatively determine the seismicity of this fault. Based on this evidence, it can be stated that the fault is undeniably active.

1/ Figure 46 is located at the end of this section along with other fold-outs.

2/ Yerkes et al., 1965.

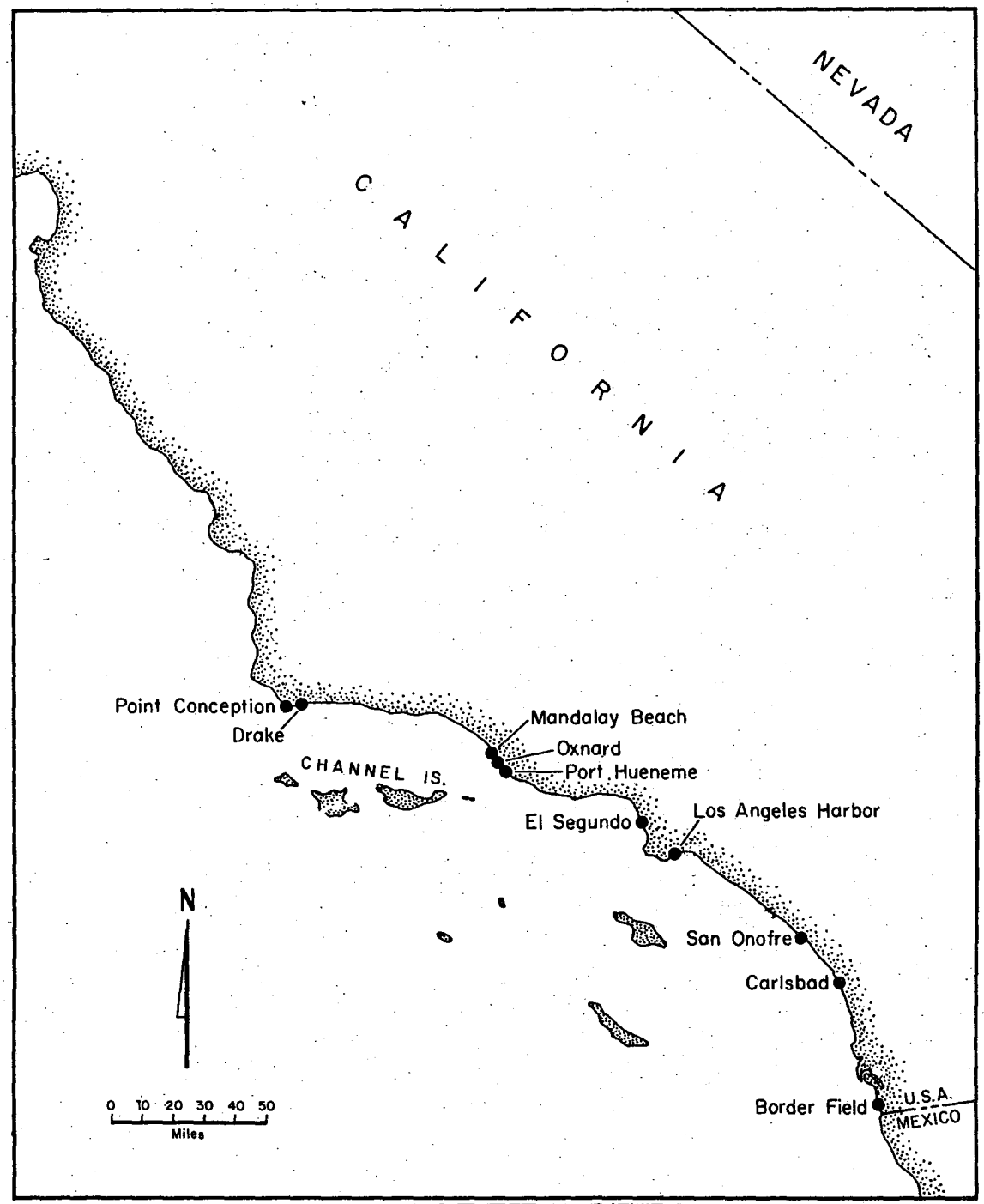

Figure 45. Location of Sites Analyzed in Southern California

Surface displacement at the site, due to a magnitude 7 event on the Palos Verdes Hills fault, is estimated at 4 feet. Yerkes, et al., 1974, gives a possible upper bound of 6.5 feet of vertical and over 10 feet of total displacements for the same event.

Due to a lack of historical data and the absence of work to delineate slip rates on the Palos Verdes Hills fault, it is not meaningful to attempt a determination of the probability of any events associated with that fault. It cannot be said that due to its lack of historical activity there is little probability for events in the near future since, with minor exceptions, it appears that every event since 1912 greater than magnitude 6 in southern California occurred on a fault without known prior historic activity.[1/]

In view of the fact that the site is located on a fault with known activity and that there is a potential for the generation of large vertical and horizontal displacements on the Palos Verdes Hills fault, and that the occurrence of such an event could threaten the structural integrity of the proposed facility, the Los Angeles site has been rejected from further study.

Port Hueneme

The Port Hueneme site is located approximately 2 miles east of the town of Port Hueneme and adjacent to Ormond Beach. This alternative, as proposed by the applicant, would require that the berth site for the LNG ships be located just outside the Port Hueneme harbor and would be connected to the plant site by means of a 2-mile long subsurface cryogenic transfer line. The emplacement of a cryogenic pipeline of this magnitude and nature could create technical difficulties resulting from the thermal differential between the pipeline and the surrounding soil and groundwater. Mitigating measures, such as pipelines carrying heated water surrounding the cryogenic line, would have to be employed in order to prevent freezing of the soil and groundwater which could result in frost heaving or other related phenomenon. Even if such measures were to be employed, the degree to which they would be effective in preventing freezing and heaving would be questionable. For this reason, the Port Hueneme alternate site, as proposed by the applicant, was rejected from further study. It should be realized, however, that a more feasible method of developing the Port Hueneme site would consist of a pier and tanker mooring that would extend directly from the site to offshore Ormond Beach, which would eliminate the need for the subsurface cryogenic pipeline. Utilizing this configuration, the Port Hueneme site would be a viable alternative. Further information

1/ Lamar, et al., 1973.

concerning the potential of the Port Hueneme site will be presented later in this study.

Carlsbad

The Carlsbad site is located in San Diego County approximately 33 miles north of San Diego Harbor and 65 miles south of Los Angeles Harbor. The main portion of the site for storage and vaporization facilities would be located south of the city of Carlsbad and inland about 3 miles. The development of the Carlsbad site would require the construction of a cryogenic transfer line over 3 miles in length, which would be beyond the limits of technical feasibility and would create problems with vaporization of the transported gas. For this reason, the Carlsbad site was rejected from further study.

A field investigation of alternative sites conducted by the staff in May 1975 led to the discovery of a second potential site near Carlsbad, located closer to the shore, which would eliminate the need for the lengthy cryogenic line. This site is located just south of Agua Hedionda and is bordered to the west by U.S. Interstate Highway 5. Further investigations indicated that residential development is occurring immediately adjacent to the site and that LNG development would conflict with the present Master Plan (for land use) of Carlsbad.

Border Field

The Border Field site is located just north of the international boundary with Mexico. A pier about 2,500 feet long would be required for mooring LNG ships, which would be within the limits of technical feasibility. Operation of LNG ships at the site, however, would require that a turning basin and a 5,000-foot long channel be dredged in order to reach water of sufficient depth. The actual plant site is located approximately 2,000 feet inland from the beach and would be bounded by the Border Field State Park, which encompasses the beach and adjacent inland property. Development of the site would require that the cryogenic pipeline be routed through the park which would not be compatible with the conservation-oriented land use of this state property.

El Segundo

The El Segundo site is located on Santa Monica Bay several miles north of Los Angeles harbor and in close proximity to extensive oil storage and shipping facilities. Development of the site would necessitate the construction of a subsurface cryogenic transfer line over 1.5 miles long which would be routed outside the site

boundaries and along a major street. In addition, the numerous industrial complexes in the area maintain extensive underground pipelines which could significantly interfere with installation of an LNG transfer and seawater exchange system. For these reasons, the El Segundo site was rejected from further consideration.

ii. Site Assessments

The five potential sites that were considered acceptable according to the criteria prescribed in the initial rating system include Point Conception, Oxnard, Drake, Mandalay, and San Onofre sites. The locations of these sites are illustrated in Figures 47 to 51, respectively.

Each site has been subjected to an in-depth analysis which involved the tabulation of the pertinent physical characteristics of each site, and an assessment as to which site most closely correlated with the physical requirements of the project and the established criteria. Each site has also been subjected to a detailed environmental analysis in an effort to determine the diversity and sensitivity of ecosystems and populations within the site area and the relative magnitudes of impacts that could result from project development at each of the five sites. Table 40 [1/] compares the physical characteristics of each site, a summary of which is included below, and the results of the environmental analysis are included in the following section of the report.

Of the five sites that were considered acceptable for terminal development, the Oxnard, Mandalay, and San Onofre sites exhibit the potential for the development of seawater exchange systems. The three sites are in proximity to the Ormond Beach (Steam) Generating Station, the Mandalay Steam Generating Station and the San Onofre Nuclear Generating Station, respectively, and seawater transfer lines could be constructed without serious economic or technical ramifications. The California Coastal Zone Conservation Commission, however, stated in their comments to the DEIS that the Mandalay Steam Generating Station should be considered a minor siting travesty and that its life should not be further extended by linking it in a mutual dependency relationship with a new base load LNG terminal through a seawater exchange system. The benefits that would be derived from the development of such a system relate specifically to potential impacts upon the biological environment and will be discussed in detail in the environmental analysis section of the report.

With the exception of the San Onofre site, all other sites are adjacent to established shipping traffic patterns which consist of 2 one-way lanes with an intermediary separation zone. It should be noted, however, that the San Onofre site is in an area which is removed from extensive commercial and recreational

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1/ Table 40 is located at the end of this section along with other fold-outs.

