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NUCLEAR POWER PLANT SITING CAMP PENDLETON MARINE CORPS BASE

prepared for
SAN DIEGO GAS AND ELECTRIC COMPANY
San Diego, California 92112
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in association with
FUGRO, INC. and BOOKMAN-EDMONSTON ENGINEERING, INC.

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1. INTRODUCTION AND CONCLUSIONS

1.1 PURPOSE

San Diego Gas & Electric Company (SDG&E) will require electric generating capacity over and above that which is presently existing or planned by the late 1980s or early 1990s. Currently, the lead time required to place a nuclear plant in commercial operation from project conceptualization is 10 to 12 years. Therefore, general site screening studies are being performed to improve the data base for planning future generation. This is one such study and covers the Camp Pendleton Marine Corps Base.

Historically, the coastal area has been considered a desirable location in which to site power plants. Many of the advantages for siting near the coast have been economic - and economical power plants result in lower rates for the consumer. Coastal plants have lower transmission line costs because they are nearer to California's population. These plants also have lower pumping and water supply line costs because of the supply of cool seawater nearby. Other coastal factors that contribute to lower plant costs are shorter access roads; more direct access for shipping materials, replacement parts, and equipment; and easier access for plant personnel. These positive factors naturally lead toward considering a coastal site for the location of a power plant.

Safety and conflicting land use are factors adverse to locating a plant at the coastline, and these must be considered in the site screening process. The population in southern California is heavily concentrated in the coastal areas. Nuclear power plants particularly must be located suitable distances from these populated areas to assure public safety. Major fault systems, that are capable of generating large earthquakes, trend along the southern California coastline and present a significant problem for coastal nuclear power plant selection. Furthermore, the offshore geologic investigations required for coastal sites are based heavily on indirect data which may be inconclusive and subject to interpretation thereby complicating the licensing process. There often is competition for the land use in the coastal areas, including recreational, scenic preservation, housing, agricultural, and industrial activities. In addition, a review of the history of obtaining permits and licenses to locate power plants along the coast of California reveals increasing complexity of the process, resulting in substantial project delays and costs.

A study[1] performed for the State of California Resources Agency and the U. S. Atomic Energy Commission investigated various alternative siting concepts for California power plants. The results were incorporated into the State's 20-year plan. One conclusion of that 1973 study was that there were a limited number of potential nuclear power plant sites along the coast of southern California which might be licensable for shore-based nuclear plants. The study indicated that the number of sites might be increased if consideration would be given to plants located several hundred feet in elevation and several miles in from the shore and that the increase in bus bar cost for a plant located there would not be too great.

San Diego Gas & Electric Company authorized Pickard, Lowe and Garrick, Inc., and Fugro, Inc., to investigate further the potential for these hillside, or coastal/inland, sites in southern California. That study,[2] performed in May 1976, concluded on the basis of population distribution, conflicts in land use, and geology/seismology that the Camp Pendleton area appeared to have the only potential for siting a nuclear power plant in the coastal or coastal/inland areas of southern California in the near future. On the basis of that conclusion, SDG&E authorized additional study.

The primary purpose of this current study was to bring together and organize selected and existing data covering the Camp Pendleton Marine Corps Base. The data focused primarily on the geology/seismology considerations, population, and the hazardous operations at the base.

A secondary purpose of the study was to screen out areas within Camp Pendleton which do not meet criteria set forth for the study and to rank the remaining areas to determine where further evaluation to identify locations for nuclear power plants might be warranted. The criteria for screening and comparative evaluations were:

- Area capability in meeting nuclear power plant regulations and siting guidelines concerning safety.
- Comparative evaluations were to consider economic and environmental factors.
- The plant cooling system would be once-through cooling using ocean water (assumed economically feasible if the plant were located no greater than 5 miles inland and 400 feet in elevation).
- Existing and available data on geology/seismology, population, and base operations would be used (i.e., no new field data were to be developed in this preliminary study).

The study did not evaluate the constraints that might be imposed by the Marine Corps on availability of the land. It did not investigate the procedures necessary to acquire or lease an area for power plant use by an electric utility.

1.2 METHODOLOGY

The approach taken in the study generally consisted of identifying principal site/safety parameters to screen out areas at Camp Pendleton which apparently do not satisfy U. S. Nuclear Regulatory Commission (NRC) regulations[3] and guidelines.[4,5] Information from precedent nuclear power plant licensing cases was also considered. Candidate areas which remained after screening were evaluated for local differences with respect to a number of safety parameters, as well as the environmental impact and the comparative economic costs of a plant. Finally, the candidate areas were ranked to identify those that might warrant further investigation.

The three principal safety parameters used in the initial screening process were population, geologic/seismologic, and hazardous operations. Candidate areas were evaluated for anticipated difficulty in obtaining site approval on the basis of geologic/seismologic considerations, proximity to hazardous operations, security, and hydrologic factors.

Environmental parameters considered for candidate areas included climatology, land use compatibility, biology (including endangered species), cultural and historic resources, and aesthetics.

Economic parameters which were evaluated for each candidate area included costs for site access, flood protection, site development and slope stability, soil conditions, water transportation, and power transmission. These estimates of cost necessarily were cursory, although sufficient to permit comparative evaluations.

The study examined available literature, supplemented with reconnaissance level field investigations. Consequently, extensive use was made of information available from the U. S. Marine Corps, Camp Pendleton, U. S. Geological Survey - Water Resources Division, and data obtained from state and surrounding county and city government organizations. Additionally, meetings or telephone conversations were held with military organizations associated with Camp Pendleton operations to augment the available documents. A brief field reconnaissance was made to correlate field conditions at each candidate area with study findings.

After evaluating the candidate areas with respect to each of the siting parameters, a ranking system was devised to provide visibility of safety, environment, and economic factors. Based on numerical values ranging from 0 to 4, where 4 represents the best rating of Camp Pendleton sites, the relative evaluations of each candidate area for each siting factor were quantified. Safety, economic, and environmental factors are not normally evaluated in the same terms; thus, no attempt was made to combine all the numerical values for each candidate area. Instead, safety was considered an overriding factor and the average of its separate parameter values was compared with the value of economic parameters and then with the average value of environmental parameters. Candidate areas having numerically high values in both comparisons were ranked highest. Details of this system are discussed in Section 6.

1.3 RESULTS AND CONCLUSIONS

Two observations were important to placing the results of this study in proper perspective. First, siting a nuclear power plant is a long and complicated process requiring many steps. This study is only a first and very preliminary step. Second, sites must be approved by State and Federal agencies in the context of formal applications and requests. No such application has been made. Thus, the candidate areas that are identified only represent judgments based on interpretation of State and Federal siting guidelines. Such guidelines are continually revised. Therefore, it is clear that the candidate areas identified, including the ones which appear to have the more favorable characteristics, could all be found unacceptable in subsequent steps of the siting process.

Applying the guidelines adopted for this study to existing data and information covering Camp Pendleton led to the following conclusions:

- ✓ In the initial screening process, about 93 percent of the base was determined to be unacceptable.
- Of the remaining areas, no single location was identified which could be determined to meet Federal siting regulations and guidelines, based on existing data.
- The primary siting uncertainty is due to the lack of detailed information on the geology and seismology ~~outside~~ the area ~~of the San~~ Onofre Nuclear Generating Station. Extensive geologic field work would have to be performed to provide a firm basis for evaluation of potential sites with respect

to applicable regulations and guidelines. Even after such investigations, there is no assurance that an acceptable site would be identified (Section 4.2.6).

- Cooling water transport is the most significant additional cost item of the economic factors studied for the coastal/inland concept at Camp Pendleton. The capital cost of the pumping stations, supply and discharge water lines, as well as operating and maintenance costs for these facilities represent an appreciable portion of the total plant cost where areas are relatively high in elevation and far from shore.

- On strictly a comparative basis within Camp Pendleton, the highest ranked siting area is located northwest of Las Pulgas Canyon and southeast of the existing San Onofre Nuclear Generating Station, inland of Interstate Highway 5. The location is designated San Onofre Foothills/Las Flores North and is seen in Figure 1-1. ~~While providing~~ an area ~~of focus,~~ it ~~should be noted~~ that further geologic investigations are ~~required~~ due to the area's proximity to suspected capable faults (see Figure 5-1).*

Some of the steps which would have to be taken before Camp Pendleton sites can be considered viable include the following, with an estimate of potential cost and schedule magnitudes:

- Extensive geotechnical studies of suspected capable faults in the Camp Pendleton area (1 to 3 years to complete and $2,000,000 to $4,000,000 cost; military operations would also have to be suspended and the area cleared of live ordnance for investigations in impact zones; ~~extensive offshore investigations would also be required~~).

*While, as noted above, this study did not evaluate the constraints which might be imposed by the Marine Corps on availability of land in Camp Pendleton, the Marine Corps Base has however indicated that the north bluff sites along the coast are the areas which would have the least impact on Camp Pendleton activities, and the other siting areas would not be acceptable, including San Onofre Foothills/Las Flores North. (Letter from U.S. Marine Corps, Camp Pendleton, to Pickard, Lowe and Garrick, Inc., dated March 25, 1977).

- Quantification and evaluation of hazardous operations in terms of the threat to plant safety (6 months to a year and up to $250,000 cost).
- Following passage of enabling legislation, discussions and negotiations with the U. S. Marine Corps for use of Camp Pendleton land (approximately 3 years, based on the experience of the San Onofre Nuclear Generating Station).
- Possible on-site meteorology measurements and preliminary population dose calculations (1-1/2 years and $300,000 cost).

1.4 REPORT CONTENT

Section 2 presents the Camp Pendleton setting in terms of its location and the immediate surrounding areas. The evaluation of the base and the importance of its current activities to the Marine Corps are also discussed.

The siting factors, which are identified in regulations and guidelines and applied in this study, are discussed in Section 3. Also noted are some of the factors which were not assessed in the study.

Section 4 presents an assessment of Camp Pendleton in terms of the principal safety factors (population, geology/seismology, and hazardous operations) used to screen out areas which do not appear to fulfill the requirements of nuclear power plant sites. Exclusion areas are shown for each factor. The resultant candidate areas were subjected to evaluation of local conditions.

Section 5 incorporates an evaluation of the candidate siting areas for each of the safety, economic, and environmental parameters examined. Comparative rating of candidate areas is provided with respect to each parameter.

A classification and ranking system for combining the separate parameter evaluations is presented in Section 6 along with a summary of the principal characteristics of each candidate area. The combined rating of the parametric analysis is displayed and the higher ranked siting areas are identified. The section also expands on the conclusions resulting from the study.

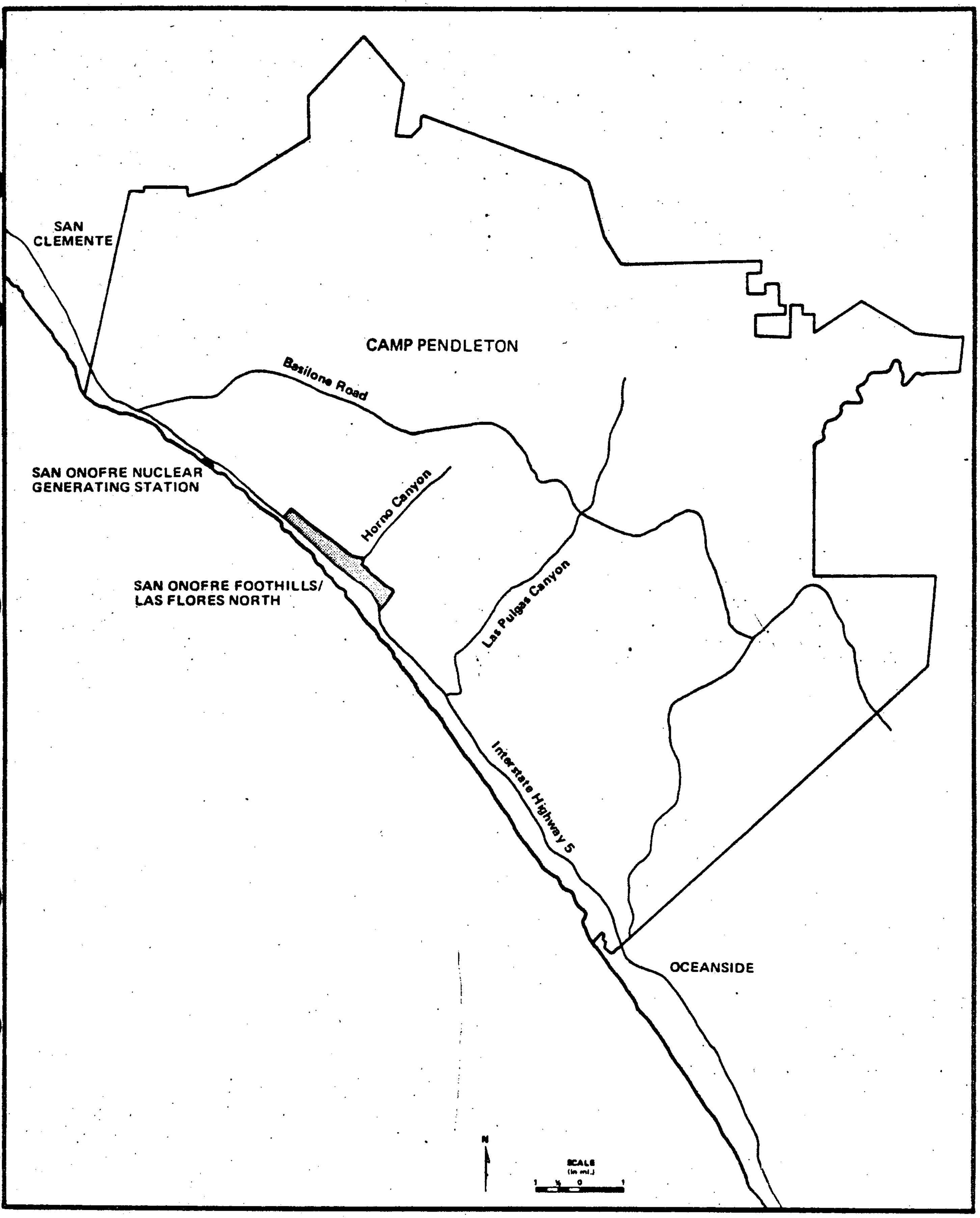


FIGURE 1-1: HIGHEST RANKED AREA

2. DESCRIPTION OF CAMP PENDLETON

The Camp Pendleton complex is located in southern California in the northwestern corner of San Diego County (Figure 2-1). It is about 70 miles southeast of Los Angeles and 40 miles northwest of San Diego. It is readily accessible from Interstate Highway 5 and is also accessible from Interstate Highway 15 and California Highways 74 and 76. The City of San Clemente with a population of over 22,000 people is located on the northwest boundary of the complex. Oceanside, with a population in excess of 53,000 people, is located immediately to the south of Camp Pendleton. The northern and eastern boundaries of the complex border the Cleveland National Forest, as well as rugged grazing lands, and agricultural lands used principally for growing avocados, citrus, and truck crops. The community of Fallbrook, an avocado growing area, is located on the northeast corner of the complex.

Camp Pendleton (Figure 2-2) contains over 196 square miles (125,000 acres) and fronts on about 17 miles of the Pacific Ocean. Four major activity areas exist at the complex in which are located over 46,000 military personnel, their dependents, and civilians: the Marine Corps Base; the Marine Corps Auxiliary Landing Field; the Naval Hospital; and the Fallbrook Annex of the Naval Weapons Station, Seal Beach.[6]

The Marine Corps Base was commissioned in 1942 as a training ground and has been an embarkation point for three wars. Military training operations include the use of troops, aircraft, artillery, and tanks.

This base and Camp Lejeune, North Carolina, are the only Marine facilities in the United States having beaches suitable for marine amphibious training. The base is the sole training site in the western United States where integrated amphibious training with simultaneous, coordinated helicopter assault and over-the-beach landings for the Fleet Marine Force are conducted. Within the complex, there are several impact zones in which aircraft bombing and strafing as well as artillery firing occur. Other zones and firing ranges are used for small arms firing and relatively short ranged weapons delivery in training exercises.

Infantry personnel trained at the base include mortarmen, machine gun and antiassault men, and riflemen. Special schools provide training in artillery, communications, personnel administration, and tracked vehicle repair. The Marine Corps Base also is the home of the 1st Marine Division since its return from Vietnam.

The Marine Corps Auxiliary Landing Field (MCALF) is a satellite of the Marine Corps Air Station in El Toro. It is located about 5 miles inland from the ocean. The field is utilized only under visual flight rules (VFR). It bases light helicopter and fixed-wing aircraft (OV-10A) used in support of Marine ground forces training. It is the only Marine OV-10A training facility on the west coast and also serves in the conduct of transition training using light helicopters.

The Naval Hospital is a 600-bed unit located adjacent to Lake O'Neill in the northeast area of the complex. In addition to supporting the Marine Corps Base, the hospital serves as a regional facility and provides complete or partial medical support to the Fallbrook Annex of the Naval Weapons Station, Marine Corps Air Station at El Toro, Marine Corps Supply Center at Barstow, and the Marine Corps Base at Twenty-Nine Palms.

The Naval Weapons Station, Fallbrook Annex, is a satellite of the Naval Weapons Station, Seal Beach. It is located in the northeast section of the complex.

Military housing is located throughout the complex as seen in Figure 2-2. In addition, family housing has been developed near the boundaries of Camp Pendleton to be closer to amenities of adjacent communities and to be sufficiently removed from the training areas. Housing is discussed further in Section 4.

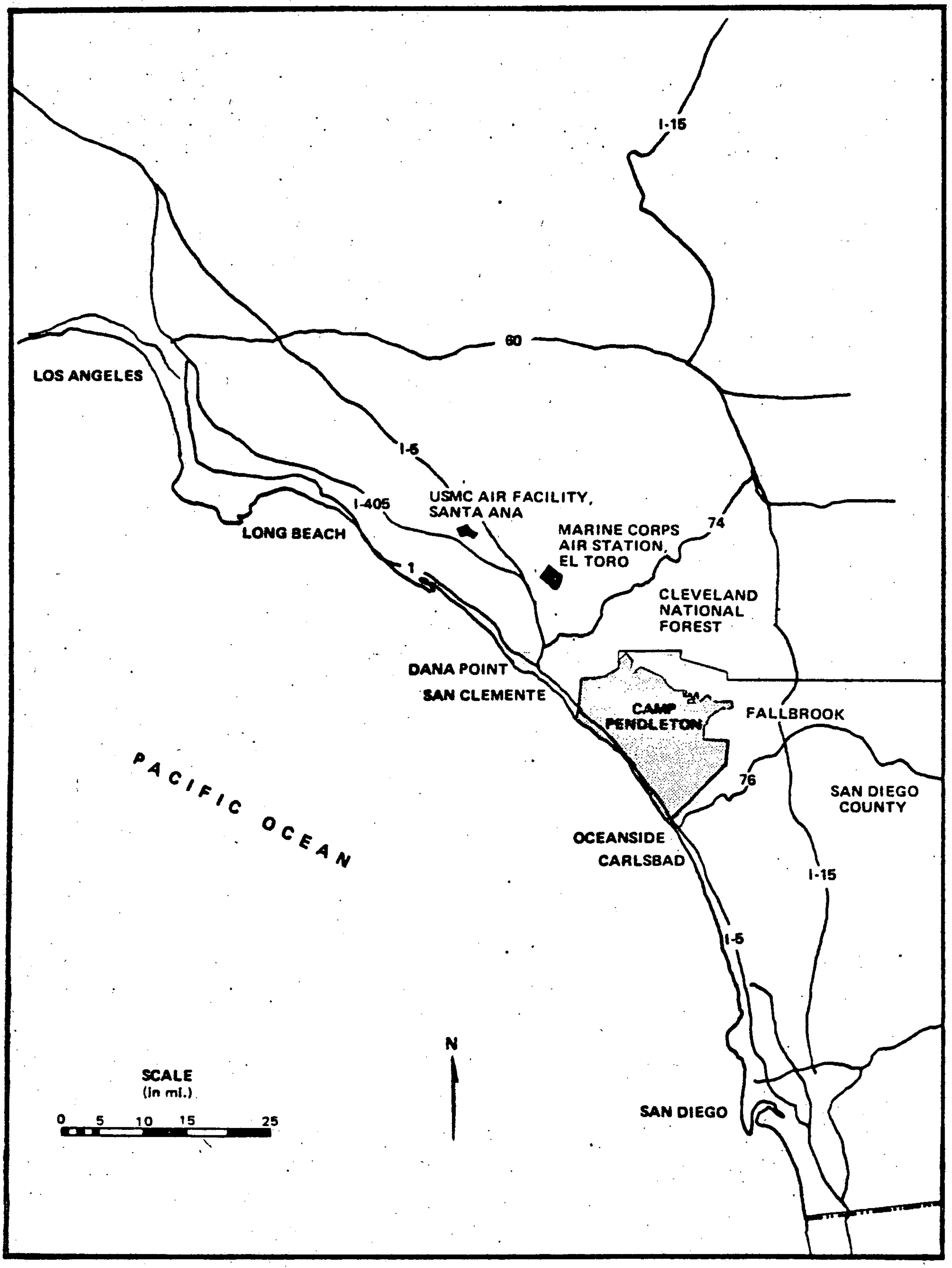


FIGURE 2-1: SOUTHERN CALIFORNIA

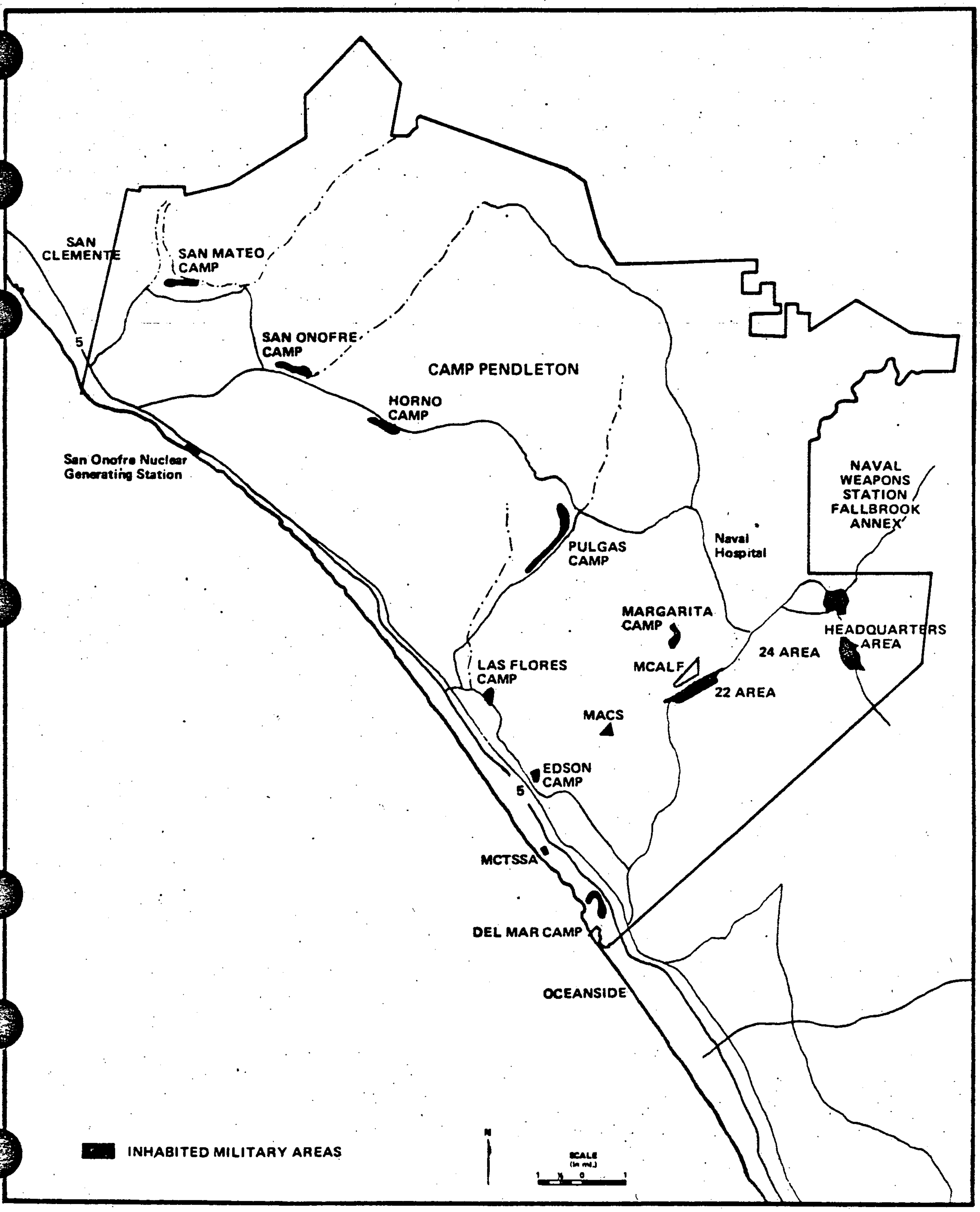


FIGURE 2-2: CAMP PENDLETON MARINE CORPS BASE

3. FACTORS FOR EVALUATING SITING AREAS

The factors for excluding areas and for evaluating and ranking remaining potential siting areas were derived from information contained in NRC guidelines[4, 5] and an electric utility industry study[7] of siting methodologies. All factors which normally are used to compare the merits of nuclear power plant sites are discussed in this section. Those that are judged to be similar for all the investigated areas at Camp Pendleton are noted and are not further considered in the study. The other factors are either used to exclude areas which do not conform to site criteria or are used to compare the relative merits of areas not excluded.

The factors which are being considered in this study fall into three general categories:

- Safety
- Economics
- Environmental

In addition, site size has been considered so that areas which do not have sufficient size to locate at least a one-unit nuclear power plant are not further considered. Areas required for one to four units are examined.

Safety considerations, primarily geology/seismology, are paramount in siting because the applicable regulations must be satisfied in order to license a site. However, when other factors such as environmental are examined for a siting area, steps often can be taken to mitigate adverse impacts. Therefore, only safety parameters were used to determine areas excluded from further analysis.

Factors which are about the same for areas of Camp Pendleton and which are not pursued in this screening study are:

- Construction labor and equipment availability.
- Construction labor support facilities.
- Basic plant design (with the exception of grading, foundations, cooling water lines, and pump stations).
- Water quality.

- Air quality.
- Public acceptance.
- Meteorology and atmospheric dispersion.

3.1 SITE SIZE

The size of a site for a nuclear plant is determined by two factors: one is the physical area required to locate the main structures of the plant and its supporting operations, and the second is the amount of land surrounding the reactor building necessary to provide an adequate exclusion zone.

An example of the area required to house all the facilities of a nuclear power plant on the coast is the San Onofre Nuclear Generating Station. The existing site area utilized for three units is about 84 acres. San Onofre Units 2 and 3 occupy a total of about 53 acres and additionally utilize acreage nearby for construction support. The minimum area required for a single unit is about 20 acres[1] excluding additional requirements for construction laydown, parking, and storage areas. Typically, these added requirements could require an additional 10 to 15 acres, making a total of about 35 acres required to locate the facilities of a nuclear power plant.

Facility area requirements for up to four units would be somewhat less than four times 35 acres, due to common-use areas. Considering that the three-unit San Onofre Nuclear Generating Station site is perhaps one of the most consolidated multiunit sites in the United States today, it would be reasonable to assume that a typical four-unit site might require between 100 and 120 acres to house the permanent facilities as well as to provide a construction support area.

Additional land is required to provide an exclusion zone around the plant. The exclusion area would provide for control over all activities in an area immediately surrounding the plant to facilitate appropriate emergency action in the event it becomes necessary. Boundaries are also set to assure acceptably low levels of radiation dose to persons outside these boundaries during routine operation. An exclusion area having a minimum radius of 0.4 mile from the reactor will normally provide the required radiation protection.[4] Smaller radii may be acceptable following a specific plant/site evaluation. However, for this study it was assumed that a single unit nuclear power plant site would require a 0.4 mile radial circular area, or about 320 acres.

A site at which four units might be located would be able to take advantage of joint exclusion areas for each unit. The degree of space and facility sharing would depend on the proximity of the plants; however, it can be assumed that two or more of the units might be separated by as little as 500 feet. That would require an additional 100 acres for a total of 420 acres to site a total of four units. Allowing for some flexibility in the shape of available acreage, and considering less stringent placements of adjacent reactor buildings, site planning for up to four units should consider a minimum required size of about 500 acres.

In addition, site planning would have to account for access to existing transmission right of ways or for new transmission line right of ways whichever might be applicable. For planning purposes, it can be assumed that transmission lines would approximately require the indicated minimum widths:

Circuits	Approximate Easement Width (Feet)
1 - 500 kv	200
2 - 500 kv	300
2 - 230 kv	100
4 - 230 kv	200

3.2 SAFETY

3.2.1 Population

A nuclear power plant is required by the NRC to have an exclusion area wherein all activities are controlled. Plant design must be such that radiation doses to individuals at any point on its boundary for 2 hours immediately following the onset of a postulated fission product release will be less than certain prescribed values.[3] Transportation corridors, such as highways, railroads, and waterways, are permitted to traverse the exclusion area as long as they are not so near the plant as to interfere with its operation, and if in case of an emergency, traffic can be controlled in the exclusion zone to protect the public health and safety. As discussed in Section 3.1, an exclusion area of 0.4 mile in radius was assumed. Shorter radii have been used in the past and are evaluated by the NRC on a case-by-case basis taking into account plant design, meteorology, and safety features.

The NRC also requires that a nuclear power plant have a low population zone (LPZ) outside the exclusion zone in which the population is sufficiently low and distributed in such a way that there is a reasonable probability that appropriate measures could be taken in their behalf in the event of a serious accident. Based on the existing conditions at nuclear plants, the NRC has indicated that a radius of at least 3 miles from the reactor is usually adequate for site planning.[4] The LPZ can be and has been set at less than 3 miles for some sites, based on safety evaluations showing that the 30-day doses following a postulated accident are below regulatory limits.

Reactors are required to be a distance from the boundary of population concentrations of about 25,000 residents or more at least one and one-third times the LPZ radius.[3,4] Thus, for an assumed LPZ radius of 3 miles, the population center boundary would have to be 4 miles from the reactor.

Population density in the area surrounding the nuclear plant represents another factor which is considered. The NRC indicates as a general guideline that the population density, including time weighted transient population, projected at the time of initial operation of a nuclear power plant should not exceed 500 persons per square mile averaged over any radial distance out to 30 miles, and the projected population density over the lifetime of the facility should not exceed 1,000 persons per square mile averaged over any radial distance out to 30 miles.[4] Transient population is included where significant numbers of people work, reside part time, or engage in recreational activities and are not just passing through nor are permanent residents of the area. Then that transient population is accounted for by weighting it according to the fraction of time the transients are in the area. Where population densities exceed the indicated amounts, the Guide encourages consideration of alternative sites having lower densities.

These guidelines have not been met in certain nuclear power plant applications. Changing, more stringent criteria account for some of the deviations. In other applications where conforming alternative sites do not exist, other considerations could allow for reduced LPZ distances. Relaxation of this criteria (i.e., smaller Low Population Zone) does not provide a significant increase in the area available for siting at Camp Pendleton.

3.2.2 Geology/Seismology

Geology/seismology criteria are intended to provide reasonable assurance that a nuclear power plant can be constructed and operated at a site without undue risk to the health and safety of the public. These criteria can affect the feasibility of a site in addition to being important economic considerations. The most critical considerations related to safety of a facility are susceptibility to damage from surface faulting, earthquake ground motion, and unstable foundation conditions.

Potential for surface faulting at a site is extremely critical and can dictate the site's ability to be licensed. The NRC Standard Review Plan on Surface Faulting[8] specifically states: "No nuclear plant has ever been constructed on a capable fault and it is an open question as to whether it is possible to design for surface or near-surface displacement with confidence... It is, therefore, staff policy to recommend relocation of plant sites found to be located on capable faults..." As the potential for surface faulting is so critical for determining site suitability, the Standard Review Plan also states: "It has been the policy of the staff to encourage applicants to avoid areas where there is a possibility for surface faulting."

The seismic and geologic siting criteria for nuclear power plants[3] consider "capable faults" to have potential for tectonic ground displacement and for generation of earthquakes. They define "capable fault" as a fault having one or more of the following characteristics:

- Movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years.
- Instrumentally determined macroseismicity.
- Structural relationship to a capable fault such that movement on one could be reasonably expected to be accompanied by movement on the other.

The criteria require investigation of all faults greater than 1,000 feet long, any part of which is within 5 miles of a site, to determine whether these are capable faults. The criteria require additional, extremely detailed investigations to determine the possible hazard from surface faulting in close proximity to capable faults, within a zone euphemistically called the "Zone Requiring Detailed Faulting Investigation" (ZRDFI). It is difficult to anticipate completely the level of investigation needed to demonstrate no hazard from surface faulting within the ZRDFI. This is because precedent is lacking due to nuclear power plants normally not being in such close proximity to capable faults. Experience has shown that sites in close proximity to capable faults have not been licensed (e.g., Malibu, Bodega Bay, and Bolsa Island). Width of the ZRDFI is the maximum width of mapped fault traces, measured within 10 miles from the closest approach to the site, increased by a factor dependent on the largest potential earthquake related to the fault. Minimum width of the ZRDFI is one-half mile.