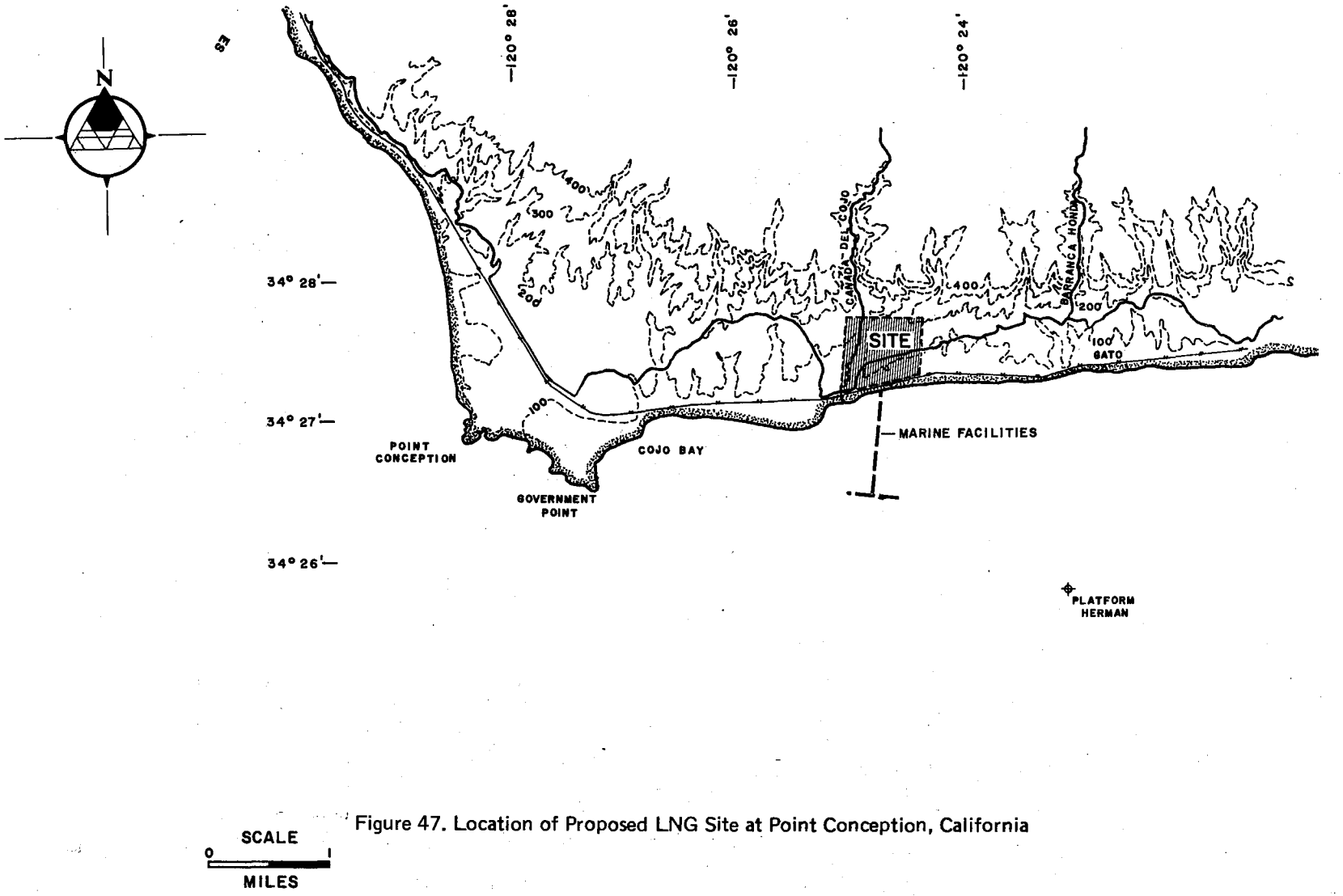


Figure 47. Location of Proposed LNG Site at Point Conception, California

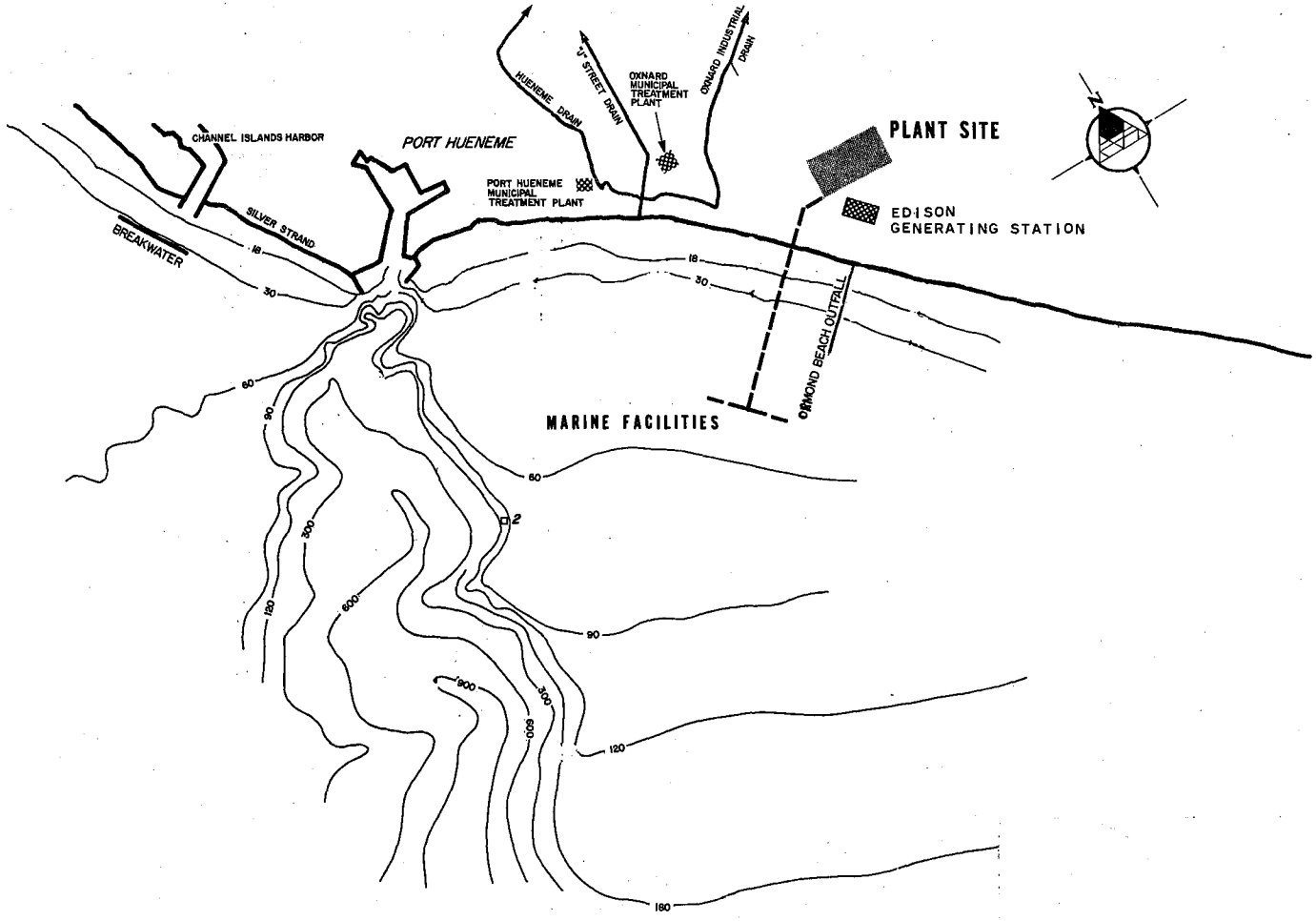


Figure 48. Location of Proposed LNG Site at Oxnard, California

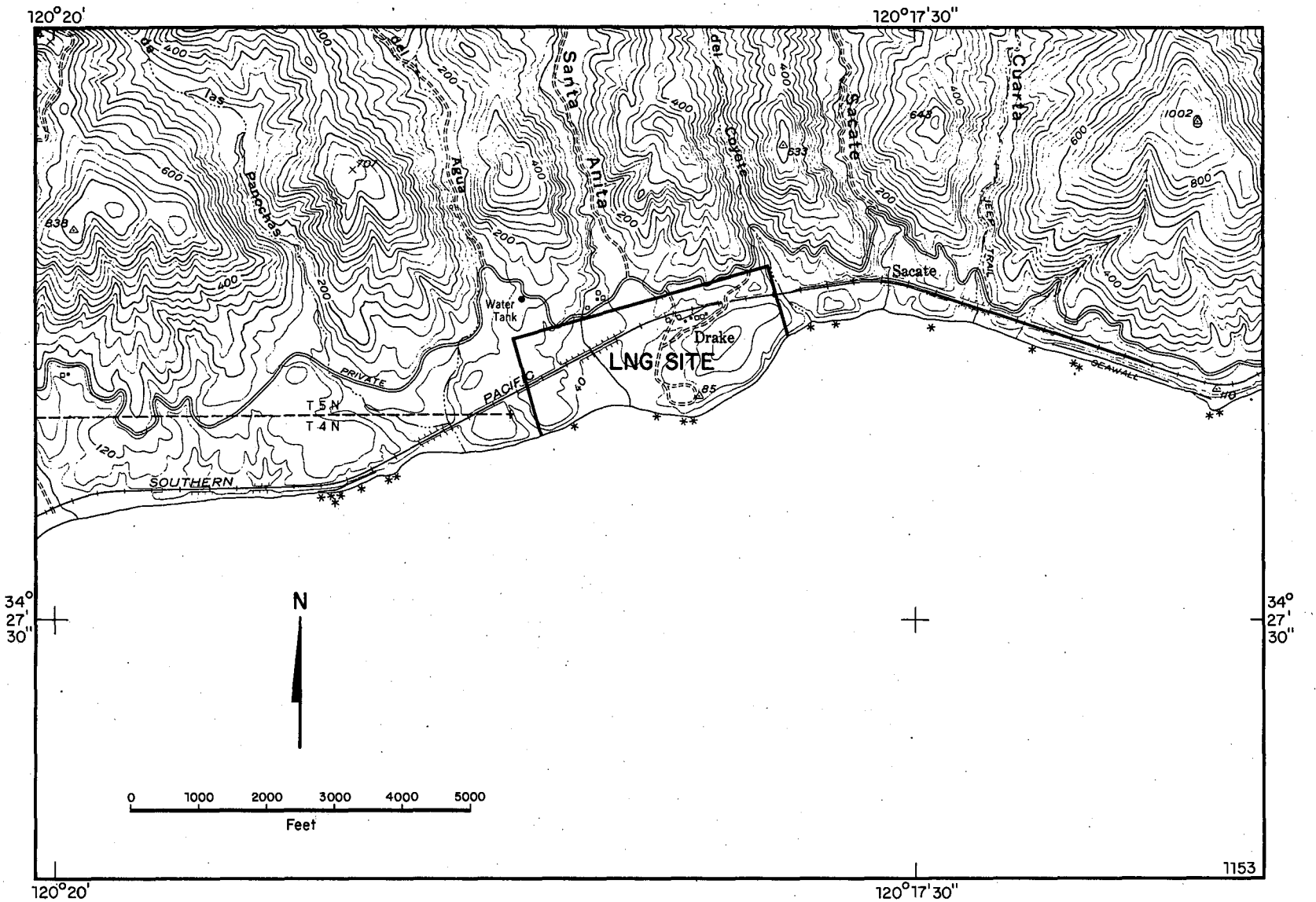


Figure 49. Location of Proposed LNG Site at Drake, California

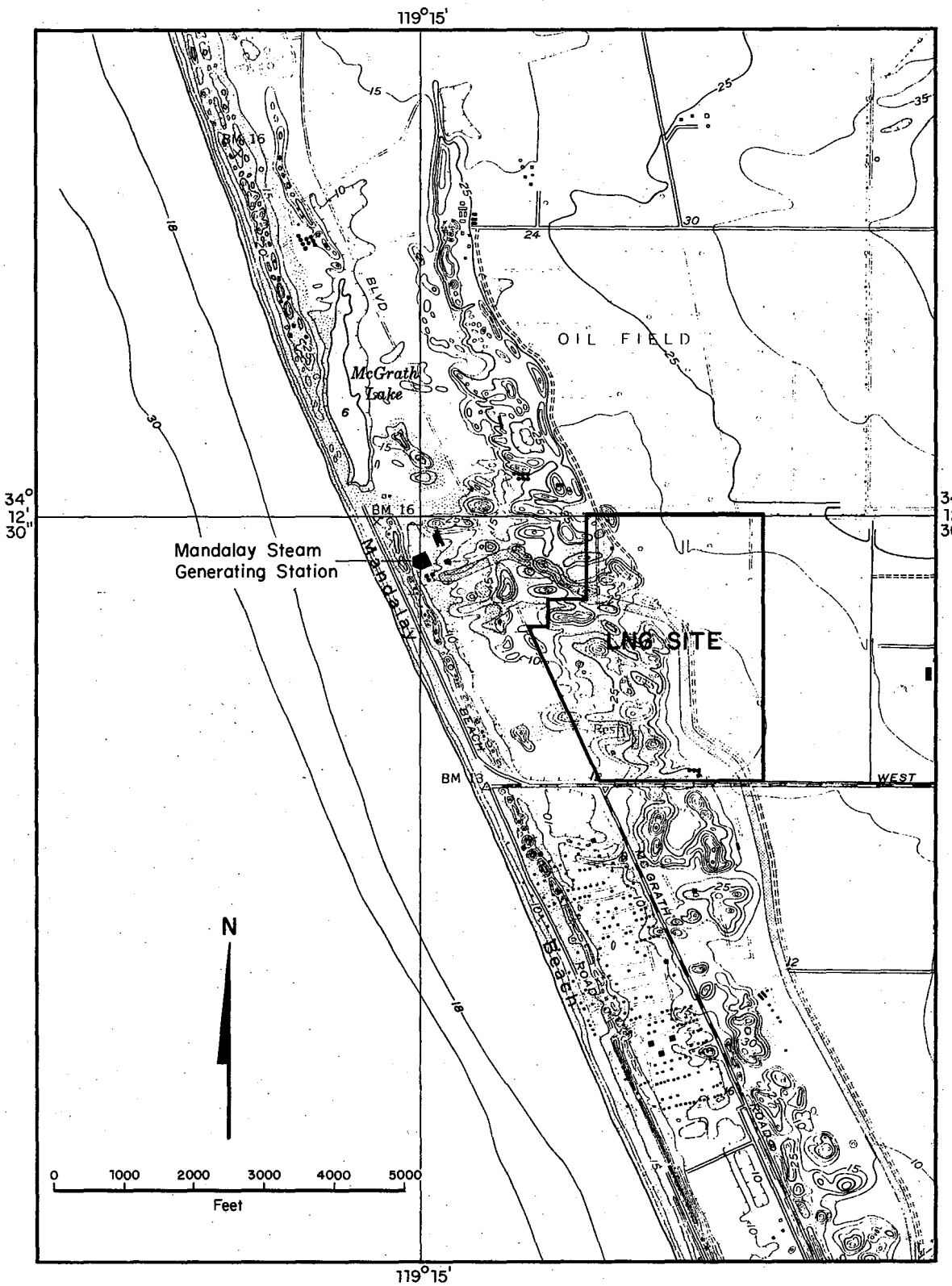


Figure 50. Location of Proposed LNG Site at Mandalay Beach, California

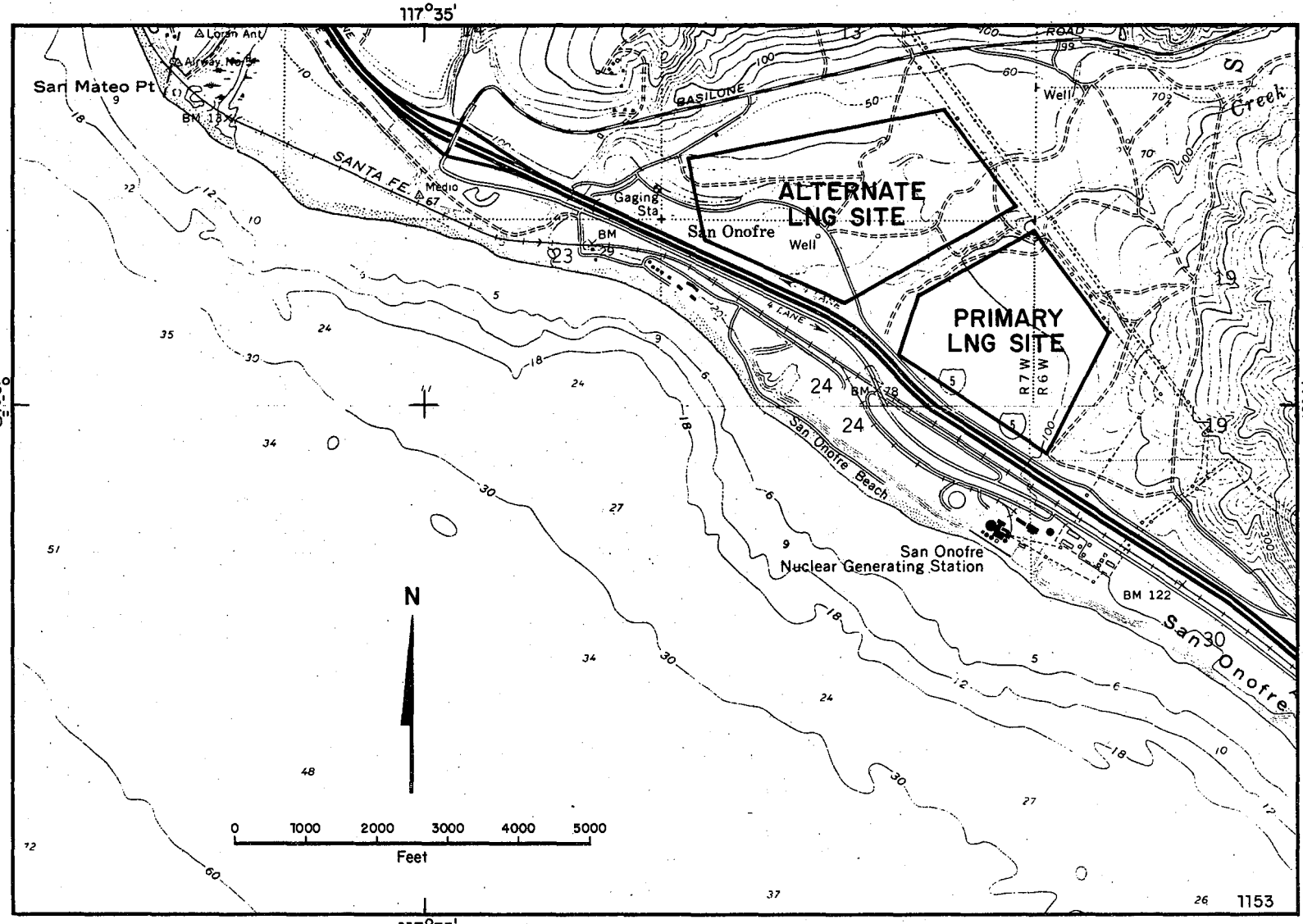


Figure 51. Location of Proposed LNG Site at San Onofre, California

vessel traffic, which would account for the lack of established shipping traffic lanes. Navigation near the San Onofre site, however, would have to be coordinated with the United States Marine Corps, which presently engages in amphibious maneuvers in the vicinity of the potential LNG site. Intersea stated that it had been reported that the Marine Corps would not favor the continuous presence of large LNG tankers near their amphibious operations training beach.

The Oxnard site and its immediate vicinity is the only location which has a definitive land use classification directed toward heavy manufacturing or industrial use and where extensive industrial development is expected and planned for the future. The land use in the vicinity of the five potential sites is shown in Figures 52 through 56 , respectively.

Although the San Onofre site is within the boundaries of Marine Corps base Camp Pendleton, the land is presently leased to Southern California Edison by the Marine Corps. The feasibility of developing the LNG facility at this location would hinge upon agreement to legal conditions that may be imposed by Southern California Edison and the Marine Corps. The San Onofre potential site is also in proximity to a nuclear generating station, the presence of which could raise the question as to potential adverse interaction between the two facilities in the event of an accident at either, and/or increased risk. Based on information provided by the applicant in its application and obtained through the staff's letters of inquiry and independent research, the staff believes the proposed LNG facility would be designed in an acceptable manner to meet safety standards that were applied to construction, maintenance, and operation. The staff has little information concerning the safety standards that were applied to the nuclear generating station, nor does it have the expertise to determine the safety or risk involved with the operation of the nuclear facility relative to the proposed LNG project. The Nuclear Regulatory Commission (NRC) has stated, however, that the risk to the safety of the San Onofre Nuclear Generating Station due to the close proximity of an LNG terminal would certainly exceed NRC criteria and that the seismic design basis of the proposed LNG terminals is significantly less stringent than that of the nuclear generating station.

Transmission pipelines could be constructed from each of the five potential terminal sites to existing compressor or metering stations for eventual connection to existing mainline systems. (See Figure 57.) A detailed discussion of the proposed Point Conception pipeline route is given in the body of this Environmental Impact Statement. As can be seen from Figure 57, the pipeline that would issue from the potential Drake site nearly coincides with the Point Conception route and hence the material presented elsewhere in this environmental impact statement can be considered applicable to the Drake pipeline route. The following excerpts from the site

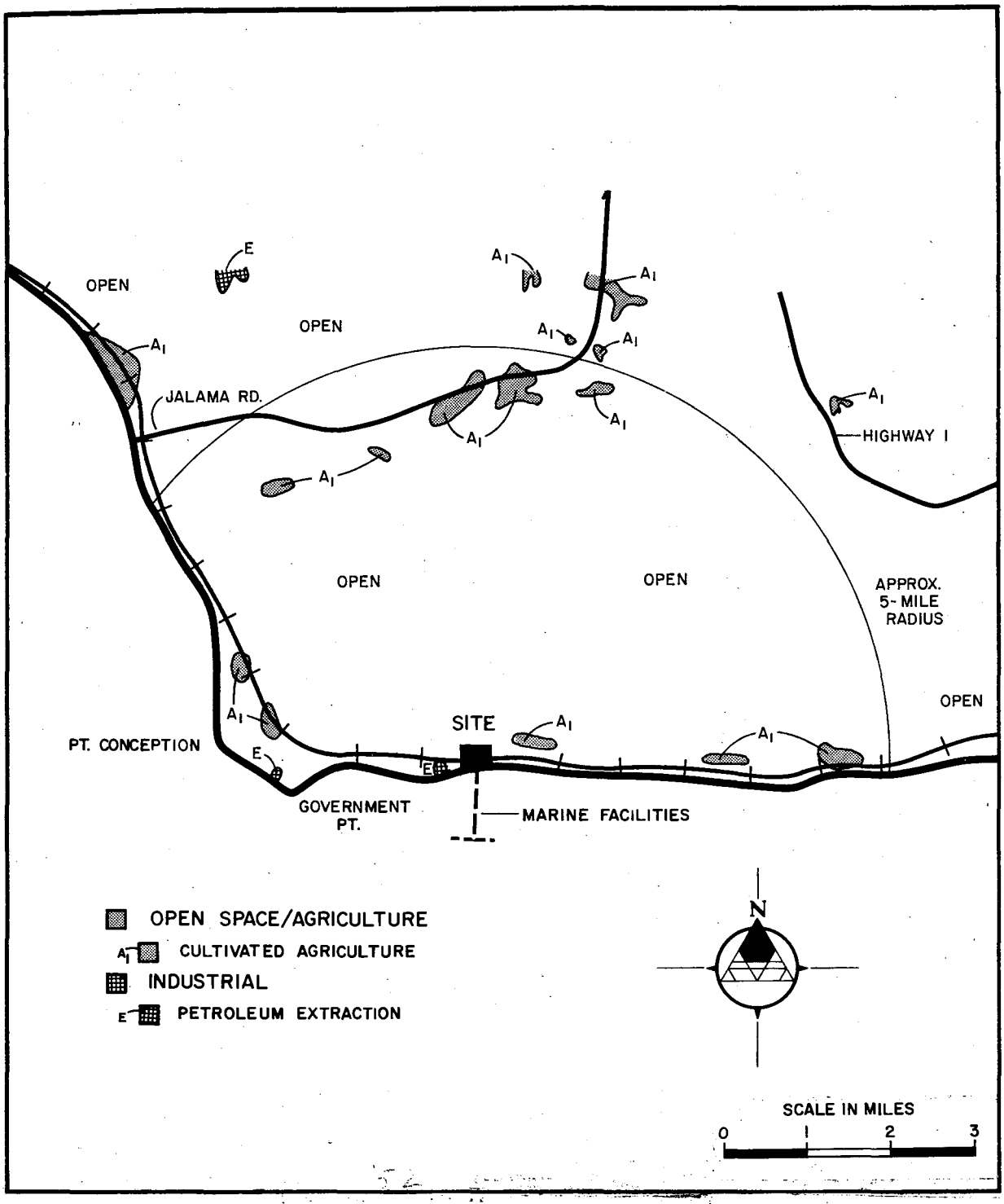


Figure 52. Land Use for Point Conception

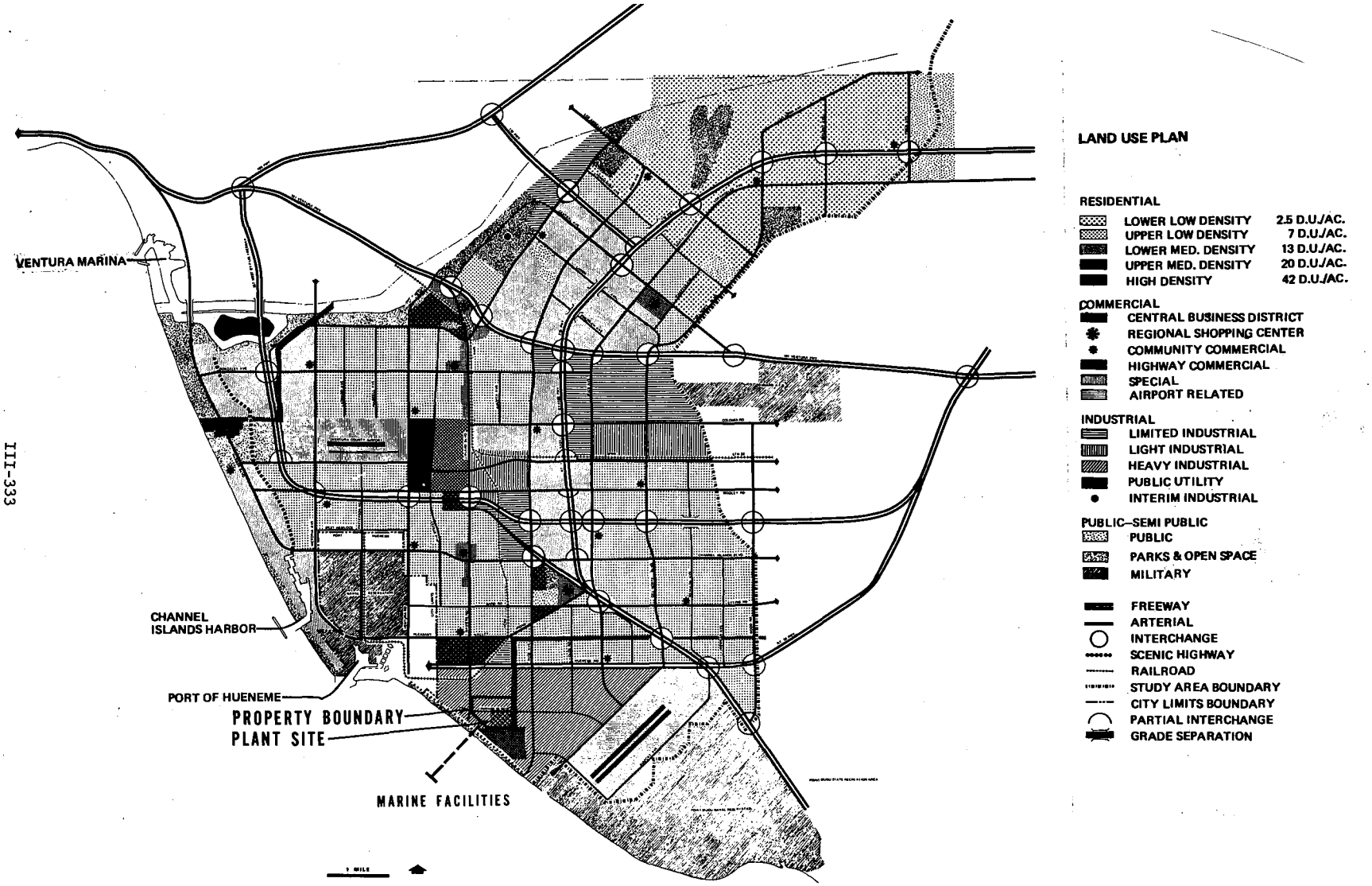
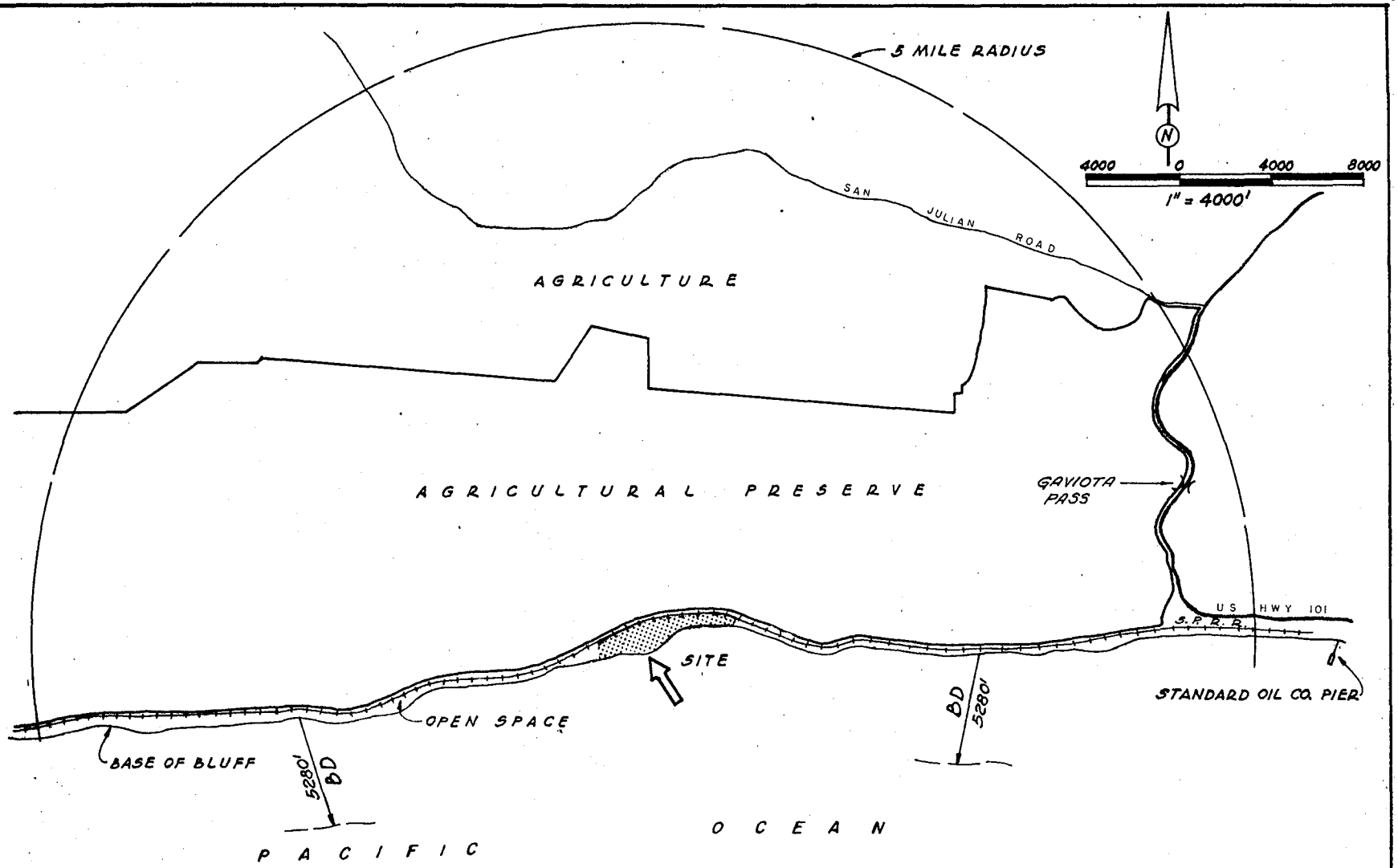


Figure 53. Oxnard General Plan



BD = Beach Development District

Figure 54. Land Use Plan Santa Barbara County, California
Drake Site

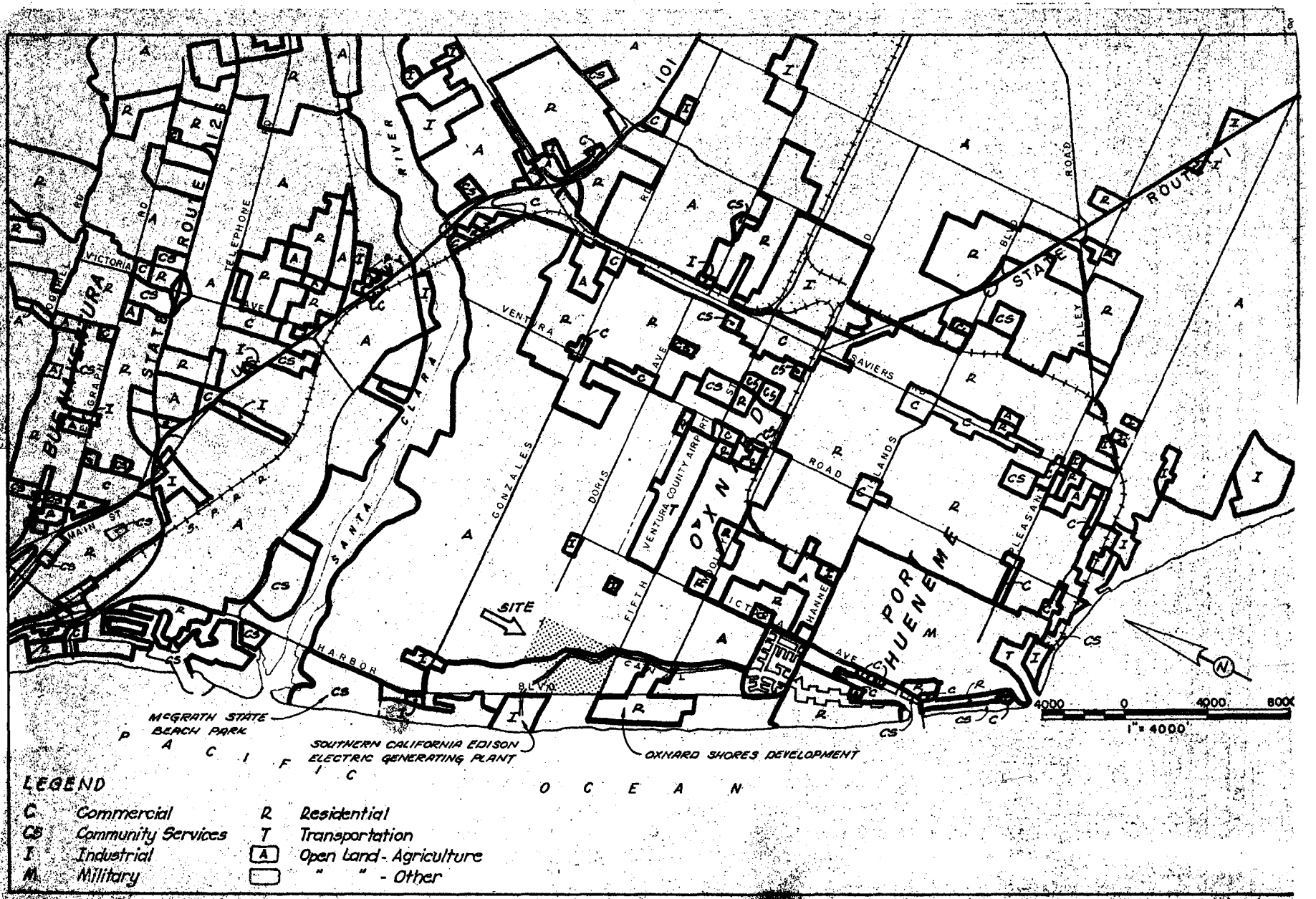


Figure 55. Land Use Plan 1975 Ventura County, California Mandalay Site

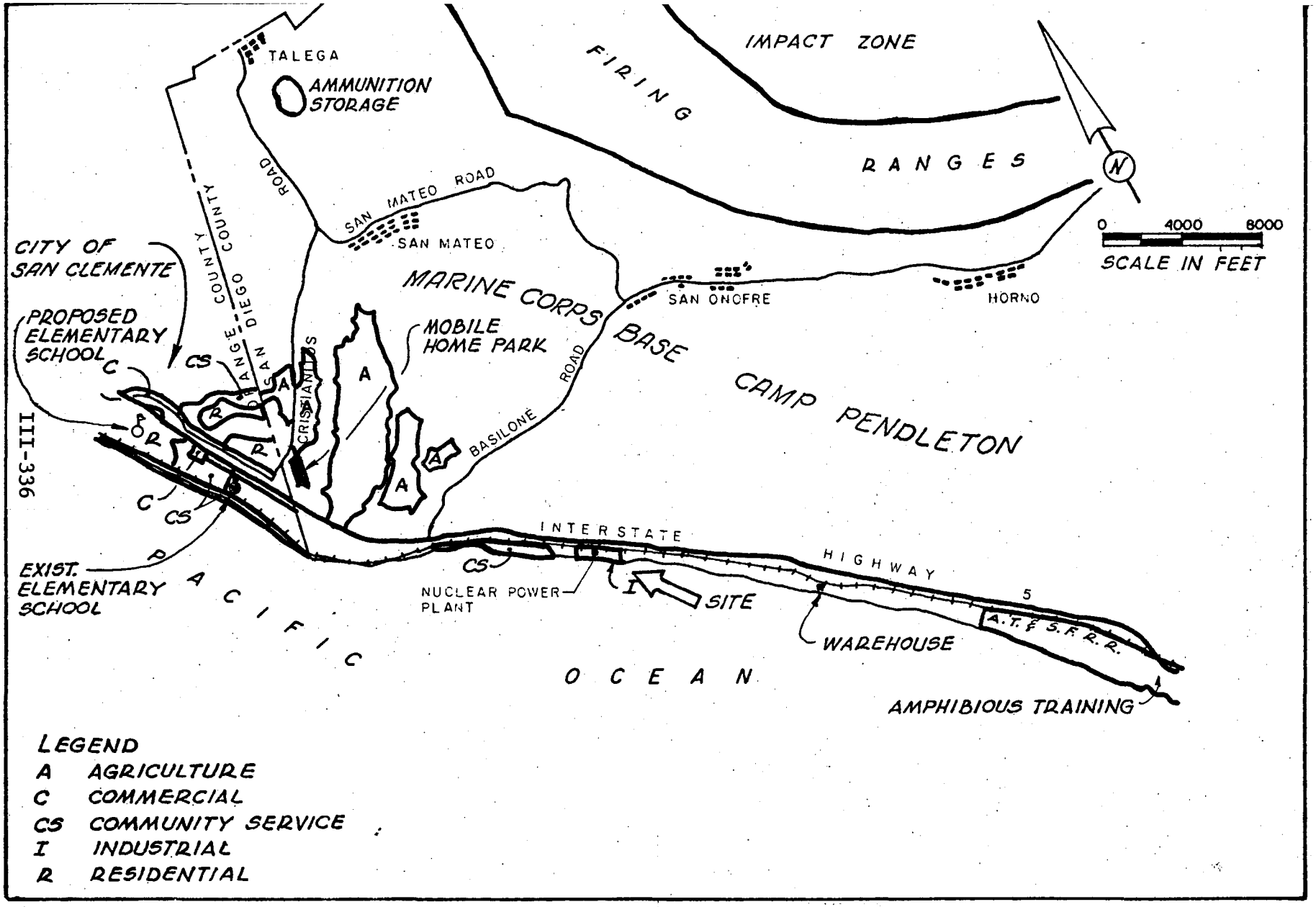


Figure 56. Land Use Plan San Diego County, California
San Onofre Site

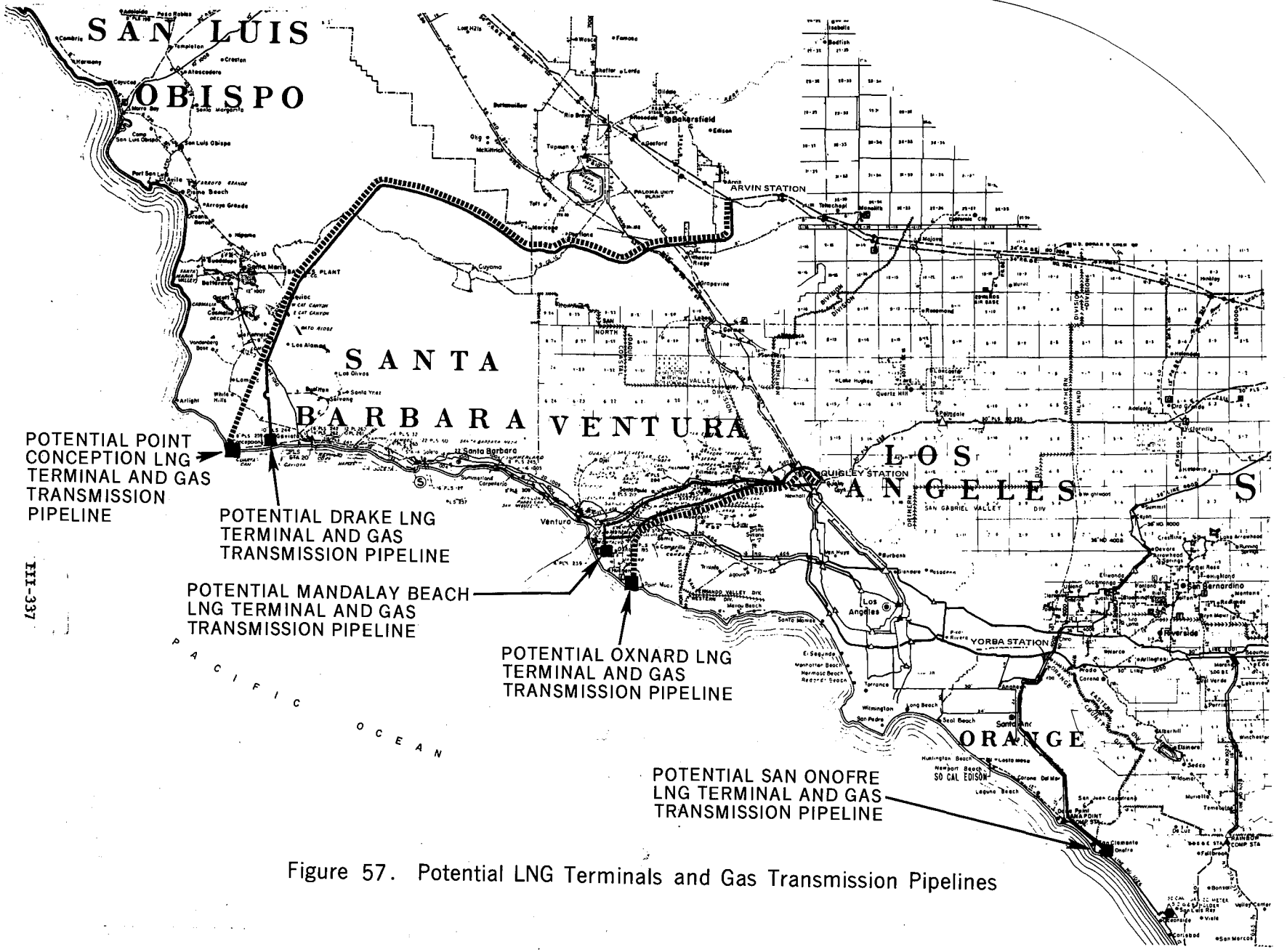


Figure 57. Potential LNG Terminals and Gas Transmission Pipelines

study by Intersea are presented for the purpose of providing information concerning the connecting pipelines that would issue from the Mandalay Beach and San Onofre sites. Since the pipeline route that would issue from Oxnard is nearly coincident with the Mandalay Beach route, the information presented from the Mandalay Beach route can be considered applicable to the Oxnard pipeline route.

GAS TRANSMISSION PIPELINE

The location of Mandalay Beach makes connection to interstate transmission lines an involved problem. Energy requirements and the engineering complexities involved in modifying existing facilities would need to be studied in depth. Alternate pipeline routes leading from this site have been investigated (Figures 30 and 31).

The first proposal would be to run approximately 12 miles of transmission line to the Center Street and La Vista metering station. SCG 18-inch line 404 and 22-inch line 406 which run from Los Angeles to Ventura, transverse this station. Pacific Lighting Service 34-inch line 324, which is routed from the Castaic Junction station, is metered at this location.

The pipeline would be routed through the Oxnard basin. Elevations would vary from about 10 feet above sea level at the LNG site to approximately 200 feet at the metering station.

If existing lines were to be used to distribute gas from this station, transmission system modifications would be required to reverse flow. PLS has a 34-inch line 225 which connects the Castaic Junction station to the Quigley Canyon station. PLS 30-inch line 235 terminates at Quigley Canyon station. This line runs through several compressor stations as it crosses California. It enters California at the Arizona border. The Castaic Junction station also services lines which connect the Los Angeles area with Northern California. The Dames and Moore study, in Docket No. CP-75-83 before the FPC, investigated routing a new transmission pipeline along existing PLS line 225 to the Quigley Canyon stations.

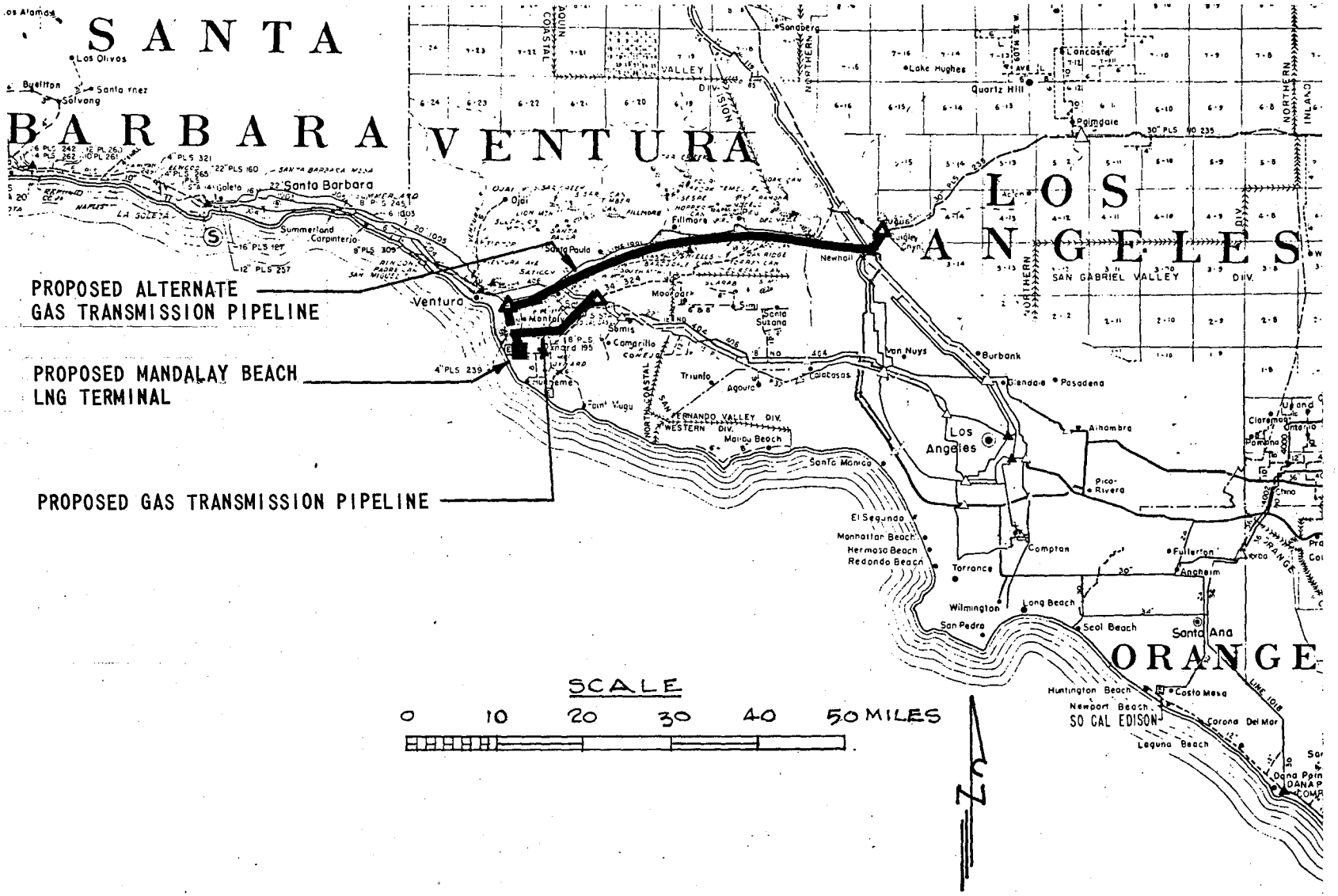


Figure 30. Gas Transmission Pipeline Routing Study
Mandalay Beach Site

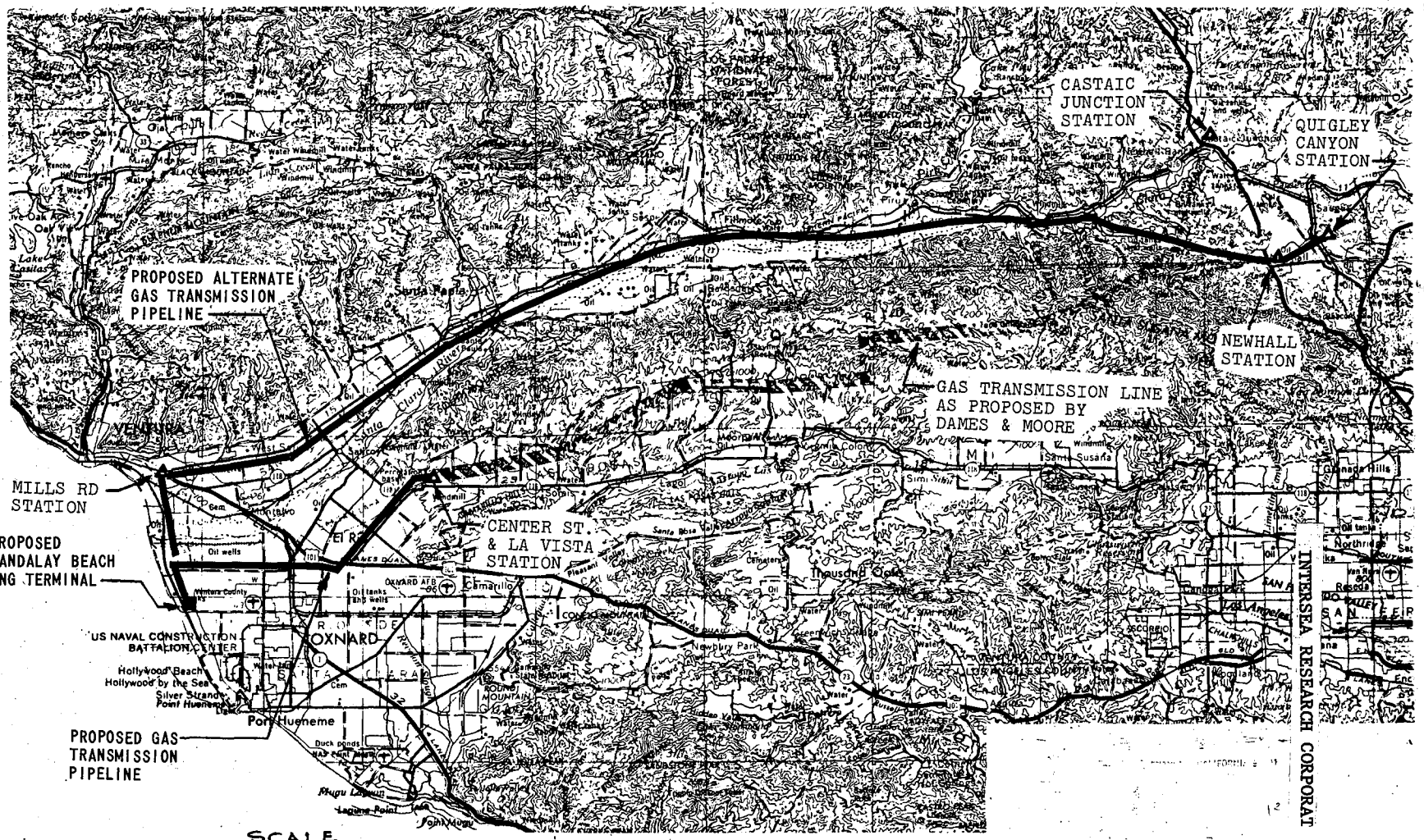


Figure 31. Gas Transmission Pipeline Routing Study
Mandalay Beach Site

If energy requirements necessitate laying a new pipeline from the proposed Mandalay Beach LNG site to the Quigley Canyon station, an alternate proposal would be to run a new pipeline through the Santa Clara River Valley. This line would begin with a 5-mile line to the Mills Road metering station. This station services lines connecting the Los Angeles area to the Ventura and Santa Barbara areas. SCG 12-inch line 1001 connects the Mills Road station with the Newhall station. A new transmission line routed from Mills Road to Newhall would generally parallel line 1001. The length of the new line would be approximately 45 miles.