Although the NRC regulations do not rule out siting within 5 miles of capable faults, the NRC guidelines[4] indicate that an area within 5 miles of a capable fault greater than 1,000 feet in length usually is not suitable for nuclear power plant sites and that extensive detailed geologic and seismic investigations are necessary to demonstrate the suitability of such sites. Even if it is assumed that a site ultimately can be proven acceptable, the complexity and difficulty of the site investigation are increased as more detailed faulting investigations are required by the criteria. Such investigations under those circumstances typically disclose numerous features that demand even more investigation and often generate technical controversy. The requirement for these more intensive investigations, therefore, reduces the probability that a site ultimately can be licensed, in addition to increasing the cost and duration of the siting study. As a result, it is desirable that a site be more than 5 miles from capable faults and even more desirable that a site be outside the ZRDFI.

Within the Camp Pendleton area, there are several faults that display some evidence suggesting they are capable and would require extensive further investigation to determine definitely whether they are or are not capable. Summarily excluding a 5-mile distance on each side of these suspected capable faults would prematurely remove nearly the entire base from consideration, including areas that might be proven acceptable by further investigation. For the present study, each such fault has been evaluated individually and an estimate has been made of (1) the likelihood that it could be proven not capable, and (2) its anticipated influence on nearby sites in the event it is capable. The results of this evaluation have been used to determine the relative merits of potential areas within Camp Pendleton.

In order to establish the relationship of the site to capable faults, it is necessary to determine whether capable faults are present in the area surrounding the site. When faults are identified in the site vicinity, it must be determined that these faults are not capable.[8] In the tectonically active southern California area, proving a fault is not capable generally requires demonstrating that it is overlain by undisturbed strata that are older than the 35,000-year or 500,000-year criteria. Because it is difficult to demonstrate that an observed separation along the fault represents single fault displacement, it is most desirable that strata be older than 500,000 years. However, younger units may be acceptable such as the 120,000-year old terrace deposits at the San Onofre site.

Absence of large displacements along faults also may be demonstrated by continuity of ancient landforms such as alluvial or marine terraces. However, the resolution of continuity studies commonly is inadequate to demonstrate that no movement whatsoever has occurred on a fault. As a result, continuity studies are less desirable than direct observation of a fault overlain by undisturbed strata. Because of these factors, it is critical that a potential site be in an area containing undeformed strata that are demonstrably older than the dates specified in the criteria. Sites not having suitable stratigraphy are considered unlikely to be licensable under the current siting criteria.

In order to establish the absence of capable faults, it is most desirable that undeformed, datable stratigraphy be exposed extensively within 5 miles of a prospective site. There is no location within the base around which a 5-mile radius is entirely, or even largely, covered by datable, undeformed units. Prospective sites having only limited exposures within a 5-mile radius (as is the case at Camp Pendleton) may be acceptable because relationships of faults to stratigraphy may allow later demonstration that the faults are not capable.

Besides capable faults other geology/seismology criteria can influence economic feasibility of a potential site, such as:

- The design basis for vibratory ground motion.

- Other design considerations affecting the foundations of the proposed nuclear power plant structures (e.g., liquefaction or settlement) or influencing stability of slopes near the nuclear power plant.

In extreme cases, where design requirements exceed the state of the art, these design considerations may also affect licensability.

The design basis for vibratory ground motion generally is considered most important because it influences the design for structures, systems, and components of the nuclear power plant. The design basis for vibratory ground motion is determined from the severity of earthquakes that can be associated with capable faults and tectonic provinces in the region surrounding a site. The characteristics of vibratory ground motion at a specific location are the result of:

- The size and mechanism of the earthquake.

- The distance from the earthquake to the site.

- The travel path of the seismic waves.

- The regional and local geology.

Design conditions for soil stability take into account the physical properties of materials underlying a site and consider their effect on foundations of the nuclear power plant. These considerations include both instability resulting from vibratory ground motion (e.g., liquefaction, fissuring, or differential consolidation) and other forms of instability (e.g., subsidence, uplift, or poorly consolidated soils). The criteria also require evaluation of stability of all slopes, the failure of which could adversely affect the plant. Because of these considerations, it is prudent to select sites having relatively competent and stable earth materials in order to reduce the need for additional investigations, costly design requirements, and consequent licensing delays. However, soil stability and slope stability generally are not of primary importance in site selection.

3.2.3 Military Operations

Postulated accidents at nearby military installations could affect the safety of a nuclear power plant. In particular, military aircraft ordnance delivery, test, and firing areas represent potential hazards to safe nuclear plant operation. The acceptability of a site depends primarily on establishing that accidents and normal operations will have little or no effect on a plant at the site. In the event this cannot be demonstrated following detailed studies, then it could be necessary to seek alternative sites or design the plant so that its safe operation and/or shutdown would not be prevented by an accident at the military installation.

This factor has been significant in the past in causing relocation of a proposed plant or requiring the structures to withstand impact of aircraft or missiles. Examples are the proposed Boardman site in Oregon which was abandoned in lieu of an alternative site and Douglas Point in Maryland where the facilities were designed to safely shut down following an aircraft impact.

As an alternative to designing for a military hazard, an otherwise unacceptable site could be made acceptable by a change in military operations. If the military organization were to alter its installation or mode of operation to reduce the likelihood or severity of potential accidents which could involve the nuclear station, the site and proposed plant could be acceptable.

It was therefore necessary to determine existing land use and modes of operation at Camp Pendleton and, to some degree, review the accident history at the base as it relates to aircraft, tank ordnance, and other potentially hazardous military operations. Areas obviously having high levels of risk associated with nearby military hazards could then be avoided.

3.2.4 Other Hazards

Nuclear power plants which are in close proximity to gas and other utility pipelines may be subjected to risk in the event of accidental rupture of the lines. Similarly, rail, highway, and waterborne traffic which carry flammables and explosives would present hazards in the event of transportation accidents. On investigation of these potential accidents, the risk might be sufficiently high to require detailed studies of the pipeline or transport system design and operation as well as atmospheric dispersion of product releases. The result could affect the design basis of the plant. Therefore, siting areas nearer these systems may be less desirable and their proximity to them was investigated.

Areas of concentrated air traffic near airports and below established military or civilian airways must be considered. Commercial airway traffic over a location generally represent less risk than air traffic near an airport. However, site locations furthest from these activities are subjected to less risk. Therefore, airways and aircraft activities in the vicinity of potential siting areas were investigated.

3.2.5 Security and Isolation

Security of nuclear power plant installations from penetration by insurgent groups can best be provided by area administrative control and system design. Isolation of the plant location in a military environment would tend to be more discouraging to security breach attempts. Sites within the military area but close to a public highway would tend to be more accessible for security breaches and therefore would be less desirable. The Camp Pendleton area was studied to determine whether there is a significant difference between siting areas of access that might result in security breaches.

3.2.6 Hydrology

Conditions resulting from the probable maximum flood at a nuclear power plant site with attendant wind-generated wave activity constitute the design basis flood conditions that safety-related structures, systems, and components must be designed to withstand so that they can retain a capability for cold shutdown and maintenance. These conditions may be caused by a seismically induced flood, hurricane, seiche, tsunami, surge, or heavy local precipitation.

Sites within the Camp Pendleton area have some variation in annual rainfall, depending on orographic influence. Further, in comparing the probable maximum flood at various sites, and comparing the potential cost for alleviating significant flood hazards, another factor to be considered is the size of the drainage area for runoff passing adjacent to or through a site. Natural drainage channels or streams are the basis for identifying potential flood paths and for determining the size of their associated drainage areas upstream of a considered site. Soil absorption differences between drainage areas for different sites are also considered. Historical flood level records, if available near a considered site, will tend to validate preliminary calculations of flood potential at the site.

Another consideration is the potential failure of impounded water facilities resulting from seismic activity or from rain conditions. Areas being considered which are not within the path of a potential water storage facility naturally are in less danger than a site which might be flooded from a dam failure. One consideration could be the reinforcement of the dam, at some cost, to withstand a potential earthquake. Alternatively, it is possible to assess the impact of the failure by adding the surge volume by impounded water to the volume of runoff water when calculating the maximum flood.

Sites located near the shore must be considered for tsunami activity. This can be accomplished by penalizing sites at those locations with the cost of shoreline wall protection consistent with the size of the potential tsunami.

Finally, the height of the groundwater system will have a bearing on the type and cost of foundations required by the plant structures. In the case of the containment building, the foundations are particularly deep to accommodate the reactor and its supporting system. Sites having high groundwater tables will be less desirable than those where the groundwater table is well below the depth of foundations.

3.3 ECONOMICS

3.3.1 Soil Conditions

There are a number of earth material conditions which could result in costly construction and influence the relative desirability of sites. These conditions include soil instability, slope instability, and insufficient foundation bearing capacity. Undesirable features affecting stability of earth materials include:

- Areas of actual or potential subsidence or uplift possibly caused by underlying depressions or cavities, withdrawal of groundwater, injection of groundwater, or regional deformation.

- Deformational zones such as shears, joints, fractures, folds, or combinations of these.

- Zones of alteration or irregular weathering profiles and zones of structural weakness composed of crushed or disturbed materials.

- Unrelieved residual stresses in bedrock.

- Rocks or soils that might be unstable because of their mineralogy, lack of consolidation, or water content.

Recognition of these factors generally requires detailed, site specific investigation. In the absence of these investigations, there is no evidence that variations in these conditions exist. As a result, they were not used as a basis for initial site screening in the study.

It is essential to evaluate and make design provisions for stability of all slopes, the failure of which could adversely affect a plant. In addition to static stability analyses, effects of seismic shaking are required to be taken into account, thereby increasing the complexity and conservatism of the analyses. The additional site investigations, engineering, and construction resulting from potential slope instability can be a significant economic consideration at sites having large topographic variation, such as exists at some of the potential areas in Camp Pendleton. Areas located away from steep slopes are preferred.

Soil bearing values impact on the size of foundations required to carry building loads. Competent rock and dense sedimentary materials normally will permit large unit bearing pressures, while the less dense soils are more limited in the amount of load which they can safely support. Thus weaker soils require larger foundations or modification of the soil materials. Sites having rock or soils with higher bearing values at or near the surface, or at the structure depth required, will be preferred because the size of foundations can be minimized. In the absence of information from soils investigations throughout the camp, this factor cannot be readily evaluated.

3.3.2 Site Access

Plants located in remote areas may alleviate some of the siting problems such as population center distance, aesthetics, and land-use conflicts while, at the same time, the investment for providing access to the plant during construction and operational periods is increased. Sites which are more inaccessible require more road construction and perhaps more utility services construction. The cost for required improvements may be compounded for some sites, particularly in the Camp Pendleton area where the existence of extremes in topography may require the improvements to be run through less direct routes in order to gain access. Therefore, the potential routing, length, and construction magnitude of roads and utility feeder systems, if required, are considered and reduced to economic terms.

3.3.3 Site Development

The plant must be placed in the middle of a large acreage required mostly to provide an exclusion area. The smaller area in which the plant would be located might be less than 40 or 50 acres, and it is principally in this area that topography is a consideration in site development costs. Plants located in hilly areas will generally require more excavation to develop level construction sites and construction support sites. Further, in hilly areas the cost for developing level building pads and yards is increased by the cost of excavating and possibly buttressing hillsides to achieve slope stabilization. The cost for site development is in proportion to estimates of the earthwork required.

3.3.4 Water Transport

Water transport is one of the considerations in site selection activities where the operating costs can be as much concern as the initial capital costs. The initial cost of offshore cooling water supply and discharge lines would not differ between most sites where the hydrography is similar, no underwater troughs or escarpments exist, and no requirements exist for alleviating problems associated with the biota at individual sites. The hydrography along the Camp Pendleton coastline is reasonably consistent for this evaluation and is not a consideration in this study. If interferences with biota along the coastline differ along the Pendleton coastline, that could be overcome by additional water lines routed to avoid it. However, the different lengths of the onshore cooling water line routes to potential siting areas; differences in construction needed to alleviate conflicts at existing road, railroad, and utility line crossings; and the differences in elevation to the various areas need to be considered. Some additional capital costs are encountered with increased area elevations, both from more difficult pipeline laying and from increased pump sizes and pumphouses. A substantial difference in operating costs occurs with increased site elevations and route lengths. Therefore, the evaluation includes identification of water line routes for each of the potential siting areas, as well as cost estimates of capital and operating expenses.

3.3.5 Transmission Lines

The assumption is made in this study that a new generating station in the Camp Pendleton area would require new transmission lines, although existing rights of way could be examined to assess their potential use in locating new lines. On that basis, some routing options are examined and differences in route length and difficulty in constructing the line connecting to the transmission line network substations are assessed. Maintenance and operating cost differences over the various routes may be significant and are estimated along with capital costs for extending service from various plant locations.

3.4 ENVIRONMENTAL

3.4.1 Land Use Compatibility

The nuclear power plant may have an impact on the nearby existing or planned land use during the construction and operational periods of the plant. The incompatibility with hazardous land uses was discussed in the safety considerations earlier. Plant construction and operation activities might have a negative impact on public amenity areas such as local, state, and federal forests; unusual landforms, beaches, or coastal lagoons; and historical areas, if in competition with them. On the other hand, activities such as agriculture may be well suited to mix with power plant land use.

Future land use around potential siting areas was assessed based on planning documents such as provided by the Master Plan at Camp Pendleton, the General Plan or Land Element Plan for each of the surrounding communities; the plans by County, State, or National forest services, refuge, and recreational organizations; and the Coastal Plan of the California Coastal Zone Commission to judge the compatibility of potential plant siting areas at Camp Pendleton.

3.4.2 Aesthetics

Potential sites are judged subjectively as to the impact a power plant would have on the natural environment from an aesthetic point of view. The placement of a plant at a site which is in the immediate view of the public, particularly along a frequented public thoroughfare, is likely to gain more criticism than plants essentially hidden from public view. Aesthetic impacts can be reduced by selecting sites more distant from public thoroughfares or where existing topography will screen station structures from nearby scenic, historic, or recreational resources and avenues.

3.4.3 Biota

Areas of significance to the local ecosystem may present major difficulties if important species or ecological systems are significantly affected by the siting of a nuclear power plant. It may be possible to mitigate such impacts through replacement of destroyed habitats or other actions. It is first important to determine whether endangered or rare species inhabit an area, estimate their quantity as a portion of the whole species, then determine whether destruction of the habitat would have an impact on the species and, if so, determine the mitigation that might be used to avoid the destruction. The same is true of aquatic biota in the area of offshore intake and discharge cooling water lines.

Potential sites at Camp Pendleton can be compared with respect to endangered species or habitats present. If such species or habitats are known to exist or are suspected at potential sites, then those sites are less desirable.

3.4.4 Land Availability

The areas of Camp Pendleton which might be identified as potential nuclear power plant sites are all presently owned by the Federal Government. Because of their present or planned use by the Government, the opportunity for acquiring desirable plant sites will be offset by the Government's planned use of the property. An analysis of the Camp Pendleton Master Plan and discussions with operating personnel have yielded indications as to which of the potential sites would interfere with planned operations at Camp Pendleton. Areas which have the least impact on planned base operations would be more desirable.

3.4.5 Historic/Archeologic Compatibility

The coastal areas of southern California are known to contain historically significant sites, particularly as they pertain to the early Indian cultures. It would be undesirable to locate a plant such that future public access to immovable or irreplaceable historic sites would be precluded. Significant federal and state historic sites are cataloged and generally known. Where these coincide with potential siting areas or with areas suspected of having historic or cultural significance, the siting areas are rated lower.

4. SAFETY ASSESSMENT AT CAMP PENDLETON

This section presents an analysis of Camp Pendleton in terms of the principal safety parameters discussed in Section 3. These parameters of population, geology/seismology, and hazardous operations are assessed and the results are used to screen out areas which do not conform to criteria. The remaining areas are further analyzed and are compared in Section 5.

4.1 POPULATION

4.1.1 Analysis

The criteria used for excluding potential siting areas on the basis of population considerations are summarized as follows:

- The population exclusion area radius around the reactor will be 0.4 mile.

- The Low Population Zone radius around the reactor will be 3 miles and, therefore, the nearest distance from the reactor to the boundary of a minimum 25,000 population center will be 4 miles.

- The maximum cumulative population density (including time weighted transient population) out to 30 miles from the reactor will not exceed 500 people per square mile in 1990, the earliest year of plant operations, nor 1,000 people per square mile in the year of retirement, assumed to be 2030.

The population data for this study were acquired from a number of sources including the State; each of the three counties involved (Orange, San Diego, and Riverside); the two largest cities closest to Camp Pendleton - Oceanside and San Clemente; and Camp Pendleton.[9-18]

Population data in all cases were provided from respective census taken at least as recently as 1975. These data were available at county, major subregional area, and census tract levels. Thus, as a whole, the population data used are current as of 1975. Population forecasts from some of the information sources varied as to the maximum future date applicable. The State projections at the county level extend to the year 2020. County published forecasts were generally presented at the level of major subregional areas and were therefore more usable in predicting population within 30 miles of Camp Pendleton. These predictions generally were provided to the year 1990.

The principally occupied areas of Camp Pendleton are noted in Figure 4-1. The population throughout the base is comprised of military personnel, civilian workers, and the family dependents of military personnel. In early 1975 the population at the base was about 36,000 but has risen to over 46,000 for all categories. This larger population results from the drop in overseas activities and the base's now accommodating large on-going training and readiness forces. Table 4-1 indicates the breakdown of personnel by type and location. Table 4-2 combines types of population and locates them by area. Planning personnel at Camp Pendleton anticipate future population will not exceed current levels, and distribution between types and location will not change significantly.

The existing population (1975) within 30 miles of the camp was plotted as seen on Figure 4-2. Each dot represents 1,000 people and was located with respect to current census tract locations and counts. The forecast population for 1990 is seen on Figure 4-3. This population distribution and density represents that which could be expected the first year the plant would be in operation.

Population centers of 25,000 people or more were identified in order to later establish boundary distances of 4 miles to a potential site. Oceanside, including Camp Del Mar just north of Oceanside, represents a 1975 population level south of Camp Pendleton in excess of 53,000 people, with levels predicted to exceed 70,000 by 1990. On the north side of Camp Pendleton, San Clemente with a 1975 population of over 21,000 can be expected to exceed 32,000 by 1990. Therefore, population centers of 25,000 or more will exist at San Clemente and Oceanside/Del Mar Camp, and population center boundaries for 1990 are as indicated in Figure 4-3.

Four typical locations were selected as representative of siting area locations at Camp Pendleton. Population densities were examined for each prior to identifying potential areas. These locations are shown on Figure 4-2 and are designated as A, B, C, and D.

A population template, shown in Figure 4-4, consisting of circles having 5-mile distant increments from a reactor was used out to a distance of 30 miles. The template also divides the circular areas into sixteen 22-1/2 degree segments, and these were used for the population counts presented by directional segment in Tables 4-5 through 4-8.

Cumulative densities in circular areas were calculated for each location for radial distances in 5-mile increments out to 30 miles from the plant. The results are shown in Tables 4-3 and 4-4 for the years 1990 and 2030, respectively. While population data for 1990 were obtained from individual county forecasts by major subregional areas and census tracts, the data for the year 2030 was obtained by proportionally increasing the State's forecast for the years 2020 to 2030 and apportioning the population to each subregional area or census tract on the basis of the 1990 distribution. Such extrapolation may result in overestimates for cases such as Orange and San Diego counties where county growth has been disproportionately high in recent years. For example, Oceanside has witnessed over 7 percent annual growth over the last several years, while San Diego County as a whole has averaged 3.4 percent; and areas in Orange County such as Newport Beach are exhibiting record growths. Nevertheless, Table 4-4 is provided as a point of reference.

Transient populations were also considered, although not included in the tables. Sources of these transient populations are recreational visits to the beaches at San Onofre and San Clemente, visits to San Juan Capistrano, and visits to the San Onofre Nuclear Generating Station. In a 1-year period from 1974 to 1975, the following statistics[19] were applicable:

Beaches	2,894,000 people/year
San Onofre Nuclear Station	111,900 people/year
San Juan Capistrano Mission	1,000,000 people/year

Considering the duration of each activity in the area and calculating the equivalent permanent population over an annual period, and assuming all of this transient population within the area of one segment, the population density in a single segment out to 30 miles would be increased by less than 25 people per square mile.

It can be seen from Tables 4-3 and 4-4 that Locations A, C, and D conform with the criteria of 500 persons per square mile at the initial year of operation and 1,000 persons per square mile during the plant's lifetime. The average population density out to a distance of

10 miles from a plant at Location B would slightly exceed the criteria; however, since the variance for Location B is small, it is considered that all four locations meet the NRC guidelines[4] for population density.

To provide further reference material, population densities were also calculated around each location within each 22-1/2 degree segment of a circle for successive cumulative 5-mile radial distances out to 30 miles from the plant. Tables 4-5, 4-6, 4-7, and 4-8 indicate the results of those computations. Shown are the existing densities for 1975 as well as forecast densities for 1990. These values are of use in making direction-specific judgments. As seen in these tables, the actual population density in the nearby coastal areas is quite high, approaching 3,600 people per square mile in some areas.

Population density studies have been made by the NRC in the past using an assessment technique which computes a factor referred to as SPF, or Site Population Factor.[20,21] The SPF is an index which, for a given site, indicates an average normalized population density over the surrounding area taking into consideration that higher densities closer to the reactor are of greater concern. An SPF of 1.00 is the base and reflects an average density of 1,000 people per square mile. Although NRC has no formal criterion for allowable SPFs, over 84 percent of the licensed plants have a maximum SPF below 0.5 based on the 1970 census.[22]

The SPF for each of the four locations examined at Camp Pendleton, based on 1975 and 1990 forecast populations, is as follows:

Location	Maximum SPF (Out to 30 Miles) 1975	1990
A	0.478	0.727
B	0.470	0.715
C	0.395	0.601
D	0.375	0.570

Comparing the maximum 1975 SPF values from Camp Pendleton with the maximum 1970 NRC values[22] indicates that many plants have been licensed with SPFs higher than those calculated for Camp Pendleton sites. For example, licensed plants which have maximum SPFs that exceed these values include Indian Point (1.49), Zion (1.02), and Limerick (0.90).[22] Further, it is likely that if SPFs for licensed plants based on 1990 population forecasts were calculated, their average would be substantially higher than 0.50.

4.1.2 Excluded Areas - Population

The populated areas which are expected to contain more than 25,000 people and are thus considered as population centers are San Clemente and Oceanside. Based on criteria adopted for this study, nuclear power plants located closer to the boundary of a population center than 1-1/3 times the radius of the low population zone were excluded. Therefore, plant sites should not be considered closer than 4 miles to the populated areas of San Clemente and Oceanside. That constraint is shown on Figure 4-5.

Within the low population zone, it must be possible to effect emergency procedures over any activities in that area. These activities can include the occupants of the Camp Pendleton area. However, the NRC guidelines state that surrounding a plant site there should be an exclusion zone of about 0.4 mile radius within which there would only be activities which are under full control by operators of the power plant. Consequently, Figure 4-5 indicates areas in Camp Pendleton within which there are facilities permanently occupied by military personnel. Planning personnel at Pendleton indicate that new areas probably will not be developed. Assuming that the existing facilities are permanent and are not to be abandoned, a 0.4-mile distance surrounding each of these inhabited areas is shown on Figure 4-5. These represent areas to be excluded from siting considerations at this time.

4.2 GEOLOGY/SEISMOLOGY

The bases for preliminary site evaluation with respect to geology/seismology were presented in Section 3 and are summarized as follows:

- Sites should be located no closer than 5 miles to a known capable fault greater than 1,000 feet in length.

- Sites should be in an area containing undeformed strata demonstrably older than the 35,000-year NRC standard.

- It is desirable that sites not be in close proximity to suspected capable faults. If found to be capable, these faults would be considered to have potential for tectonic ground displacement and generation of earthquakes. Structural trends and photolineaments similarly would require investigation to determine whether they are capable faults. In addition, it is desirable that sites not be in close proximity to major pre-Quaternary faults because these are controversial features and likely would require independent age determination if in proximity to a site.

- Sites preferably should contain stable, competent earth materials that provide suitable foundation support and do not present slope-stability problems.

Particular emphasis is given in this section to the geologic factors critical to screening nuclear power plant sites: distribution of undeformed datable stratigraphy and existence of capable faults. Distribution of geologic units and vibratory ground motion also are discussed. Foundation conditions and slope stability are evaluated in Section 5.

Existing geologic data for the Camp Pendleton area have been compiled and analyzed in this study. The study benefited from Fugro's previous experience in the Camp Pendleton area, which has included various geologic investigations for the San Onofre site as well as previous regional and local site selection studies. Data were obtained from review of published geologic literature and unpublished reports, including reexamination of references cited in geologic reports on SONGS Units 2 and 3, in addition to review of references published subsequently. Sources used in compilation of this report are cited in the text and listed in the Appendix. University and Government agency geologists, knowledgeable in this area, were contacted in regard to existence of additional data and clarification of some published works.

In particular, contacts were made with the present and former Camp Pendleton base geologists and their unpublished data were reviewed.

Locations of terrace deposits and photolineaments were determined from review of black and while aerial photographs at scales of 1:18,000 and 1:32,000 flown in 1941 and 1967, respectively. This review was supplemented by published data. Evaluation of large-scale tectonic features included examination of color infrared and natural color high-altitude NASA aircraft photography, and false-color composite LANDSAT imagery.

The review of existing data was supplemented by limited field reconnaissance in accessible critical areas. Three field-days were spent examining structural and stratigraphic relationships in areas of suspected capable faults.

4.2.1 Terrace Sequences

Marine terraces are relic wave-cut surfaces formed during ancient stands of sea level. They are datable geomorphic and geologic features that commonly can be correlated for several miles and, where undeformed, can be used to indicate minimum age of fault movement and demonstrate the absence of capable faults. As a result, continuous marine terraces and terrace deposits are an important geologic consideration in nuclear power plant siting along the California coast.

A sequence of marine terraces is prominent along the coast and well developed alluvial terraces are present in Talega Canyon, San Mateo Canyon, and San Onofre Canyon (Figure 4-7). Detailed studies for the San Onofre Nuclear Generating Station have established correlations between the two lowest emergent marine and alluvial terraces.[23] Compilation of all available data indicates that the age of the first (lowest) emergent marine terrace is about 120,000 years.[24] There are no age data for the higher terraces in this area. They are believed to be older than the first emergent level, but regional geologic relationships do not suggest an age of more than 500,000 years.

Age data from other locations in southern California generally indicate a middle Pleistocene age for the highest marine terraces. Lajoie and others[25] obtained amino acid ages of 500,000 and 1,000,000 years for terraces on San Nicolas Island at about 400 and 800 feet of elevation, respectively. The Linda Vista Terrace, at an altitude of 300 to 500 feet in southern San Diego County, is believed to be middle Pleistocene in age.[26] However, uplift in the northern part of San Diego County appears to have been greater than in the area of the Linda Vista Terrace. Preliminary data suggest that terraces above the second emergent level in the Camp Pendleton area may be younger than those of equivalent elevation near San Diego (K. Lajoie, oral communications, 1976). However, the age of the lowest emergent terrace was well documented in studies for the San Onofre site as discussed above.

4.2.2 Stratigraphy

Rocks exposed in the mountains and hills of Camp Pendleton consist of generally southwest-dipping, largely marine sedimentary beds of Cretaceous to Tertiary age unconformably overlying a basement complex of Mesozoic plutonic and metavolcanic rocks. Along the coast, the Tertiary units are unconformably overlain by the gently dipping to flat-lying Pliocene-Pleistocene San Mateo Formation and Pleistocene terrace deposits. General distribution of these formations is shown on Figure 4-6.

4.2.2.1 Basement Complex. The basement complex in the Camp Pendleton area comprises plutonic rocks of the southern California Batholith and associated hypabyssal intrusive, metavolcanic, and older metamorphic rocks. This assemblage crops out in the northeastern half of the base (Figure 4-6). The rocks of the southern California Batholith are Cretaceous in age and the associated hypabyssal volcanic and metamorphic units are believed to be Triassic to Jurassic.[27]

The basement rocks are faulted at several locations and have been observed to contain numerous unmapped small faults and minor shear zones of undetermined age. Such features would require evaluation to determine whether they are capable faults, if in proximity to a prospective nuclear power plant site.

4.2.2.2 Cretaceous and Tertiary Sedimentary Rocks. Unmetamorphosed, relatively undeformed sedimentary formations of Late Cretaceous to Tertiary age unconformably overlie the basement complex. The sedimentary rocks generally dip southwestward.

The Cretaceous and Eocene formations crop out in a 3 to 5-mile wide belt trending northwestward across the central part of Camp Pendleton (Figure 4-6). Directly overlying the basement complex is a sequence of upper Cretaceous conglomerate, sandstone, and siltstone originally assigned to the Chico Formation[28] but later included in the Trabuco and Williams formations.[29] These beds are unconformably overlain by Eocene sandstone and shale assigned to the La Jolla Group by Moyle.[29] Cretaceous beds are intruded by Tertiary volcanic rocks at Horno Summit and Morro Hill.

The San Onofre breccia is a resistant unit of Miocene age and forms the unnamed range of rugged hills lying just inland of the coastal plain (Figure 4-6). This unit is characterized by well indurated beds of breccia containing glaucophane schist clasts but also includes conglomerate, sandstone, and shale.

The Monterey and Capistrano formations are marine shale and siltstone of middle Miocene to Pliocene age and unconformably overlie the San Onofre breccia. These formations are exposed in the northwest corner of the base, generally west of the Cristianitos fault, and locally along the sea cliffs east of this fault.

Several faults have been mapped in the Cretaceous and Tertiary sedimentary rocks at Camp Pendleton (Figure 4-7). In addition, these rocks very likely contain minor faults that have not been mapped in the studies performed to date. In general, however, the Cretaceous and Tertiary sedimentary rocks are less deformed and contain fewer faults than the underlying basement complex. Geologic structure is discussed in more detail in Section 4.2.3.

4.2.2.3 <u>San Mateo Formation.</u> The San Mateo Formation largely consists of massive, slightly indurated arkosic sandstone with scattered interbeds of conglomerate, silty sandstone, and siltstone. The formation crops out in a large area west of the Cristianitos fault and also is present in small exposures along the sea cliffs and in the southernmost part of the base (Figure 4-6). There are no definitive age data for the San Mateo Formation. Woodford[28] considered it to be Pliocene in age while Blanc and Cleveland[30] called it Pleistocene. An age of middle Pliocene to middle Pleistocene seems reasonable for the San Mateo Formation because it overlies the upper Miocene to lower Pliocene Capistrano Formation and clearly is older than the middle to late Pleistocene marine terraces.

The San Mateo Formation is flat-lying to gently dipping and is largely undeformed. However, it is cut by the Cristianitos fault and associated features in the western part of the base and by northwest-trending faults in the area between Las Pulgas Canyon and the

San Luis Rey River. The massive sandstone of the San Mateo Formation also exhibits minor shear features caused by regional or local stress release.[31-34]

4.2.2.4 Pleistocene Terrace Deposits. Marine terrace deposits are exposed extensively along the coastal plain and on the higher dissected terrace remnants. Alluvial terrace deposits interfinger with the marine terrace deposits near the outlets of larger drainages and are prevalent along Talega, San Mateo, and San Onofre canyons (Figure 4-7). Correlations have been established between two lower marine and alluvial terraces; the higher alluvial and marine terraces are not preserved well enough to allow definitive correlations but also are assumed to be interrelated.[23] The presence of these terrace deposits is important to establish critical fault-age relationships and the existence or absence of capable faults.

Terrace deposits consist of clastic and fine grained sediments and have nearly horizontal stratification or are at slight depositional angles. Detailed geologic investigations for the San Onofre Nuclear Generating Station have concluded that faults do not cut the 120,000-year old terrace deposits near the plant site and do not disrupt the profile of the corresponding alluvial terrace in San Juan and Bell Canyons.[23, 31-34] During the present investigation, a few minor faults, with vertical separations of a foot or less, were found in terrace deposits along the sea cliff within about a mile north of Las Flores Creek. These are discussed in Section 4.2.3.7.

4.2.2.5 Late Pleistocene to Holocene Alluvium. Alluvium in active stream channels and overbank deposits consists of gravel, sand, and silt with abundant cobbles and boulders. These deposits are Holocene in age and have a maximum thickness of about 100 feet. A lower, older alluvial unit has been recognized only in the Santa Margarita River Valley.[35] This unit is encountered 60 to 90 feet below the present river grade and extends to a maximum depth of about 200 feet (190 feet below sea level) at Ysidora Narrows. This older alluvial unit may have been graded to the low stand of a sea level during the Wisconsin glaciation. If this were the case, its maximum age could not exceed 120,000 years (the age of the lowest marine terrace) and probably would be much younger, perhaps less than 35,000 years, and therefore would be too young to establish that faults are not capable.