The elevation at the Mills Road station is approximately 20 feet above sea level. Santa Clara River valley narrows to 2-½ miles between 850-foot peaks at Santa Paula. The proposed pipeline would follow a route beginning at a 20-foot elevation and rising to 260 feet at Santa Paula. The route continues to rise to 440 feet at Fillmore, 680 feet at Piru, and 950 feet at the entrance to Potrero Canyon. The proposed transmission pipeline then follows Potrero Canyon for approximately 5 miles to the high point of the route, 1650 feet, as it passes over the Santa Susana Mountains into Pico Canyon. As the route follows Pico Canyon into the Newhall area, the elevation drops to 1225 feet. The line passes through Newhall and terminates at Quigley Canyon Station at an elevation of approximately 1350 feet.

The Newhall area serves as a major junction for lines connecting Northern and Southern California. SCG has three existing lines running from the Newhall area to the Quigley Canyon station, 30-inch line 3000, 30-inch line 3003, and 34-inch line 3008. Modifications to these lines might eliminate the need for running an additional line to Quigley Canyon.

Existing transmission system facilities would require modification for further gas distribution.

GAS TRANSMISSION PIPELINE

Two potential pipeline routes were investigated to connect an LNG terminal located at San Onofre to a mainline system. See Figure 37. The first could be accomplished by a line to the Dana Point compressor station with system modifications and upgrading of existing lines as terminal capacity is increased. The alternate line could be laid across Camp Pendleton and connect the terminal to the Rainbow compressor station.

Figure 38 indicates the proposed routing of the first line. The line parallels SCG line number 1026 through San Clemente and follows established transmission line routes. The first segment of this route would consist of an approximately 9-½ mile line which would terminate at the Dana Point compressor station. The pipeline route would begin at an elevation of approximately 95 feet above sea level at the LNG terminal. Elevation drops to 10 feet as the route traverses the San Mateo Creek basin, then rises to 100 feet through the city of San Clemente. The line generally parallels El Camino Real from San Clemente to Dana Point at an elevation of about 10 feet.

SCG transmission line number 1018 connects Dana Point to the Yorba pressure limiting station. Line 1018 is a 30-inch and 36-inch line. Energy needs and terminal capacity would determine the necessity for laying a new line beyond Dana Point. If the need existed for continuing the line, it would parallel line 1018 through an established corridor to the Yorba station.

The segment of the route from Dana Point to the Yorba station would require approximately 38 miles of pipeline. Beginning at an elevation of

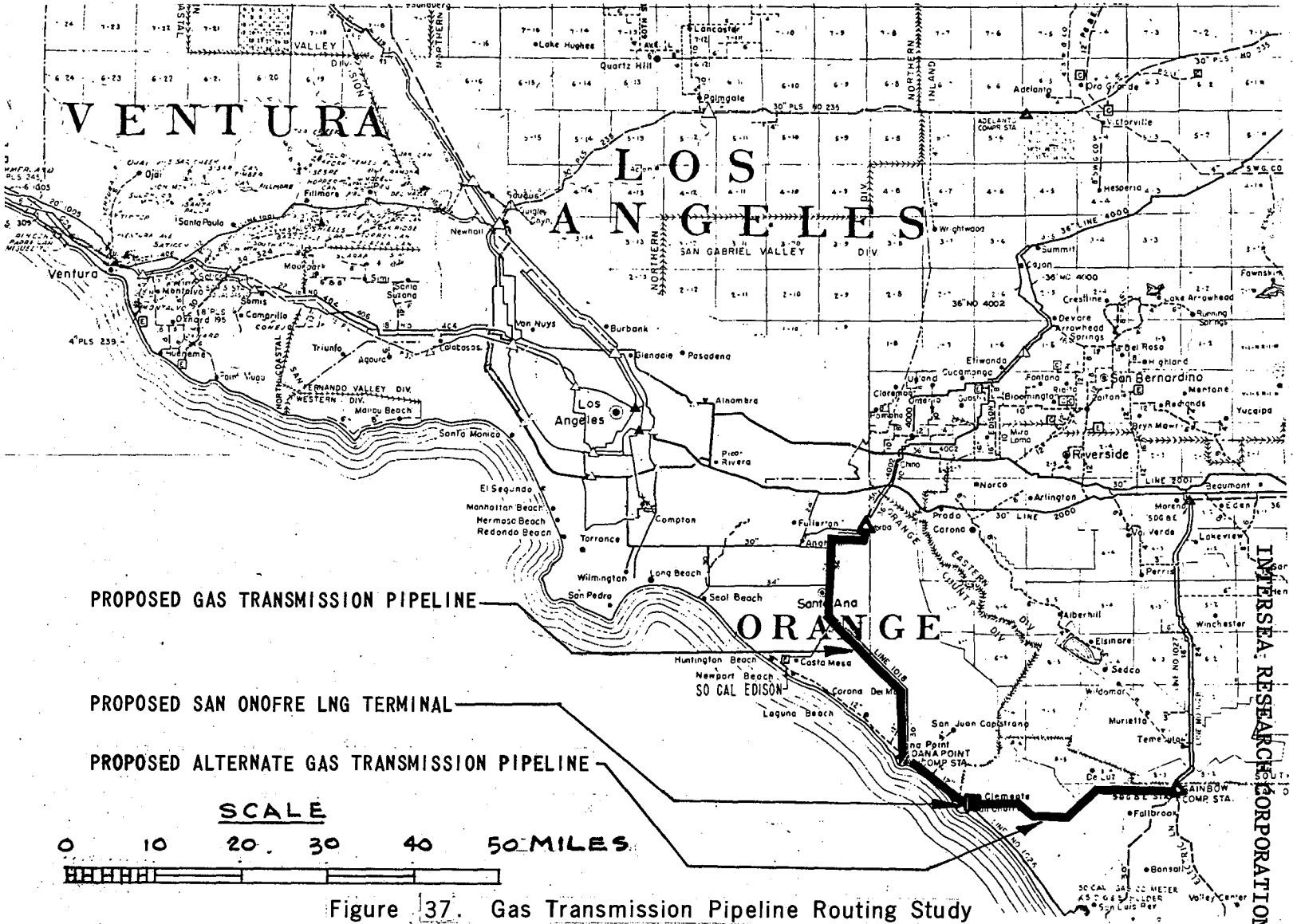


Figure 37. Gas Transmission Pipeline Routing Study
San Onofre Site

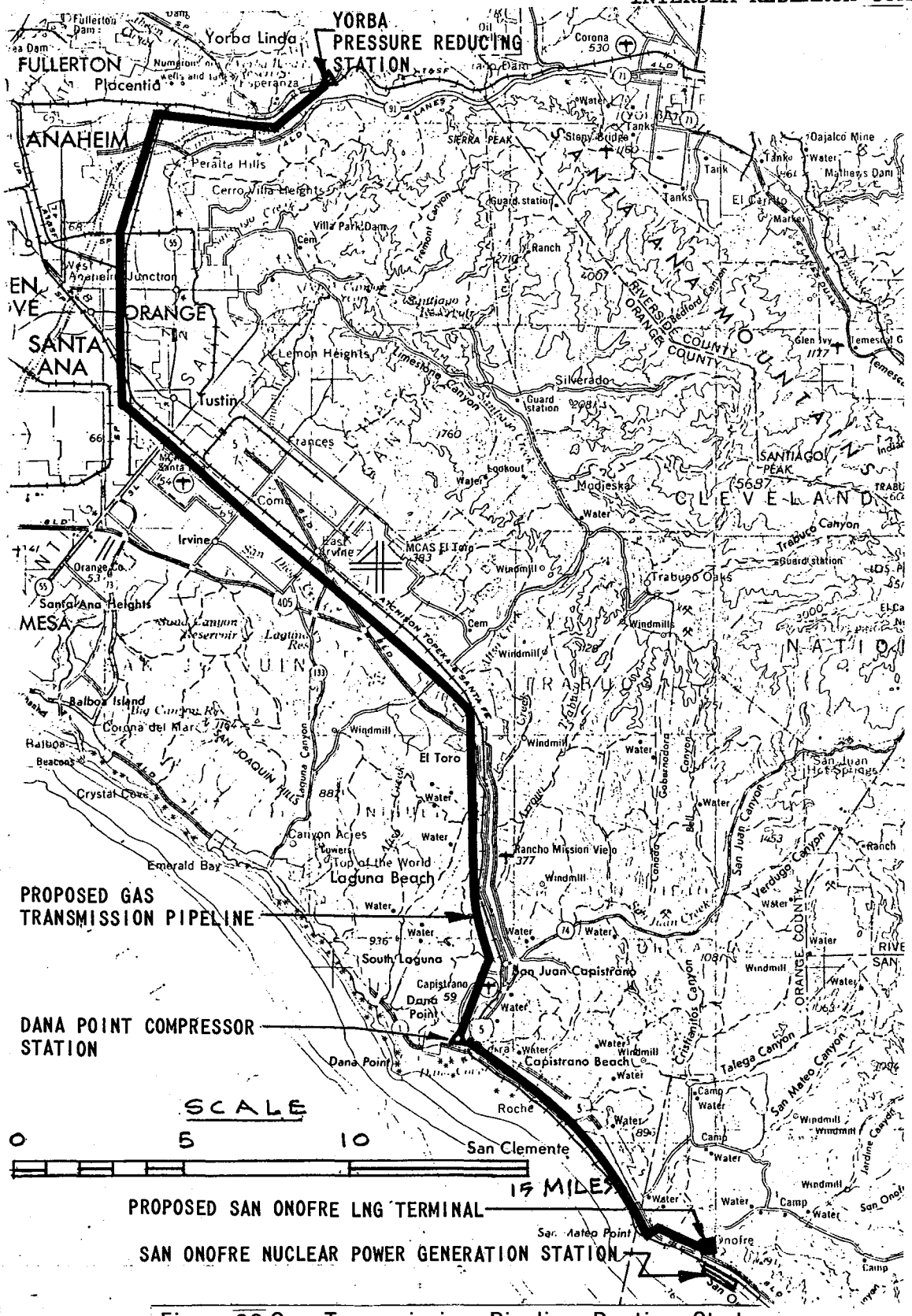


Figure 38, Gas Transmission Pipeline Routing Study
San Onofre Site

10 feet the line enters the San Juan Creek valley and rises to 150 feet at San Juan Capistrano. The pipeline route follows the Atchison, Topeka & Santa Fe Railroad as it climbs to 450 feet, the high point of the route, then drops to 50 feet at Irvine. The transmission line continues parallel the AT&SF RR as it passes through the cities of Santa Ana and Orange. The line gently rises to an elevation of about 300 feet at the Yorba station. The Yorba station provides access via 30-inch SCG lines 4000 and 4002 to the Newberry compressor station and major interstate transmission lines.

The alternate route is shown on Figure 39. This route would be approximately 30 miles long with 22 of those miles running through the Camp Pendleton Marine Corps Base. New rights-of-way would have to be established for the entire pipeline. The line, starting from an elevation of approximately 95 feet, would run easterly generally following Basilone Road through the South Fork San Onofre Canyon. Route elevation reaches 200 feet east of San Onofre Camp. Continuing along Basilone Road, the route skirts Camp Hornor and the impact zones climbing to 800 feet near Hornor Summit. Here the line turns southeasterly and drops to 240 feet at Las Pulgas Canyon. A small mountain range separates Las Pulgas Canyon and Aliso Canyon. Elevation at the top of this range is 480 feet. Aliso Canyon bottom elevation is 395 feet. The pipeline route continues easterly at the point where Basilone Road turns south toward Vandegrift Boulevard. The line passes through Wood Canyon as it passes into the Santa Margarita River valley. High point elevation in Wood Canyon is about 400 feet. The proposed route would then turn northeasterly along the Santa Margarita River and follow this route to a point

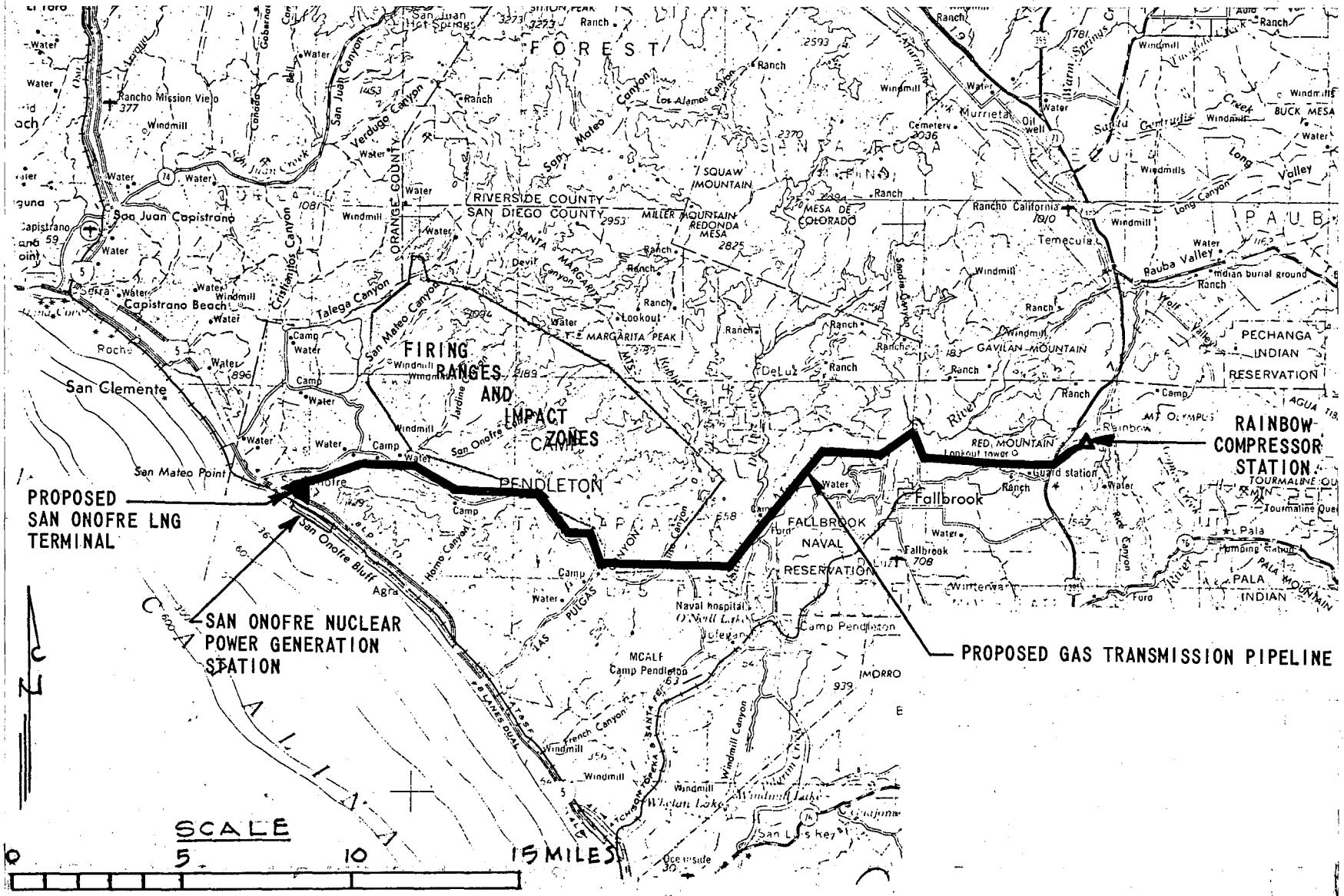


Figure 39. Gas Transmission Pipeline Routing Study
San Onofre Site

north of the U.S. Naval Weapons Station and the city of Fallbrook. The route enters the Santa Margarita River valley at an elevation of 120 feet. The valley narrows to less than 100 yards as it winds through the mountains. The elevation at the point north of Fallbrook where the line leaves the Santa Margarita River is 300 feet. Here the line climbs to 820 feet as it crosses over the mountain and turns south into Fallbrook. This alternate line would then run parallel Mission Road from Fallbrook to U.S. Highway 395. Elevations along Mission Road range from 800 to 1000 feet. The line then follows U.S. Highway 395 to Rainbow Valley Boulevard and the Rainbow station. Rainbow station elevation is approximately 1000 feet.

The San Diego Gas and Electric Company's compressor-metering station at Rainbow is the termination point for 24-inch line No. 1028 and 16-inch line No. 1027. These lines provide access to the interstate transmission lines which enter California at the Ehrenberg station. These lines together with SCG 12-inch line 1026 provide the natural gas requirements of the San Diego area. Transmission system modifications would be required for further distribution of gas.

If San Onofre were selected as a site for LNG facilities, a study of energy requirements might indicate advantages in combining these two alternate pipeline routes. The Los Angeles and San Diego areas could thus be served as well as access provided to interstate transmission lines.

As can be seen from the aforementioned and referenced discussions of potential pipeline routes, the construction and development of such routes would be well within the limits of technical feasibility, and there would probably be no insurmountable unrectifiable difficulties encountered long either route. The length of pipeline that would be required to connect the LNG terminal facility with existing mainline systems is of obvious importance from the combined standpoints of technology, environmental concerns, and economics. The Point Conception and Drake potential sites would require the longest connecting pipelines, each being about 140 miles in length. The length of pipelines required to connect the San Onofre, Mandalay Beach and Oxnard sites would be 47.5 miles, 50 miles, and 53.3 miles, respectively. Table 41 indicates the approximate percentage of each of the five connecting pipeline routes that would follow existing utility rights-of-way.

e) Environmental Analysis

Of the five LNG facility sites and associated pipeline routes under consideration along the southern coast of California, it appears that utilization of the Oxnard site and route would present the least potential for damage to the biological environment. The Mandalay Beach and San Onofre alternatives would probably produce a slightly greater impact, while the impacts of Point Conception and Drake alternatives would be much greater.

The three factors most important in reaching the above conclusions were the relative differences in existing habitat disturbance on each site and route, the length of the pipelines involved, and the existence of circumstances offsetting the potential impacts of the LNG vaporization system. Existing habitat disturbance was considered important as an indicator of the quality and quantity of natural habitats remaining in the areas under consideration. Undisturbed areas generally have more biological value as habitats than disturbed areas. The lengths of the pipelines are important as direct indicators of the amount of habitat each route would impact. The existence of offsetting circumstances in connection with an LNG facility's LNG vaporization system is of prime importance since the operation of a heat exchange system using seawater as the exchange medium can have extensive and long lasting effects on the marine environment.

Table 41

Approximate Percentage of Pipeline Routes
Adjacent to Existing Utility Rights-of-Way

Potential Site	Total Length of Route (Miles)	Length Along Existing Rights-of-Way (Miles)	Ownership of Existing Rights-of-Way	Percentage of Route Along Existing Rights-of-Way
Point Conception	142.3 1/	13.45 2/	Varied	9 2/
Drake	140	13.45 2/	Varied	9 2/
Oxnard	53.3	51.3	SCG 34-inch Line 324	96.25
Mandalay Beach	50	39	SCG 12-inch Line 1001 SCG 30-inch Line 3000	78.
San Onofre	47.5	47.5	SCG Line 1026 SCG 30x36-inch Line 1018	100

1/ As proposed by applicant in filing to FPC.
2/ Includes highways, improved and unimproved roads, pipelines, and powerlines.

The impacts of the proposed LNG vaporization system would include the entrainment of organisms, the actions of anti-fouling chemicals (biocides), and the effects of lowering the water temperature in the vicinity of the LNG plant. Operating the LNG facility in conjunction with an electric generating station could potentially offset many of these impacts. The LNG facility and the generating station could share a single seawater circulation and biocide system, and at least some of the heat released from the generating station in its seawater outfall would be removed by passing the water through the LNG facility.

In the cases of the Point Conception and Drake alternatives, all these factors weigh heavily. These sites and their associated pipeline routes are relatively undisturbed by human activities, and few existing rights-of-way would be followed. The routes are nearly three times as long as the routes of the Oxnard, Mandalay Beach, and San Onofre alternatives, and there are no means available to offset the effects of an LNG vaporization system at Point Conception or Drake.

The Oxnard, Mandalay Beach, and San Onofre sites and routes already exhibit relatively greater habitat disturbance than the Point Conception and Drake sites and routes. The San Onofre site has less existing habitat disturbance than either Oxnard or Mandalay Beach. The Oxnard, Mandalay Beach, and San Onofre pipeline routes are similar in length. Electric generating stations near the Oxnard and San Onofre sites could provide heated seawater in sufficient volumes to offset the impacts of LNG regasification almost completely, while another generating station near the Mandalay Beach site could only provide about one-third the required heated seawater.

The Oxnard alternative was therefore rated superior to the Point Conception, Drake, and San Onofre sites on the basis of relative habitat disturbance, superior to the Point Conception and Drake sites on the basis of pipeline length, and superior to the Point Conception, Drake, and Mandalay Beach sites on the basis of factors offsetting the impacts of the LNG regasification system.

Due to the large population and local urban development in the Oxnard-Port Hueneme area, the impacts on housing and community services associated with the influx of the construction and LNG facility crews and their families would be slight for the

Oxnard and Mandalay Beach alternatives. The smaller urban development in the San Clemente, San Onofre, San Mateo, and Horno areas would be relatively less able to cope with such impacts if the San Onofre site were chosen. The same low level of urban development in the Lompoc and Gaviota areas argues against the use of the San Onofre and Drake sites.

Another major advantage of the Oxnard site is its location within an industrial area. This means that the future land use of the area would not be changed appreciably by the presence of the LNG facility. The Mandalay Beach site is near some industrial development, but it is also adjacent to a residential development. The location of an LNG facility at Mandalay Beach would seriously affect existing property values and the future spread of other housing developments. In addition, the Mandalay Beach site would appear to conflict with current state acquisition proposals. The California Coastal Zone Conservation-Commission has specified that the coastal region near the San Onofre site be reserved for public recreation should the Marine Corps ever give up control over that portion of its Camp Pendleton property. The County of Santa Barbara has similar plans for the future of the coastal zone in the Point Conception and Drake site areas, which are presently used primarily for agriculture. Thus, three sites would be in conflict with potential recreational developments.

In summary, it appears that the Oxnard site offers the least potential for significant socioeconomic impacts. The Oxnard site is the only site which has a large urban population nearby to absorb some of the impacts, yet avoids conflicts with housing and recreational developments.

f) Conclusions

It is the opinion of the environmental staff, based upon its independent analysis of alternative LNG terminal sites, that the Oxnard site would constitute the most suitable location for development of the proposed LNG terminal project. As is indicated in the preceding site analysis, the physical characteristics of the Oxnard site comply with the basic technical requirements of the proposed project, and both the marine and land-based components of the facility could be developed in an acceptable manner with regard to technology, safety, and economics.

The Oxnard site similarly exhibits several environmental advantages that would permit project development with a minimal amount of environmental disruption. A seawater exchange system could be developed with the Ormond Beach Electric Generating Station which would mitigate the effects of a cold water outfall plume. Land use in the vicinity of the site is directed toward industrial development, so the placement of the LNG facility at the Oxnard site would be compatible with existing and planned land uses.

The connecting pipeline that would issue from the plant site would not be excessively long and would follow existing pipeline rights-of-way for more than 95 percent of its length. These two factors combined would permit emplacement of the connecting pipeline with a minimal amount of disruption to undistrubed land and reduce the effects of vegetative clearing and soil compaction.

The proposed El Paso project involves approximately 2.809 billion cubic feet of natural gas per day in liquid form which would be available at Point Conception for storage, revaporization, and transportation to the lower 48 states. However, two other projects should be identified to give a full perspective of the volumes of gas to be imported to California and the possible need for one or more LNG import, storage, revaporization, and transportation, facilities within the State of California. In addition to the El Paso project, Pacific Indonesia LNG Company has proposed in Docket No. CP74-160 to import from Indonesia approximately 523 million cubic feet of natural gas per day to a proposed LNG storage, revaporization, and transportation facility at Oxnard, California. Also, Pacific Alaska LNG Company has proposed in Docket No. CP75-140 to transport from Alaska approximately 400 million cubic feet of natural gas per day to a proposed LNG facility in Los Angeles Harbor, California. Together the three projects would thus involve an average importation of approximately 3.73 billion cubic feet of natural gas per day into the State of California. Thus, it would appear that one importation terminal designed to handle an average load of 4 billion cubic feet of natural gas per day and 1 billion cubic feet of gas per day peaking capacity would be adequate to handle the proposed gas volumes of all three projects at this time. This would

be particularly true in the event that the El Paso volumes of gas from Alaska are reduced. 1/

The applicant has indicated that for a single plant with a peak and base load capacity of 4.9 billion cubic feet per day sited at Oxnard, 46.4 miles of twin 42-inch diameter pipeline, 46.0 miles of single 42-inch diameter pipeline, and 85.2 miles of single 48-inch diameter pipeline, i.e., a total of 224 miles of pipeline (not actual distance) would be necessary for the combined El Paso, Pacific Alaska, and Pacific Indonesia projects. This is approximately 117.4 miles of pipeline more than the originally proposed 106.6 miles of pipeline from Oxnard to Quigley with no known customers to the time. The pipeline for the most part would traverse and/or parallel existing rights-of-way.

In comparison, the applicant has indicated that for a similar single terminal/joint project concept at Point Conception, 142 miles of triple 42-inch diameter pipeline from Point Conception to Arvin and 105 miles of twin 42-inch diameter pipeline from Arvin to Cajon, i.e., a total of 636 miles of piepline, would be required. This is approximately 247 pipeline miles longer than the originally proposed 389 miles of pipeline from Point Conception to Cajon. This pipeline for the most part would require new rights-of-way. It should be pointed out that the need for triple 42-inch diameter lines from Point Conception to Arvin is not clear to the staff at this point. The applicant's original proposal called for the transmission of up to 5 billion cubic feet of gas per day from Point Conception to a point near Arvin utilizing twin 42-inch pipelines. However, in their comparisions between Point Conception and Oxnard for a single terminal, three 42-inch diameter pipelines would now be required to transmit equivalent volumes of gas from the same sendout terminal to the same point near Arvin. No explanation as to why this additional 42-inch diameter pipeline is required has been given to the staff at this time.

1/ On December 19, 1975, El Paso testified to an alternative to their proposal showing the receipt at Point Conception of 2.107 rather than 2.809 billion cubic feet of gas per day as originally proposed. As a result, the number of seawater vaporizers and the capacity of the seawater exchange system would be reduced proportionately to reflect the lower baseload capacity of the plant. The reduced volumes of gas would probably result in a rescheduling of the LNG tankers and a reduction in the size of the fleet. The proposed gas transmission pipeline from Point Conception to Arvin would be revised whereby the final 43-mile segment of twin 42-inch diameter pipelines to Arvin would be replaced by a single 42-inch diameter pipeline

It can rationally be concluded from this comparison that the pipeline from a single/joint project LNG terminal at Oxnard would disrupt considerably less undistrubed native habitat and vegetation than pipeline construction involved with a single combined terminal at Point Conception. Also, the cost of the pipeline and compression associated with a single combined terminal at Point Conception would be more than twice that associated with a single combined terminal at Oxnard. In addition, it should be pointed out that the total pipeline necessary for a combined terminal at Oxnard would involve approximately 185 miles less pipeline than that which would be required for the same volumes of gas imported to three terminals located at Point Conception, Oxnard, and Los Angeles, California.

As previously indicated on Page III-323 of the site selection study, the Port Hueneme potential site would be a viable location for project development if the need for a 2-mile subsurface cryogenic pipeline could be eliminated. In keeping with the staff's opinion that a single LNG facility be designed at Oxnard to handle the import load of all three of the aforementioned projects, the Port Hueneme site could serve to supplement the available land at Oxnard, should the need for expansion arise in the future. Expansion onto the Port Huaneme site would preclude the necessity for a lengthy/cryogenic pipeline in that the proposed berthing facility offshore from Ormond Beach could be used in conjunction with both the facility at Oxnard and any expanded facility at the Port Hueneme site.

The California Coastal Zone Conservation Commission in its latest proposed Final Coastal Plan, to be submitted to the Governor and the Legislative of California, states in part, "Only one LNG marine terminal shall be permitted in the California coastal zone until (1) engineering and operational practices can eliminate any undue risk or (2) guaranteed supplies of LNG and distribution system dependence on LNG are substantial enough that an interruption of service from a single LNG facility would cause substantial public harm." The staff is in basic agreement with this theme of this part of the plan. The plan goes on to state that "Until the risks inherent in LNG terminal operations can be sufficiently identified and overcome and such terminals are found to be consistent with the health and safety of nearby human population concentrations.....At such time as LNG marine terminal operations are found consistent with public safety, sites in developed or industrialized port areas may be considered." This language implies that the Coastal Zone Conservation Commission would not agree with staff's choice of locating an LNG unloading, storage, and revaporization terminal at Oxnard, California. The staff has analyzed the issues of public safety, including the scenario raised as to whether putting "all the eggs in one basket," i.e., a one terminal concept, would be in the public interest because should a major

(prolonged) disruption of service occur because of a major terminal accident, sabotage, etc., the interruption of service could be significant, particularly to California customers. While the staff would agree that although a major accident must be recognized as possible and the consequences of such an accident must be taken into consideration, it is held to be highly unlikely and, therefore, the risks inherent with an LNG operation at Oxnard are concluded to be of an acceptable nature to the public. Although the safety analysis presented in Section C-13 and other safety studies were considered, this conclusion is primarily based upon an independent study conducted by the environmental staff responsible for the overall assessment of LNG site alternatives. This study arrived at conclusions similar to those previously discussed and is found as Appendix A to Volume 1 of the FEIS. In summary, it is the staff's conclusion that one LNG terminal be constructed and operated at Oxnard, California for the three volumes of gas associated with the aforementioned projects and that such a terminal is feasible, and could be operated in a safe and efficient manner without posing a significant hazard to the surrounding populace.

Figure 46 . Symbolic Ratings - West Coast

	Topographic Conditions	Foundation Stability	Seismic Considerations	Atmospheric Conditions	Oceanographic Conditions	Distance to Deep Water	Navigational Suitability	Anchorage Suitability	Land Use Conflicts	Sea Water Exchange
Oxnard	○	○	◐	○	○	○	○	N.A. 1/	○	Yes
Point Conception	○	○	◐	○	○	○	○	N.A. 1/	○	No
Los Angeles	○	○	●	○	○	○	○	N.A. 1/	○	No
Port Hueneme	○	○	◐	○	○	●2/	○	N.A. 1/	○	Yes
Carlsbad	○	○	◐	○	○	●	○	N.A. 1/	○	Yes
Border Field	◐	◐	◐	○	○	●	○	N.A. 1/	●	No
El Segundo	◐	○	◐	○	○	●	○	N.A. 1/	●3/	No
Drake	○	○	◐	○	○	○	○	N.A. 1/	○	No
Mandalay Beach	○	◐	◐	○	○	○	○	N.A. 1/	○	Yes
San Onofre	○	○	◐	○	○	○	○	N.A. 1/	◐	Yes

LEGEND

○ - Favorable Condition

◐ - Sub favorable condition that could be mitigated with appropriate measures

● - Unfavorable condition that could not be mitigated or which would present a serious problem or hazard.

1/ Not applicable - No designated anchorage areas near site. Water depths and bottom conditions, however, would permit anchoring in emergency situations.

2/ Refers to configuration presented by applicant in its filings to FPC.

3/ Land use conflict primarily with cryogenic transfer line.

Table 40. LNG Terminal Site Characteristics

Site	TOPOGRAPHY			SOILS		
	Elevations of Site	Slope of Site	Topographic Irregularities	Soil Description	Degree of Drainage	Soil Depth
Point Conception	Min. El.= 40 ft.	Average slope is 5% to 10% (1:20 to 1:10)	None	Surf. soils-clayey sands and clayey silts; some organic matter(sub-surf. unk.)	Unknown	Unknown
Oxnard	5 ft. to 9 ft.	East. half of site- Avg. slope = 5%(1:20) West. half little or no slope	None	Alt. layers of loose, silty, f. sd. & soft to med. stiff cly. & sdy. silt (14-20 ft. thick) dense to very dense, clean & silty fine sd, occ. layers of stiff to very stiff cly. silt up to 5 ft. thick (tot. seq. is 60 ft. thick) Alt. lay. of stiff to very stiff cly. silt & dense clean & silty sd. (50 ft. thick) Very dense clean & silty sd. with some gravel (max. depth - 220 ft.)	East. half - well drained West. half - poorly drained Water table- 2 ft. bel. surf.	20 ft.
Drake	Differential between highest and lowest elevation is 120.0 ft.	Slopes vary from 3% to 12%	Steep slopes at NW corner of site	Alluvial soils consisting of silts, clays, sands, and gravel.	Permeability of clay soils is low but may increase with depth.	Deep (actual depth unknown)
Mandalay	Differential between highest and lowest elevation is 15.0 ft. Elevations vary from sea level to 15 ft. above MSL.	Eastern half of site has Avg. slope of 3% western half of site is hilly with slopes averaging 3% - 5%	Western half of site is extremely hilly	Alluvial soils consisting of silts and clays with some sands and gravel. Silts and clays may be moderately to highly expansive. Some dune sand deposits present.	Permeability of silt and clay is low; dune sand and sandy and gravelly alluvium have high permeability	Deep (actual depth unknown)
San Onofre	Site has been modified by Edison's San Onofre construction program. Differential between highest and lowest elevation is about 30 feet. Elevations vary from about 40 to 120 feet.	Slight (site has already been partially graded)	None	Sand, silt, and clay with occasional cobbles. Silt and clay are moderately to high expansive. overly 2200 feet of Pliocene marine sediments including the San Mateo sands and Capistrano siltstones.	Permeability of soils is low to moderate. Water table estimated to be at 5 to 10 feet above sea level	40 feet

Table 40. LNG Terminal Site Characteristics (Continued)

	GEOLOGY							
	Active Faults	Expected Maximum Earthquake Magnitude	Landslides, Mass Movement or Subsidence	Liquefaction Potential	Bedrock Description	Depth to Bedrock	Max. Expected Tsunami Runup and/or Wave Heights	Mineral Resources and Exploration
Point Conception	No faults on site. Santa Ynez Fault, 3 mi. from site.	Max. expected Mag. = 7.0-7.6 Max. bedrock accel. over 0.7g (Santa Ynez fault).	Low Potential	Low Potential	Weathered sedimentary rocks of Sisquoc Formation; white weathering massive impure diatomite, diatomaceous shale, pure laminated diatomite.	Up to 80 feet.	Estim. max. wave height at Santa Barbara is 13 ft. for recurr. interval of 500 yrs.; 6.2 ft. for 100 yrs.	No production or exploration on site. Offshore oil development about 5 miles from site.
Oxnard	No faults on site Nearest fault-offshore Hueneme Canyon-2 mi. from site	Max. expected Mag. - 6.0-6.8	Low Potential Nearest landslide occur. - 6 mi. from site. Nearest subsidence occurrence 1 mile east of site. Consid. subsidence occurred in Santa Clara River floodplain during Fort Tejon earthquake (1857) and to lesser extent with Pt. Mugu earthquake (1973)	Sur. soils on site may liquefy-Soils below el. -5 to -11 ft. less likely to liquefy.	N.A. Bedrock surface is overlain by up to 2,000 feet of Pleistocene and Holocene sediments.	N.A.	Earthquake of 1812 may have caused runups of 15 feet at Ventura. Largest wave amplitude reported at Pt. Hueneme = 8.8 ft.	No production or exploration on site.
Drake	None on site. Closest historically active faults are San Andreas (59 miles to NE and Big Pine fault (35 miles to NE). South Branch of Santa Ynez fault located 2 miles east of site. Fault is considered potentially active.	7.5 (from movement of South Branch of Santa Ynez fault)	Low Potential	Low	Weathered sedimentary rocks of Sisquoc Formation; white, weathering massive impure diatomite, diatomaceous shale, pure laminated diatomite	Unknown - Expected to be very deep- No bedrock exposures on site.	Estim. max. wave height at Santa Barbara is 13 ft. for recurr. interval of 500 yrs.; 6.2 ft. for 100 yrs.	No production site has been previously explored for petroleum. Abandoned well sites present near site.
Mandalay	Closest active fault is Oak Ridge fault-3 mi. to east of site. Santa Monica-Raymond Hill fault zone is 20 mi. to east. Numerous other smaller faults in vicinity such as Santa Rosa fault (15 miles east).	7.5 (from major displacement of Oak Ridge fault)	Earthquake shaking could cause densification of dune sand deposits.	Moderate	Basement rock is an igneous-metamorphic complex. Basement rock is overlain by thousands of feet of Cretaceous and Pleistocene marine sediments.	Several thousand feet	Earthquake of 1812 may have caused runups of 15 feet at Ventura. Largest wave amplitude reported at Pt. Hueneme = 8.8 ft.	Montalvo oil field just north of site.
San Onofre	Newport-Inglewood fault-27 miles from site. Whittier-Elsmore - 22 miles from site. Christianos fault - potentially active, 2000 ft. E of site. Santa Monica to Baja zone of deformation - potentially active, 5 miles offshore.	7.5 (from displacement on Whittier-Elsmore fault) Max. bedrock accel. = 0.66g (Santa Monica to Baja zone of deformation).	Low potential (except for slides on steep slopes to the northwest)	Low	No outcrops on site.	Not applicable	Earthquake of 1812 may have caused runups of 15 feet at Ventura. Largest wave amplitude reported at Pt. Hueneme = 8.8 ft.	No production or exploration on site.

Table 40. LNG Terminal Site Characteristics (Continued)

TERMINAL EXPOSURE

Point Conception

Frequency of High Winds

Mean spd= 12.6 mph.

Speed (mph)	Ann. % freq.
0-4	20
5-9	23.6
10-14	20.4
15-19	14.7
20-24	11.2
25-29	6.7
30-34	1.4
35-40	1.5
≥40	0.5

Frequency of Fog

Dist. (mi.)	Ann. % freq.
½	2.6
1	4.5
5	18.1

Wave Action

Wave ht. (feet)	% freq.
∠ 4	87.1
4-5	7.8
6-7	3.5
8-9	1.3
10-11	0.2
12-13	0.0

Current Velocities

Average Current ∠ 1 Knot

Oxnard

Point Mugu

Mean spd= 5.6kn.