4.2.3 Geologic Structure

In general, geologic structure of the Peninsular Ranges province is characterized by large, northwest-trending faults, such as the Whittier-Elsinore fault, the Palos Verdes fault, the Newport Inglewood structural zone, the South Coast Offshore fault, and the Rose Canyon fault. It has been suggested that the latter three structures combine to form a major tectonic feature, the Santa Monica to Baja California zone of deformation.[36, 37, 38] This structural system is about 4 to 6 miles offshore of Camp Pendleton. North-northwest to northeast trending faults, such as the Cristianitos fault, also are important in the Camp Pendleton area.

Camp Pendleton is within the tectonically active southern California region. As a result, it may be expected that conclusive evidence will be required in order to establish that faults suspected of having Quaternary displacement are not capable faults according to the NRC criteria, as discussed in the following paragraphs. Numerous faults are present in the Tertiary and older rocks at Camp Pendleton (Figure 4-7). Faults having greater extent or suspected of having Quaternary displacements are important for relative site evaluation and are discussed in the following paragraphs.

4.2.3.1 Santa Monica to Baja California Zone of Deformation. As discussed above, this feature is considered by the U. S. Geological Survey and the NRC to be a through-going tectonic discontinuity extending at least 240 km from near Santa Monica into Baja California. This feature is defined by a 1 to 13 km-wide band of discontinuous, generally northwest-trending faults and folds in Tertiary and Quaternary rocks. It is associated with historic seismicity, including the 1933 Long Beach earthquake and therefore is considered "potentially active and capable of an earthquake whose magnitude could be commensurate with the length of the zone."[36] The U. S. Geological Survey and the NRC adopted this position in spite of the large volume of opposing evidence presented in Appendix 2E of the Preliminary Safety Analysis Report for San Onofre Units 2 and 3.

Although the U. S. Geological Survey has discussed this structural system in reports, no maps showing its total extent have been published. This is partly due to the interpretive nature of mapping shallow folded rocks and discontinuous faults offshore. Based on locations of late Quaternary faults published by Ziony and others,[39] it is approximately 5 miles offshore of the San Onofre site and curves gently southeastward to within about 3-1/2 miles of the coast opposite Oceanside Harbor. It is anticipated that detailed offshore investigations (e.g., seismic reflection profiling) as done for the San Onofre site would be required to establish the closest approach of this zone to any new coastal nuclear power plant site in this area.

4.2.3.2 Cristianitos Fault. The Cristianitos fault is exposed prominently in the sea cliff southeast of the San Onofre site. From this point, it extends about 25 miles in a north-northwest direction to the Santiago Canyon area.[40] Offshore seismic reflection data indicate that the Cristianitos fault also continues about 2 miles offshore and "dies out into the South Coast Offshore fault."[41] Displacement on the Cristianitos fault is believed to be chiefly normal, the west side being relatively down dropped. Maximum vertical separation along the central part of the fault is 3,500 to 4,000 feet.[42] Vertical separation along this fault at the coastline is no less than 90 feet.[43] Extensive geologic investigations for the San Onofre Nuclear Generating Station have concluded that the Cristianitos fault does not displace the 120,000-year old terrace and, based on all the available evidence, it is not a capable fault.[36] Major pre-Quaternary faults tend to be controversial features. [As a result, the Cristianitos fault may require independent evaluation of age of last movement if another site were to be located in proximity to it.]

4.2.3.3 Las Pulgas Fault. Several geologists have recognized a northeast trending fault about a mile north of and parallel to Las Pulgas Canyon.[29,44,45] This fault is informally called the "Las Pulgas fault" for this discussion. Weber[44] and Rogers[45] depict the Las Pulgas fault as about 8 miles long and displacing Eocene and older rocks. Moyle[29] depicted surficial units in more detail and showed this fault juxtaposing Quaternary older alluvium against pre-Tertiary basement complex (his unit designations), implying movement during Quaternary time.

The Las Pulgas fault coincides with a pronounced topographic break, which is evident on aerial photographs, LANDSAT imagery, topographic maps, and in the field. However, the actual fault was not observed during field examination performed for the present study. Much of the extent of this fault, including the portion depicted by Moyle[29] as juxtaposing Quaternary sediments against basement complex, was not accessible for exploration as it is within an impact area used by field artillery and air-to-ground ordnance. Geologic relationships in upper Piedra de Lumbre Canyon suggest that an additional, unmapped, northeast-trending fault may be present northwest of the Las Pulgas fault (Carlson, oral communication). This also suggests that geologic structure in the area of the Las Pulgas fault may be somewhat more complex than indicated on existing maps. Available literature is inconsistent in its interpretation of geologic units juxtaposed along this fault. Therefore, it is presently not considered a proven capable fault. Definitive evaluation of whether the Las Pulgas fault is capable would require:

- Interruption of military operations in the area.

- Clearance of unexploded ordnance in areas selected for exploration.

- Surface and subsurface exploration to evaluate the existence of the fault and its relationship to Quaternary deposits.

Because of these operational difficulties, it is expected that the evaluation of the Las Pulgas fault would represent a very significant problem for any nearby proposed nuclear power plant site. The fault could preclude siting in the area if additional investigations could not be performed or if the fault is determined to be capable.

4.2.3.4 Las Flores Lineament. Las Flores Creek and Las Pulgas Canyon form a distinct topographic alignment evident on LANDSAT imagery and high-altitude aerial photography. Although this lineament has not been recognized in the field as a fault, it coincides with geologic discontinuities that suggest a fault may be present:

- Outcrop area of the San Onofre breccia appears to be offset several hundred feet to the left across this alignment.

- Faults apparently aligning across lower Las Pulgas Canyon have been interpreted to have opposite senses of movement (Campo, oral communication, 1976).

- Las Flores Creek coincides with abrupt changes in the width of the coastal plain, the number of marine terraces present, and the degree of dissection of terraces at equivalent elevations.[46]

- There is a marked difference in the predominant trend of photolineaments on the lower marine terraces north and south of Las Flores Creek.

- Bedrock exposed underlying marine terrace deposits has markedly different lithology and structure on opposite sides of Las Flores Creek.

Taken together, these factors suggest that a fault trends northeastward along the Las Flores lineament. Differences in the elevations and other characteristics of marine terraces on opposite sides of this lineament could be interpreted to indicate that significant movement may have taken place within the past 500,000 years, suggesting presence of a capable fault. However, because the available geologic literature does not address the existence or age of movement along this feature, it is not considered a proven capable fault for this study.

Evaluation of whether the Las Flores lineament is a capable fault would require detailed geologic mapping of the area along its trend along Las Flores Creek and through Las Pulgas Canyon. Based on the results of this mapping, subsurface and/or geophysical exploration programs might be planned. Detailed correlations of the marine terraces on opposite sides of the Las Flores lineament would be necessary to evaluate whether multiple movement had occurred during the past 500,000 years. Existing data indicate that such correlations may be inconclusive and subject to alternate interpretations. Because the lineament coincides with a major drainage channel in which terrace deposits have been removed by erosion, it appears unlikely that any associated fault could be found overlain by undeformed strata demonstrably older than 35,000 years. As a result, it may be very difficult to determine conclusively whether the Las Flores lineament is or is not a capable fault, in which case it would have to be assumed to be capable.

4.2.3.5 <u>Onshore Extension of the Rose Canyon Fault.</u> Offshore geophysical studies[42] for the San Onofre site concluded that the Rose Canyon fault curves northward and projects onshore near Oceanside. From this location, it was extended northward to at least the south end of DeLuz Creek on the basis of reconnaissance geologic mapping.[47] The U.S. Geological Survey[36] disagreed with this interpretation and found that the Rose Canyon fault probably continues northwestward and connects with the South Coast Offshore fault.

The only evidence presented to date for Quaternary movement along the proposed onshore extension of the Rose Canyon fault was fault juxtaposition of stream terrace gravels against granite in a quarry cut west of O'Neill Lake. A recently published geologic guidebook to Camp Pendleton[48] casts doubts on this interpretation and suggests that the gravels are in depositional contact with the granite, rather than in fault contact.

Evaluation of the onshore extension of the Rose Canyon fault during the present study included:

- Review of aerial photographs (at various scales) and LANDSAT imagery.

- Reconnaissance examination of exposures along the postulated fault trend.

- Careful examination of the quarry cut exposure.

From this limited investigation, it appears that there is no positive evidence for Quaternary movement along this fault trend. However, the trend is marked by prominent topographic lineaments, suggesting existence of some tectonic structure not necessarily of geologically young age. Based on the available data, the onshore extension of the Rose Canyon fault is considered likely to be pre-Quaternary in age. Significance of this structure for any proposed nuclear plant site would have to be determined from an in-depth investigation and evaluation of onshore and offshore data.

4.2.3.6 Stuart Mesa Fault. A geologic map of Camp Pendleton, on file at the Marine Base (Campo, unpublished data), depicts a northwest-trending fault cutting Quaternary terrace deposits in upper Newton Canyon and Aliso Canyon. (This previously unnamed fault is informally designated the "Stuart Mesa fault" for the present discussion). A brief field inspection of these two locations found that the fault is not exposed at the ground surface, although the observed geologic relationships suggest its existence. San Onofre breccia is observed structurally overlying siltstone mapped as geologically younger San Mateo Formation. The mapped fault trace also coincides with photolineaments and irregularities in drainage patterns on a Quaternary terrace. The relationship of the fault with overlying terrace deposits is not apparent from surface exposures observed in the field and is not represented consistently in the available literature. Published maps[29] do not depict this fault as cutting the Quaternary terrace deposits. Because of the inconsistency in the available literature, the Stuart Mesa fault is not considered a proven capable fault for the present study. Determination of whether it is a capable fault would require detailed geologic mapping along its trace, followed by subsurface exploration to establish the relationship of the fault to the terrace material.

4.2.3.7 Minor Breaks in Quaternary Terrace Deposits. A few minor faults, having vertical separations of a foot or less, are exposed cutting marine terrace deposits along the coastline within about a mile north of Las Flores Creek (Figure 4-7). Because these features are exposed only on steep slopes within canyons eroded in the sea cliff, their extent along strike and any possible relationship to larger structures could not be determined during the present study. Evaluation of these displacements would require large-scale geologic mapping and possibly extensive subsurface exploration.

4.2.4 Seismicity

In the vicinity of Camp Pendleton, seismicity is sparse, consisting of scattered earthquakes smaller than magnitude 4. The greatest concentration of seismicity in the region is along the northern portion of the Santa Monica-Baja California zone of deformation. In this northern portion numerous earthquakes have been recorded, up to magnitude 6.3 (1933 Long Beach earthquake). Seismicity has not been reliably associated with any of the other faults on or directly adjacent to the Camp Pendleton Marine Base.

The characteristics of vibratory ground motion at a specific location are the result of:

- The size and mechanism of the earthquake.
- The distance from the earthquake to the site.
- The travel path of the seismic waves.
- The regional and local geology.

For the San Onofre Nuclear Generating Station Units 2 and 3, the maximum vibratory ground motion was established as 2/3 g for a postulated earthquake of Modified Mercalli intensity X occurring on the Santa Monica-Baja California zone of deformation.[36] Since the zone of deformation parallels the coast approximately 5 miles offshore, it is anticipated for this study that if other sites along the Camp Pendleton coast south of San Onofre could be licensed, a similar design acceleration could be applicable. For those candidate sites located inland, the ground motion levels from earthquakes on large offshore faults likely would be slightly less; however, smaller inland faults closer to potential sites, if found capable, could influence the design acceleration. Design accelerations for candidate sites would have to be determined from a site-specific investigation involving detailed geologic and seismologic studies. However, it appears that there are no sites at Camp Pendleton, either on the coast or inland, that at this stage of investigation could be positively identified as having a beneficial advantage because of a clearly lower design basis earthquake.

4.2.5 Summary of Geologic/Seismologic Conditions

Geologic/seismologic conditions in the Camp Pendleton area are not favorable for nuclear power plant siting, although the data available at this time do not absolutely rule out siting. Unfavorable conditions include: (1) proximity to a large number of suspected capable faults, (2) limited extent of undeformed, datable stratigraphy, and (3) anticipated high levels of vibratory ground motion.

Several suspected capable faults are in or adjacent to Camp Pendleton. The Santa Monica-Baja California zone of deformation, a major fault system believed to be capable of generating large earthquakes, lies about 5 miles offshore of Camp Pendleton. The Las Flores lineament is suspected of being a capable fault. There is some evidence suggestive of Quaternary movement along the Las Pulgas fault, Stuart Mesa fault, and the minor breaks in terrace deposits along the sea cliffs. These would require detailed investigations to determine whether they are capable faults. The area also contains two probable pre-Quaternary faults of significant extent, the postulated onshore extension of the Rose Canyon fault and the Cristianitos fault. In consideration of the geologic/seismologic setting of the Camp Pendleton area, it is likely that detailed geologic investigations (as would be performed in the area of a proposed nuclear power plant site) would identify additional suspected capable faults. In general, areas in which several geologically young faults have been mapped are likely to contain additional, unmapped faults of similar age.

There is greater likelihood of previously unknown capable faults being discovered during investigations in coastal areas, such as Camp Pendleton, than in inland areas. Investigations of offshore geologic structure generally are based heavily on interpretation of geophysical data supplemented by few, widely spaced drill holes or seafloor samples. Therefore, their results are not as definitive as on-land studies, in which geologic structures usually can be observed directly. Because of this lower level of confidence in existing data, there is a greater likelihood that new investigations may identify previously unknown structures in offshore areas which have not been investigated in detail. Furthermore, alternate interpretations may be developed readily from identical data, as discussed in the U.S. Geological Survey evaluation of the San Onofre site.[36]

Within the Camp Pendleton area, stratigraphy suitable for evaluating minimum age of fault movement is present as marine terrace deposits along the coast and as alluvial terrace deposits along major stream drainages. These exposures are of limited extent and other areas do not appear to have stratigraphy suitable for evaluation of fault capability. The most extensive terrace deposits at Camp Pendleton are about 120,000 years old. Other, fragmentary deposits, are believed to be older than these but younger than 500,000 years. These deposits are of sufficient age for the criteria defining capable faults by single displacements, but strata older than 500,000 years generally are more desirable for evaluation of fault capability.

Vibratory ground motion levels are anticipated to be high throughout the Camp Pendleton area, probably in the same range as design levels at SONGS Units 2 and 3. This level of vibratory ground motion (2/3 g) is significantly higher than at most nuclear power plant sites and would result in increased costs of engineering and construction.

4.2.6 Excluded Areas - Geology/Seismology

As discussed in Section 3.2.2, the NRC position is that areas within 5 miles of capable faults usually are not suitable for nuclear power plant sites even though the criteria do not specifically preclude siting in such areas. It is very unlikely that a site could be licensed successfully in these areas, and they normally are excluded from further consideration in regional site selection studies. However, there are some questions as to whether suspected capable faults on Camp Pendleton actually are capable. Areas within 5 miles of these faults have not been excluded in the present study because they may be proven acceptable by further, more detailed investigations. As indicated by the shaded areas on Figure 4-8, nearly all of Camp Pendleton is within 5 miles of one or more suspected capable faults. If these faults cannot be proven to be not capable, it would be unlikely that a site could be licensed in most of the Camp Pendleton area.

In addition, present NRC practice precludes locating a plant on the surface trace of a fault. Faults presently mapped on Camp Pendleton are shown on Figure 4-7. However, more detailed investigations could uncover additional fault traces that also would have to be excluded.

4.3 HAZARDOUS OPERATIONS

Within the boundaries of Camp Pendleton there are many activities which might be considered as potentially hazardous to a nuclear power plant. Hazardous operations include aircraft bombing and strafing; ammunition storage; military personnel and equipment training maneuvers involving live ammunition; helicopter personnel drops, commercial airways, military airfield operations; and petroleum and gas pipelines. However, the base is large and, depending on the proximity of the activity to a plant, the existence of the activity on or near the base may not present a hazard which precludes siting of a plant there. For example, the distance to the hazard may be sufficiently great, or the probability of an accident occurring so low that the operation would not be a threat to a plant. Further, plant safety could be insured by including the accident conditions in the design bases for the plant.

4.3.1 Maneuver Areas and Impact Ranges

The major portion of Camp Pendleton is used for amphibious assault exercises, maneuvering, firing ranges, and impact zones.[6] Amphibious training exercises begin at four well defined beaches along the Pendleton coastline as noted in Figure 4-9. Eight vehicle crossings along the coast under Interstate Highway 5 provide access to a network of tactical roads and interior maneuvering terrain. Las Pulgas and Aliso canyons are frequently used. Large scale assault training is conducted at Red Beach, with smaller exercises taking place at Green Beach and Blue Beach. White Beach is utilized primarily for tracked vehicle training. Plant locations in immediate proximity to the beach landing areas would be subjected to heavy surrounding military activities and, although no live ammunition is fired in these areas, it would be desirable not to propose a plant location which would require significant or considerable modifications to Marine activities in the area.

The entire complex is used for many types of maneuvering including helicopter operations, offensive and defensive combat, tank-infantry attack, and mechanized infantry attack. These maneuver areas are designated on Figure 4-9.[49] Generally, within the maneuver areas, no firing of arms is permitted. However, there are a limited number of designated small arms firing ranges within the maneuver areas. These are located in Figure 4-9 and are as follows:[50]

Range	Use
107	Skeet and Trap (Shotgun)
200	Infiltration (No Weapons)
206	Quick Fire (M-16 Rifle, 50 Meters)
207	Demolitions (1/2-Pound Charges)
215	Offensive Combat (Rifles, 150 Meters)
233	Demolition (100-Pound Tamped Charges)
300	Zeroing Range (Rifles, 15 Yards)
401	Ordnance Disposal (40 Pounds)
403	Police Pistol and Shotgun (50 Yards)

Nuclear plants located in the maneuver areas would not be subjected to significant hazard from stray firing of small arms. The small size of the individual ranges should not present a problem in locating plants to avoid them. However, their relocation appears feasible if needed to qualify a plant location.

Designated impact areas are used for the delivery of ordnance or the frequent conduct of training involving the use of high explosives. Tank ordnance is up to 105 millimeters and artillery ordnance up to 155 millimeters in size. The impact areas are identified in Figure 4-9 as Sierra One, Sierra Two, Whiskey, Zulu, XRay, and Edson Range. Edson is used for high powered rifles and pistols. XRay is used in the firing of rifles (maximum range of 1,800 meters), grenades, machine guns, and rocket launches. Sierra One and Sierra Two are used for firing rifles, infantry weapons, machine guns, and mortars (maximum range 2,500 meters). Whiskey and Zulu are used for firing rifles, machine guns, rockets, and mortars (maximum range 4,000 meters at Whiskey; 5,500 meters at Zulu). Firing positions into these impact areas are from the inside perimeter of the impact areas. Operations cease between midnight and 6 am.

4.3.2 Military Aircraft Operations

There are two restricted air spaces, R-2503 and R-2533, over Camp Pendleton as shown in Figure 4-10.[49] Restricted Area 2503 overlays the larger portion of the base and extends up to 15,000 feet in elevation. Contained within this space projection are the Whiskey Aircraft Bombing and Strafing Range and the Zulu impact areas. In addition to ground-fired ordnance, these areas are used for aircraft operational training and for close air support in troop training missions. The air activities include strafing, low level fire bombing, rockets, dive bombing, glide bombing, low level bombing, and radar controlled bombing by A-4, A-7, and F-4 aircraft. Live ordnance up to 500 pounds may be dropped from these aircraft into the impact areas.

Attack aircraft operating in R-2503 maintain a flight pattern within the zone while over the base. They are permitted to make firing runs on any magnetic heading of 080 degrees through 140 degrees in the Whiskey impact area and any magnetic heading of 030 degrees through 300 degrees in the Zulu impact area. Ordnance carrying aircraft are not permitted to fly over permanent camp sites, housing areas, or the hospital, nor to maneuver in a manner which could endanger these areas.

The military jet aircraft are generally based at the Marine Corps Air Station in El Toro, but sometimes they are based at a number of other locations including aircraft carriers standing offshore. When using the impact areas, aircraft flight paths usually are a takeoff from

El Toro to the north and east, a right turn, and an approach to the impact area at Camp Pendleton to coincide with the restricted headings over the impact areas. Turnouts from the impact areas are to the north or northeast. After the missions, these aircraft climb up to between 10,000 and 15,000 feet, fly over the Marine Corps Auxiliary Landing Field at the base, head seaward and turn right, or northwest, and then fly a straight landing pattern over Dana Point into El Toro.

The fixed-wing aircraft are also used without ordnance to support maneuvers in the coastal area. In those operations the flight patterns from El Toro are out to sea and approaching the complex in an easterly or northeasterly direction, but at an altitude below 2,000 feet, the ceiling on military traffic operating in R-2533. These flights approach Pendleton approximately 5 miles south of the northwest Camp Pendleton boundary line. Flights from offshore carriers enter the Camp Pendleton area similarly. However, flight patterns into the area do vary, depending on the base from which the aircraft comes and the specific mission it is to perform.

It is reported that overflight restrictions near a power plant in the coastal zone would cause hardship in fulfilling flight missions, particularly those which support landing maneuvers from offshore.

Helicopters are used with and without ordnance. From Santa Ana and elsewhere offbase these helicopters are AVH-3, CH-53, and CH-46. Camp Pendleton based aircraft are AH-1J and UH-1E helicopters and twin turbo prop OV-10. Helicopters with ordnance operate only in the impact areas. These aircraft generally are stationed at the Marine Corps Auxiliary Landing Field at Camp Pendleton to reduce the hazard of flying with live ordnance. Flight patterns for the live ordnance missions generally are from the field directly into the R-2503 area from the southeast.

Simulated close air support and observation operations without live ordnance may be conducted by any of the named types of aircraft and in any of the maneuver areas at the base. Most of the air traffic is by helicopters. However, Restricted Area 2533, Figure 4-10, extending along the coast from San Clemente to the Camp Del Mar area, restricts the military air activities in those areas to an elevation below 2,000 feet and 3 miles seaward.[50]

Air traffic from the Auxiliary Landing Field generally is directed to the coastline after takeoff although some light aircraft turn earlier within R-2533.

Transport and utility air missions are conducted. They include the transportation of personnel, vehicles, and cargo to destinations inside or outside Camp Pendleton or photographic and other aerial reconnaissance missions by fixed or rotary wing aircraft.

Additionally, there are parachute and paradrop missions performed, dropping or releasing personnel, cargo, illumination, and other items. These impact onto designated drop zones located throughout the base as noted in Figure 4-9.

Helicopter landing sites located throughout the base are also shown on Figure 4-9. These are used for administration of base activities. In addition, there are confined area landing sites for the training and practice of support helicopter pilots.

The Camp Pendleton Special Use Airspace Report indicates that during this 1-year period ending with September 30, 1976, there were a total of 15,080 aircraft hours of use in airspace R-2503 and 7,250 aircraft hours of use in R-2533.

Nuclear plant sites located in the approach or departure paths of armed aircraft heading toward bombing or strafing impact zones on the complex would be subjected to the risk of premature, late, or accidental ordnance release from the aircraft and the impact of the aircraft itself. Siting locations in these paths might be unacceptable for licensing. The helicopter operating areas at Camp Pendleton are so broad that it is probable a plant located in most of the areas of the base would be subjected to the risk of helicopter impact. This would have to be studied in detail when a particular site is chosen.

Further, fixed-wing military aircraft can be expected to operate over most of the base, although they represent substantially less traffic than helicopters. These aircraft are not permitted to carry live ordnance approaching impact zones from any but the specified routes. However, their potential presence almost anywhere at the complex must be studied to determine if they represent a sufficient hazard as to require inclusion in the plant design bases.

In the past, proposed locations for plants near areas of heavy military flight activities such as the Boardman site in Oregon have been extensively evaluated by the NRC. In the Boardman case, NRC indicated that additional protection would be necessary to lower the probability for damage such as earth berms around the plant to reduce the effective target for low angle approaches. In other cases such as Seabrook in New Hampshire and Douglas Point in Maryland, plant design was evaluated to assure safe shutdown could be achieved following aircraft impact.

Therefore, it is considered that plant locations outside the impact zones are feasible; however, it will be necessary to determine what plant features may be required to assure that potential accidents associated with aircraft will not result in unsafe plant operation. A cost/benefit analysis must be performed for these additional features in conjunction with the costs and advantages of the potential location to determine if the plant location is viable.

4.3.3 Marine Corps Auxiliary Landing Field (MCALF)

The Auxiliary Landing Field is under the operational control of the Marine Corps Air Station at El Toro. It has a single runway, heading 030 degrees to 210 degrees and is 6,000 feet long. Air operations within 5 miles of the airport are controlled from the control tower. MCALF has deficiencies in airfield and obstruction lighting, limited fuel storage capacity, and parking facilities, which account for the limited number of aircraft at the field. Most operations necessarily are daytime, ceasing at 10 pm.[6]

About 10 to 15 fixed-wing aircraft (OV-10 twin turbo prop) and 30 to 40 small helicopters are presently based at MCALF. These are seen in Figure 4-11. Up to C-130 size cargo aircraft also land there. A total of about 7,000 operations occur each month, or 80,000 to 90,000 per year. The normal landing pattern by fixed-wing aircraft is a pattern from northeast over the Fallbrook area. However, OV-10 aircraft used in landing approach, touch-and-go training at MCALF approach the field from the north-northwest. Takeoff is to the southwest out to the Oceanside VORTAC located on the beach a few miles north of Oceanside. From there the pattern for Camp Pendleton air traffic is usually a right turn and flight parallel to the beach within the 2,000-foot high restricted air zone (R-2533), remaining away from the coastal mountains and transmission lines in the area. Training flights turn right before the coastline and circle back to the north. These paths reverse during periods of wind reversals.

Plant locations in the takeoff pattern from MCALF were excluded for a width of about 1,000 yards each side of the pattern to reduce the potential hazard. Further, aircraft accident analysis is required by NRC when a nuclear plant is located closer to the field than 5 miles, or if the airfield has projected annual operations greater in number than 500 d^2, where d is the distance to a plant within 10 miles, or greater in number than 1,000 d^2 beyond 10 miles. With an annual traffic at MCALF of 80,000 to 90,000 operations, plants located at distances less than 10 miles from the field (< 100,000 operations per year) would require such an analysis. It is expected that this analysis would indicate that accident probabilities are below 10^{-7} per year per unit for potential locations studied in this report.

Assuming that a plant could be designed to withstand the impact of a helicopter or other aircraft, and considering that most of the air operations from MCALF are helicopter traffic, plant locations further than 5 miles from the field may not be required to have an analysis of other larger and faster aircraft impacts. All locations beyond 5 miles from the plant are considered to have about the same probability of accidents with respect to aircraft operations associated with MCALF.

4.3.4 Commercial Airways

Several federal airways 8 nautical miles wide overlay a portion of Camp Pendleton as shown in Figure 4-10. These are used for commercial and general aviation.[51,52] Victor 23 from Dana Point intersection to Oceanside (VORTAC) covers the southwestern portion of Camp Pendleton adjacent to and outside of R-2503. The centerline of Victor 27 from Los Angeles intersection to San Diego is located about 12 nautical miles offshore from the base. Victor 208 extends from Oceanside westerly to Santa Catalina Island. These three airways are low altitude routes with traffic up to 18,000 feet altitude. A high altitude airway, J-1, is located similarly to V-23 over the coastline, but on a heading of 294 degrees out of Oceanside, while V-23 has a heading of 301 degrees.

The Federal Aviation Administration[53] indicated that last year's peak day traffic for IFR flights in those airways was 163 flights per day, or about 50,000 to 60,000 flights per year. These flights are primarily military and commercial, with perhaps two-thirds of them commercial flights. El Toro control for those airways reports an estimated total of 100,000 to 120,000 flights per year, based on a combination of radar and visual sightings for all aircraft. This would seem to indicate that general aviation accounts for about half the total traffic in the area. Although aircraft have been observed above 2,000 feet over R-2533 at Camp Pendleton, most of the air traffic has been observed in the offshore portion of the airways.

Some plants located near heavy commercial or general aviation traffic have been evaluated and found capable of withstanding aircraft impact. For example, Three Mile Island was designed for impact by a B-720 commercial aircraft and Zion was designed to withstand impact by general aviation aircraft.

Plant locations within 5 miles from the centerline of Federal airways may be subject to detailed accident probability analysis in the licensing process. Based on evaluation of aircraft accident statistics, the probability of aircraft accidents decreases exponentially with increased distances from airway centerlines. Therefore, plant locations further from the centerline of airways are preferable. However, it is not anticipated that commercial air traffic is extensive enough at the complex to require inclusion of a large aircraft impact in the plant design at any location. The potential hazard from airway traffic would be further reduced if a proposal by the Marine Air Station to FAA is approved whereby the airways would be moved seaward to permit R-2503 to extend 3 miles offshore of the coastline and to delete R-2533. This would result in a restricted area up to 15,000 feet and preclude general aviation along the coast.

4.3.5 Storage and Transportation of Hazardous Materials

There are two ammunition and weapons storage areas to be considered. The first is a large storage facility located in the Naval Weapons Station, Fallbrook Annex, which is on the eastern edge of the Pendleton complex. The Annex is a satellite station of the Seal Beach facility.

Ordnance is stored throughout the Annex in igloos in accordance with Department of Defense standards. These standards set minimum spacing requirements for each storage unit as a function of the type and maximum amount of ordnance stored in the unit. On that basis an accidental detonation in one facility will not affect the other units nor populated areas in close proximity to the facilities.

The closest populated areas to the Annex storage facilities are the Naval Station living quarters, the Fallbrook community, and the Camp Pendleton Headquarters area. The proximity of these populated areas to storage facilities varies between one-half and one mile. Nuclear plant locations no closer to the Annex than 1 or 2 miles would probably be acceptable. Therefore, these storage facilities do not pose an unacceptable hazard to nuclear plant locations being considered.

There also is an ammunition storage facility at Camp Pendleton near Pulgas Camp. It serves the missions being performed at the base. Ammunition is stored in underground bunkers in the area. Their location at about the center of the base would pose a potential hazard which would have to be examined for nuclear plant locations in close proximity to that storage facility. However, plant locations further than about 1 mile from the storage facility probably would be unaffected by a detonation there.

Ordnance shipments are by rail or road. Rail shipments are via the Atchison, Topeka, and Santa Fe Railroad which roughly parallels Interstate Highway 5 and has a branch line which parallels Vandegrift and Fallbrook Roads to access the Annex and the Fallbrook community. The rail shipments include liquid propane gas and ammunition. Flammable liquids and gases, compressed gases, petroleum products, solvents, and miscellaneous chemicals are carried by trucks on Interstate Highway 5. Studies[19] of the area have shown that probabilities of accidents in these modes are less than 10^{-7} per year and that overpressures and missiles from explosions are not hazardous at relatively close distances, due to the limitations on quantities being shipped. Depending on the power plant locations being considered, those which might be in very close proximity to the rail and road routes may have to be examined for the impact on the plant of an accidental ordnance detonation in the transportation mode. Locations immediately adjacent to these routes would have to be examined during the licensing process for accident consequences in accordance with guidelines.[54] However, locations beyond one-quarter mile will essentially be unaffected.

4.3.6 Gas and Petroleum Lines

There are three main fuel transmission line systems which pass through Camp Pendleton.[55] One is a 10-inch diameter petroleum line adjacent to and paralleling Basilone Road, as seen in Figure 4-9. This line, owned and operated by San Diego Pipeline Company and Southern Pacific Pipe Lines, Inc., carries any of several liquid petroleum products. This line is buried about 30 inches and is pressurized to 1,440 psi. Flow automatically stops when there is a pressure drop. This line could pose a hazard to a nuclear plant located in close proximity to the line under a condition whereby the line is ruptured and fuel is spilled and ignited. Depending on the topography between the plant and the spill source, a plant might be subjected to explosion and fire hazards, particularly if the slope of the terrain encourages fuel drainage towards the plant. Otherwise, it is anticipated that a plant located further than one-half mile or so from the line would not be subjected to a hazard that would preclude its location there.

There is a 12-inch diameter natural gas transmission line extending across the base at a location approximately paralleling and adjacent to Interstate Highway 5. The line is buried 30 inches and is pressurized to 400 psi. A break in this line could pose a missile and overpressure hazard to a nuclear plant located in close proximity to the line. Further, a break in the line could release gas which might enter ventilation intakes and affect control room personnel. A diffusion analysis would have to be performed to determine if a potential hazard would exist at plants in close proximity to the line and, if so, this could require special plant safety features or possible relocation of the line to reduce the hazard. For site evaluation purposes, it can be assumed that plants located no closer to the line than about one-quarter mile would be acceptable. (Shorter distances are shown in the FSAR for San Onofre Nuclear Generating Station to be within acceptable plant design limits.) For closer locations, the impact would be one of cost, with the greater cost for line relocation or plant protection.