Speed (Knots)	% freq.
1-3	20.9
4-6	29.9
7-10	23.0
11-16	8.7
17-21	2.0
22-27	.7
28-33	.1

Vis. ∠ 7 mi., 32.8% of time

Waves ∠ 6 ft., 85% of time
Waves ∠ 2 ft., 58% of time

Mean current 0.5 knot (Santa Barbara Channel)

Drake

See data for Point Conception

See data for Point Conception

See data for Point Conception

Avg. current speed is 0.16-0.20 knots

Mandalay

See data for Oxnard site

See data for Oxnard site

See data for Oxnard site

Avg. current speed less than 1 knot

San Onofre

Speed (mph)	Annual % Frequency
0-2.9	19.14
3-7	40.58
8-12	33.45
13-18	6.04
18-25	1.06
25	.22

(Breaking wave significant Heights - winter)

Wave ht.	% Frequency
0-1	8.8
1-2	38.6
2-3	19.6
3-4	16.9
4-5	4.2
5-6	6.0
6-8	4.6
8-10	0.8
10-12	0.3
12-15	0.2

Avg. current speed less than 1 knot

Table 40. LNG Terminal Site Characteristics (Continued)

CHANNEL AND NAVIGATIONAL FEATURES

Site	Width of Approach Channel	Depth of Channel	Amount of Dredging Required	Navigational Obstructions	Estimated Vessel Traffic	Established Traffic Patterns	Traffic Safety Systems	Navigation Aids	Suitability of Anchorage Area	Depth at Anchorage Area	Dimensions of Anchorage Area
Point Conception	Approx. 3 miles wide (includes 2 traffic lanes and separation zone)	120 ft. (center)	None	Danger area near site (controlled area for U.S. Navy and Air Force operations. Occasionally closed to commercial traffic) Some plats. & oil wells near site (all equipt. with radar, reflectors, lights, and/or horns. (no sig. hazard)	573/month (Santa Barbara Channel)	Traffic moves parallel to coast	2 traffic lanes with separation zone	Point Conception Horn (Fl 30 sec. 133 ft. 18m) Platform Harry lighted horn Herman (rocks) lighted horn Sev. marker buoys offshore	Not applicable	Not applicable	Not applicable
Oxnard	Approx. 3 miles wide (includes 2 traffic lanes and separation zone)	120 feet	None for anchorage or turning basin.	None	Port Hueneme Har. 1974. 102 Com. ves. 140 mil. ves. 1973 96 com. ves. 140 mil. ves. 1972 38 com. ves. 170 mil. ves.	Traffic moves parallel to coast	2 traffic lanes with separation zone.		Sandy, silty, bottom, slopes to SW at approx. 40 ft. per mile (1°)	50 feet	Not applicable
Drake	Approx. 3 miles wide(includes 2 way traffic & separation zone)	120 feet	None	None	573/month (Data for Santa Barbara Channel) Standard Oil Company pier located 5 miles east of site	Traffic moves parallel to coast	2 traffic lanes with separation zone	Point Conception Horn & Lighthouse Platform helen 1.5 miles offshore due south of site	Not applicable	Not applicable	Not applicable
Mandalay	Approx. 3 miles wide (includes 2 traffic lanes and separation zone)	120 feet	None	None	573/month (Data for Santa Barbara Channel)	Traffic moves parallel to coast. Traffic moves in and out of Mandalay Beach tanker berth	2 traffic lanes with separation zone.	Lighted buoys 2½ miles to north at Ventura. Lighted buoy at seaward end of Mandalay Beach tanker berth. Fixed lights on Edison Power stacks. No other major navigation aids in immediate area.	Not applicable	Not applicable	Not applicable
San Onofre	No designated channels	Sufficient	None	None	____	None - Area is removed from major vessel traffic and concentration of pleasure crafts.			Not applicable	Not applicable	Not applicable

Table 40. LNG Terminal Site Characteristics (Continued)

Site	Existing Zoning Stipulations	Present Land Use of Site	Land Uses of Surrounding Areas	National Parks, Forests, Recreation Areas, etc.	Historical Sites	Archaeological sites	Transportation and/or Utility Corridors	Future Land Land Use Trends
				LAND STATUS				
Point Conception	Zoned as 100-AL-O Limited Agr. District (by County of Santa Barbara). Beach area zoned BD (Beach Devel.)	Cattle grazing.	Mostly cattle grazing and agriculture (little res. devel. in local area).	None at present Gen. County Plan proposes 4 parks: Point Conception Fed. Park - 3.5 mi. from site. Cojo Beach Co. Park - 0.5 mi. from site San Augustine Co. Park - 1.5 mi. from site El Bulito Co. Park - 3.0 mi. from site.	No Fed. designated sites on site 2 hist. sites in area Lompoc La Purisma Mission Los Alamos Los Alamos Ranch House.	3 sites on prop. SBa-546 (on site) shells & scrappers high significance SBa-202 (in grn. belt) high significance SBa-545 (in grn. belt) high significance 3 sites near area SBa-203, SBa-541, SBa-542 poss. of arch. resource being discovered on site. Poss. of offshore resources.	Sing. lane priv. road con. site & Hwy. 101 and Gaviota Beach Rd. Priv. unim. gated rd. con. site to Jalama St. Beach Park (NW of site) U.S. Hwy. 101 - 10 mi. east Cal. Hwy. 1 - 5 mi. fr. site Jalama Rd. - 3 mi. fr. site. So. Pac. R.R. coastline rte. crosses site.	Cont. of existing land use (grazing & open space) Jalama Rd. & pvt. rd. fr. Gaviota-Pt. Conception are desig. as planned scenic rds. New Co. Pk. at Sacate Bch. 7.5 miles from site.
Oxnard	Industrial Use (Oxnard County Planning Board).	Agriculture/ open space. Indus. sites north & south of property.	Mostly open space/agriculture; Ind. sites adj. to N&S prop. boundaries. Gov't./ institutional res. areas approx. 1 mi. from site.	Pt. Hueneme City Beach Pk. - .75 mi. NW of site Hueneme Pub. Fishing Pier - ∠1 mi. NW of site. Pt. Hueneme Sport-fishing - 1.8 mi. NW of site.	No Fed. designated hist. sites or landmarks in area.	No arch. sites on property Num. sites 8-9 mi. SE of site.	Hueneme Rd. (west of Arcturas Rd.) Saviers Rd (north of Hueneme Rd.) Ventura Rd. (north of Channel Is. Rd.) St. Hwy.1(north of Hueneme Rd.) St. Hwy 34 (east of Pleasant Valley Rd.) St. Hwy. 126 (west of Victoria Rd.) U.S. Hwy. 101 (west of Lewis Rd.) U.S. Hwy. 101 (west of State Hwy. 1)	Chang. toward higher density uses (res. & commercial devels., urban growth).
Drake	Agricultural classification (agricultural preserve north of site Beach area & site zoned BD (Beach Development District).	Undeveloped	Agricultural zoning, agricultural preserve, and open space.	Nearest state park is Gaviota State Beach - 5 miles east of site.	None	Three sites in vicinity. a. one site at Drake not surveyed. b. Arroyo El Bulito- 1.8 miles west of Drake. c. St. Augustine (No. S.B. 574)- 3 miles west of Drake.	SPRR traverses site. U.S. Hwy. 101- approx. 5 miles east of site. 2 small unimproved roads on site.	Agricultural preserve to north of site has 10 year contract.
Mandalay	Agriculture and open land.	Undeveloped	Mostly agriculture and open space residential development (Oxnard Shores Development) adjacent to site on south. Southern California Edison Plant on west boundary of site.	McGrath State Beach Park approx. 8000 feet from northern boundary of site.	None	None	Within city boundary of Oxnard. Numerous local roads adjacent and around site.	California Ceastal Zone Commission has recommended extension of McGrath State Park to northern boundary of Southern California Edison Plant. Residential development expected to take place just south of site.
San Onofre	Located within boundaries of Marine Corps Base Camp Pendleton site is on property leased to So. Cal. Edison.	Undeveloped	Almost entirely under military control. Three marine corps camps within 5-mi. radius. So. Cal. Edison Nuclear Power Elec. Gen. Station adj. to plant site.	San Onofre State Beach, Camp Pendleton Enlisted Men's Club, San Clemente Beach State Park, and city parks in San Clemente all within 5-mile radius.	Reg. His. Landmark No. 562 (Los Cristianitos hist'l site) 4½ mi. north of site.	None	Int. Hwy. 5 and A.T.&S.F.R.R. border site to north. Basilone Rd. approx. 7,750 west of site.	Cal. Coastal Zone Comm. has expressed interest in obtaining additional Camp Pendleton shoreline for public use.

Table 40. LNG Terminal Site Characteristics (Continued)

SOCIOECONOMICS

Site	Distances to Nearest Population Centers	Distances to Nearest Residences	Population Densities	Population Trends
Point Conception	Gaviota (pop. 80) 10 mi. E. of site. Lompoc (pop. 25,000) 13 mi. N. of site.	Small beach cabin - 500 ft. west of site. Small summer cottage- 4,000 ft. east of site.	1 person/ sq. mi. within 10 mi. of site.	Population within 50 mi. increased at avg. rate of 5.5% bet. 1960-1970. Bet. 1970-1973 grth. rte. was 2.8%.
Oxnard	Pt. Hueneme pop. 16,331 2 mi. WNW of site. Oxnard pop. 18,685 4 mi. N of site. Naval Construction Batallion Center day pop. - 9,000-10,600 3 mi. NW of site. U.S. Naval Installation at Pt. Mugu day pop. - 9,918 4½ mi. SE of site.	2 residences on prop. boundary-½ mi. N. of tanks (will be relocated).	Pop. within 2 mi.- 23,160 Pop. with 5 mi. - 79,426 Pop. within 10 mi. - 158,480	Ventura County 1950 pop. - 114,647 1960 pop. - 199,138 1970 pop. - 378,497 1974 pop. - 440,459 Gr. rate 1960-1970 90.06% Gr. rate 1970-1974 16.37%
Drake	Seven residences on site (Data from U.S.G.S. Topographic map).	On site	50 residents within 5 miles.	
Mandalay	Site is within city boundary of Oxnard. Approx. 5 residences on site.		114,000 persons within 5-mile radius of site. Population density of 3,413 persons per square mile.	
San Onofre	City of San Clemente is 3½ miles to NW of site.	Nearest civilian residence is 3 mi. from site. Approx. 100 workers at So. Cal. Edison Nuc. Gen. Plant.	25,800 persons within 5 mi. radius (assumes all three military camps will be fully occupied). 50 percent of this population is military personnel.	

Table 40. LNG Terminal Site Characteristics (Continued)

	BIOLOGY				
Site	Unique Ecosystems	Areas of Special Biological Significance Identified by California Coastal Zone Conservation Commission	Rare Flowering Plants	Kelp Beds Offshore	Existing Marine Habitat Disturbance
Point Conception	Botanically significant areas in the Canada del Cojo.	Special Coastal Land Habitat located at site. Coastal Bluff Intertidal Reserve area along the coast at site.	Three species may occur locally.	Yes	Oil pipeline crosses sea floor offshore from site.
Oxnard	None	Area of Special Marine Biological Significance along the coast at the site.	None	No	Jetties, power plant and sewage outfalls, nearby ship movements.
Drake	Ornithologically significant occurrence of eastern wood warblers and a nonmigratory subspecies of white-crowned sparrow.	Coastal Bluff Intertidal Reserve area along the coast at the site.	13 species may occur locally.	Yes	No permanent disturbance
Mandalay Beach	None	Area of Special Marine Biological Significance along the coast at the site.	Four species may occur locally.	No	Power plant and sewage outfalls, jetties.
San Onofre	None	Riparian Woodland area just north of site along San Mateo Creek.	11 species may occur locally.	Yes	Power plant outfall.

Table 40. LNG Terminal Site Characteristics (Continued)

BIOLOGY (CONTINUED)

Site	Existing Terrestrial Habitat Disturbance (Site)	Existing Terrestrial Habitat Disturbance (Pipeline)	Pipeline Length	Least Tern Nesting	Mitigation of Impacts of LNG Vaporization System
Point Conception	Some grazing, introduced plant species.	Major portion relatively undisturbed; some agricultural and urban development.	142.3 miles	None	None
Oxnard	Mostly farmland; some marsh and dunes area still relatively untouched but in need of protection.	Large portion relatively undisturbed; about 1/3 under agricultural development; some urban development.	53.3 miles	Nesting in Ormond Beach area nearby. Dames & Moore survey saw one nestling outside site area.	Electric generating station nearby could provide most, if not all, of the LNG vaporization system's requirements, thus eliminating or lessing several impacts.
Drake	Some grazing, introduced plant species.	Major portion relatively undisturbed; some agricultural and urban development.	140 miles	None	None
Mandalay Beach	Mostly farmland.	Mostly agriculturally developed, many orchards.	50 miles	None	Electric generating station nearby could provide about 1/3 of the LNG vaporization system's requirements, leaving 2/3 to be provided by additional seawater intake.
San Onofre	Mostly bulldozed for power plant storage area; much of surrounding area relatively undisturbed.	Mostly agricultural development.	48 miles	None	Nuclear electric generating station nearby could provide more than enough water to satisfy the LNG vaporization system's requirements, thus lessening several impacts.

3. No Action or Postpone Action

The actions that are available are to grant the various permits that are sought, to deny them, or to postpone action pending further study. If action is postponed, this decision will ultimately lead to one of the other two.

The alternative of "no action" means the denial of the permits necessary for the functioning of any part of the integrated El Paso-Alaska system. Denial of permits for the El Paso-Alaska portion of the integrated system would, in effect, be no action on the entire system.

The alternatives to "no action" on the integrated El Paso-Alaska systems are: 1) alternative transportation modes, (2) the alternative energy sources, or (3)the Arctic Gas System as fully described in USDI's Alaska Natural Gas Transportation System EIS.

Denial of the Point Conception terminal and its associated pipelines could result in: (1) no action on the entire system, or (2) action on an equivalent alternative site with other associated pipeline construction.

I. RECOMMENDATIONS

The recommendations referenced with a footnote one (1/) apply only to Western's proposal as described in Section A, Volume III of this FEIS. All other recommendations apply regardless of the final LNG terminal site selection.

1) The LNG facilities should be designed to withstand a design maximum earthquake of Richter Magnitude 7.5 using a design bedrock acceleration-time history with a maximum acceleration of at least 0.6g. 1/

2) In its design for the seawater intake structure at the Point Conception plant site, the applicant should be required to use a horizontal traveling screen and a fish bypass system to reduce potential damage to organisms entrained in the intake flow. (See Bates, D.W., 1969, "The Horizontal Traveling Screen," in Engineering Aspects of Thermal Pollution, F.L. Parker and P.A. Krenkel, eds., pp. 225-242.) 1/

3) Prior to the start of construction of the LNG facilities, the applicant should conduct a study, to be submitted to the appropriate state or Federal agency, with a copy to the FPC, for a determination of the effects of the cold water discharge on the chemical, physical, and biological environment. 1/ The study should include but not be limited to the following:

   a) Detailed design features and locations of the vaporization system and any peripheral systems or devices associated with the vaporization system;

   b) The collected environmental data used for the assessment of the possible effects of the once-through seawater vaporization system;

   c) An evaluation of the feasibility of reducing the temperature differential between the receiving water and the seawater discharge by extending the outfall into deeper and hence cooler water.

4) The trestle and breakwater should be designed to minimize interference with longshore sediment transport. Such design should conform to Coastal Plain Policy 19, p. 44, promulgated by the California Coastal Zone Conservation Commission. 1/

5) Western should notify local kelp harvesters of the proposed marine facilities and allow them to harvest the kelp prior to construction. 1/

6) Written notification of construction plans, including date, location, and duration of construction should be provided to the commercial fishing industry, local yacht clubs, and users of the boat launch facilities at Gaviota. 1/

7) The proposed permanent electric transmission lines should be located on the same rights-of-way which were used for the temporary transmission lines. 1/

8) The guidelines and criteria listed in the publication by the U.S. Department of the Interior and the U.S. Department of Agriculture entitled, "Environmental Criteria for Electric Transmission Systems" (1970) should be used when planning the electric transmission line design and routing.

9) The applicant should be required to coordinate the location of all access roads and pipeline rights-of-way with the California Department of Fish and Game to select the most environmentally sound routes.

10) Western should consider possible future conflicts which could develop between the proposed pipeline and either the construction of the Lompoc Dam and Reservoir or the construction of local water conveyance facilities which would result from extensions of the Coastal Branch of the California Aqueduct and should take whatever mitigating steps are reasonable in order to reduce or eliminate such conflicts. 1/

11) Prior to commencement of construction, qualified biologists should survey the proposed rights-of-way and access road routes to determine if any rare and endangered animal species located along the proposed route would be adversely affected. Measures such as relocating the route, moving animals to other suitable habitat, or scheduling construction to avoid the breeding season should be considered.

12) Prior to construction, rare and endangered plant species located within all areas to be disturbed should be identified to the extent practical. Areas of concentrations of such plants should be avoided.

13) Construction activities in naturally vegetated areas should be timed to avoid peak wildlife nesting periods. In general, mid-summer through winter would be the preferred times for construction. Streams near the coast should be crossed in mid-summer to avoid both spring spawning and fall and winter migration periods of fish.

14) Springs along the proposed pipeline route which are known or suspected to be of value to wildlife should be avoided.

15) In all areas where trees and shrubs would be cleared, with the exception of land directly over the proposed trenches, vegetation should be cut to the ground leaving the roots intact. This would allow the roots to hold soil and resprout, significantly increasing the rate of revegetation.

16) In the desert and any other areas which are too arid for fertilizers to be effective, the topsoil should be removed and separated from other soil layers and stockpiled during grading and trenching operations. During backfilling, the subsoils should be placed in the trench first and the stockpiled topsoil placed in last to insure soil fertility. The applicant should consult with the local offices of the U.S. Soil Conservation Service (Conservation Service) to determine whether this soil separating technique should be used in any other areas along the proposed route, specifically where the underlying soils differ in mineral content or pH from the topsoil to the extent that revegetation would be prevented. Procedures recommended by the Conservation Service should be followed.

17) The applicant should give serious consideration to the installation of additional sectionalizing transmission line blockvalves, over and above those required by the minimum Federal safety standards, in areas such as the San Andreas and Garlock faults where potential seismic activity represents a distinct probability for pipeline rupture.

18) Western should install blockvalves at appropriate locations on both sides of all active fault zones to isolate any sections of pipe which could be ruptured due to fault movement.

19) The environmental staff recommends the proposed pipeline route from Arvin to Cajon, pending an environmental determination by the U.S. Fish and Wildlife Service (USFWS) of the proposed route segment between approximately MP 4 and MP 9. This segment of pipeline might adversely affect a proposed California condor critical habitat area. Should the USFWS oppose this segment, the applicant should be required to find an alternative route to bypass the proposed critical habitat. If the USFWS endorses the proposed pipeline, the applicant should consult with appropriate USFWS personnel for appropriate mitigating measures. 1/

20) The disease known as coccidioidomycosis (San Joaquin Valley Fever, Valley Fever, etc.) is endemic along the proposed pipeline route in Santa Barbara, San Luis Obispo, and Kern Counties. Construction workers exposed to dust from the pipeline trench would run the very real risk of contracting this highly infectious, sometimes fatal disease. Western should instruct its employees in recognizing the disease symptoms, insuring that they wear dust masks and protective gloves while at work, and providing them with a program of medical screening utilizing skin tests and chest X-rays to detect the disease as early as possible. 1/

21) Pursuant to the National Historic Preservation Act of 1966 and the Archaeological and Historical Preservation Act of 1974, staff recommends that the applicant should be required to initiate a cultural resource survey and salvage program in order to minimize the loss of cultural resources (historic and prehistoric sites, structures and objects) due to pipeline related activities. The applicant should allocate sufficient funds for such a program and should allow a reasonable period of time for adequate surveys, preservation and salvage.

The surveys should cover the pipeline corridor, including all areas that would be affected by construction of the pipeline and related facilities. The surveys and salvage should employ the services of competent archaeologists, historians and other relevant specialists, and should be made in full cooperation with the appropriate State Historic Preservation Officers (SHPO) and officials of the Department of the Interior. The surveys and salvage should be adequately coordinated to insure reliable, comparable and scientifically viable results as well as for the expeditious execution of all operations. Construction personnel should be instructed on the importance and identification of cultural resources.

In order to provide the most straight-forward coordination, assuring quality control, the proper phasing of surveys and investigations with construction schedules, and procedural compliance with the pertinent statutes and all State and Federal jurisdictions, the staff recommends that the entire sequence of work be administered by the Departmental Consulting Archaeologist in the Department of the Interior, utilizing funds received from the applicant as authorized by Sections 3(a) and 6 of the Archaeological and Historical Preservation Act of 1974.