A 6-inch natural gas system is used to feed gas to distribution lines on the base. It is owned by San Diego Gas & Electric Company. One line runs from the coast highway main near the beach club, and then paralleling Basilone Road, serving San Mateo Camp and Pulgas Camp. Another line feeds the eastern portion of the complex from the Oceanside/Fallbrook areas. The lines are buried 36 inches and are pressurized to 200 psi. Plants located greater than about one-quarter mile from these lines would not be subjected to undue hazards.

4.3.7 Fires

Live ordnance and pyrotechnics used in training exercises are the cause of fires in many areas of the complex. Over the past 10 years, the number of brush fires has averaged 410 per year. Most areas which were burned were held to less than 100 acres each occurrence. This was the result of active firefighting crews at the complex. In 1975 one fire encompassed 5,200 acres. Thus, fires can present a hazard. However, because the fires are mostly started from training activities which involve live ordnance, the hazard greatly diminishes with increased distance from the impact areas. One of the mitigations to eliminate the hazard could be to clear the area immediately surrounding a plant of combustible materials.

4.3.8 Excluded Areas - Hazardous Operations

The areas which are subject to concentrated military ground traffic, such as exist near the beach landing areas, firing ranges, and impact areas, are excluded from further consideration. Maneuver areas could be acceptable, provided that locations near firing ranges are excluded. These are seen in Figure 4-12.

Considering that high speed, armed aircraft enter the impact areas from the northwest and normally turn to the north or northeast after releasing their fire or payloads, locations within those normal approach and departure zones should likewise be excluded from consideration.

Helicopter landing areas will be subject to concentrations of helicopter activity. Drop areas represent a similar situation. Both types of areas might be relocated if necessary to reduce a potential hazard for a specific site. However, there are few helicopter landing areas and drop zones outside of excluded areas. These are not shown as excluded areas at this time, but would be considered for relocation if, at a later date, specific plant sites would interfere with their continued use.

An area about 1 mile around the Camp Pendleton ammunition storage facility is excluded due to the potential hazard to a nuclear plant.

Other areas can be considered with the reservation that helicopter and fixed-wing military aircraft traffic at the base is high and may be cause for designing certain portions of a plant for their impact. Also, portions of commercial and general aviation airways are over the base and a detailed accident analysis would be required.

4.4 IDENTIFICATION OF CANDIDATE SITING AREAS

4.4.1 Physiography and Related Criteria

The criteria established at the start of the study included a limitation of about 400 feet in elevation and a distance of 5 miles from the shore. This was related to an examination of areas in light of the relatively high capital and operating costs for pumping large quantities of ocean water greater distances and elevations in a once-through cooling system. This cost is further discussed in Section 5 of the report.

In general, the Pendleton area includes about 17 miles of beaches and bluffs at the shoreline. There are 24,000 linear feet of beach in the vicinity of San Onofre Nuclear Generating Station and extending northward past the Orange County line. The shoreline south of San Onofre is characterized by sandstone or shale bluffs extending inland as much as several hundred feet from the ocean and up to about 100 feet in elevation. Small beaches are interspersed along the shore below the bluffs, with increased size in the vicinity of the Santa Margarita River.

As seen in Figure 4-13, marine terraces rise from the shoreline inland to the coastal ranges, meeting the hillsides generally from one-quarter to two miles in from shore.[56] The coastal range within the Camp Pendleton area varies generally from 1,000 to over 2,100 feet in elevation. Within an area 5 miles from the shore, the maximum elevation is over 1,600 feet. Much of that area is between 800 and 1,200 feet in elevation and contains numerous natural drainage paths and erosion features.

There are several canyons which extend through the hills to the shore. At the northernmost portion of Camp Pendleton, Talega Canyon joins Cristianitos Creek which intersects San Mateo Creek, an extremity of San Mateo Canyon. The San Mateo Creek marsh is a nontidal wetlands area and part of Camp Pendleton's natural resources conservation program.[57] San Onofre Canyon and South San Onofre Canyon join to form San Onofre Creek which reaches to the shore just south of San Mateo Creek. Las Pulgas Canyon, almost bisecting Camp Pendleton, passes through the coastal range, meeting Las Flores Creek which also has a nontidal wetlands at the shoreline. These wetlands are also part of the Camp Pendleton conservation program. Continuing south, Aliso and French canyons are smaller and extend to the shore area. The southerly most natural drainage area is the Santa Margarita River and its tributary DeLuz Creek. Both extend through the northeastern boundaries of Camp Pendleton. The mouth of the Santa Margarita is a tidal wetlands area, also a part of the conservation program. With the exception of the wetlands areas noted, the canyons and creeks carry water only during periods of heavy precipitation. Lake O'Neill, fed through a controlled bypass system from the Santa Margarita River, is a holding lake periodically drained to recharge the river basin.

The areas of Camp Pendleton which have elevations greater than 400 feet are shown in Figure 4-13. Although it may be desirable to be less exacting in regard to a 400-foot elevation cutoff contour, increases in elevation of 100 or 200 feet do not appreciably provide additional area for consideration within 5 miles of the shore due to the gradient generally existing in that area.

The areas which are within about 5 miles from shore and lie within the 400-foot elevation are the northerly reaches of San Mateo Canyon, inland reaches of San Onofre and South San Onofre canyons, Las Pulgas Canyon, Aliso Canyon, and northern reaches of the Santa Margarita River. Also, potential siting includes the terrace area which parallels the shoreline and has a width varying from one-half mile at the northerly end to two miles at the southerly end.

4.4.2 Candidate Areas

The areas in Camp Pendleton which have been excluded in the safety screening process, considering population, geology/seismology, and hazardous operations are shown on Figure 4-14. The figure also indicates areas which are not necessarily excluded but do not meet the criteria limitations on elevation and distance from shore; these areas could be further considered.

The candidate siting areas are represented by the remaining areas shown on Figure 4-14. They have been partitioned into 11 separate areas to aid in evaluating local differences. Some of these candidate areas are noted as being within 5 miles of suspected capable faults (the faults might be proven not capable by further detailed investigations). Seen in Figure 4-14, within each of the areas a site has been identified as typical for the area. The purpose was not to recommend specific sites, but to have a basis for providing distance or elevation values where required in the analyses in this section. However, the ratings which resulted from such site analyses are considered indicative of each site's respective area.

Included below for each siting area are the ranges in distance to the shore and in elevation, as well as the acreage available for construction. Additional acreage is available in each case to meet exclusion zone requirements.

Area	Distance From Shore (Miles)	Elevation (Feet)	Area Available for Construction (Acres)
San Mateo Canyon	4 to 5	180 to 400	360
San Mateo Hills	3 to 4	400 to 700	660
Santa Margarita	6 to 8-1/2	120 to 500	1,780
Pulgas Branch	4 to 4-1/2	200 to 400	200
Pulgas Lake	3 to 4	180 to 400	300
Las Flores North	1/2 to 2-1/2	80 to 400	1,930
Las Flores South	1/2 to 2-1/2	80 to 400	1,210
San Onofre Foothills	1/2 to 1	170 to 400	590
San Onofre Bluff	0 to 1/2	0 to 180	500
Las Flores Bluff North	0 to 1/2	0 to 140	480
Las Flores Bluff South	0 to 1/2	0 to 190	300

TABLE 4-1: CAMP PENDLETON PERSONNEL
September 1, 1976

Type of Personnel	Location	Number of Personnel
Military	Headquarters	3,839
	Del Mar	1,825
	Las Flores	1,098
	22 Area	2,744
	24 Area (Including MCALF)	2,485
	Edson	2,875
	Margarita	3,602
	San Onofre	1,548
	Pulgas	2,929
	Horno	4,318
	San Mateo	4,465
	NRMC	757
Total Military		32,485
Civilian	NRMC	381
	Dental Clinic	20
	MCTSSA	45
	MCK, Clubs, Special Services	1,487
	22 Area	1,400
	Other Areas	1 411
Total Civilian		3,744
Family Housing Units		
619 Units	Headquarters	1,860*
178 Units	Del Mar	535*
600 Units	San Onofre Quarters	1,803*
218 Units	O'Neill Heights	656*
1,082 Units	Wire Mountain	1,082*
474 Units	South Mesa	1,424*
148 Units	Mobile Home Park	445*
Total Family Housing Units		9,974

*Approximations.

TABLE 4-2: TOTAL CAMP PENDLETON POPULATION BY AREA

Location	Number of Personnel
Headquarters	5,699
Del Mar	2,360
Las Flores	1,098
22 Area	4,144
24 Area	2,485
Edson	2,875
Margarita	3,602
San Onofre	1,548
Pulgas	2,929
Horno	4,318
San Mateo	4,465
NRMC	1,158
MCTSSA	45
MCK, Clubs, Special Services	1,487
O'Neill Heights	656
Wire Mountain	3,251
South Mesa	1,424
San Onofre Quarters	1,803
Mobile Home Park	445
Other	441
Total	46,203

TABLE 4-3: AVERAGE POPULATION DENSITIES - 1990

Location	Cumulative Radial Distance - Miles					
	0-5	0-10	0-15	0-20	0-25	0-30
A	152	197	345	432	424	467
B	394	509	349	297	312	345
C	165	334	312	281	298	357
D	76	133	257	332	378	365

TABLE 4-4: AVERAGE POPULATION DENSITIES - 2030

Location	Cumulative Radial Distance - Miles					
	0-5	0-10	0-15	0-20	0-25	0-30
A	283	366	641	803	788	868
B	733	947	649	552	580	641
C	307	621	580	522	544	664
D	141	247	478	617	703	678

TABLE 4-5: POPULATION DENSITY BY SEGMENTS - 1975 | 1990

Location A By Segment	Cumulative Radial Distance - Miles											
	0-5		0-10		0-15		0-20		0-25		0-30	
	1975	1990	1975	1990	1975	1990	1975	1990	1975	1990	1975	1990
N	0	0	0	0	0	0	12	12	16	24	68	119
NNE	0	0	51	51	45	45	51	64	57	65	62	79
NE	0	0	0	0	0	0	25	38	49	73	96	186
ENE	0	0	0	0	0	0	12	25	16	24	11	28
E	0	0	0	0	0	0	51	76	41	57	34	45
ESE	0	0	0	0	113	113	178	216	138	163	113	147
SE	0	0	101	101	203	203	318	547	537	806	452	826
SSE	0	0	0	0	23	23	471	573	456	636	373	594
S	408	408	101	101	45	45	25	25	16	16	11	11
SSW	0	0	0	0	0	0	0	0	0	0	0	0
SW	816	816	203	203	90	90	51	51	32	32	22	22
WSW	408	408	153	153	68	68	38	38	24	24	17	17
W	204	816	662	916	294	407	165	229	106	146	73	102
WNW	0	0	662	1528	837	1833	738	1400	660	1206	690	1160
NW	0	0	0	101	882	2263	1095	2789	839	2950	1771	3662
NNW	0	0	0	0	22	430	25	827	24	562	73	475

TABLE 4-6: POPULATION DENSITY BY SEGMENTS - 1975 | 1990

Location B By Segment	Cumulative Radial Distance - Miles											
	0-5		0-10		0-15		0-20		0-25		0-30	
	1975	1990	1975	1990	1975	1990	1975	1990	1975	1990	1975	1990
N	0	0	0	0	0	0	0	0	24	24	39	45
NNE	0	0	0	0	0	0	12	25	16	24	45	73
NE	0	0	153	204	136	204	76	114	57	89	39	68
ENE	204	204	255	356	158	226	127	165	81	106	62	79
E	1428	1428	458	458	271	271	153	165	114	122	90	96
ESE	612	612	917	1120	543	702	369	598	448	660	328	475
SE	612	612	1018	1528	769	1245	568	1197	627	1206	543	1109
SSE	0	1020	611	1528	452	1335	496	1209	497	1116	441	1279
S	0	0	1834	1986	928	996	522	560	334	358	232	249
SSW	0	0	152	152	68	68	38	38	24	24	17	17
SW	612	612	153	153	68	68	38	38	24	24	17	17
WSW	204	204	51	51	22	22	12	12	8	8	5	5
W	0	0	0	0	0	0	0	0	0	0	0	0
WNW	816	816	407	407	226	249	165	178	114	130	79	90
NW	0	0	101	101	158	158	267	420	415	1075	702	1868
NNW	408	408	102	102	45	45	38	38	33	33	28	45

TABLE 4-7: POPULATION DENSITY BY SEGMENTS - 1975 | 1990

Location C By Segment	Cumulative Radial Distance - Miles											
	0-5		0-10		0-15		0-20		0-25		0-30	
	1975	1990	1975	1990	1975	1990	1975	1990	1975	1990	1975	1990
N	0	0	0	0	0	0	12	12	16	16	22	39
NNE	204	204	51	51	23	23	12	12	16	24	34	51
NE	408	408	102	102	90	90	63	76	40	49	34	45
ENE	612	612	306	306	317	384	229	280	155	187	107	130
E	108	408	713	815	407	475	267	318	195	252	136	175
ESE	0	0	255	968	747	1268	534	1019	521	953	600	979
SE	612	612	1375	1833	951	1516	662	1324	481	1051	430	1103
SSE	408	408	866	866	569	656	445	560	448	578	384	758
S	0	0	0	0	0	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	0	0	0	0
NW	0	0	102	102	271	385	471	789	530	1182	622	1335
NNW	0	0	305	305	204	204	115	115	228	472	475	1098

TABLE 4-8: POPULATION DENSITY BY SEGMENTS - 1975 | 1990

Location D By Segment	Cumulative Radial Distance - Miles											
	0-5		0-10		0-15		0-20		0-25		0-30	
	1975	1990	1975	1990	1975	1990	1975	1990	1975	1990	1975	1990
N	204	204	51	51	45	45	25	25	24	24	28	34
NNE	0	0	0	0	0	0	12	12	49	65	62	85
NE	0	0	0	0	0	0	12	12	8	16	23	45
ENE	0	0	0	0	68	90	51	76	32	49	22	39
E	0	0	0	0	158	204	140	165	106	130	85	102
ESE	408	408	662	662	656	724	560	674	407	538	413	566
SE	204	204	101	101	430	928	623	776	497	880	447	832
SSE	0	0	305	305	679	702	764	1031	603	1060	521	883
S	0	0	0	0	0	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0	0	0	0	0	0
WNW	0	0	153	153	68	68	38	38	24	24	17	17
NW	0	0	509	509	769	1313	840	1897	921	1907	832	2139
NNW	0	0	102	102	45	45	267	611	448	1361	328	1092

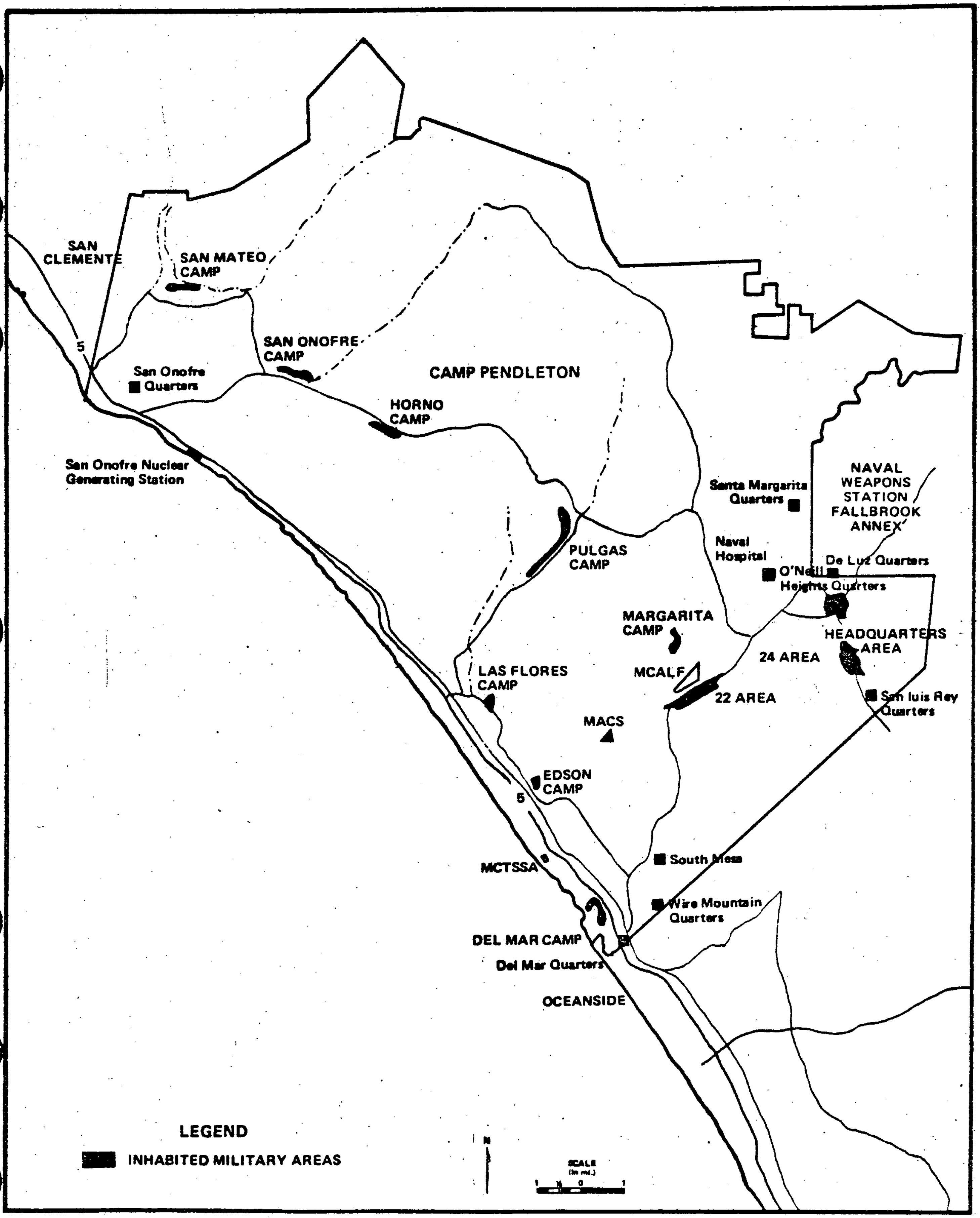


FIGURE 4-1: POPULATED AREAS WITHIN CAMP PENDLETON

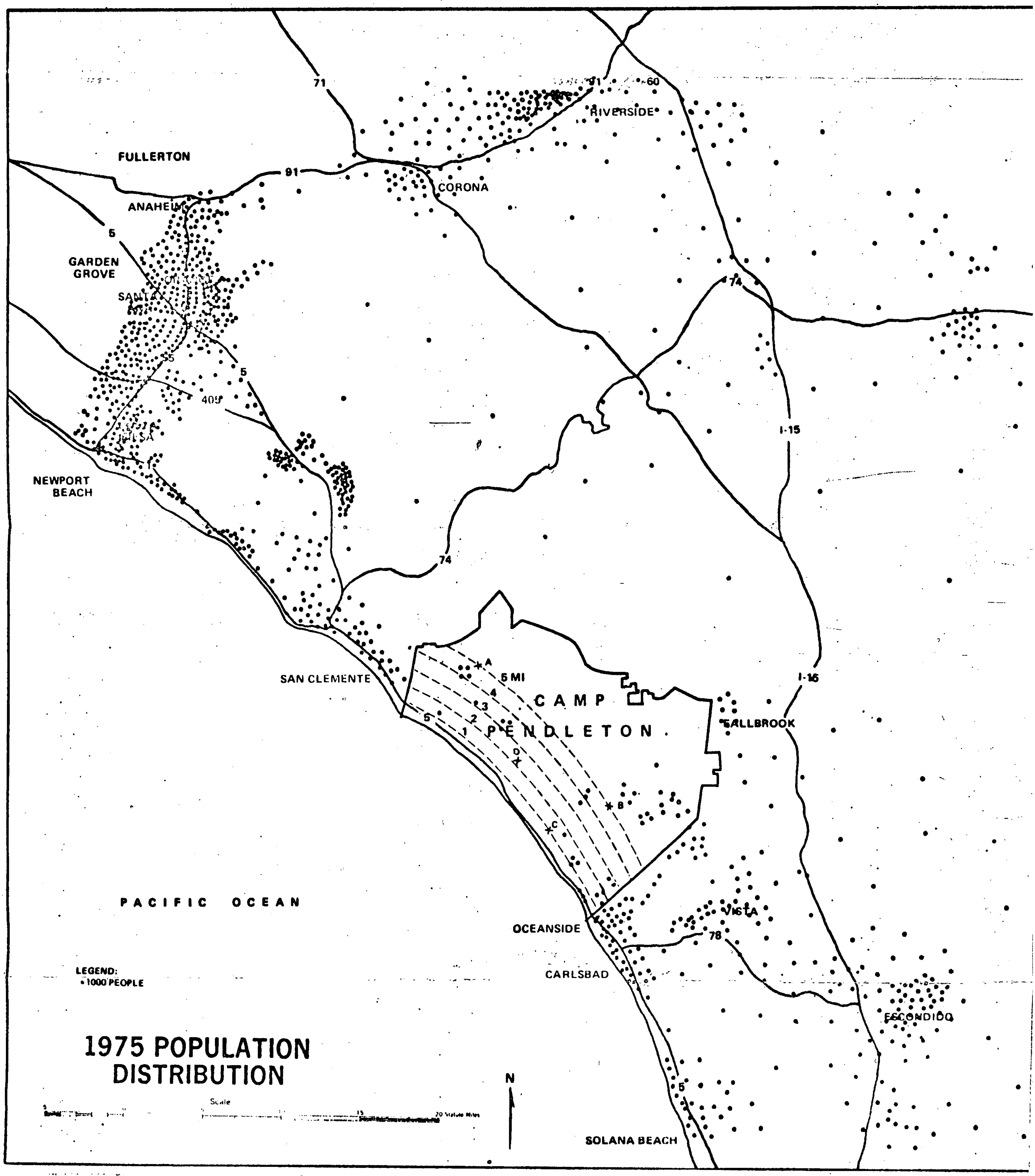


FIGURE 4-2: 1975 POPULATION DISTRIBUTION

FIGURE 4-2: 1975 POPULATION DISTRIBUTION

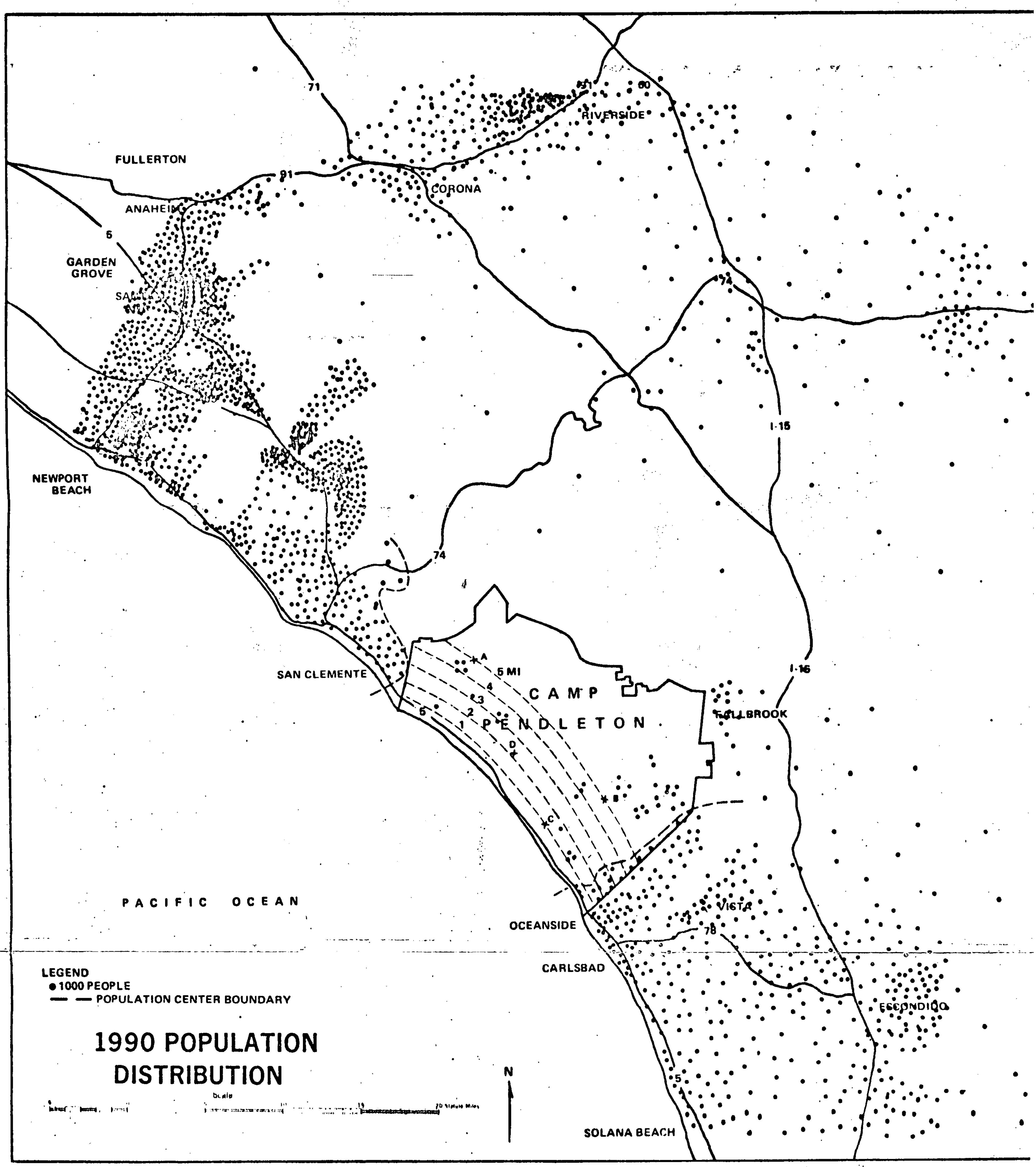


FIGURE 4-3: 1990 POPULATION DISTRIBUTION

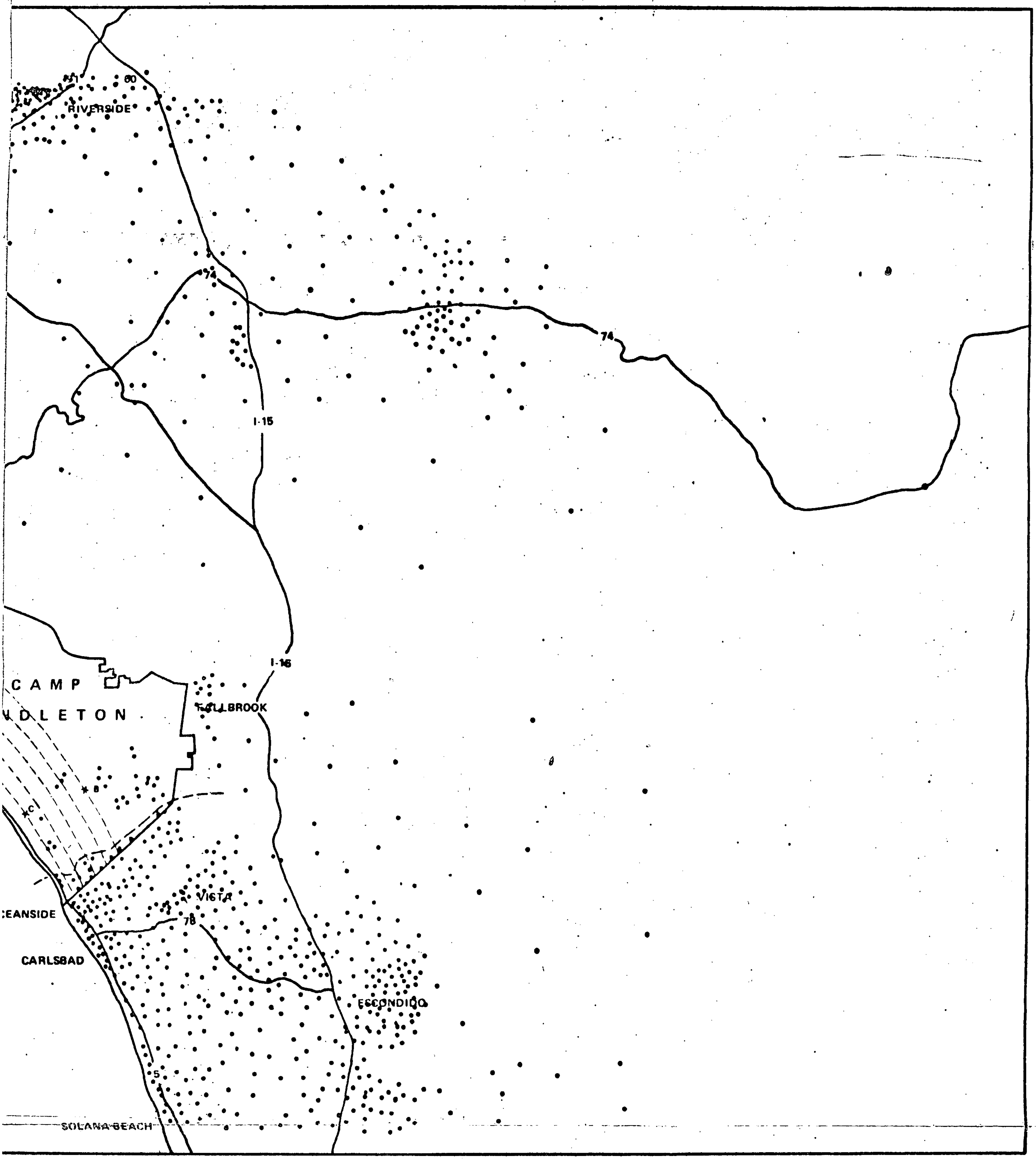
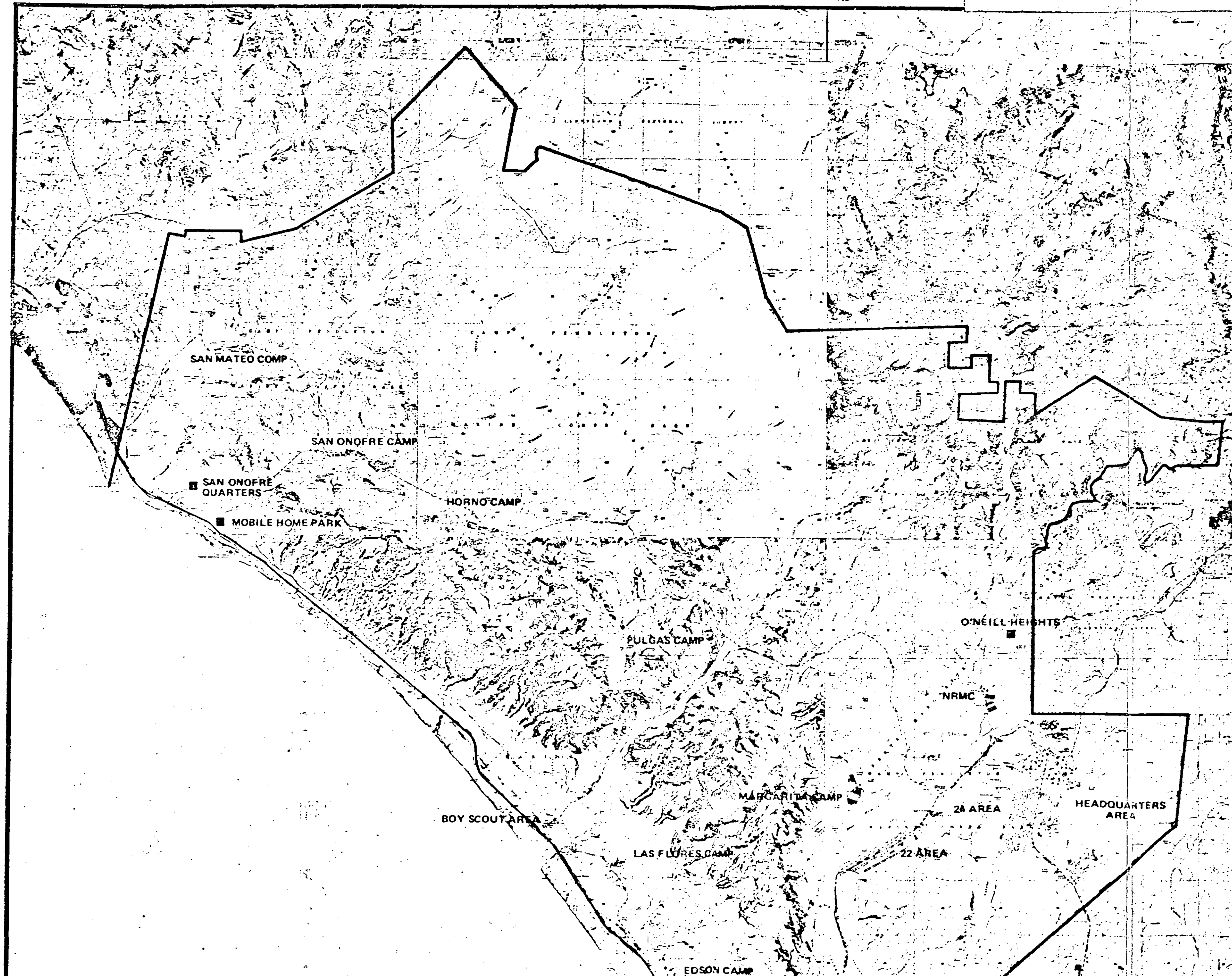