The survey and salvage program should include the following:

A. Prior to the determination of final alignments and locations of project related facilities and in consultation with the appropriate SHPO, the applicant should have conducted cultural resource surveys to include at least the following:

(1) the review of background historic, prehistoric, and pertinent environmental data and existing information on historic and prehistoric resources including the National Register of Historic Places;

(2) the intensive field inspection of the pipeline corridor, borrow areas, and other related areas of potential impact;

(3) the identification of all locatable historic and prehistoric sites subject to possible effect and areas of probability of archeological site occurrence;

(4) an evaluation of the significance of discovered sites, a determination of their eligibility for inclusion in the National Register of Historic Places and analysis of the impacts expected from pipeline-related construction.

B. Before construction of the pipeline and related facilities the applicant should avoid and/or mitigate adverse impacts on significant sites and areas of cultural resource concentration including at least the following:

(1) the avoidance of significant sites, including those on or determined to be eligible for inclusion on the National Register of Historic Places, by changes in the pipeline alignment or by other alterations in the locations and design of project related facilities;

(2) where avoidance of sites is not prudent or feasible, the salvage of those sites in consultation with the appropriate SHPO and in a scientifically acceptable manner.

C. During the construction phase of the pipeline, support facilities, borrow areas, etc., archaeologists should accompany construction crews through areas where a probability of significant archaeological site occurrence exists, in order to identify sites previously overlooked and to recover cultural remains discovered during construction.

D. Artifacts and other materials removed from sites on Federal lands should remain the property of the Federal government; artifacts and other materials removed from non-Federal lands should be disposed of after analysis and as agreed upon by the survey coordinator and the landowner(s) under applicable state laws.

E. Reports should be made periodically to appropriate state and Federal agencies including the FPC on the results of all operations, and a final program report should be issued at the completion of the entire program.

22) The applicant should develop and implement a public information program to educate the public, particularly the frequent users of the LNG offshore project area, of the potential hazards resulting from an LNG spill.

23) Western should be required to use all excess overburden materials from cut and fill operations at the LNG plant site for landscaping inside the site fenced-in area and for the creation of earthen ridges on the southern and eastern boundaries of the site which would aid in obscuring the view of the LNG facilities. Native grasses and shrubery should be planted on those ridges for slope stabilization and additional visual screening. 1/

24) The applicant should consult with appropriate departments within the Resources Agency, local offices of the U.S. Soil Conservation Service, and any other pertinent agencies to determine the proper means to control erosion and revegetate the proposed rights-of-way and disturbed non-utilized areas of the LNG site. Where necessary, techniques such as terracing, matting, mulching, and planting of shrubs and trees should be utilized in addition to reseeding. In addition to the usual rapidly germinating grasses, the proposed rights-of-way and disturbed non-utilized areas of the LNG site should be reseeded with mixtures of seeds of annual and perennial plants which include native species from the different communities. If periodic inspections of

the completed right-of-way and LNG site reveal that revegetation and/or erosion control measures have not been successful, seeding and other measures recommended by local agencies should be reaccomplished.

25) Soils compacted by construction activity on agricultural land should be filled to restore the original characteristics of aeration and permeability.

26) Streams and other drainage channels should be restored to their original gradients immediately following construction.

27) In all areas where the completed right-of-way or access roads enter or leave dense shrubland and woodland, a fence and gates should be constructed (contingent upon landowner approval) across the opening created by the right-of-way in order to prevent access by off-road and other vehicles.

APPENDIX C

Risk Assessment of Casualties Ashore from LNG Ship Accidents at Point Conception, Oxnard, and Los Angeles Harbor, California

Introduction

Applicant has proposed a schedule of 425 deliveries per year of LNG by ocean-going ships to each of three proposed Western LNG terminals at Point Conception, Oxnard, and Los Angeles Harbor, California.[1/] The ships proposed have 165,000 cubic meters LNG capacity divided into five tanks. These ships are 1000 feet long with 150 foot beam, and have a draft of 40 feet loaded. They displace 125,000 long tons and are of a double-hull design.

The marine transport and handling of LNG is a hazardous operation. Spills of LNG from ship collisions in or near harbors could result in the formation of a flammable vapor cloud that could drift ashore and cause loss of life and property inland. The purpose of this risk assessment is to estimate the probability of such undesirable events in the vicinity of the proposed terminals.

1/ Western LNG Terminal Company" Detailed Environmental Analysis", September 1974, FPC Docket No. CP75-83.

Port Characteristics

Point Conception - There is substantial commercial ship traffic along the California coast near Point Conception composed primarily of coastal tankers, oil barges, and fishing vessels. In addition, small-boat traffic, consisting primarily of pleasure craft is extremely heavy in the summer season. The shipping corridor for ocean-going vessels in the Santa Barbara Channel contains separated northbound and southbound lanes with the southbound lane seaward. Thus LNG tankers arriving from Alaska will cross the northbound lane in order to enter the Point Conception marine terminal. In this area the coastline is along an E-W direction.

The proposed unloading dock is about 4,600 feet offshore in 60 feet of water, and can accommodate and unload two LNG ships simultaneously. Between the berth and shore is a small-boat dock with fuel storage, pumps, and vehicle parking spaces.

The Point Conception site is isolated from large population centers. Most of the land within five miles of the site is undeveloped with scattered ranches in the canyon and foothills of the Santa Ynez mountains. The nearest city is Lompoc (pop. 25,000) about 13 miles north of the site. The

village of Gaviota (pop. 100) is 10 miles east. Because of the remote location this analysis is restricted to the population in the immediate vicinity of the LNG terminal.

Oxnard

The ship berths are to be constructed about 6,000 feet from shore in 50 feet of water, and the cryogenic lines from the dock carry the LNG another 2,000 feet overland to the LNG plant site. The site is about 1.5 miles SE of the Port Hueneme Harbor; and the south edge of the city of Oxnard (pop. 70,000) is about one mile north. Much of the land for miles to the NE and E of the site is open and under agricultural use.

There are U.S. Navy shore facilities about one mile north (Sea Bee Center) and one mile east (missile range) of the proposed LNG ship berths. In addition, there is an electric power generating station adjacent to the beach about one mile east of these berths. In this area the coastline is in a NW-SE direction.

Los Angeles Harbor

The proposed LNG marine terminal is located on a proposed landfill in the midst of the harbor, which is one of the busiest in the U.S., and is surrounded by an industrial area. During 1975 there were 742 tanker arrivals into the Port of Los Angeles carrying 18 million tons of petroleum products, which represented about 70 percent of the total weight shipped through the Port. 1/

The marine berths will be built in 45 feet of water and will accommodate two LNG ships simultaneously. The site is bounded on the east by a U.S. Navy base, and on the north and west by additional harbor facilities.

Probability Model

In order to perform this assessment we construct an elementary probability model that has the following form:

(Probability of a fatality per year from LNG fire from a ship accident) = (Probability of an LNG ship accident)

x (Probability of an LNG spill following an accident)

x (Probability of no ignition at the accident site)

x (Probability of proper wind direction)

x (Probability of no ignition between ship and shore)

x (Probability of ignition ashore)

x (Probability of fatality from vapor plume fire)

Each of the above factors may be modeled in more detail. In particular the LNG ship accident and spill probabilities may be based on data from oil tanker accidents and spills. Throughout this analysis the assumption is made that oil tankers are the closest comparable ships to LNG carriers with respect to operating characteristics, accident frequency, spill size distribution, and damage sustained.

Accident Probability

Tanker accident statistics have been collected for major port areas of the U. S. These data indicate an average of about 4.4×10^{-3} accidents per transit, which is independent of

the volume of port traffic. 2/ A similar result was obtained in an independent analysis of tanker traffic in Delaware Bay. 3/ Thus for Point Conception and Oxnard terminals we adopt this average accident rate in the absence of specific data. For Los Angeles Harbor specific accident rate data are available 2/ that indicate a rate of 2.4×10^{-3} accidents per transit, which we use here.

Double-Hulls for LNG Ships

LNG ships are designed with double hulls so the probability of rupture should be significantly less than for oil tankers. Thus, for the same direction and degree of impact an LNG ship should be less vulnerable to damage than other types of tankers. Based on a 73 percent reduction in oil spills from groundings of oil tankers constructed with double bottoms, we take 0.25 as a reasonable estimate of this factor. 4/

Probability of a Damage in a Vulnerable Area

An LNG ship may be struck or be grounded at any point along the hull and from any direction. However, some points are more vulnerable to damage than others. The LNG tanks

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2/ "Offshore Petroleum Transfer Systems for Washington State" Oceanographic Institute of Washington, December 1974.
3/ Federal Power Commission, Draft Environmental Impact Statement for LNG Terminal at Raccoon Island, N. J., July 1974.
4/ "Report on Environmental Factors for the Marine Transportation of LNG in the Delaware Estuary," El Paso Algeria Corp., FPC Docket No. CP73-258, September 1973.

do not occupy the entire length of the ship, but only a major portion of it. Thus not all collisions or groundings will have relevance to tank ruptures and spills. A conservative estimate for this factor is 0.67 based on vulnerability, studies of tankers. 5/

Coast Guard Safety Efforts

The Coast Guard is in the process of developing a vehicle traffic system (VTS) for U. S. harbors, and a prototype system in San Francisco Bay has been evaluated. In addition, a Coast Guard evaluation of an existing VTS in the St. Lawrence Seaway and in the Port of Rotterdam showed a four-fold reduction in ship collision. 4/ Thus we take 0.25 as the reduction factor for a VTS in this analysis.

Probability of a Spill Following an Accident

The probability of LNG spills has been analyzed on the basis of world-wide oil spill data from all types of tanker accidents including breakdowns and fires. 4/ All oil spills were considered, both large and small; no attempt was made to exclude small spills. The data obtained showed 197 pollution-

5/ V. U. Minorsky "An Analysis of Ship Collisions with Reference to Protection of Nuclear Power Plants," Journal of Ship Research, October 1959.

causing incidents from 983 tanker accidents, which indicates a probability of spill equal to 0.20.

A more recent survey of world-wide oil-tanker casualties provides a distribution of oil spill sizes from tanker casualties.[2] This distribution is assumed to be exponential, which is of the form:

$$P_S = e^{-S/S_M} \qquad (1)$$

where

P_S = probability of an oil spill greater than size, S.

S = spill size in cubic meters.

S_M = mean oil spill size, which for harbor entrances (as distinguished from coastal areas, harbors, or piers) is taken to be 435 cubic meters.[2]

On the assumption that LNG spill sizes from LNG tanker casualties follow this distribution, we adopt Eq. 1 with S_M = 435 m^3 for this study. The data from which Eq. 1 was formed indicate wide variations about the average, which on the assumption of a normal distribution, is measured by the standard deviation, σ. For example, for S_M = 435 m^3, σ = 305 m^3.

Table 1 shows some representative LNG spill sizes and values of p_s calculated from Eq. 1. Also shown are values of p_s for the mean spill value equal to $(S_M + \sigma)$, which indicat

the sensitivity of p_s to the relatively large standard deviation present in the data. It is to be noted from Table 1 that LNG spill sizes greater than 3300 m^3 are extremely unlikely. This volume represents about 10 percent of the capacity of a single LNG tank aboard the 165,000 m^3 vessels. All LNG spills in this analysis are taken to be instantaneous rather than originating from slow leaks.

From Ref. 2 the mean oil-spill size for coastal areas is about 1570 m^3; for harbor areas, 178 m^3; and for piers, 94 m^3. Thus for the present study the largest mean oil-spill size has been chosen that is conceivably appropriate for the LNG terminals proposed. A more reasonable mean value to use for these terminals may be that for harbors areas (178 m^3), however.

Values of spill probability used in this analysis are given later in the discussion of plume ignition on shore.

Table 1

Probability of a Spill of a Given Size

(S_M = 435 m^3, σ=304 m^3)

Fraction of an LNG tank Capacity	LNG Spill Size, Cubic Meters	Average spill size	
		S_M	$S_{M+\sigma}$
		Probability of a spill larger than this size	
1.0	33,000	negligible*	negligible
0.2	6,600	$\sim 3 \times 10^{-7}$	1.3×10^{-4}
0.1	3,300	$\sim 5 \times 10^{-4}$	1.15×10^{-2}
0.05	1,650	0.022	0.105
0.02	660	0.22	0.41
0.01	330	0.47	0.64
0.005	165	0.69	0.80
0.002	66	0.86	0.92
0.001	33	0.93	0.96
0.0005	16.5	0.96	0.98

* Computed to be about $\varepsilon^{-76} \simeq 10^{-33}$, which is indeed negligible.

Probability of No Ignition of LNG Plumes at the Spill Site

Historical data from liquid petroleum gas (LPG) spills and fires indicate that the probability of ignition near the spill site is a log-normal function of the ground area covered by the flammable vapor plume. 6/ These results are shown in Table 2. Since LPG and LNG have similar vapor hazard characteristics, these results are used to estimate the probability of LNG ignition at the spill site.*

Table 2 indicates that if two ships of the size proposed are covered by escaping LNG vapor (30,000 m^2)**, the probability of ignition is about 96 percent. Thus we take 0. 04

6/ "Risk Assessment of Storage and Transport of LNG and LPG", Science Applications, Inc., November 1974.

* We recognize that LPG is stored under pressure so that when released it flashes adiabatically until the vapor pressure equals 1 atm. In this way a large vapor cloud forms immediately, although the remaining liquid vaporizes by heat transfer from its surroundings as does LNG. Also LPG vapor disperses in a negatively buoyant plume as does LNG, and its flammable portion ignites readily also.

** The horizontal surface area of the ships is assumed to be rectangular, 300 meters long and 50 meters wide. Thus:

$300 \times 50 \times 2 = 30{,}000\ m^2$

is the total area covered by the escaping vapor. We assume that any size spill of interest in this study covers both ships with flammable vapor.

as the probability of no ignition at the spill site. This result is valid for spills large enough for the escaping vapor to cover at least 10,000 m^2 (Table 2), which corresponds to a spill size greater than 200 m^3 (Table A1) under conditions of no wind.

The smallest spill size included in Table A1 is 10 m^3 (about 2500 gallons). This spill size is much larger than expected from spills of LNG aboard ship from hoze or flange breaks, which may be less than 100 gallons. For these relatively minor spills the probability of ignition aboard ship is assumed to be small because of the extensive safety measures in force during LNG transfer operations.

If no ignition occurs at the spill site, we assume that no additional LNG spillage takes place later as a result of

Table 2

LPG PLUME AREA VS IGNITION PROBABILITY

Plume Area Range, m^2	Total Ignition Probability
< 30	0.522
30 - 100	0.639
100 - 300	0.736
300 - 1000	0.824
1000 - 3000	0.886
3000 - 10,000	0.934
10,000 - 30,000	0.963
30,000 - 1×10^5	0.981
1×10^5 - 3×10^5	0.990
3×10^5 - 1×10^6	0.995
1×10^6 - 3×10^6*	0.997
3×10^6 - 1×10^7	0.998

*1 sq. mi. = 2.59×10^6 m^2

the original accident. If ignition does occur, we assume that if the fire causes additional spillage, then the additional LNG is always ignited at the spill site.

LNG Plume Behavior

In order to perform an assessment of the risk from LNG vapor plumes the behavior and movement of such plumes following an LNG spill on water must be investigated. This has been done in Attachment 1 of this Appendix.

This plume analysis follows the growth and movement of the plume while it is negatively buoyant at ground level. By the time the plume reaches neutral buoyancy it has dissipated although it is still very cold. At this point it is assumed to be no longer a fire hazard at ground level and is out of reach of the numerous sources of ignition aboard boats and on shore. The cold dissipated cloud continues to warm and disperse as it rises into the atmosphere.

This model of plume hazards is independent of atmospheric stability conditions since there is extreme turbulence within the plume at water level and extreme stability at its upper boundary. Both of these conditions occur independently of the atmospheric stability existing at the time of the spill.

From Attachment 1 the largest spill produces a hazardous plume at water level in 10 mph winds no further than about 2,600 meters from the spill site. LNG spills further than this distance from shore will represent negligible hazards to persons and property on shore. The analysis has been done for 5 mph winds also, since 5-10 mph winds are very common in this maritime climate. 7/

Probability of Proper Wind Direction

Each of the three proposed LNG terminals has local meteorological conditions that are different both seasonally and annually. Wind speeds and directions have been collected for these sites, 8/ and wind directions are summarized in the following discussion.

Point Conception - The marine terminal and sea lanes are due south of the coastline which is an east-west direction in this area. The prevailing wind in the summer is from the NW and in the winter from the ESE. Thus there is a good chance

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7/ D. Bruce Turner, "Woodbook of Atmospheric Dispersion Estimates," U.S. Environmental Protection Agency, AP-26, March 1972.

8/ "Behavior of Massive LNG Spills from Storage Tanks at Point Conception, Oxnard and Los Angeles Harbor, California," Meteorology Research, Inc., July 1975.

than an LNG vapor plume from a marine accident would not reach shore. The meteorological data indicate that such a vapor plume would go toward shore in the vicinity of the LNG plant about 15 percent of the time. 8/ Thus we take 0.15 as the factor for this probability.

Oxnard - The marine terminal and sea lanes are southwest of the coastline, which is in a NW-SE direction in this area. The prevailing wind is from the W in the summer, and from the NE in the winter. Thus there is a possibility that an LNG vapor plume from a marine accident would drift to sea. The data indicate that such a plume would drift shoreward is the vicinity of the military and commercial facilities about 25 percent of the time, on an annual basis. 8/ Thus we take 0.25 as the factor for this probability.

Los Angeles Harbor - The marine terminal and sea lanes are due south of the coastline, which also encircles these lanes on the west. The prevailing wind is S in the summer, and NW in the winter. The meteorological data indicate that an LNG vapor plume orginating in the harbor would drift toward the nearby industrial area about 50 percent of the time on annual basis. 8/ Thus we take 0.50 as the factor for this probability.

Probability of No Ignition of Plume Between Spill Site and Shore

Between the LNG spill site and shore there may be small-boat traffic and other ships. These objects may serve as sources of ignition for the flammable vapor plume overhead. Because of lack of detailed information on such traffic, we take the "worst-case" approach and assume that the plume reaches shore without being ignited by these sources.

Since the LNG ships will dock at different distances from shore for the three proposed terminals, the vapor plume may or may not reach shore depending on the size of the spill. Table 3 shows the extent of the downwind hazard for various tank spills accompanied by a 10 mph wind based on the plume analysis in Attachment 1.

Table 3

LNG Downwind Hazard
(10 mph wind)

No. of ship-board LNG tanks spilled	Size of spill, cubic meters	Downwind hazard from LNG plume, meters
1	33,000	1370
2	66,000	1770
3	99,000	2100
4	132,000	2330
5	165,000	2570

Plume Ignition Probability On Shore

Point Conception - The ship dock is 1400 meters from shore, and we assume the plant is an additional 120 meters from the shore. From Table 3 the 1-tank spill will not produce a plume that reaches the plant before lifting away from the ground. As a result, plumes reaching the plant include only those from spills greater than one tank (33,000 m^3), and from Table 1 their probability of occurrence is negligible.

For the plumes that do reach the plant their area of coverage over the plant is estimated (from Table 2) to be sufficiently large to represent an ignition probability at the plant of about 98 percent. Thus we adopt 0.98 as the probability of plume ignition on shore at this site.

Oxnard - Here the ship dock is 1800 meters from shore, which precludes plumes from 1-, and 2-tank spills from reaching shore (Table 3). From Table 1 the probability of occurrence of spills greater than two tanks is negligible.

The plume from a 3-tank spill is estimated to cover an area onshore of about 2×10^5 m^2.* This area is large enough

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* (2100-1800) x 700 = 2.1×10^5 m^2, where the plume is taken to be rectangular and one-third as wide as it is long.

to ignite the plume with a probability of 99 percent (Table 2). The contribution of extremely rare 4- and 5-tank spills to this result is neglected. Thus we adopt 0.99 as the probability of plume ignition on shore at this site.

Los Angeles Harbor - The LNG ships dock in the harbor at the water's edge, which is assumed to be about 300 meters from the nearest public area outside the LNG plant boundary. Thus plumes longer than 300 meters can drift over the neighboring populated area, which from Attachment 1 corresponds to spills greater than about 700 m^3 or 0.02 tank of LNG. Spills larger than this cover a greater area outside the plant, but occur with rapidly decreasing frequency.