FIGURE 4-3: 1990 POPULATION DISTRIBUTION


SAN MATEO COMP
SAN ONOFRE CAMP
SAN ONOFRE QUARTERS
HORNO CAMP
MOBILE HOME PARK
PULGAS CAMP
O'NEILL HEIGHTS
NRMC
MARGARITA CAMP
24 AREA
HEADQUARTERS AREA
BOY SCOUT AREA
LAS FLORES CAMP
22 AREA
EDSON CAMP

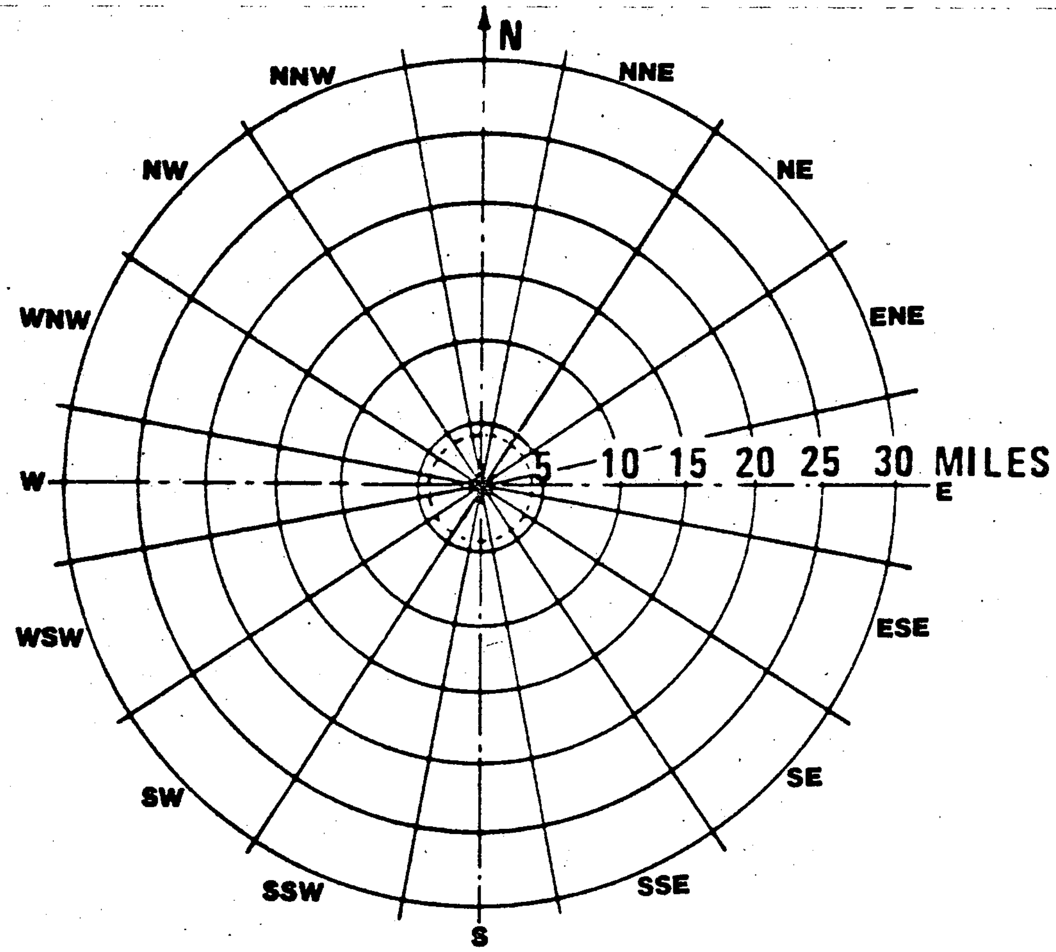


FIGURE 4-4: POPULATION TEMPLATE

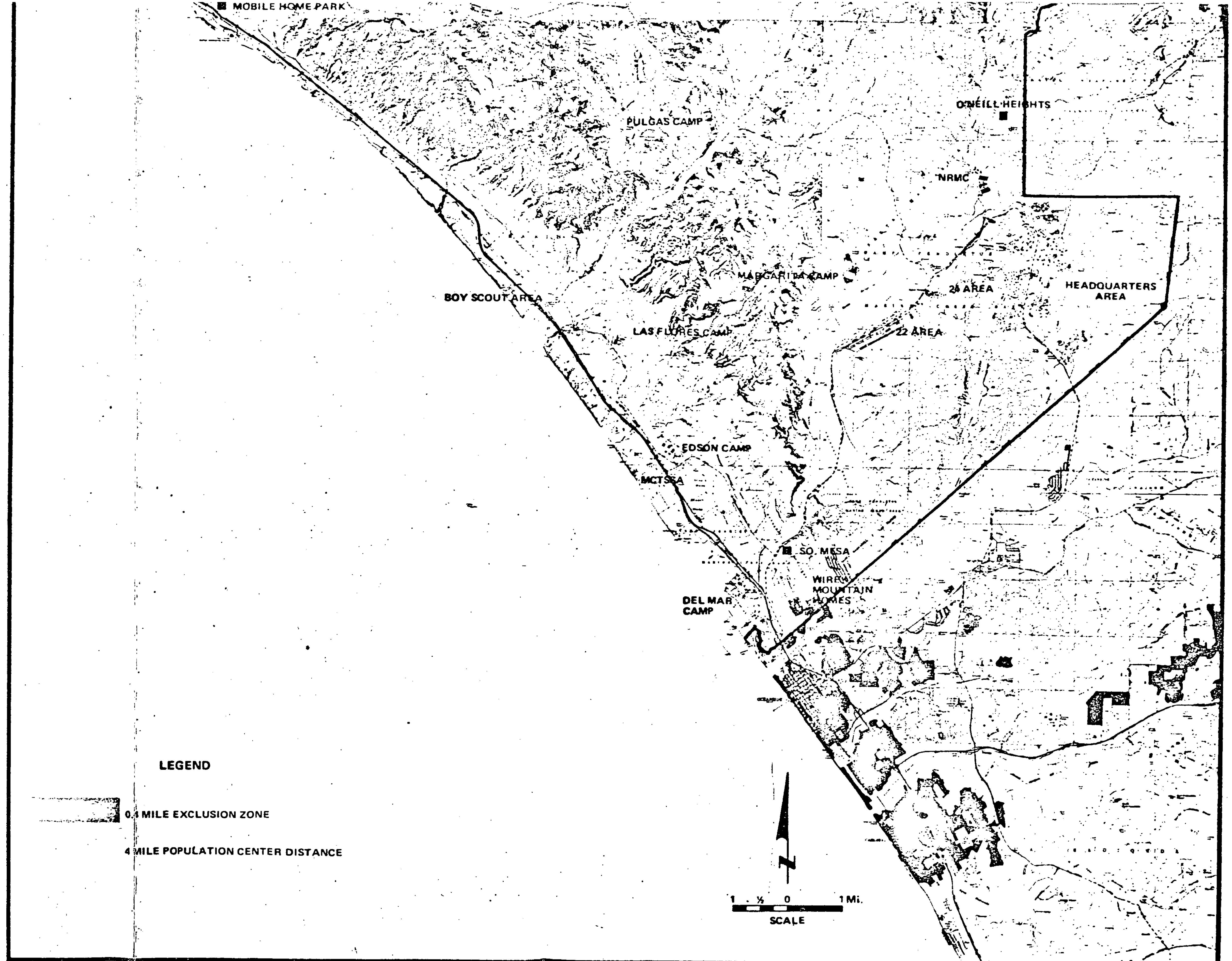
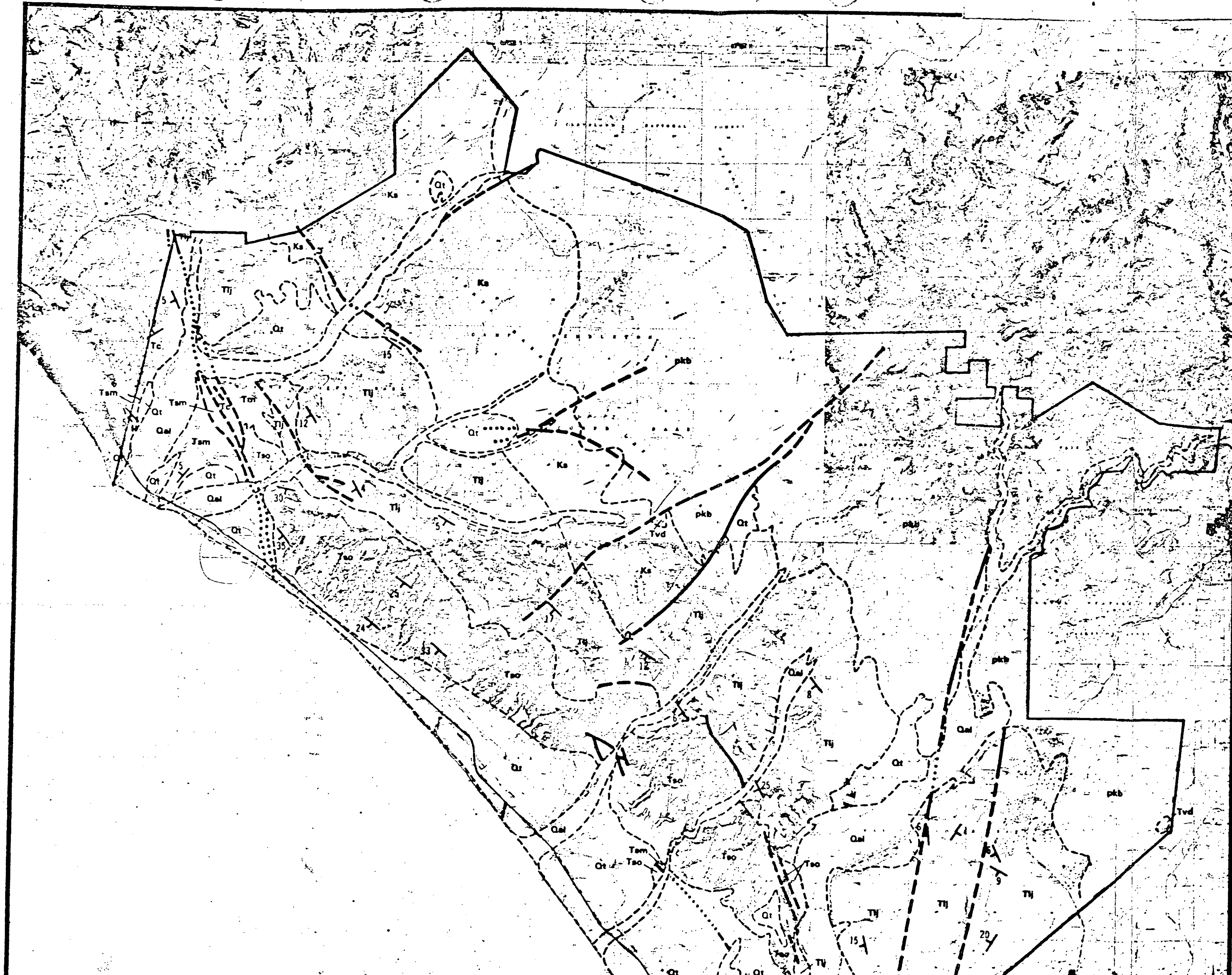


FIGURE 4-6: POPULATION DISTANCE EXCLUSION AREAS



EXPLANATION

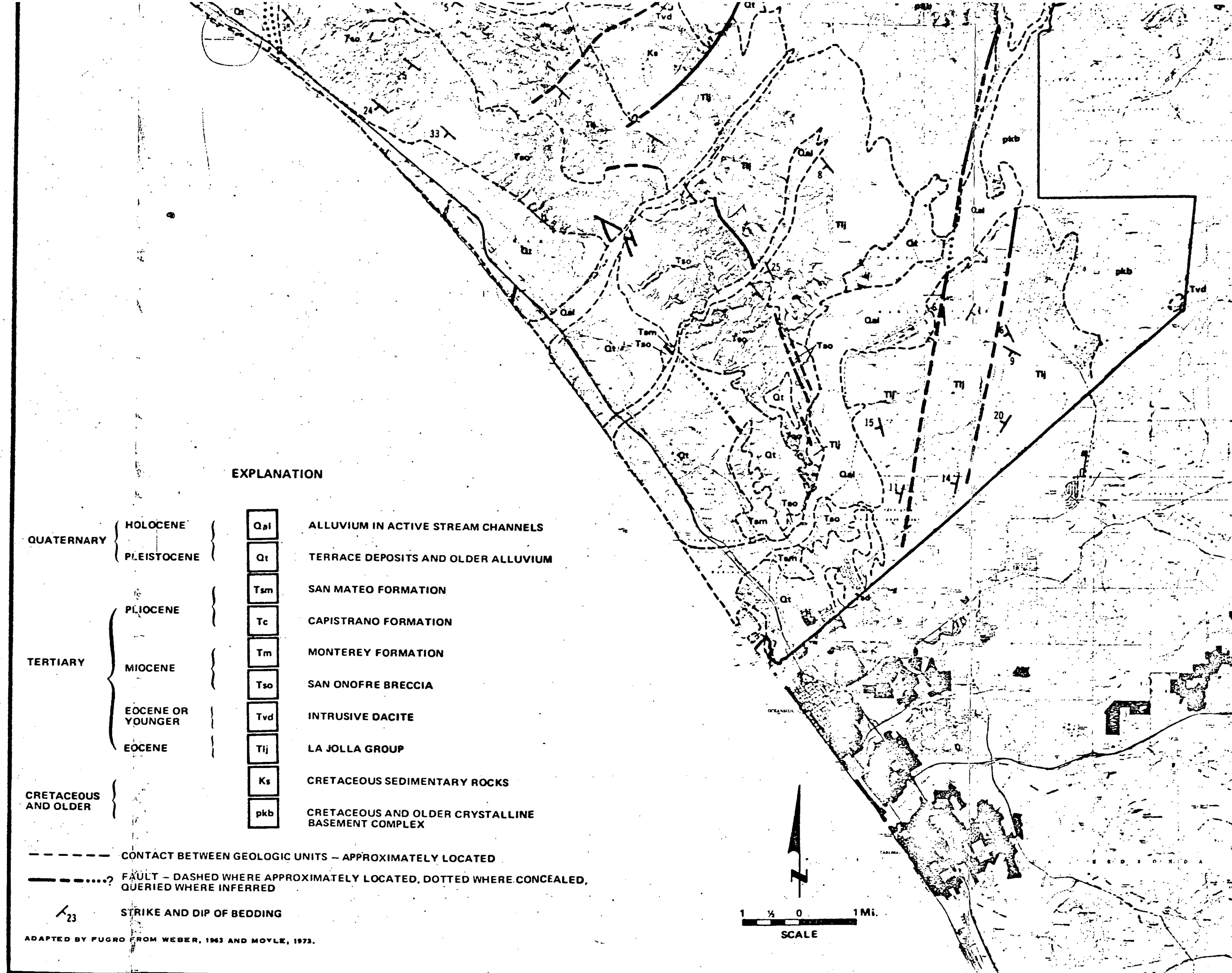
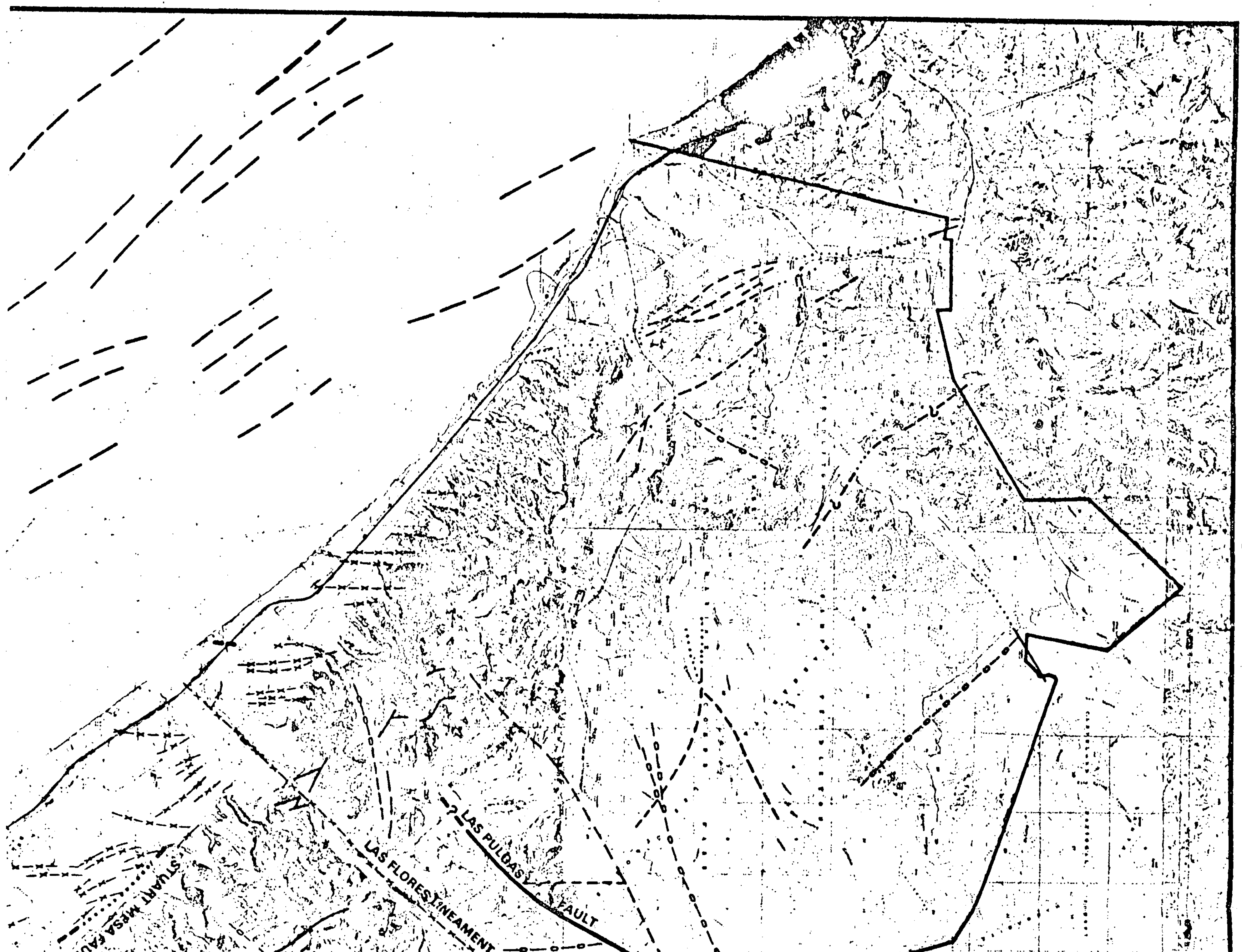


FIGURE 4-6: GENERALIZE GEOLOGIC MAP



LAS PULDAS FAULT
LAS FLORES LINEAMENT
STUART MESA FAULT
POSTULATED ON SHORE EXTENSION
OF THE ROSE CANYON FAULT

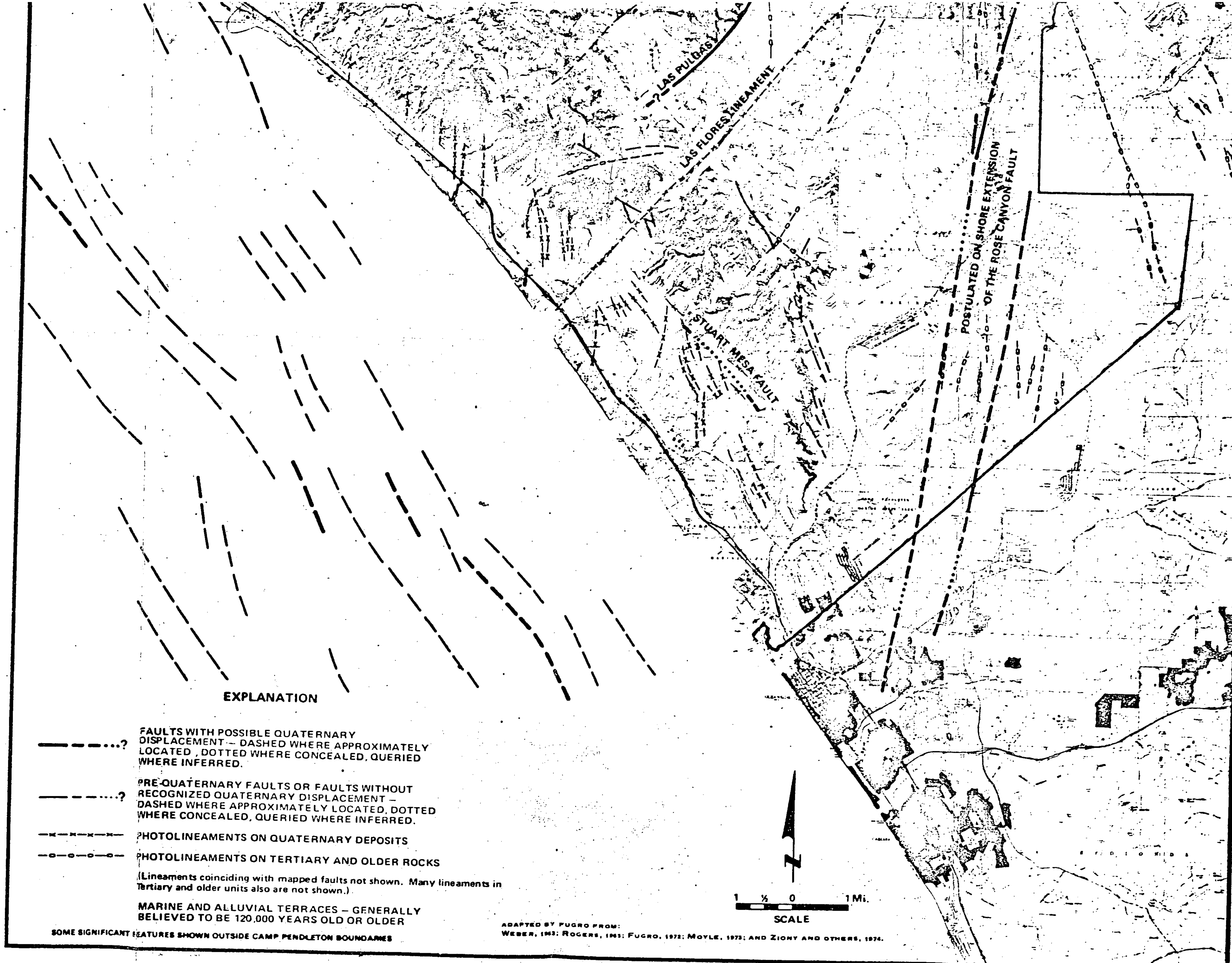
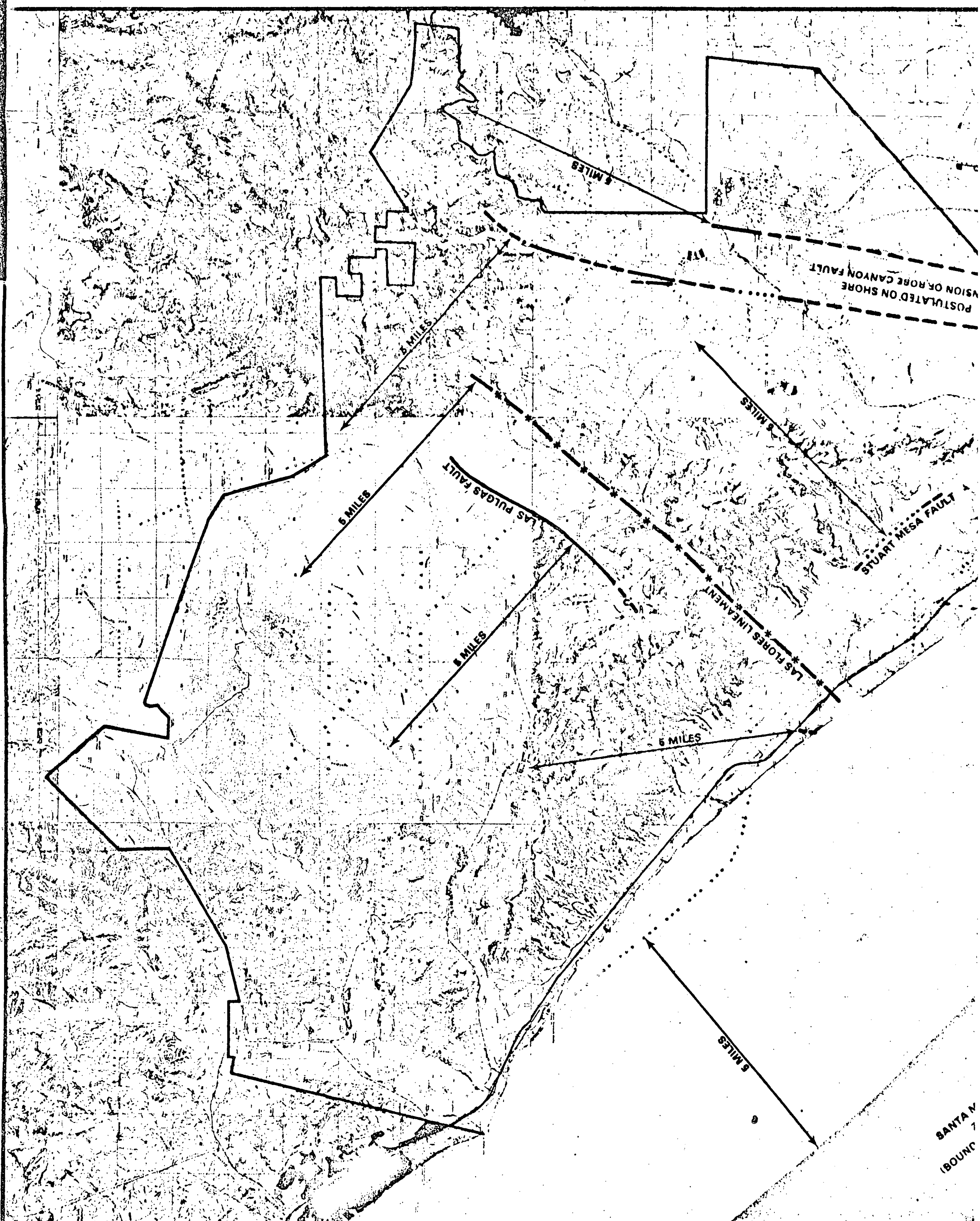


FIGURE 4-7: FAULTS AND PHOTOLINEAMENTS IN THE CAMP PENDLETON AREA


5 MILES
5 MILES
5 MILES
5 MILES
5 MILES
5 MILES
5 MILES
LAS PULGAS FAULT
LAS FLORES LINEAMENT
STUART MESA FAULT
POSTULATED ON SHORE

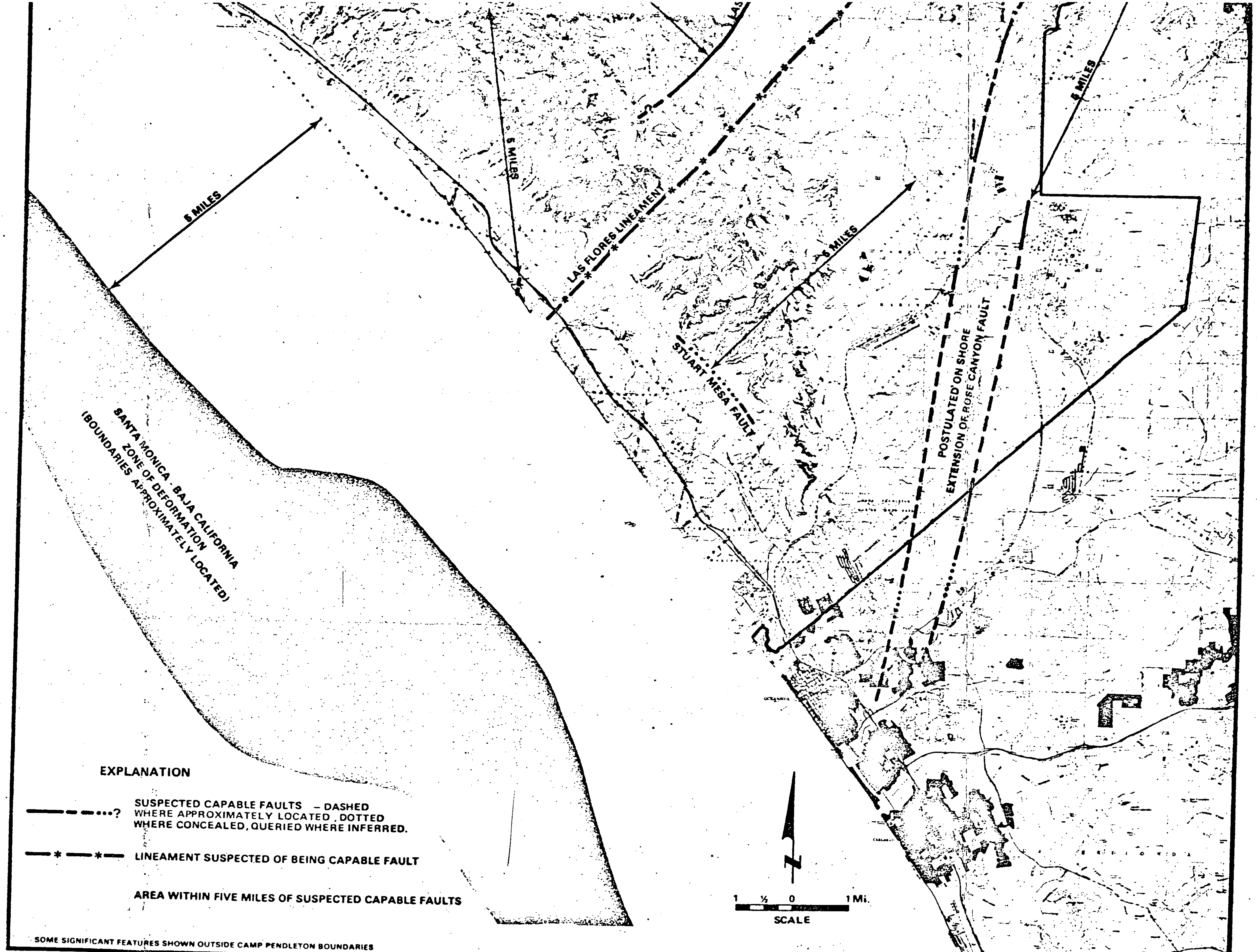
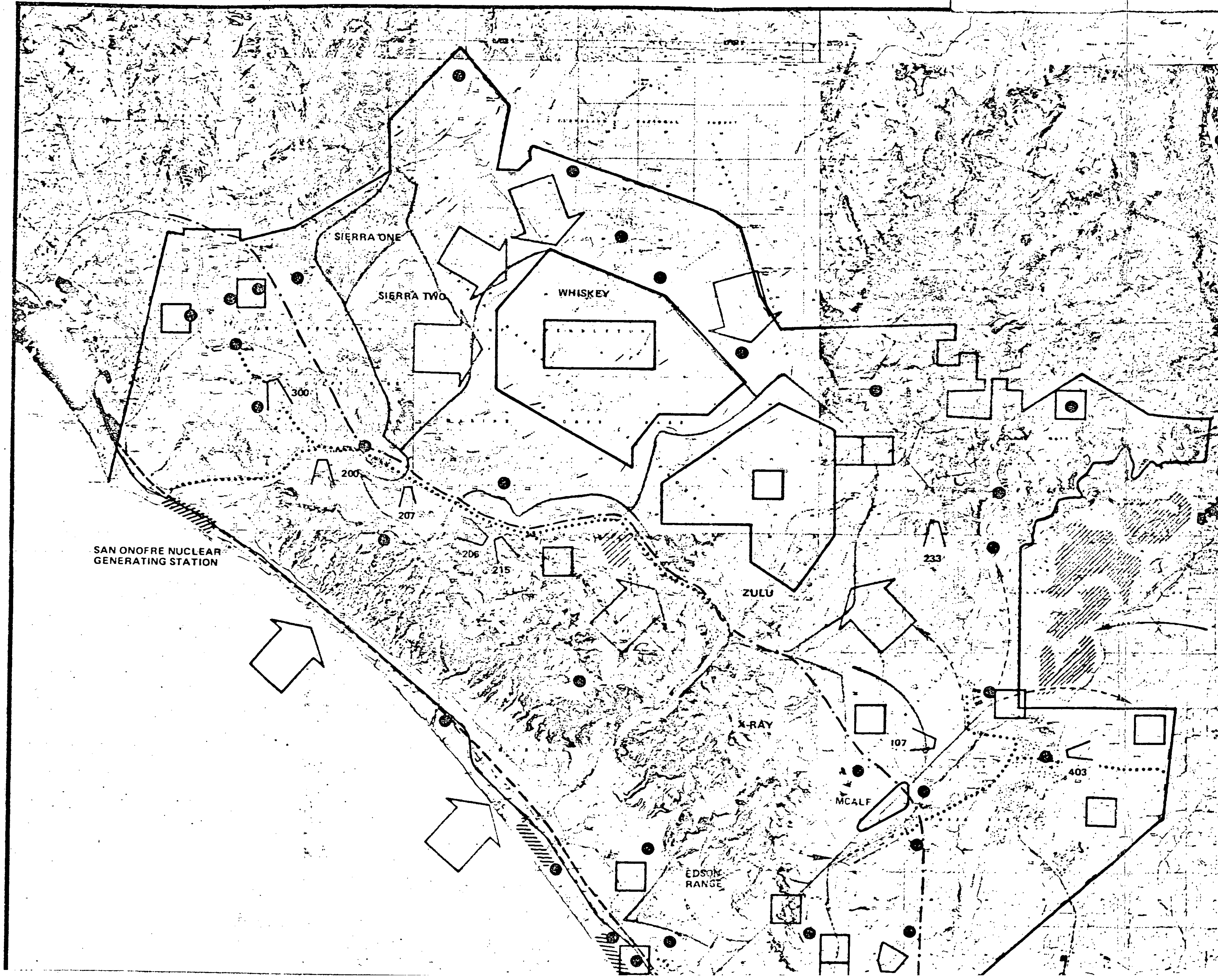


FIGURE 4-8: GEOLOGY/SEISMOLOGY EXCLUSION AREAS


SIERRA ONE
SIERRA TWO
WHISKEY
300
200
207
206
215
SAN ONOFRE NUCLEAR
GENERATING STATION
233
ZULU
X-RAY
107
403
MCALF
EDSON
RANGE

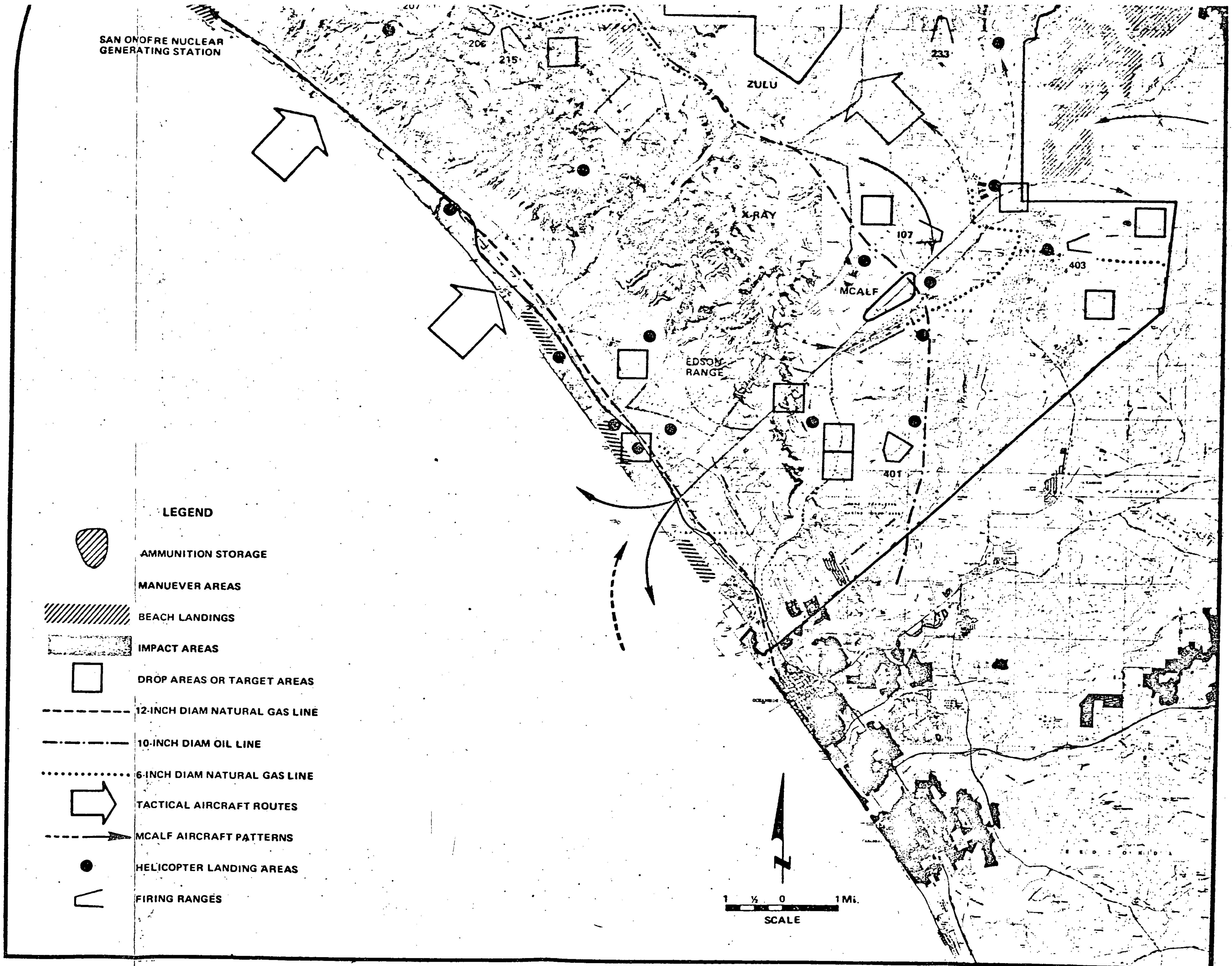
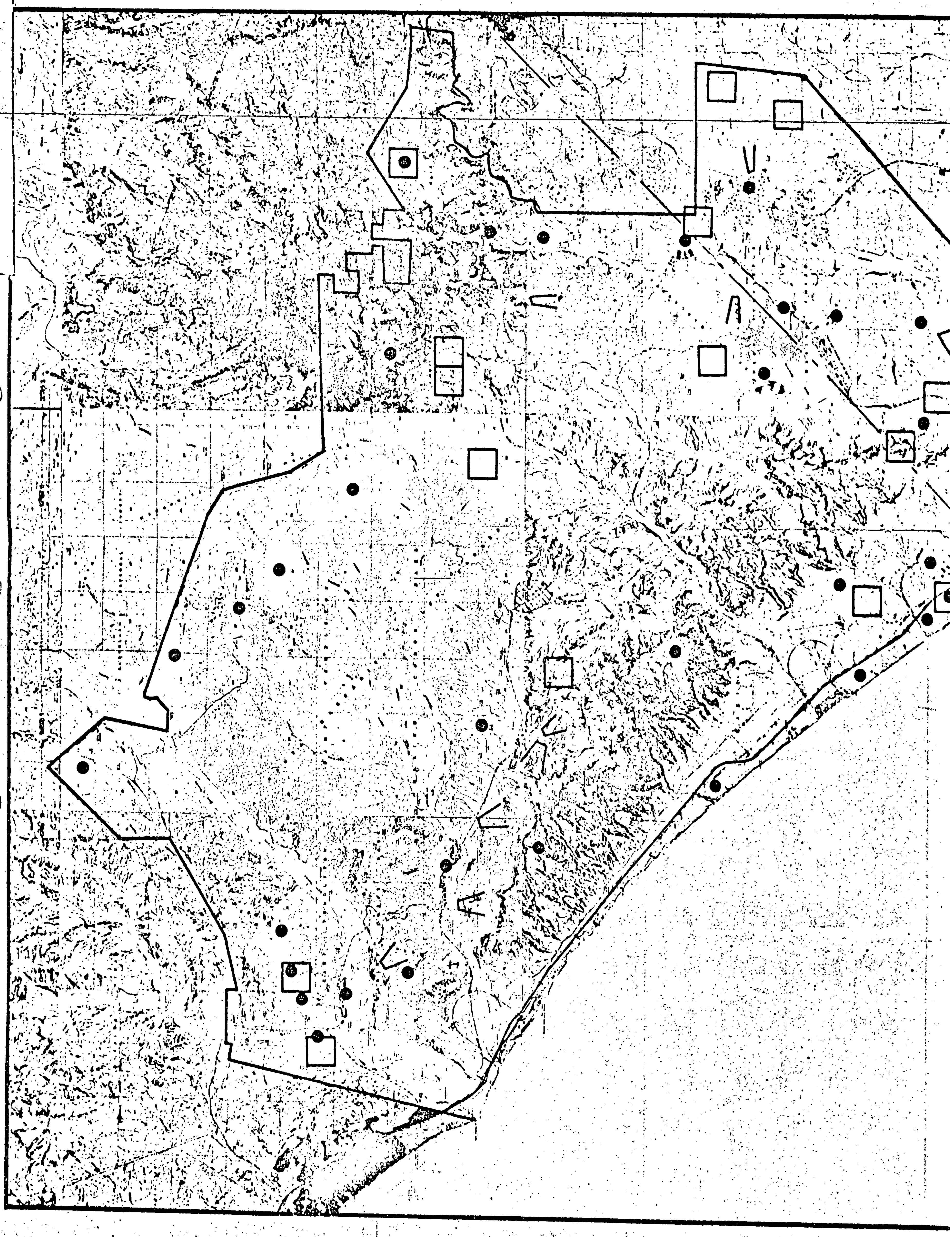


FIGURE 4-9: HAZARDOUS OPERATIONS



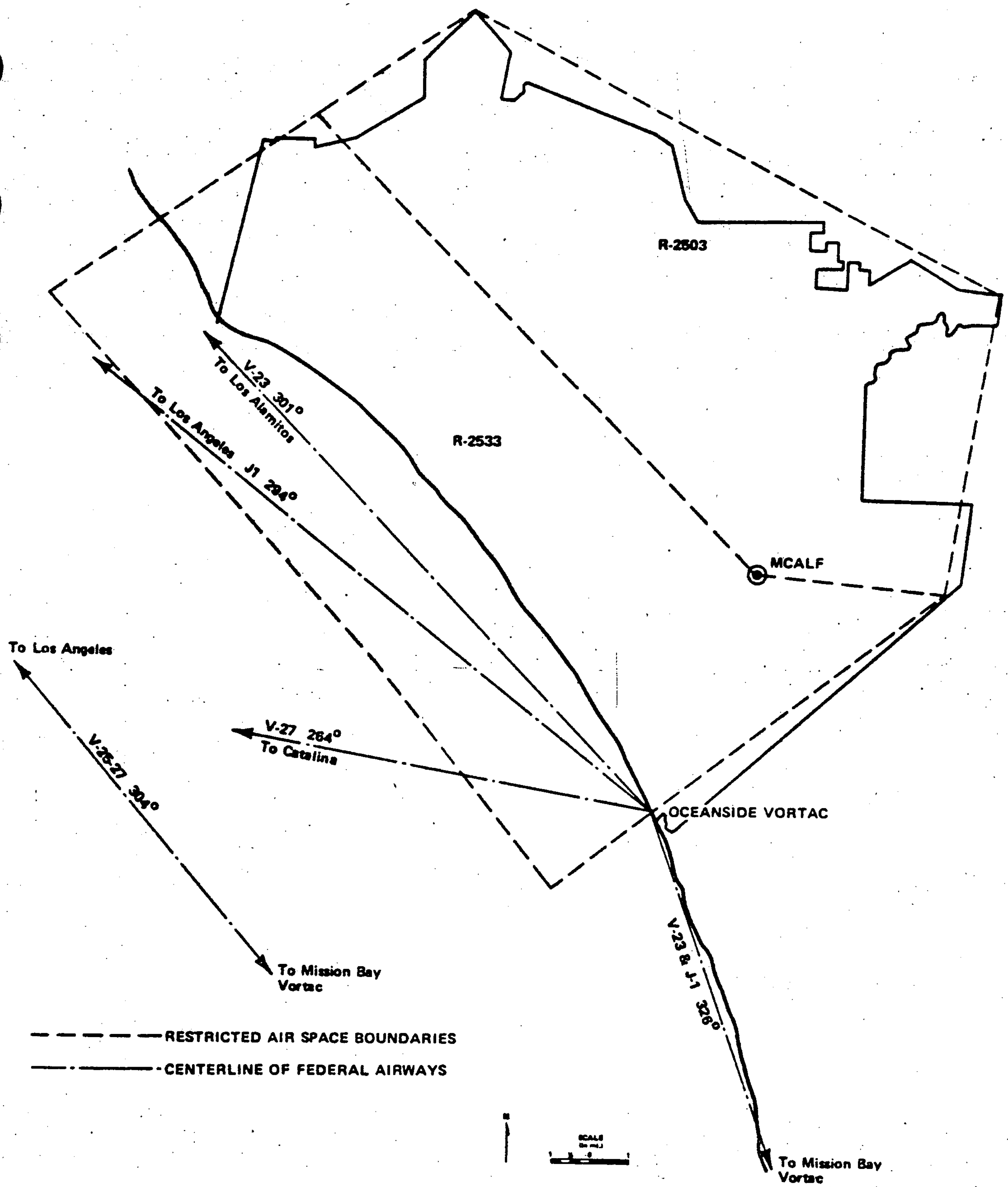
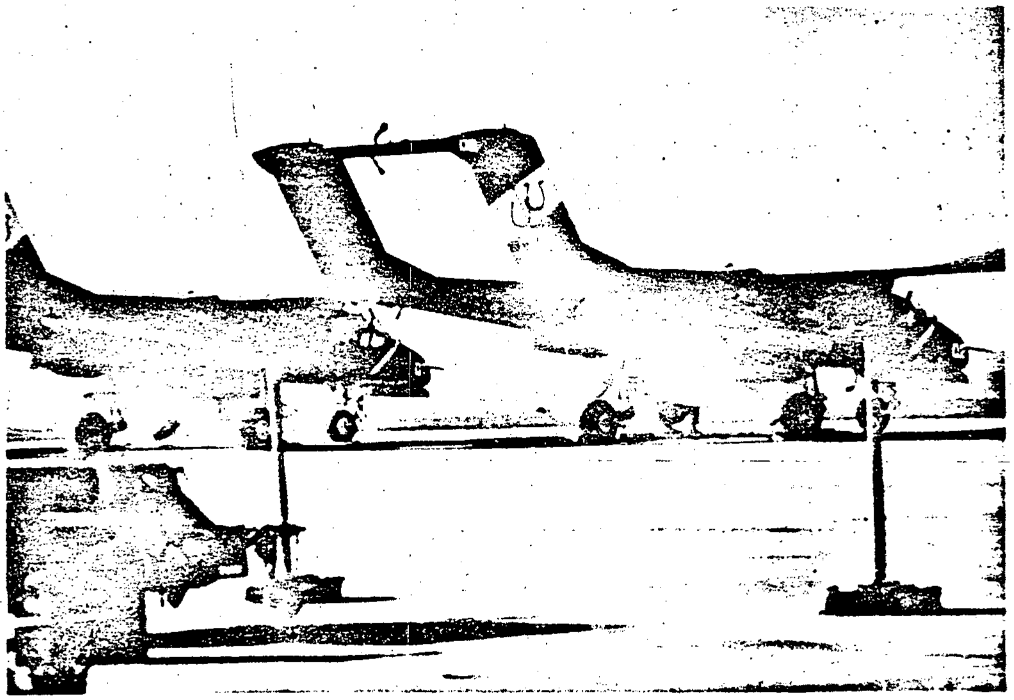


FIGURE 4-10: AIRWAYS



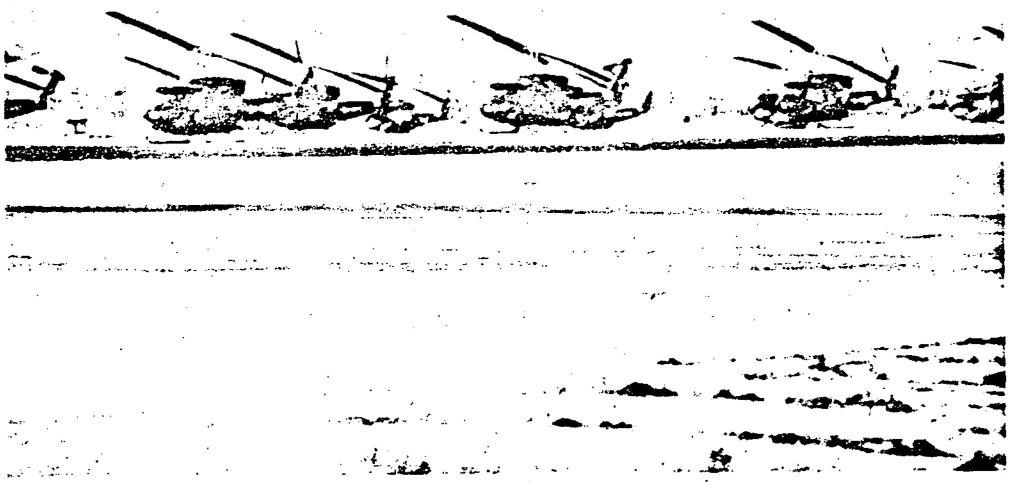


FIGURE 4-11: CAMP PENDLETON BASED AIRCRAFT

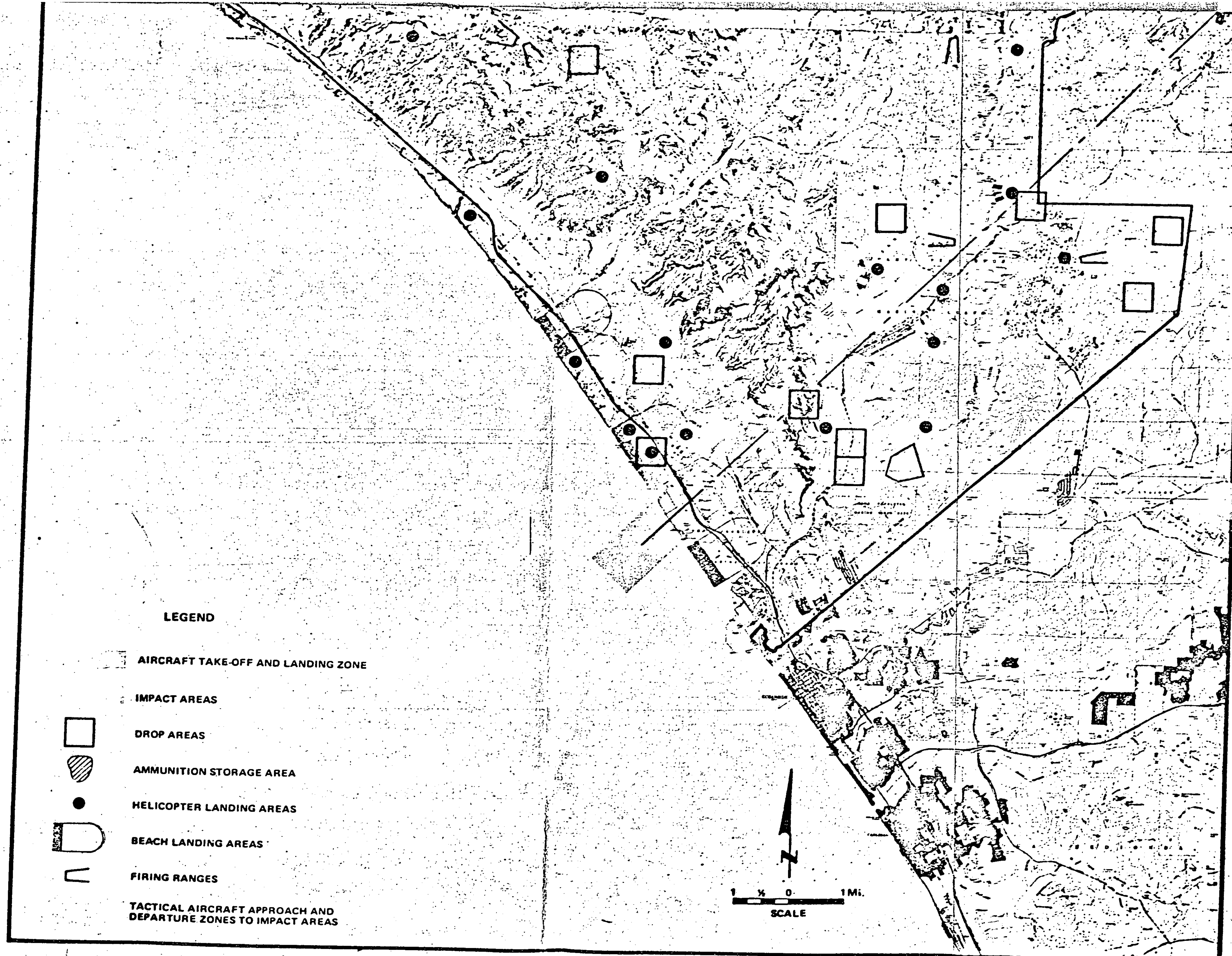
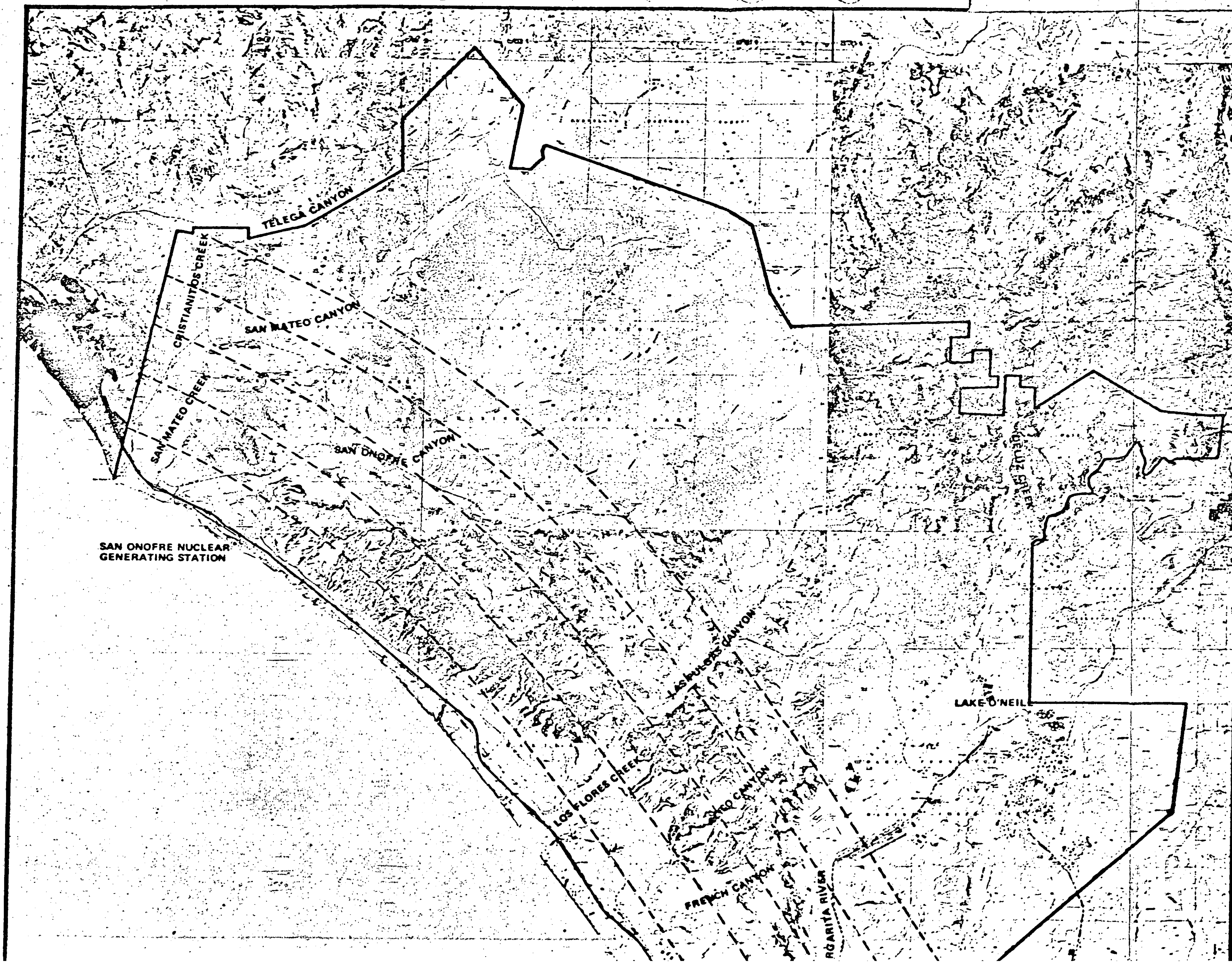


FIGURE 4-12: HAZARDOUS OPERATIONS EXCLUSION AREAS



TELEGA CANYON
CRISTIANITOS CREEK
SAN MATEO CANYON
SAN MATEO CREEK
SAN ONOFRE CANYON
SAN ONOFRE NUCLEAR
GENERATING STATION
LOS FLORES CREEK
LAS PULGAS CANYON
FRENCH CANYON
DELUZ CREEK
LAKE O'NEIL

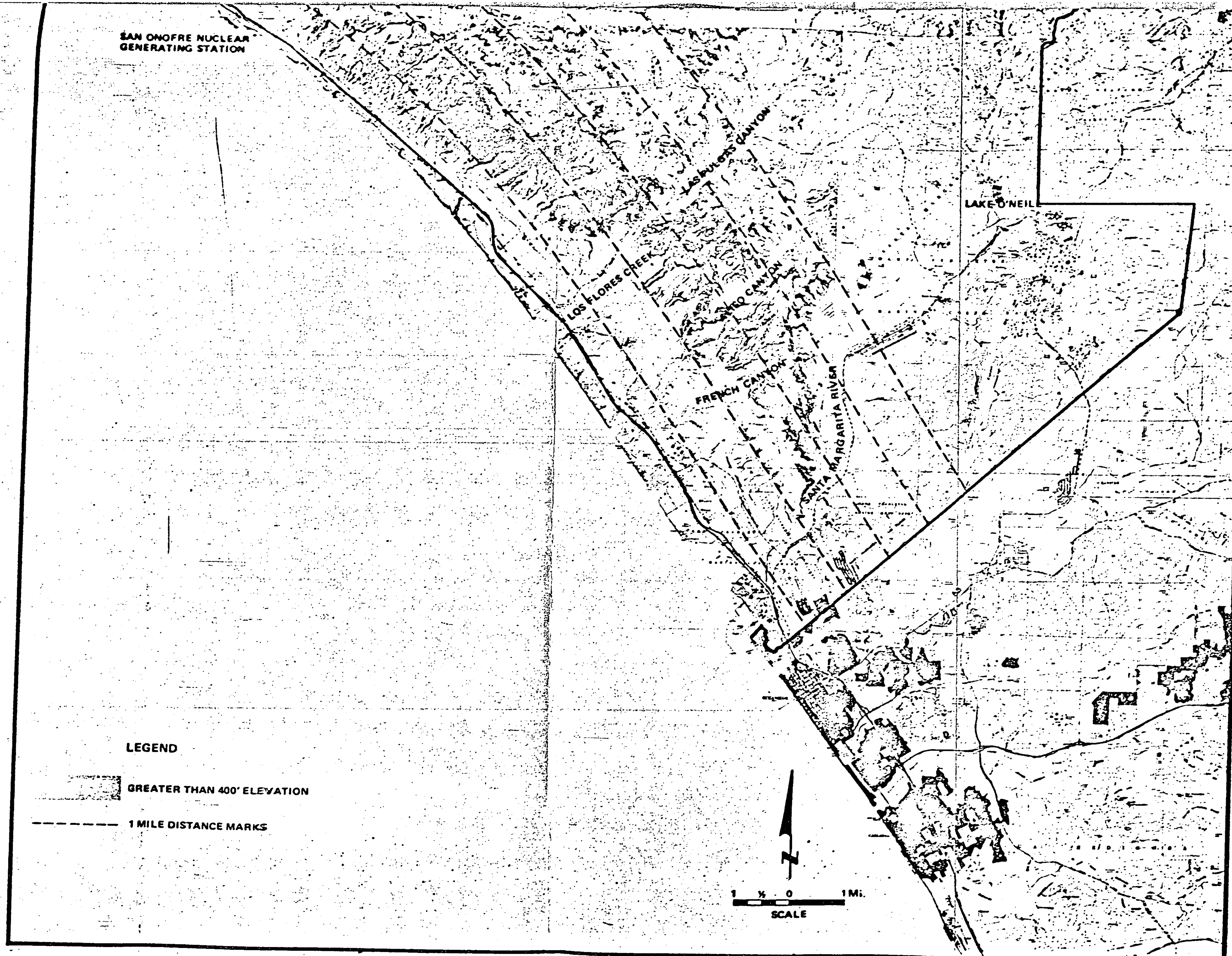
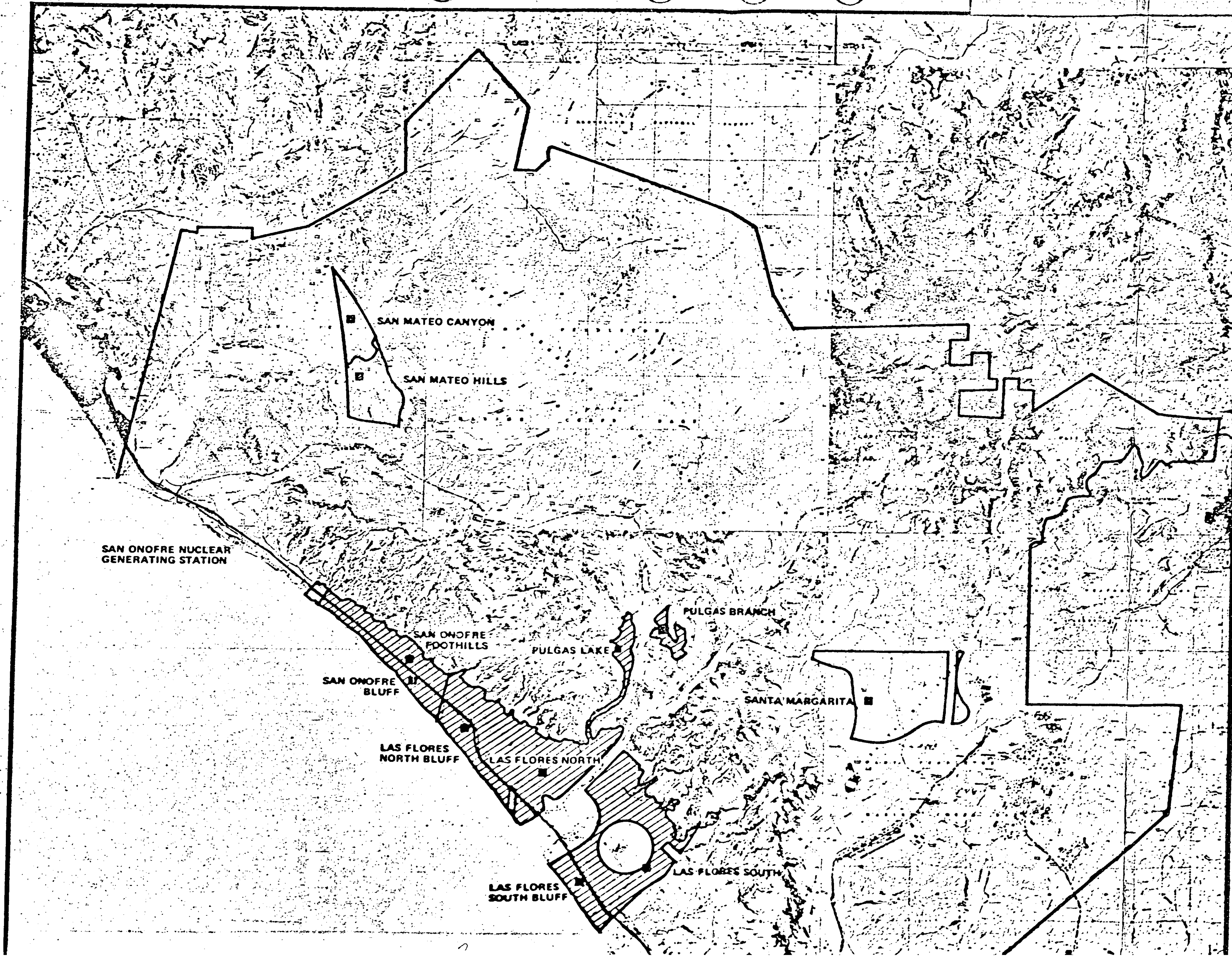