From Table 1 the most potentially damaging spill appear to be about 1650 m^3 (0.05 tank) in size, which corresponds to a plume area outside the plant of 1.7×10^4 m^2.** The corresponding probability of ignition on shore is 0.96 (Table 2). This size spill has a probability of occurrence of 0.022 (Table 1), which we adopt in this study.

** (420-300) x 140 = 1.7×10^4 m^2, where the plume is taken to be rectangular and one-third as wide as it is long.

Number of Persons at Risk to Fire On Shore

In this analysis we assume that the risk to LNG fire is from ordinary fire rather than a fire storm, a fireball, or from detonation of LNG. The conditions for a firestorm are not met, and detonation of confined LNG vapor has not been demonstrated. Also, the burning of unconfined LNG vapor does not result in a fireball but in a flame front that propagates through the air-LNG mixture. 6/

Point Conception - The LNG plant is the only major source of plume ignition in the vicinity. The plant employs about 100 persons although not all would be present at one time. However, for this analysis we assume all are at risk to an LNG ship accident.

Oxnard - This semi-agricultural site is assumed to be located in an area with a population density of about 100 persons per square mile (385 per square kilometer). The smallest spill that reaches shore covers about $2x10^5$ m^2 (see above), which includes about 80 persons who will be at risk to such a plume.

Los Angeles Harbor - This LNG terminal is near an industrial area with an assumed population density of 3000 persons per square mile (1160 persons per square kilometer). For a

plume area equal to 1.7×10^4 m^2 this corresponds to about 20 persons at risk to such a plume. We recognize that this is a conservative calculation since the area in the immediate vicinity of the LNG terminal may be sparsely settled and not representative of the average population density of the surrounding area.

Probability of Fatality per Person Exposed

There is only one example in the U. S. of fatalities from an LNG fire, and this occurred in Cleveland in 1944 when a storage tank containing 38,000 bbls of LNG collapsed. The escaping liquid caught fire soon after the rupture, and flowed into the neighboring areas as it burned. Fire also spread from the thermal radiation from the flames of the burning pool of liquid near the tank. Flames reached a height of 2,800 feet and combustible materials ignited by radiation at distances of more than 1,000 feet away. In all, 133 people were killed. There was no evidence of one massive "fireball", nor any firestorm, nor detonation of LNG. 6/

Lacking more specific information, we estimate that the area at risk was about 0.25 mi^2, with a population density of 4,000 - 5,000 persons per square mile. Thus about 1,000 - 1,500 persons were exposed from which we adopt 0.10 as the probability of fatality per person exposed to the risk of fatality from fire.

Outbound Trips

The LNG tankers retain about 3-5 percent of their cargo for the maintenance of cold tanks during their return trip to Alaska. However, we consider the probability of a significant vapor plume developing from an accident on the outbound trip to be effectively zero. Thus 425 deliveries per year is the number of transits for which there is any possibility of developing a hazardous vapor plume. This delivery schedule is held constant for all three terminals in order to focus on the other variables in the model.

Multiple Trips

The accident probability estimated earlier is for a single transit of the terminal area and its sea lanes. For

multiple transits the probability of an accident is approximately the single-trip probability times the number of trips per year. The exact equation:

$$P_t = 1-(1-P_1)^t$$

where t = number of transits

P_1 = single-transit probability of an accident

P_t = accident proability for t transits.

If P_1 is much smaller than t then:

$$P_t \simeq P_1 \text{ xt.}$$

Results

The model used for the estimate of the probability of a fatality ashore from a ship accident in the vicinity of a marine terminal is composed of the factors discussed above. The result is a product of these factors, and is shown in Table 4 for each of the three terminals in question.

TABLE 4
Probability Factors

FACTOR	SITE		
	L.A. Harbor	Oxnard	Point Conception
	VALUE		
• Single-trip probability of a tanker accident	2.4×10^{-3}	4.4×10^{-3}	4.4×10^{-3}
• Reduction factor for double hulls in LNG ships	0.25	0.25	0.25
• Probability of damage in vulnerable area	0.67	0.67	0.67
• VTS reduction factor	0.25	0.25	0.25
• Probability of no plume ignition at spill site	0.04	0.04	0.04
• Probability of proper wind direction	0.50	0.25	0.15
• Probability of the smallest LNG spill large enough to reach the public on shore	0.022	negligible	negligible
• Probability of plume ignition on shore	0.96	0.99	0.98
• Number of persons exposed to fire on shore	20	80	100
• Probability of fatality per person exposed	0.10	0.10	0.10
• Number of LNG deliveries per year	425	425	425
• Probability of fatality per year	3.6×10^{-5}	negligible	negligible
• Probability of fatality per person per year	1.8×10^{-6}	negligible	negligible

Table 5
Comparison of Risks

Hazard	Fatalities per 10^6 people per year
Coal mining, underground	820*
Motor vehicles	280
Falls	89
Fires	37
Firearms	12
Electrocution	5.7
Tornadoes	0.45
100 nuclear power plants	0.0002
Fire from LNG ship accidents near:	
Point Conception	negligible **
Oxnard	negligible **
Los Angeles Harbor	1.8

* Based on 0.41 fatalities per million man-hours in 1971, and 2,000 hours per year of exposure.

** Computed to be $<10^{-31}$ primarily because of the negligible probability of spills large enough to reach shore.

Comparison with Other Risks

The results in Table 4 may be compared with other everyday risks encountered by the public. These risks have been tabulated previously, 9/ and are shown in Table 5 for comparison. Electrocution and fire are common to all geographical areas and age groups while fatal falls are age dependent, and tornadoes are prevalent in certain geographical areas. In addition, Table 5 shows the calculated probability of fatality for accidents from nuclear power plants as given in Reference 9. Also, Table 5 shows the fatality rate from underground coal mining activities as given in Reference 10.

The results in Table 5 are given in terms of probability of fatality per person per year. This measure of risk has a personal meaning and in convenient for comparison with many types of risk. For involuntary exposure to risks from natural phenomena the individual probability of fatality is of the order of 10^{-7} per year. For nuclear power plants the

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9/ Reactor Safety Study, U.S. Nuclear Regulatory Commission WASH-1400, October 1975.

10/ "Accident Facts", National Safety Council, 1973.

limiting value of 10^{-7} fatalities per person per year has been suggested. 11/ We believe that this a reasonable value for the acceptability of LNG ships also, and is adopted here for this analysis.

The present results indicate that the fire risk ashore from LNG ships at Point Conception or Oxnard is negligible. Thus staff concludes that operation of an LNG import terminal at either of these two proposed locations is acceptable.

For Los Angeles Harbor the model shows an added risk from fire due to LNG marine operations that is about 5 percent of the nationwide average fire risk (Table 5) and is greater than the limiting value given above. However, the calculations in the model are thought to be overly conservative particularly with respect to the mean spill size used and the number of persons at risk to a plume. Nevertheless, staff feels that an acceptable risk of LNG ship operations at this site is not clearly demonstrated. Instead, the risk of LNG shipping at this site appears to be marginal.

11/ M. Meleis and R. C. Erdmann, "The Development of Reactor Siting Criteria Based on Risk Probability," Nuclear Safety 13, 22 (1972).

ATTACHMENT 1 to Appendix C

EXTENT OF THE FIRE HAZARD FROM NEGATIVELY BUOYANT LNG PLUMES

INTRODUCTION

When LNG spills on water it spreads and evaporates as it spreads. The cold vapor generated forms a negatively buoyant plume. Additional heat from the air and water causes the vapor to continue to warm and spread, become neutrally buoyant, and disperse. By the time neutral buoyancy is reached vapor has become very dilute from the expansion and from turbulent mixing with air at the surface of the water.

In this treatment the downwind hazard from a spill of LNG on water is analyzed from the point of view of the extent negatively buoyant plume. Hoult 1/ has pointed out that for large spills of LNG on water the fire hazard area is confined essentially to the area covered by this plume.

ANALYSIS

Calculations have been made of the extent of a negatively buoyant plume at water level following a water spill of LNG. In this model a constant wind vector in a given

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1/ Hoult, D.P. "The Fire Hazard of LNG Spilled on Water," Conference Proceedings on LNG Importation and Terminal Safety, National Academy of Sciences, June 1972.

direction is superimposed on the vapor cloud from the spreading spill. The distance downwind of the leading edge of this vapor cloud at neutral buoyancy is assumed to be the extent of the flammable hazard. After this time the cloud dissipates, becomes positively buoyant, and is no longer a hazard at water level. This model of LNG cloud behavior is based on turbulence at the water surface and extreme stability at the top of the cold cloud, and is thus independent of air stability conditions. Vapor dispersion by Gaussian diffusion is not part of this model.

A conceptual picture of this hazardous spill is given in Figure A1. In sketch (A) the LNG is spilling onto the water with turbulent vapor rising above the spreading pool. In (B) the spill is complete but the pool continues to spread over the water, and the vapor cloud is drifting downwind and spreading with horizontal velocity, u_i, due to spreading. In addition, the wind superimposes a speed, u, on the vapor.

In (C), evaporation of the liquid pool is complete at time, t_E, after the instanteneous spill, and the pool has reached its maximum radius, r_E. In (D), the cloud has reached its greatest extent as a downwind hazard. Also, it has dissipated from the strong turbulent mixing near the water

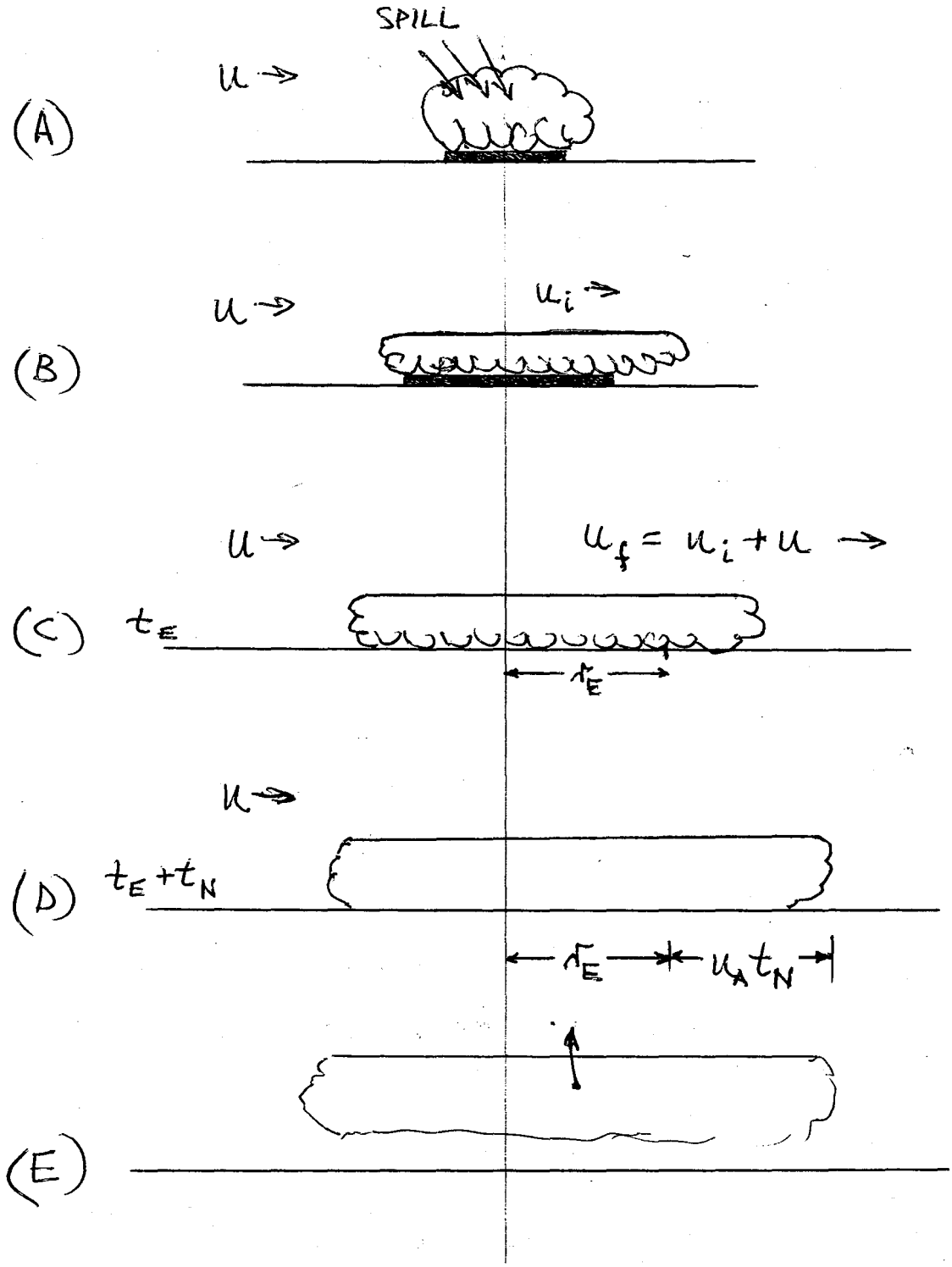

Fig. A1

Growth and Movement of
Negatively Buoyant Cloud of LNG

surface. The leading edge of this cloud is at distance

$D_f = r_E + u_A t_N$ beyond the point of the spill,

where

u_A = average speed of the cloud, which may be written:

$$u_A = \frac{u_i + u_f}{2}$$

where

u_i = initial speed

u_f = final speed = $u + u_i$

Thus

$$u_A = u_i + \frac{u}{2} \qquad (1)$$

and with the aid of Eq. 1 the expression for D_f may be written:

$$D_f = r_E + u_i t_N + \frac{u}{2} t_N$$

or

$$D_f = r_N + \frac{u}{2} t_N \qquad (2)$$

where

r_N = radius of the cloud at neutral buoyancy in the absence of wind. After this point the cloud lifts (sketch(E)) and is assumed to be no longer a fire hazard at water level.

In order to compute D_f the methods given in Hoult are used.1/ The appropriate equations are:

$$r_E^2 = \sqrt{g\left(1 - \frac{\rho_L}{\rho}\right) V}^{\frac{1}{2}} t_E \qquad (3)$$

$$t_E = 47.6\, V^{\frac{1}{3}}, \text{ sec} \qquad (4)$$

$$t_N = r_N^2 \left[\frac{4g}{\pi(1+\rho)}\left(1 - \frac{\rho_A}{\rho_V}\right) V_E\right]^{-\frac{1}{2}} \qquad (5)$$

$$r_N = r_E \times (1.116) \qquad (6)$$

where the symbols have the meaning as described in Hoult. 1/ With the values inserted Eqs. 3-6 become:

$$r_E = \sqrt{(9.8 \times 0.585)^{\frac{1}{2}} \times 47.6}^{\frac{1}{2}} \times V^{5/12}, \text{ meters}$$

where V is in cubic meters, or

$$r_E = 10.7\, V^{5/12}, \text{ meters} \qquad (7)$$

$$t_N = r_N^2 \left[\frac{4 \times 9.8}{1.611}\ (0.260) \times 237\ V\right]^{\frac{1}{2}} \text{ sec}$$

where $V_E = 237 \times V$

or

$$t_N = \frac{r_N^2}{21.8}\ V^{-\frac{1}{2}}, \text{ sec} \qquad (8)$$

From Eqs. 7 and 8 then Eq. 2 becomes:

$$D_f = 1.116\, r_E + \frac{u}{2}\ \frac{(1.116)^2}{21.8} \times (114)\ V^{\frac{1}{3}},$$

which for u = 5 mph (2.24 m/sec) is:

$$D_f = 11.9\ V^{5/12} + 7.22\ V^{1/3}, \text{ meters} \qquad (9)$$

RESULTS

For a wide range of volumes of LNG spilled, Eq. 9 has been used to compute the downwind extent of the fire hazard. These results are shown in Table A1 and are plotted in Fig. A2. In addition, Table A1 and Fig. A2 shows results for u = 10 mph (4.48 m/sec). For a spill of 25,000 m^3 (a single LNG tank aboard ship) the downwind hazard extends about 1200 meters.

Table A1
Computations of Downwind Distance

Volume of LNG spilled 10^3 m^3	r_N, meters	Wind speed 5 mph $\frac{u}{2} t_N$, meters	Wind speed 10 mph $\frac{u}{2} t_N$, meters	Wind speed 5 mph D_f, meters	Wind speed 10 mph D_f, meters
175	1830	405	807	2240	2640
150	1710	382	762	2090	2470
125	1590	362	724	1950	2310
100	1450	336	670	1790	2130
75	1280	304	608	1580	1890
50	1085	266	532	1350	1620
25	812	211	422	1030	1230
10	554	156	311	710	865
5	415	124	248	540	660
3	336	104	209	440	545
1	212	72	144	280	360
0.3	128	49	97	180	225
0.1	81	34	67	115	150
0.03	49	22	44	71	93
0.01	31	15	30	46	61

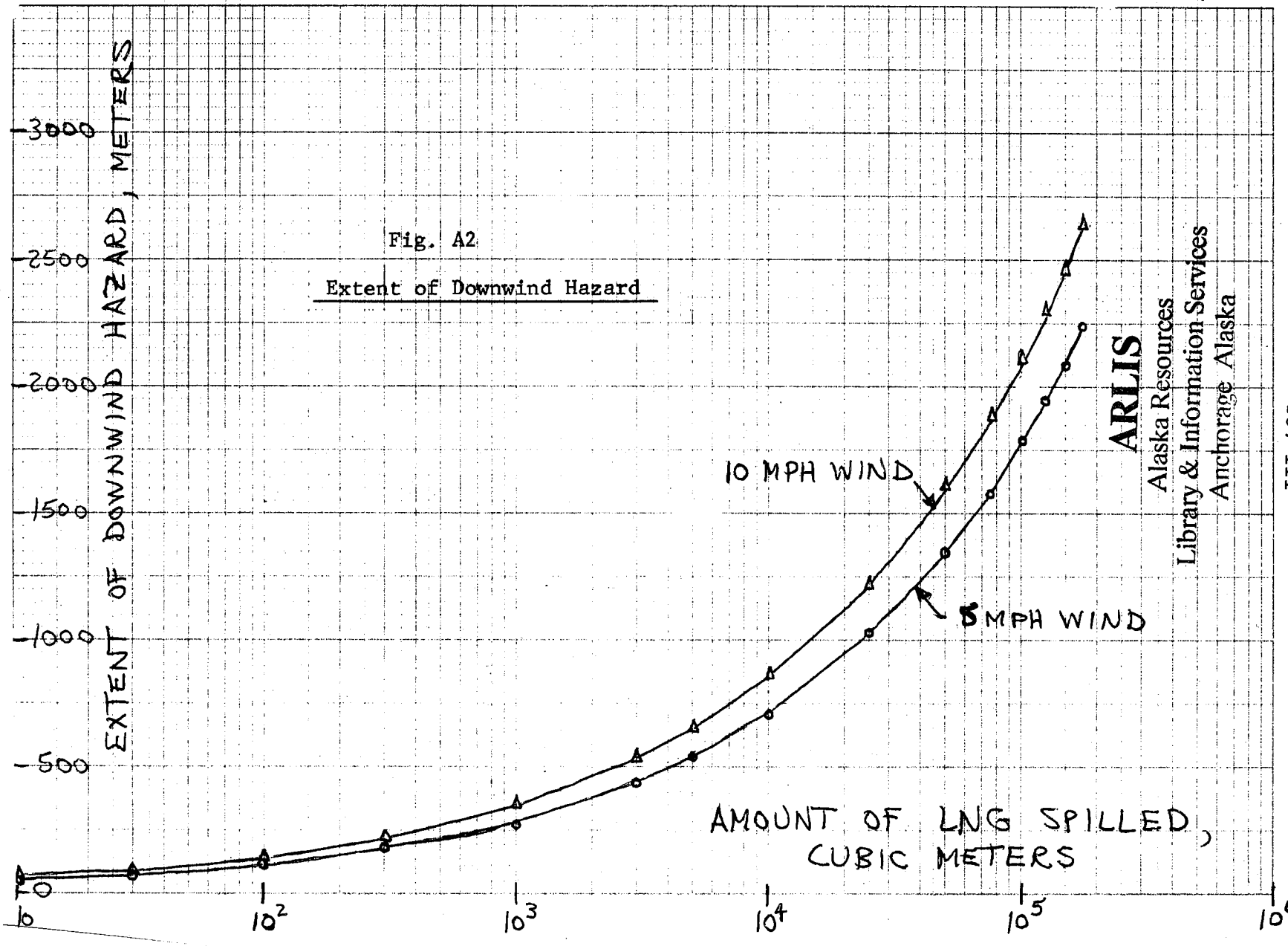

Fig. A2

Extent of Downwind Hazard