FIGURE 4-13: SURFACE FEATURES EXCLUSION


SAN MATEO CANYON
SAN MATEO HILLS
SAN ONOFRE NUCLEAR
GENERATING STATION
PULGAS BRANCH
SAN ONOFRE
FOOTHILLS
PULGAS LAKE
SAN ONOFRE
BLUFF
SANTA MARGARITA
LAS FLORES
NORTH BLUFF
LAS FLORES NORTH
LAS FLORES SOUTH
LAS FLORES
SOUTH BLUFF

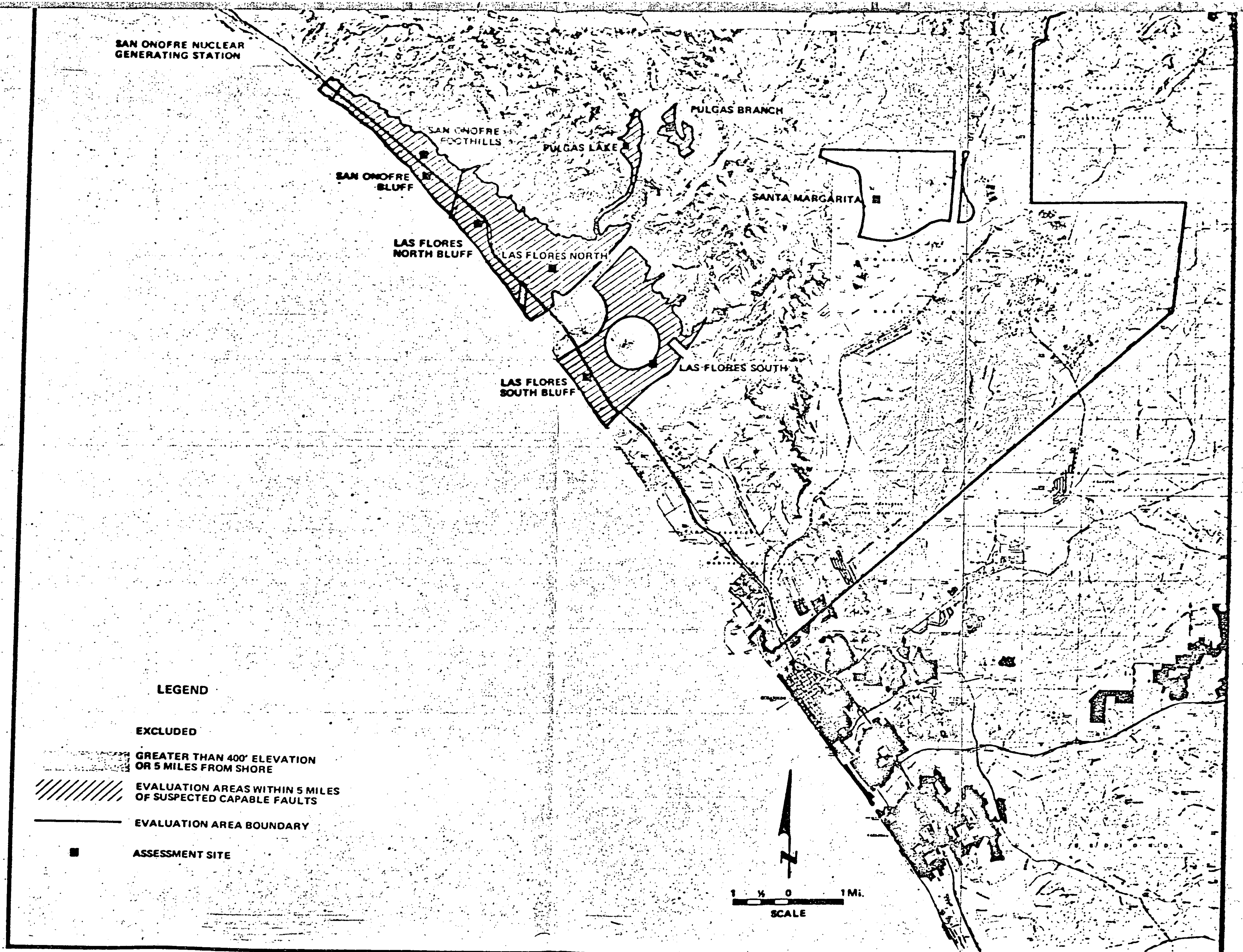
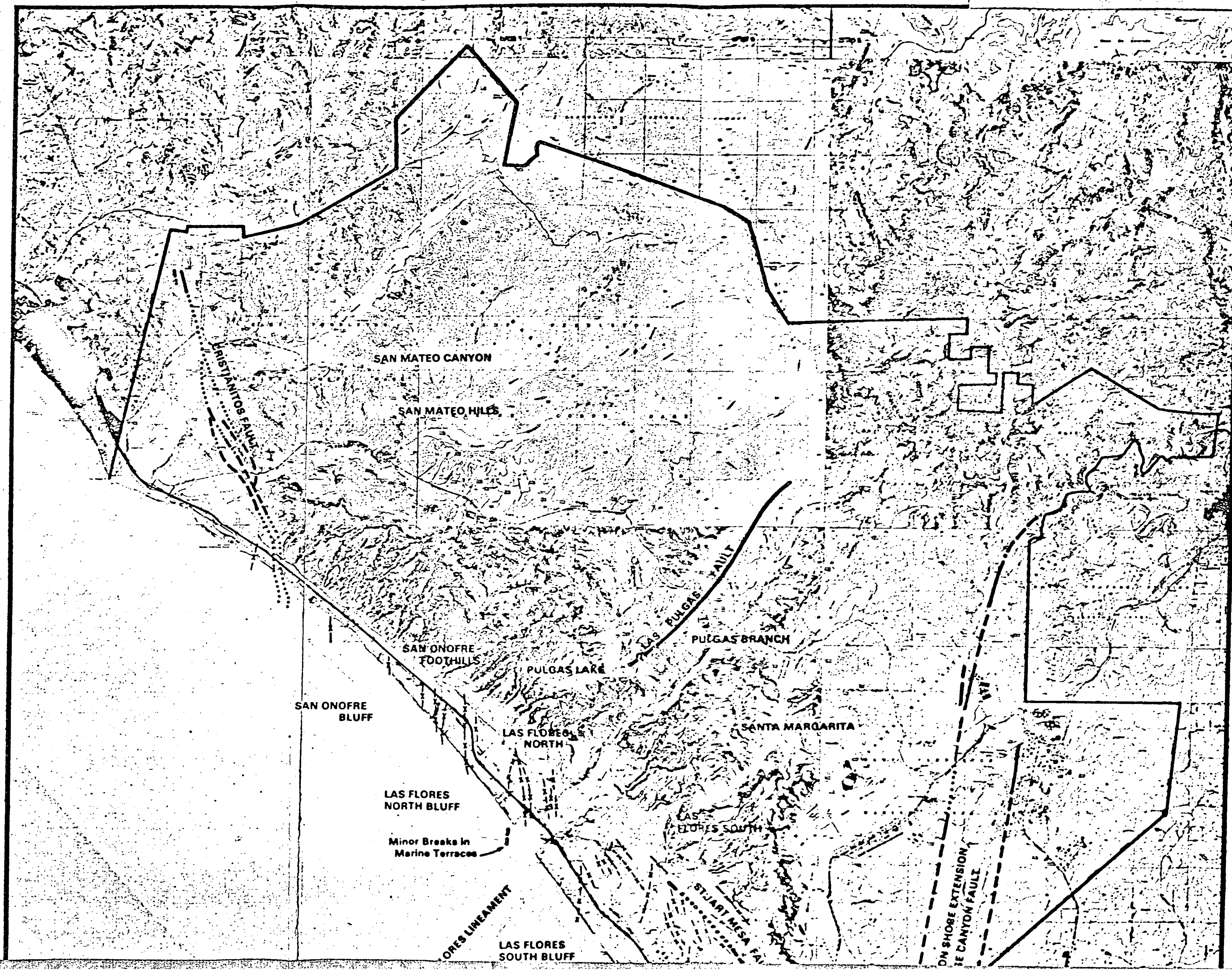


FIGURE 4-14: POTENTIAL SITING AREAS


SAN MATEO CANYON
SAN MATEO HILLS
CRISTIANITOS FAULT
LAS PULGAS FAULT
PULGAS BRANCH
SAN ONOFRE FOOTHILLS
PULGAS LAKE
SAN ONOFRE BLUFF
LAS FLORES NORTH
SANTA MARGARITA
LAS FLORES NORTH BLUFF
LAS FLORES SOUTH
Minor Breaks in Marine Terraces
LAS FLORES SOUTH BLUFF
ON SHORE EXTENSION

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4. SAFETY ASSESSMENT AT CAMP PENDLETON

This section presents an analysis of Camp Pendleton in terms of the principal safety parameters discussed in Section 3. These parameters of population, geology/seismology, and hazardous operations are assessed and the results are used to screen out areas which do not conform to criteria. The remaining areas are further analyzed and are compared in Section 5.

4.1 POPULATION

4.1.1 Analysis

The criteria used for excluding potential siting areas on the basis of population considerations are summarized as follows:

- The population exclusion area radius around the reactor will be 0.4 mile.
- The Low Population Zone radius around the reactor will be 3 miles and, therefore, the nearest distance from the reactor to the boundary of a minimum 25,000 population center will be 4 miles.
- The maximum cumulative population density (including time weighted transient population) out to 30 miles from the reactor will not exceed 500 people per square mile in 1990, the earliest year of plant operations, nor 1,000 people per square mile in the year of retirement, assumed to be 2030.

The population data for this study were acquired from a number of sources including the State; each of the three counties involved (Orange, San Diego, and Riverside); the two largest cities closest to Camp Pendleton - Oceanside and San Clemente; and Camp Pendleton.[9-18]

Population data in all cases were provided from respective census taken at least as recently as 1975. These data were available at county, major subregional area, and census tract levels. Thus, as a whole, the population data used are current as of 1975. Population forecasts from some of the information sources varied as to the maximum future date applicable. The State projections at the county level extend to the year 2020. County published forecasts were generally presented at the level of major subregional areas and were therefore more usable in predicting population within 30 miles of Camp Pendleton. These predictions generally were provided to the year 1990.

The principally occupied areas of Camp Pendleton are noted in Figure 4-1. The population throughout the base is comprised of military personnel, civilian workers, and the family dependents of military personnel. In early 1975 the population at the base was about 36,000 but has risen to over 46,000 for all categories. This larger population results from the drop in overseas activities and the base's now accommodating large on-going training and readiness forces. Table 4-1 indicates the breakdown of personnel by type and location. Table 4-2 combines types of population and locates them by area. Planning personnel at Camp Pendleton anticipate future population will not exceed current levels, and distribution between types and location will not change significantly.

The existing population (1975) within 30 miles of the camp was plotted as seen on Figure 4-2. Each dot represents 1,000 people and was located with respect to current census tract locations and counts. The forecast population for 1990 is seen on Figure 4-3. This population distribution and density represents that which could be expected the first year the plant would be in operation.

Population centers of 25,000 people or more were identified in order to later establish boundary distances of 4 miles to a potential site. Oceanside, including Camp Del Mar just north of Oceanside, represents a 1975 population level south of Camp Pendleton in excess of 53,000 people, with levels predicted to exceed 70,000 by 1990. On the north side of Camp Pendleton, San Clemente with a 1975 population of over 21,000 can be expected to exceed 32,000 by 1990. Therefore, population centers of 25,000 or more will exist at San Clemente and Oceanside/Del Mar Camp, and population center boundaries for 1990 are as indicated in Figure 4-3.

Four typical locations were selected as representative of siting area locations at Camp Pendleton. Population densities were examined for each prior to identifying potential areas. These locations are shown on Figure 4-2 and are designated as A, B, C, and D.

A population template, shown in Figure 4-4, consisting of circles having 5-mile distant increments from a reactor was used out to a distance of 30 miles. The template also divides the circular areas

5. EVALUATION OF CANDIDATE AREAS

This section provides an analysis of each of the siting parameters as they may affect the candidate siting areas. Safety parameters include population, geology/seismology, hazardous operations, security, and hydrology. Economic parameters include site access, hydrology, site development and slope stability, soil conditions, water transport, and power transmission. The environmental parameters analyzed are climatology, land use, biology, cultural resources, and aesthetics. Candidate areas are rated with respect to each of the parameters.

5.1 SAFETY

5.1.1 Population

In Section 4, areas to be excluded for their close proximity to population centers were defined so that candidate areas would be consistent with regulations and safety guidelines. The significance of population density was also discussed and four typical locations at Camp Pendleton were examined. As a result, it is concluded that the 11 siting areas all generally meet the guidelines; therefore, population is not analyzed further in this section.

5.1.2 Geology/Seismology

This analysis considers the potential for a siting area meeting the present criteria regarding geologic and seismic safety. It specifically addresses the plant design basis for surface faulting,[3] because a site requiring design for surface faulting presently would be deemed unlicensable. This analysis considers three principal factors:

- Presence of undeformed stratigraphy demonstrably older than the minimum ages of fault movement specified in the criteria defining capable faults.
- Proximity to known or suspected capable faults requiring evaluation for surface rupture hazard.
- Proximity to photolineaments (longer than 1,000 feet) expressed on Quaternary deposits).

Experience in siting studies for nuclear power plants has shown that these are the most important geotechnical factors for evaluation of likelihood that a site in the Camp Pendleton area can be licensed successfully. Numerical values assigned to the various factors (Tables 5-1 and 5-2) are based on an estimate of their relative importance for site evaluation and provide a basis for determining relative suitability of the areas evaluated within Camp Pendleton. Areas having higher numerical ratings are deemed more likely to satisfy the geologic/seismologic criteria.

Within the Camp Pendleton region, undeformed stratigraphy, demonstrably older than the ages specified in the criteria, is considered essential for determination of fault capability in the area surrounding a nuclear power plant site. Without such stratigraphy, it would be very difficult, if not impossible, to determine the minimum age of movement along any faults that might be discovered at or projecting towards the site. Unless such faults could be shown to be not capable, the site cannot be licensed. Therefore, stratigraphy is given the greatest weight in this evaluation.

As discussed in Section 3.2.2, for demonstrating absence of capable faults it is most desirable that undeformed strata demonstrably older than 500,000 years are exposed extensively over a distance of at least 5 miles surrounding a candidate area. Deposits of this age and extent are not present in the Camp Pendleton area. However, marine terrace deposits that have been shown to be about 120,000 years old are present along the coast and correlative alluvial terrace deposits are exposed along the major drainages (Figure 5-1). These may be suitable for demonstrating absence of capable faults in the area of a site, and, if present at the site, could establish the absence of capable faults underlying the site.

Relative numerical values of stratigraphy at potential areas are based on extent and continuity of stratigraphic units (marine and alluvial terrace deposits) within the area as well as on reliability of age determinations. As discussed in Section 4.2, the youngest and most extensive marine terrace deposit has been shown to be about 120,000 years old. Therefore, areas containing extensive exposures of this unit or older marine terrace deposits are given the greatest value, 50 (Table 5-1). Areas containing less extensive exposures of marine terrace deposits are given a lower value, 30. Alluvial terrace deposits along major drainages at Camp Pendleton are much less extensive and continuous than the marine terrace deposits along the coast, and ages of the alluvial terraces have not been established conclusively. Therefore, areas containing the alluvial terrace deposits are given a rating of 10 or 20, depending on the relative extent and continuity of the deposits. A rating of zero is given to potential areas having little or no datable stratigraphy, based on the available data.

Proximity to suspected capable faults is a principal factor in evaluating prospective nuclear power plant sites. As discussed in Section 3.2.2, the NRC position is that areas within 5 miles of capable faults are not suitable for nuclear power plant sites. Instead, the regulations strongly discourage licensing of nuclear power plants within 5 miles of capable faults by requiring exhaustive detailed investigations to demonstrate that there is no hazard of surface faulting at the site. The regulations require even more detailed analysis for sites in closer proximity to capable faults, within a zone described as the "Zone Requiring Detailed Faulting Investigation" (ZRDFI). In practice, it would be prudent to relocate the site when the need for this level of investigation becomes apparent.

For comparative evaluation of areas within Camp Pendleton, it was assumed that faults more than 10 miles from an area would have no influence on the design basis for surface faulting. Suspected capable faults and the more significant pre-Quaternary faults located 5 to 10 miles from an area were assumed to require analysis in order to establish that associated structures do not extend closer to a proposed site. Suspected capable faults and major pre-Quaternary faults within 5 miles of an area are a serious consideration for site selection as the required investigative level reduces the probability that a site ultimately could be licensed. For comparative evaluation of areas within the limited confines of Camp Pendleton, it is least desirable for sites to be within the probable ZRDFI of a suspected capable fault. Numerical values for distance of areas from suspected capable faults (Table 5-1, Part IIa) are based on these assumptions.

Several faults have been mapped in the Camp Pendleton area and it is expected that many more would be identified during any subsequent detailed geologic investigation. For the present analysis, only the major pre-Quaternary faults (e.g., Cristianitos fault) and those that have existing data suggesting they may be found capable (e.g., Las Flores lineament) have been evaluated with respect to each candidate area. Numerical weights have been assigned to each fault according to an estimate of its probable impact on site suitability (larger numbers indicating greater impact), determined from:

- Likelihood that the fault would be considered capable, based on evaluation of existing data.

- Length of the fault.
- Anticipated difficulty of adequately investigating the fault.

Numerical weights assigned to each fault are tabulated in Table 5-1, Part IIb, along with notes on pertinent evaluation factors.

The weighted numerical values assigned to each fault in Table 5-2 are obtained by multiplying the value, based on distance from the siting area, by the weighting factor determined for each fault individually. For example, a potential area within 5 miles of the Las Flores lineament would have a weighted value of:

0.4 (Value) x 9 (Weighting Factor) = 3.6 (Weighted Value)

Weighted values also take into account the percentage of an area at various distances from a fault. For example, a potential area, half of which is within 5 miles of the Las Flores lineament, and half of which is 5 to 10 miles away, would have a weighted value of:

0.4 (Value) x 9 (Weighting Factor) x 0.5 (Percent Area) = 1.8

0.8 (Value) x 9 (Weighting Factor) x 0.5 (Percent Area) = 3.6

1.8 + 3.6 = 5.4 (Weighted Value)

Weighted values for all the potential areas and faults in Table 5-2 are determined similarly.

Photolineaments expressed in Quaternary deposits would require investigation to determine whether they are related to faulting, thereby increasing the complexity of a site investigation and raising additional questions that may or may not be resolved satisfactorily. Potential areas therefore are evaluated with respect to their proximity to such photolineaments (Table 5-1).

Because no actual design acceleration can be accurately determined for each of the candidate sites at this stage of the investigation, estimated design basis values have not been included in the overall ranking scores. However, the distances between candidate sites and capable or Quaternary faults have been considered in the values, so that the candidate sites which lie farthest from the faults are given high ratings.

The Geology/Seismology Evaluation matrix (Table 5-2) presents a composite assessment of the three principal factors, based on general geology/seismology data presented in Section 4.2. The numerical totals in this matrix indicate the relative ranking of siting areas at Camp Pendleton.

5.1.3 Hazardous Operations

Section 4.3 discussed various hazards resulting from military and other operations at and near the complex. Hazardous operations considered are:

- Ground-based military firing operations.
- Military air operations associated with firing and nonfiring operations.
- Commercial and general air operations in the area.
- Ammunition storage facilities.
- Fuel lines.

The basis for rating each of the potential areas with respect to differences in their susceptibility to these hazards is their proximity to the hazardous areas. Distances to various hazards are indicated in Table 5-3.

Effects of hazards generally decrease with increased distance from the source. To determine exact effects involves extensive analysis for each event using statistical data and requiring information relating to the hazard. Depending on the hazard, the relationship between the hazard and its distance from the point of interest varies. However, most relationships used to characterize effects of, for example, explosions or aircraft impacts follow various mathematical forms. The preliminary evaluation of hazards in this study was based on the hazard decreasing as a function of the inverse square of the distance to the siting area. This relationship is considered to be representative of the specific forms that would be applicable for detailed studies.

Some consideration was given to the significance of the hazard. Military air ordnance operations are most heavily weighted, about twice the others, due to the aircraft mobility and its ordnance-carrying posture. Ammunition storage has been weighted zero because all locations are at distances greater than 1 mile from the storage facility, which is considered the threshold distance for concern. Fuel line drainage from line breaks was given about one-quarter the weight of the others because protection can easily be designed into the plant.

The following summarizes the combined comparative hazards evaluation. High values represent greater hazards.

Potential Area	Comparative Hazards Rating
San Mateo Canyon	3.30
San Mateo Hills	3.31
Santa Margarita	5.02
Pulgas Branch	2.36
Pulgas Lake	1.81
Las Flores North	2.17
Las Flores South	3.28
San Onofre Foothills	2.06
San Onofre Bluff	2.55
Las Flores North Bluff	2.51
Las Flores South Bluff	2.75

5.1.4 Security

Security at the Camp Pendleton complex presently is maintained only by monitoring traffic passing through each of the five gates that govern road access into the complex. The complex is using an open door policy so that public access is available to most areas. Special permission is required for access into the impact areas which are guarded at access point, and to certain of the maneuver areas.

Perimeter fencing is barbed-wire or cyclone fencing, relatively low, and is penetrable. Fences are not equipped with alarm or signal devices. Security on base is maintained by 24-hour per day military police patrols operating throughout the complex. The patrols are in communication with various central facilities for coordination. Observation towers throughout the complex provide additional monitoring of traffic.

There appears not to be any significant difference between security considerations at the potential power plant locations. Each would require its own fencing and security systems. In the event that circumstances at Camp Pendleton again require security controlled access to the complex, most potential power plant locations would be subject to the same advantages or disadvantages. Plants close to public highways could be given independent access much the same as presently exists for San Onofre. In these cases, the direct access to the plant from public roads might detract from the security otherwise provided through Camp Pendleton access.

5.1.5 Hydrology

Hydrology of the Camp Pendleton complex was analyzed for its impact on plant safety at potential siting areas. The results of the analysis indicated that hydrologic considerations do not appear to inhibit the safety of plants at potential locations, so long as certain additional features are provided in the plant design. Since these features would result in added cost, hydrology is discussed further in Section 5.2.2.

5.2 ECONOMICS

The considerations which follow represent the more cost sensitive elements related to the siting of nuclear power plants at Camp Pendleton. An assessment was made only of the costs which might be expected to differ between locations. These include site access, flood protection, site excavation and preparation for construction, foundations, reactor cooling water transport system, and power transmission. Cost considerations which are not expected to vary from location to location at Camp Pendleton were excluded. These consisted of costs for buildings (excluding foundations), equipment, construction support, and other common cost elements.

For purposes of making assessments of individual construction, the construction period for all locations was assumed to be about 6-1/2 years, ending with a one-unit plant being operational in 1990.

Estimates for each construction element for a one-unit plant considered were made using 1976 prices. These costs were escalated at the rate of 5 percent per year to the years during which the element might be expected to be built.

Maintenance and operating costs have been included in the assessments when considered to be of a significant value worthy of consideration in addition to construction cost. These costs were escalated for an operational year of 1990.

The accuracy of the cost estimates is limited by the absence of detailed engineering design drawings and specifications which might be prepared only in later phases of a project. However, since estimates for all locations at Camp Pendleton are subject to similar variables, the approach is consistent in this phase of comparing potential siting locations.

5.2.1 Site Access

Highway access to Camp Pendleton is obtained through north-south coastal traffic on 8-lane Interstate Highway 5 or through north-south inland traffic on Interstate Highway 15. State Highways 76 and 78 interconnect the two interstate highways. Figure 5-2 indicates the network of paved roads providing for traffic within Camp Pendleton.[6]

There are five gates serving the base. The Cristianitos Gate is planned to be relocated on Cristianitos Road and will be provided a new interchange from Interstate Highway 5. San Onofre, Pulgas, and Oceanside gates outlet directly onto Interstate Highway 5. The San Luis Rey Gate connects to the Oceanside road system.

Deficiencies of the paved network of connecting roads are categorized as localized congestion, dangerous alignments, and inadequate lighting and control systems. The most serious congestion occurs on Vandegrift Boulevard in the Headquarters area where through-traffic from San Luis Rey Gate mingles with local traffic, and on the route to Oceanside where there are numerous roadside developments. Basilone, San Mateo, and Pulgas roads have numerous hazardous curves and steep grades. There are few traffic signals and only two of the several railroad grade crossings have automatic signal alarms to protect motorists. Only four low-cost bridges designed for a 5-year flood exist at principal river crossings. Bridges at other river fords are not provided because alternate routes are available for detour during flood stages.

Access by sea is available only through the small boat harbor in Oceanside adjacent to Pendleton. It serves as a port principally for pleasure craft. The military harbor adjacent to the Oceanside Harbor has a 20-foot deep approach channel and a 17-foot deep harbor, and can receive LST size vessels. It is used in support of training missions at the Camp Pendleton base.

The Atchison, Topeka and Santa Fe Railroad has a main line operating adjacent to Interstate Highway 5. The line has passenger and freight service. A branch line extends from the Camp Del Mar area paralleling Vandegrift Road and extending north to Fallbrook.

Airports within 10 miles of the Camp Pendleton boundary, but without control towers, are located at Oceanside, Fallbrook, and Capistrano (near Dana Point). Airports with towers are located at Camp Pendleton and Palomar (near Carlsbad).

Road access to plants located in the coastal area could be gained from existing offramps from Interstate Highway 5 at San Onofre, Pulgas, or Camp Pendleton/Oceanside. There is an existing two-lane highway providing access to coastal locations throughout most of the area. Sites located inland in San Mateo Canyon area can be reached via Basilone and San Mateo roads. Those located in San Onofre and South San Onofre canyons could be reached via Basilone Road. Pulgas Road and Vandegrift Boulevard provide additional routes to inland areas being considered. Any site located on the northern end of the complex could be served via Roblar Road or an extension of Talega Canyon Road. Additional access roads of varying length would be required from the existing roads to each of the siting locations being considered.

Approximate additional road or road improvements required for access to each of the potential sites are tabulated below along with estimate of cost.

Area	Required Road (Feet)		Estimated Cost
	Nominal Terrain	Rugged Terrain	(1984-$ Million)
San Mateo Canyon	1,800		0.060
San Mateo Hills	0	3,500	0.141
Santa Margarita	500		0.017
Pulgas Branch	500		0.017
Pulgas Lake	500		0.017
Las Flores North	500		0.017
Las Flores South	4,000		0.129
San Onofre Foothills	500		0.017
San Onofre Bluff	500		0.017
Las Flores North Bluff	500		0.017
Las Flores South Bluff	6,000		0.193

5.2.2 Hydrology

Five stream systems are located within the Camp Pendleton complex as seen in Figure 5-3.[6] These are the Santa Margarita River, Aliso Creek, Las Flores Creek, San Onofre Creek, and San Mateo Creek. Surface flow in each is encountered only during and immediately following precipitation. The stream basins are in hydrologic contact with the ocean and are composed of alluvial deposits overlying impervious bedrock. The alluvium consists of lenticular deposits of clay, sand, gravel, and boulders. Basin recharge is by local precipitation and by surface runoff, with some additional recharge from treated effluent discharged from sewage disposal plants. Wells in these basins provide the potable water source for the complex.

The Santa Margarita River has a watershed area of approximately 740 square miles and is the largest and most important of the streams discharging into the ocean from within Camp Pendleton. The lower portion of the Santa Margarita River system consists of an alluvial valley and coastal basin extending upstream for a distance of approximately 11 miles from the ocean to the proposed DeLuz Dam site. The basin, consisting of about 4,580 acres, is subdivided into the upper valley and basin of 860 acres, Chappo Valley and basin of 2,640 acres, and Ysidora Valley and basin, with a surface area of about 1,080 acres.

The Santa Margarita River Basin is recharged in various ways. A rock weir diversion which crosses the narrow valley normal to the river diverts flow from the river to Lake O'Neill through a ditch. The 125-acre earth-dammed lake is also replenished by sewage effluent and flow from Fallbrook Creek. Approximately 1,300 acre-feet of water is impounded by the dam, much of which is released in the early fall to recharge the Santa Margarita River Basin. Nine on-channel water-spreading structures are situated below the rock weir diversion. Surface flow spills over each water-spreading structure in succession. The structures are not designed to withstand major flows.

Future plans include the development of a 140,000 acre-foot DeLuz reservoir and dam on the Santa Margarita about one-half mile upstream of the confluence with DeLuz Creek. Also planned is the 36,500 acre-foot Fallbrook reservoir and dam at the Lippincott site on the Santa Margarita River. Both would be used to recharge the river basin.

Aliso Creek is a minor stream system, draining only about 9 square miles before emptying into the ocean. Las Flores Creek is formed approximately 0.8 miles from the ocean by the confluence of Las Pulgas and Piedra de Lumbre creeks. This stream drains about 25 square miles of coastal mountains and foothills before discharging onto the alluvial deposits of the valley. The valley and the Las Flores Creek Basin have an areal extent of about 1,400 acres.

Pulgas Dam and Reservoir and an on-channel spreading structure are located on Piedra de Lumbre Creek, about 4 miles upstream from the confluence with Las Pulgas Creek. The dam is an earth structure with a concrete spillway and impounds about 20 acre-feet. This pond is used only for stocked fishing.

The San Onofre Creek and its tributaries drain an area of about 45 square miles with their headwaters in the Santa Margarita Mountains, approximately 12 miles from the ocean. The stream system is characterized by narrow valleys in the upper reaches and wider alluvial valleys and basins in the lower reaches. The areal extent of the significant valleys and basins extends upstream from the ocean approximately 5 miles. The area consists of about 1,450 acres, divided into two interconnected basins by the Cristianitos fault which forms a natural restriction between the areas. The upper valley has a surface area of 300 acres and the lower valley and basin an area of 1,150 acres.

Groundwater in the San Onofre Creek basin is replenished by six earth dike, on-channel spreading structures and some return of sewage effluent. Low flow is impounded behind the uppermost structure until it fills and spills into successive structures downstream. An offstream basin and diversion channel there also replenishes the groundwater.

San Mateo Creek and its tributaries have a watershed of about 137 square miles and is the second largest stream system at the complex. Headwaters are on the Santa Rosa Plateau 22 miles from the ocean. The lower portion of the San Mateo Creek system consists of an alluvial valley and basin extending approximately 10 miles inland. The valley and basin, about 2,950 acres, is divided into three subbasins. The upper valley and basin has a surface area of about 1,100 acres; Cristianitos Valley and basin 250 acres; and the lower valley and basin has a surface area of 1,600 acres.

The San Mateo Creek system has four earth dike, on-channel spreading structures, two each in the upper and lower valleys. They function similar to the others at the complex by spilling over when filled, so that flow is slowed. Sewage effluent from a base plant is recycled into the groundwater system by discharge onto coarse sediments in the floodplain. It is planned to discharge additional sewage effluent from the City of San Clemente in the future to increase groundwater storage and maintain a freshwater barrier for deterring seawater encroachment. Also planned is a dam and reservoir to be located near the northeastern portion of the stream system. It would serve as a terminus for the cross-base pipeline planned to be routed from the proposed DeLuz dam and reservoir.

At the present time there is a surplus of water in the Santa Margarita and San Mateo groundwater systems serving the complex. The Las Flores and San Onofre systems, however, are borderline for safe yield to serve water demands in their respective areas.

The U.S. Geological Survey has maintained a number of gage stations at the Camp Pendleton complex. Information from the stations, located in Figure 5-4, is used to determine maximum recorded stream flows. Maximum flows recorded at each station, date, and the period of record for each station are shown below:[58]

Stream Gage Station	Stream Peak Discharge (cfs)	Date	Period of Record
449	2,800	4/58	2/51 to 9/67
455	35	---	-/24 to -/60
460	33,600	12/27	2/23 to Current
461	960	1/52	5/51 to Current
462	2,680	4/58	10/50 to 9/67
462.5	2,600	4/58	10/46 to 9/67
463	7,300	12/66	10/52 to 9/67
463.1	2,370	3/52	-/50 to -/52
463.5	1,800	1/52	10/50 to 9/67
463.7	*10,000	12/66	10/46 to 9/67

From stream gage data, topographic surveys, and other data, the USGS prepared maps of flood prone areas. Flood prone areas were delineated for:

- Urban areas where the upstream drainage area exceeds 10 square miles.
- Rural areas in humid regions where the upstream drainage area exceeds 100 square miles.
- Rural areas in semiarid regions where the upstream drainage area exceeds 250 square miles.

Thus, with the exception of Aliso Creek, which has a drainage area of only 9 square miles, the major drainage systems at Camp Pendleton were studied.

*Dam failure.

The flood prone areas at Camp Pendleton which drain more than 10 square miles are taken from USGS maps[59] and are shown in Figure 5-4. The contours outline areas which have a 1 in 100 chance on the average of being inundated during any year. Existing Lake O'Neill and Pulgas Lake do not present hazards to potential plant siting areas. Pulgas Lake is much too small to be of concern, particularly if the site in that area were to be located upstream of the lake. Lake O'Neill empties directly into the Santa Margarita River Basin which is extremely wide and would not affect any site contemplated for use adjacent to that area.

The proposed DeLuz and Fallbrook dams might pose potential hazards in the future to facilities located in the Santa Margarita River Basin. The total of 176,500 acre-feet in both reservoirs can be postulated to be released simultaneously within a period of 6 minutes. In that case, the maximum height of a wave front coming down the Santa Margarita River Basin in the vicinity of the Santa Margarita area, the only potential siting area near the river, might be about 35 feet above the river basin elevation. Any sites which would be considered in this area would be 100 to 150 feet higher in elevation than the river basin. Thus, they would not be subjected to a hazard.

Of the potential power plant locations, only the San Mateo Canyon area is located where it could be subject to potential floods. In that area, elevations up to 275 or 300 feet might be flooded. The plant in this area could be located near the 300-foot elevation if carefully sited, but probably would require some diversion structure installed to insure its protection.

It is noted that Figure 5-4 does not show flood prone areas where the watershed is less than 10 square miles. The Pulgas Branch and Pulgas Lake areas are both located in basins draining small areas. It is likely that some form of diversion structure would be required in those locations, but it would be much smaller than that required for a plant located in the Santa Margarita area.

Other areas would probably utilize some amount of grading for local flooding control, but even the sites requiring drainage structures would have additional grading as a protection against local surface flows. Therefore, only the costs for diversion structures previously noted are estimated as follows:

Area	Estimated Cost (1984-$ Million)
San Mateo Canyon	0.980
San Mateo Hills	0
Santa Margarita	0
Pulgas Branch	0.256
Pulgas Lake	0.256
Las Flores North	0
Las Flores South	0
San Onofre Foothills	0
San Onofre Bluff	0
Las Flores North Bluff	0
Las Flores South Bluff	0

The occurrence of an earthquake in many areas along the perimeter of the Pacific Basin can generate a tsunami or earthquake-generated ocean wave. This wave, initiated by sudden displacement of the sea floor during an earthquake, travels at velocities of 300 to 400 miles per hour and may cause great damage when it approaches land. As the wave enters the shallower water nearer the shoreline, an increasingly higher wave evolves. The high wave generally will run up onshore to a predictable elevation.

The U.S. Army Waterways Experiment Station has done extensive work in predicting runup of seismic seawaves of distant origin for California coastal communities.[60] Their work is the basis for the assessment made in this study.

Apparently, only the Aleutian and Peru-Chile trenches in the Pacific Basin generate tsunamis capable of causing significant ocean runup along the coastline of southern California. Historical evidence, tsunami source characteristics and orientation, and source location relative to southern California have been used in selection of tsunamigenic areas. Based on measurements of permanent ground displacements caused by earthquakes that have generated large tsunamis, hypothetical uplift of the ocean surface can be formulated for various tsunami intensities in the selected tsunamigenic areas. Also, a historical investigation of tsunami occurrence can be used to determine the probability of generating tsunamis of different intensities.

Values of maximum runup from tsunamis have been predicted for occurrence once every 100 years and are considered to be accurate within ±40 percent. The combined effects of astronomical tides and tsunamis are incorporated into the analysis. However, storm surge and wind generated waves are not included.

The following table summarizes the runups considered to be maximums for the period indicated. The areas of inundation would be those which fall within the area bounded by the shoreline and a local contour of elevation numerically equal to the runup value.

Location	100-Year Runup Elevation (Feet)
San Onofre Bluff	5.7
Las Flores	5.6
Oceanside	5.7

It can be seen that peak elevations which might be inundated are about 6 feet above mean sea level. Allowing for a 40-percent error range, land elevations above 9 feet should be free from tsunami hazards, considering the 100-year occurrence, but ignoring storm surge and wind generated waves.

In support of licensing activities for San Onofre Unit 1, a study[1.9] of tsunami potential at the site concluded that it would be possible to achieve a superposition of a maximum high tidal stand of 7 feet, a maximum storm surge of 1 foot, and a 6-foot tsunami, trough to crest, causing a runup of 11 feet. It concluded that protection against a runup elevation of 13 feet MLLW would be adequate protection, although protection was actually provided to Elevation 28 MLLW. Additional studies in 1972 postulated a locally generated tsunami, although not generally believed probable. Extreme water elevation at the San Onofre site under those circumstances was estimated to be +15.6 feet MLLW at extreme high tide and including storm surge. It predicted no likelihood of a local earthquake generating a tsunami capable of overtopping the 28-foot high seawall at the site.

The lowest siting area being considered is in the Las Flores bluff area at about Elevation 60 or 70. Thus, tsunamis are not considered as applicable in this screening of siting areas.

5.2.3 Site Development and Slope Stability

There are a limited number of level areas in the Camp Pendleton complex. The area required for locating nuclear power plant units could have a varied shape, depending on the desired configuration of the plant site. However, there is some flexibility in that configuration because of the number of facilities, their relationship to each of the other facilities associated with a power plant unit, and the relationship between units to be located at the site.

A single unit would probably contain the following principal facilities on the site:

- Reactor Containment Building
- Auxiliary Services and Control Building
- Turbine Generator Building
- Administration Building
- Shops
- Warehouses
- Switchyard and Electric Transmission Line
- Cooling Water Transmission System
- Emergency Cooling System

Depending on the timeliness of construction and the utilization of multiple units, it might be possible to jointly share some facilities between units and thus somewhat reduce the overall space requirements at the site. The impact on site development costs would be similarly reduced.

Slope stability may represent a significant problem where natural slopes are potentially unstable or where construction excavations might undercut planes of weakness within natural slopes, creating a potentially unstable condition. Proper evaluation of this hazard would require detailed investigation in the area of a proposed plant site. However, a preliminary evaluation of the potential for slope stability problems can be based on existing data regarding geologic structure, taking into consideration the topography generally existing in a siting area.

As beds dip southwestward over most of Camp Pendleton, slope stability problems could occur when undercutting southwest-facing natural slopes. This situation might be encountered in the San Mateo Hills, Pulgas Branch, Pulgas Lake, and San Onofre Foothills areas and in part of the Las Flores North and Las Flores South areas. However, these latter areas contain large expanses of flatland and a site could be located so as to avoid slope stability problems.

Areas adjacent to the seacoast bluffs are subject to potential slope failure where geologic units and structures do not provide adequate stability (Figures 5-5 and 5-6). Instability is more critical in the regions of higher, steeper bluffs, such as the Las Flores North Bluff and South Bluff areas. As in the inland areas, actual slope stability conditions along the bluffs would be determined by site-specific investigations.

It should be possible to establish minimum grades at the site, say 2 or 3 percent, where sites have natural grades which exceed that. By excavating and filling so that the building areas have grades no greater than about 3 percent, and the immediate surrounding areas have somewhat larger grades, the overall existing grade for the area could be maintained to minimize excavation costs (Figure 5-7).

The topography at each potential location was reviewed to determine the average gradient. Assuming that less than 25 percent of the area would be used for building, that area would be subject to earth cut and fill in order to establish local minimum grades. Also, a factor is the type of materials which are to be excavated to develop the site. Alluvial deposits would be less costly to excavate, fill, and compact. Rock deposits would require blasting, ripping, hauled-in fill and compacting - a much more costly series of activities.

Rough approximations of earthwork costs for each potential area are tabulated below as a function of earthwork volumes and material types.

Area	Estimated Cost (1984-$ Million)
San Mateo Canyon	0.470
San Mateo Hills	2.520
Santa Margarita	0.440
Pulgas Branch	0.740
Pulgas Lake	0.890
Las Flores North	0.300
Las Flores South	0
San Onofre Foothills	0.150
San Onofre Bluff	0
Las Flores North Bluff	0
Las Flores South Bluff	0

5.2.4 Soil Conditions

Design basis bearing on stability of foundations of nuclear power plant structures and economics of construction operations generally is not critical for site selection within the Camp Pendleton area. However, their economic impact may provide a basis for determining relative desirability of otherwise comparable sites. Evaluation of these factors is based on the characteristics of earth materials present at a potential site.

Earth materials at the surface or at shallow depths in most of the potential areas are expected to be suitable for support of foundations and are not expected to cause unusual construction problems. These materials are the sedimentary rock of Cretaceous to Tertiary age, the San Mateo Formation, and well consolidated terrace deposits. Poorly consolidated terrace deposits, exposed along the coastline between the foothills and the shore, are less than 50 feet thick and likely would be stripped off during construction of a nuclear power plant, particularly for the deep and heavy reactor building and turbine generator building.

Deep deposits of unconsolidated alluvium are found only within the major stream channels on Camp Pendleton and are considered relatively undesirable for plant foundations. Of the potential areas, only the San Mateo Canyon and San Mateo North areas are located in a major drainage containing thick unconsolidated alluvium. The maximum thickness of alluvium at these potential areas is not known. Water wells in and near these two areas have been drilled in alluvium to depths of about 35 feet and have not been continued into bedrock. However, the configuration of the canyon suggests that alluvium may be more than 50 feet thick in these two areas. If it is assumed that an additional 20 feet of excavation are required in order to reach suitable supporting materials, then the following table reflects the estimated added construction cost in these areas:

Area	Supporting Materials Depth Added Foundation Cost (1984-$ Million)
San Mateo Canyon	9.600
San Mateo Hills	0
Santa Margarita	0
Pulgas Branch	0
Pulgas Lake	0
Las Flores North	0
Las Flores South	0

Area	Supporting Materials Depth Added Foundation Cost (1984-$ Million)
San Onofre Foothills	0
San Onofre Bluff	0
Las Flores North Bluff	0
Las Flores South Bluff	0

Excavation for nuclear power plant facilities would not be expected to encounter unusual problems in Cretaceous to Tertiary sedimentary rock, terrace deposits, or alluvium. Difficult excavation conditions may be encountered in the crystalline basement rock. This material is exposed only in the eastern half of the Santa Margarita area and could be avoided in specific site selection procedures.

Another consideration is the groundwater level in each of the potential plant siting areas. The deepest structure would be the reactor building, with foundation levels as much as 40 feet below grade. The turbine generator building and other facilities might have below-ground and foundation structure approximately 25 feet below grade.

Where water tables normally rise to levels near foundation excavation depths, construction would be more costly. Excavations might require dewatering and shoring. High groundwater tables also may influence foundation design, particularly impacting allowable bearing capacity and liquefaction potential. Thus, it can be anticipated that siting areas having high groundwater tables would result in more costly foundations. Those with water tables higher than 25 feet below the present ground surface probably would impact on foundation design and construction for most sizable structures.

Many wells have been installed at the Camp Pendleton complex, even before the camp was established in 1942. Many of those that are now functional are routinely monitored by Camp Pendleton personnel for depth of water. This information is placed in a computerized file maintained by the U. S. Geological Survey. Past records of wells in the area also appear in the USGS file. That information was used to determine the highest recorded groundwater levels at each well. From that, the groundwater level at each of the siting areas being considered was estimated, considering the variation in topographic features existing there. These highest anticipated groundwater levels and an indication of the affected buildings are as follows:

Area	Minimum Depth to Water (Feet)	Buildings Affected: None	Reactor Building Only	All
San Mateo Canyon	0-5			X
San Mateo Hills	100	X		
Santa Margarita	26		X	
Pulgas Branch	40		X	
Pulgas Lake	25		X	
Las Flores North	62	X		
Las Flores South	80	X		
San Onofre Foothills	109	X		
San Onofre Bluff	109	X		
Las Flores North Bluff	69	X		
Las Flores South Bluff	20			X

Considering the potential construction cost impact of these groundwater levels, the following table reflects the estimated range in cost. The potential additional operational cost for long term pumping of collected water in the foundations is ignored because, if applicable, it is anticipated to be a negligible cost.

Area	Estimated Cost (1984-$ Million)
San Mateo Canyon	16.80
San Mateo Hills	0
Santa Margarita	5.50
Pulgas Branch	5.50
Pulgas Lake	5.50
Las Flores North	0
Las Flores South	0
San Onofre Foothills	0
San Onofre Bluff	0
Las Flores North Bluff	0
Las Flores South Bluff	16.80

5.2.5 Water Transport

Cooling water requirements for a single 1,000 Mwe nuclear power plant are about 800,000 gpm maximum, using once-through cooling. Precise flows vary, depending on intake water temperatures, length of line from intake to the plant, and the operating power level of the plant.

The San Onofre Nuclear Generating Station Units 2 and 3 typify requirements for a plant located adjacent to the southern California shoreline. The State has limited to a maximum of 20°F the difference between ambient ocean water and discharge water temperatures, and the near-shore temperature change to 4°F resulting from the mixing which takes place between the discharge line and shore. In the case of San Onofre, with two new units added to an existing unit, it was necessary to increase and stagger discharge water points for the new water supply and discharge lines. It was also necessary to include diffuser sections at the ends for greater dissipation so that the net effect of all discharge water temperatures will not cause shoreline water temperatures to exceed the limitation.

Offshore cooling water intake points are determined by using locations having sufficient water-depth to provide cool bottom temperatures, and depths which somewhat inhibit taking in biota and bottom materials which would occur in the more turbulent shallower water.

The resultant ocean water cooling system for San Onofre Unit 2 will include an 8,200-foot long offshore reinforced concrete discharge line. The line will be 18 feet maximum diameter, stepping down in size along the last 2,500 feet which act as the diffuser. The discharge line will be buried and will lay under 48 feet of water. Unit 3 will utilize a similar line 5,900 feet long in 38 feet of water. The cooling system for each unit will include a 3,200-foot long intake line, 18 feet in diameter, buried and resting in 30 feet of water. It is anticipated that other power plant units which might be located in the Camp Pendleton area would require offshore cooling water intake and discharge lines of at least equal length and capacity as San Onofre Units 2 and 3, because the hydrography and bottom characteristics offshore are similar throughout the area.

The San Onofre units are located adjacent to the shoreline so that intake and discharge lines entering the shore-based pumping station are in close proximity to the turbine generator building. The water lines on shore are therefore short and the turbine is located at low elevations, so that line friction and head losses are low. On the other hand, locations at Camp Pendleton which are being considered for siting of future nuclear power plants are at various distances and elevations from shore. The cost for construction and operation of cooling systems is sufficiently great as to warrant conceptualizing a system for each location and comparatively assessing costs. In addition, because of the large sizes and lengths involved, the importance of the cooling lines to normal plant operation, and the potential vulnerability of these lines to hazards from seismic activity and military operation, some assessment of line reliability also appears warranted.

5.2.5.1 Reliability. The reliability of large diameter lines is assessed by examining the experience of similar lines which presently exist in California. These are examined for installations offshore and on land.

- Currently, Southern California Edison maintains and operates two 12-foot diameter cooling lines at the San Onofre Nuclear Generating Station for Unit 1. Installed in 1966, both the intake and discharge pipes extend approximately 3,400 feet out from shore and are approximately 30 feet deep at their furthest point. Both lines carry a maximum designed flow rate of 350,000 gpm.

  The lines are reinforced concrete, with a double steel cage for reinforcement. Typically, the pipe walls are 14 inches thick and the sections are 24 feet long. Joints are of bell and spigot type, with a single, 1-1/16-inch diameter rubber gasket and no metal joint rings.

  To date, there have been no reported operation or maintenance problems of any significance.

- In 1960, the City of Los Angeles constructed a 5-mile long outfall to convey treated effluent from the City's Hyperion Wastewater Treatment Facility located at El Segundo, California. The 12-foot diameter line is of reinforced concrete with double steel cage reinforcement and a wall thickness of 12 inches. The line extends about 5 miles seaward, lying in a depth of 220 feet of water. It was designed for a flow rate of 750 million gallons per day, or 521,000 gpm.

  Joints in the pipeline are of a typical bell and spigot configuration with a double rubber gasket.

  Some time ago, the only major work on the outfall occurred when a large oil tanker, anchored offshore in close proximity to the outfall, slipped its anchorage and its anchor hooked the outfall, damaging several sections of the pipe. To date, no natural problems, including seismic activity, have plagued or hindered the operation of the outfall. Inspection is made annually as required by the Water Resources Control Board.

- The Los Angeles County Sanitation Districts have four ocean outfalls which convey treatment plant effluent from the joint treatment plant in Carson to a point approximately 2 miles off of White's Point on the south slope of the Palos Verdes Hills near San Pedro. The oldest of these outfalls, constructed in 1935 and 1946, are no longer in service. The two newer outfalls, constructed in 1954 and 1964, currently convey all the wastewater effluent.

The two abandoned outfalls are reinforced concrete pipe with cast iron joints. In the past, the cast iron joints corroded and disintegrated, causing considerable problems.

The newest pipe, constructed in 1964, is 10 feet in diameter, approximately 2 miles long, and terminating at a point in 200 feet of water. The pipe is reinforced concrete and has a wall thickness of 11 inches. Double steel cage reinforcing is used in the pipe wall. Joints typically are bell and spigot with double rubber gaskets.

The second pipe is 90 inches in diameter, with a wall thickness of 8 inches. It is of concrete with double steel cage reinforcement. Cast iron joints have double gaskets, one rubber and one lead.

Both pipes have been virtually maintenance free since their installation. Annual inspections verify the integrity of these lines.

- A number of large diameter pipelines exist on dry land in California. For example, the Metropolitan Water District and City of Los Angeles both have installed lines with diameters ranging up to 15 feet in diameter. Some of these larger diameter lines have reaches in the Sylmar-Newhall-Saugus areas which were subjected to strong seismic shaking in February, 1971. No damage was experienced with these lines as a result of that or other earthquakes.

- A large water distribution system was placed into service in 1966 in the Bakersfield area for the Arvin-Edison Water Storage District. The system includes a 3-mile long pumping plant discharge pipeline having a diameter of 11 feet. The line is prestressed concrete with bell and spigot rubber gasket joints. Annual inspections reveal no damage from its environment and service.

Thus, there is evidence showing that large diameter, long pipelines can be designed and constructed for reliable use offshore as well as on land. Although the time in service for some of the pipelines is relatively short, there have been few signs of damage from their environment or service. It can be assumed that pipelines which are not routed through areas containing capable faults will be reliable.

There has been little information available to assess the experience, if any, of large diameter water lines passing through military installations. However, since these cooling water lines would not be required during emergencies resulting in plant shutdown, a loss in their availability would not affect plant safety.

5.2.5.2 System Description. The once-through ocean cooling water system on which the comparative assessment for each power plant unit was based consists of intake and discharge lines carrying water between a near shore-based pumping station and offshore points at distances and depths which will permit obtaining the water temperatures and quality required for cooling as well as permitting the dispersion of discharge water so that shoreline water temperature regulations are not exceeded. In general, offshore hydrography and bottom characteristics along the Camp Pendleton coastline appear to be similar at most locations so that concept and costs for the offshore installation would be similar at most locations. Slight rerouting in an actual case might be desirable to avoid coastal water zones of special concern. However, it was assumed that these do not provide cost differentials which significantly affect the differences in cost for the land-based portion of the cooling system.

The land portion of the system was conceptualized as beginning with the onshore pumping plant which would pump ocean water received from an offshore gravity pipeline through two parallel 14-foot diameter pipelines to the power plant site. The 14-foot diameter pipelines would be steel cylinder type concrete pipe, probably prestressed. The twin pipelines would avoid the deeper excavation and higher backfill and handling costs which would be incurred if a single larger pipe were used. Another consideration in the selection of two parallel pipelines was the increased system reliability since if one pipeline were to be damaged, a power plant could still function at a reduced output using the cooling water pumped through one pipeline. The conceptual plans include for each plant twin 19-foot, 8-inch diameter gravity pipelines to return the cooling water to the ocean with additional length extending offshore into deep water.

Pipeline routes onshore, shown in Figure 5-8, were selected to minimize distances and construction difficulties between the pumping plant and the power plant.

The length of assumed land-based routes between the various potential power plant locations and shore-based pumping plants, as well as power plant turbine elevations above the supply pumps, used in the assessment is shown in the following table:

Area	Land-Based Route (1,000 Feet)	Power Plant Elevation (Feet Above Pump)	Installed Horsepower (1,000 HP)	Power Consumption (Million kwh/year)
San Mateo Canyon	30.0	200	98.0	411
San Mateo Hills	32.4	700	302.0	1,266
Santa Margarita	39.4	480	214.4	898
Pulgas Branch	27.9	400	179.7	753
Pulgas Lake	21.8	380	169.5	710
Las Flores North	4.9	160	77.6	325
Las Flores South	9.0	100	53.1	222
San Onofre Foothills	2.0	220	100.5	421
San Onofre Bluff	0.8	140	67.8	284
Las Flores North Bluff	1.2	120	59.6	250
Las Flores South Bluff	1.4	90	47.4	198

5.2.5.3 System Economics

Capital cost estimates for the pumping plant and supply and return pipelines between the power plant and pumping plant for each location are shown in the following table. Since offshore pipelines would be about the same for all plant locations, those costs are not included. Capital costs are indicated for 1987, representing the period assumed for construction of this phase of work. Pumping energy, as well as maintenance and other annual operation costs associated with the pumping plant and pipeline, are indicated for the first operational year, 1990.

Area	Estimated Construction Cost (1987-$ Million)	Estimated Annual Operations and Maintenance Costs (1990-$ Million)
San Mateo Canyon	145.6	15.9
San Mateo Hills	241.2	47.9
Santa Margarita	227.8	34.2
Pulgas Branch	173.1	28.7
Pulgas Lake	147.8	27.0
Las Flores North	50.1	12.3
Las Flores South	53.9	8.5

Area	Estimated Construction Cost (1987-$ Million)	Estimated Annual Operations and Maintenance Costs (1990-$ Million)
San Onofre Foothills	49.9	15.7
San Onofre Bluff	31.8	10.6
Las Flores North Bluff	29.6	9.4
Las Flores South Bluff	25.3	7.4

Cooling water transport is the most significant additional cost item of the economic factors studied. The capital cost of the pumping stations, supply and discharge water lines, as well as operating and maintenance costs for these facilities represent an appreciable portion of the total plant cost where areas are relatively high in elevation and far from shore. For example, the annualized cost of cooling water transport for a plant located about 4 miles from shore and about 500 feet in elevation is estimated to be about 28 percent of the total costs. Areas located within 1 or 2 miles of the coastline, particularly at lower elevations up to 100 or 200 feet above sea level are estimated to have annualized cooling water transport costs which are about 6 percent of the total cost.

5.2.6 Power Transmission

At the present time there is one 230-kv and one 138-kv electric transmission circuit from the San Onofre Nuclear Generating Station south to the San Luis Rey Substation at Oceanside (see Figure 5-9).[61] A 69-kv transmission line extends from the Japanese Mesa Substation near the San Onofre plant to the San Luis Rey Substation. A 69-kv feeder from there serves portions of the Camp Pendleton complex, along with isolated generating stations on base.

There are two 230-kv transmission circuits owned by Southern California Edison and two 138-kv circuits owned by SDG&E extending through the complex. They exist on a right of way from the San Onofre Nuclear Generating Station into San Mateo Creek, through the State-leased land, and into the Talega Substation. This right of way includes areas for two additional 230-kv circuits which will bring power from the new San Onofre Units 2 and 3 to Talega Substation to serve Orange County. Also, two 230-kv transmission circuits will be extended from Units 2 and 3 south along the coast to the Mission Substation.

SDG&E's Sundesert plant will initiate a 500-kv transmission loop system that will connect from the east to the proposed Valley Substation and to the Rainbow Substation which will be located about 6 miles east of the Camp Pendleton complex boundary. This portion of the circuit is in addition to southerly portions of the 500-kv loop from the east to substations near San Diego.

SDG&E presently has a right of way which extends from the Talega Substation along the northern boundary of the complex to Rainbow. It was planned for use, but its need has been preempted by the extension of the 500-kv circuits to the Rainbow Substation. This right of way could be made available for other line needs. It is 200 feet wide, sufficient for a single 500-kv circuit or four 230-kv circuits, but not large enough for two 500-kv circuits which would require a width of at least 300 feet.

Any nuclear power plant in the Camp Pendleton area would not be able to use existing transmission lines, right of ways (except the unused northern one just described), or substations. They are, or will be, at capacity. For example, the San Luis Rey Substation is presently undergoing modification to enable it to handle its existing loads.

For purposes of the economic comparisons being made in this study, it is assumed that new substation terminations could be at Valley, Rainbow, or Mission Substations in order to serve the SDG&E area. Present SDG&E plans call for transmission runs from Rainbow to the San Diego area to be 230 kv. Therefore, future power circuits from the Camp Pendleton area can be assumed as no larger than 230 kv, since larger circuits would require high cost transformers to step down to 230 kv or less for the transmission south.

To provide for diversity and increased system reliability, it is assumed that new transmission lines for the potential nuclear plants in the Camp Pendleton area would utilize two 230-kv circuits to the Rainbow Substation, using the available northerly right of way when appropriate for northern plant locations, and two 230-kv circuits along the coast directly to the Mission Substation.

Routes for circuits from each potential plant location have been approximated in order to establish comparative lengths of lines and difficulty in construction. In estimating routes attention was given to avoiding ordnance impact areas and areas of special use or interest such as the Cleveland National Forest.

The following table summarizes the transmission line distances, including miles of rugged distance requiring greater construction effort, from each potential siting area to common juncture points outside Camp Pendleton. Also shown are estimated construction and estimated annual operating and maintenance costs.

Area	Distance (Miles) Rugged	Other	Total	Estimated Construction Costs (1987-$Million)	Estimated Annual Operations and Maintenance Costs (1990-$ Million)
San Mateo Canyon	18.4	32.6	51.0	29.0	2.071
San Mateo Hills	20.0	33.3	53.3	30.4	2.173
Santa Margarita	9.5	17.8	27.3	15.5	1.108
Pulgas Branch	14.9	19.1	34.0	19.7	1.062
Pulgas Lake	17.0	16.7	33.7	19.9	1.379
Las Flores North	19.0	16.2	35.2	21.0	1.444
Las Flores South	17.7	15.9	33.6	20.0	1.378
San Onofre Foothills	24.7	16.3	41.0	24.8	1.687
San Onofre Bluff	24.7	16.3	41.0	24.8	1.687
Las Flores North Bluff	22.5	16.2	38.7	23.3	1.591
Las Flores South Bluff	17.6	17.5	35.1	20.7	1.436

5.2.7 Summary Estimate

The cost estimates indicated in Section 5.2 are based on capital expenditures made in different years. Some considerations also include annual operating and maintenance costs, where applicable or significant. These costs were combined by developing annualized costs. All estimates were converted to future values for the year 1990, the assumed year of initial operations, by charging capital expenditures at 10-percent interest rate to 1990. A fixed charge rate of 14.6 percent was applied to these capital costs to obtain annualized costs which were combined with the estimated annual maintenance and operating costs. These annualized costs for the additional plant requirements are subtotaled in Table 5-4.

Further, it was desirable to compare the cost differences between areas in terms of impact on total plant cost to minimize what would otherwise be a distortion in the significance of cost differences. The basic plant cost used in the comparison was a levelized plant bus bar cost of 54.5 mills/kwhr and an annual net generation of 6.4×10^9 kwhr. This represents a hypothetical 1,000 Mwe nuclear power plant located at the shore and having initial operation in the year 1990. Table 5-4 indicates the annualized total plant cost for a plant located in each of the siting areas.

5.3 ENVIRONMENT

5.3.1 Climatology

The climate at the Camp Pendleton complex is temperate. Winter seasons are cool and moist, and summer seasons are warm and dry. During the summer season, ocean breezes are a moderating influence, which diminishes with increased distance from the coast. The central and eastern areas are somewhat warmer and drier.[6,62,63]

Humidity, particularly in the central and eastern areas, is generally low and with rare exceptions, the nights are relatively cool. Heavy fog occurs at lower levels of the coastal areas from November through January and higher levels of fog occur during the hotter months of the year. The fog is caused by close proximity to the ocean, the upwelling that keeps the ocean cool, the mountains that block wind flow, and temperature inversions which hinder the fog's dispersal.

August is the warmest month of the year with the maximum temperature in the coastal area averaging 73°F. Occasional hotspells occur in September and October. In January the minimum temperature averages 43°F, with a mean maximum of 61°F. Readings of 32°F or lower are occasionally reported, but are generally of short duration. Inland temperatures generally are higher and it is not unusual for the central and eastern areas to be as much as 15 degrees warmer than coastal areas, particularly during the summer months.

Precipitation records, initiated by the Rancho Santa Margarita in 1876 and continued by the Marine Corps Base, exhibit a wide range of rainfall. Precipitation varies from a record 30.8 inches of rainfall in 1884 to only 4.5 inches in 1961. The average precipitation for the period of record is 13.4 inches per year in the coastal zone and increasing to about 22 inches at the higher elevations of the northern boundary of the complex.

A sea-land breeze system, consisting of winds that sweep inland by day and flow toward the sea by night, along with northwesterlies are the most prevalent winds in the area. Santa Anas are more substantive, although less frequent. The northwesterlies come from the north Pacific high pressure area, reaching the southland as a cool, dry subsiding wind turning more westerly as a result of the Palos Verdes Peninsula. The Santa Anas are high velocity winds sometimes reaching 65 miles per hour and accompanied by abnormally high temperatures, occasionally a 20-degree increase, and occurring most often from mid-October through

March. They are northerly and northeasterly winds, characteristically low in humidity.

Figure 5-10 is the annual wind rose obtained from a 10-meter station at the San Onofre Nuclear Generating Station.[64] It is anticipated that potential coastal locations at Camp Pendleton would have a similar wind rose, although differences are likely for locations closer to the coastal foothills. It can be noted that the higher frequency of winds generally are westerlies with an average velocity of 7 miles per hour. The Santa Anas from the northeast also show a high frequency. Figure 5-11 is the wind rose obtained from surface observations at the Marine Corps Auxiliary Landing Field at Camp Pendleton.[65] The field is located about 6 miles inland. Most frequent wind directions are generally westerly at velocities of about 8 miles per hour.

5.3.2 Land Use

The area immediately surrounding the Camp Pendleton complex has a number of varied land uses as seen in Figure 5-12, including residential, agricultural, and open spaces. Information for this map was obtained from a number of sources.[6,66-71] San Clemente on the northwest complex boundary is a vacation and retirement area. It has medium-low density housing and a golf course occupying the initial 1-1/2 miles of the boundary with Camp Pendleton, then has about 3 miles of low density open area. This open area is secured by relatively hilly terrain and is recognized in the City's general plan for low density population. However, the residential use of the land increases in density up the coast about a mile from the boundary and is considered a medium-high to high density residential area in that location.

Orange County land adjacent to the northwest boundary of the complex and inland of San Clemente is used for agriculture, including an agricultural preserve. In general, it is open space, particularly throughout the hilly terrain existing in that area. TRW maintains a private laser development installation about one-quarter mile north and east of the boundary near Talega camp.

Some of the land in San Diego and Riverside counties adjacent to the complex on its northern boundary is open space hills and part of the Cleveland National Forest. The area to the east of the forest generally is also undeveloped open area and is likely to stay that way because of the hilly terrain. Within that area, however, there are spots of agricultural developments. The Comprehensive Planning Organization of the San Diego Region has planned a portion of that area as an agricultural preserve.

The Fallbrook community lies on the eastern boundary of the complex. While there are rugged mountains on the north surrounding the Santa Margarita River, there are gentle rolling hills which predominate throughout the central Fallbrook region and the San Luis Rey River basin to the south. These areas have been developed with avocado and citrus groves, the principal agricultural industries in the area.

The City of Oceanside lies adjacent to the southeast boundary of the complex. Approximately 20 percent of the area is used for residential purposes, including some commercial and industrial activities. Over 25 percent of the area is used for agriculture, located mostly in the northern portion of the City. That area and the City's sphere of influence to the north are planned to be an agricultural preserve over the long term. Other areas of Oceanside are open space, with residential uses encroaching on it.

The Camp Pendleton land use reflects the primary mission of the complex which is training. The greater portion of land is used for amphibious assault exercises, maneuvering, firing ranges, and ordnance impact zones. Consequently, the complex is comprised almost entirely of vacant, virgin lands. Details of the military operations were discussed in Section 4. However, there are many other land uses existing in the complex.

There are a number of built-up areas at the complex where the military personnel, their dependents, and civilian employees either work or live. These were noted in Figure 4-4. Family quarters are located nearer the perimeter areas of the complex at San Onofre, Del Mar, Wire Mountain, and in several communities in the headquarters area.

Also, there are a number of leases and easements on the complex which provide for varied other land uses.[6] The San Onofre Nuclear Generating Station lease is located in the northwest coastal area and incorporates three units which occupy essentially all of that land.

Approximately 3,000 acres have been leased to the State of California, Department of Parks and Recreation, for public use. This includes public beach area on either side of the San Onofre Generating Station and a large parcel adjacent to San Clemente which is used as a public parks area. The lease provides for the State to take additional beach north and adjacent to the leased beach at such time as the State replaces the existing beach club there. Marine landing exercises could be conducted there with advance notice in each instance.

Approximately 50 acres of the complex, located in the Las Flores area, are leased to the Orange County Council of the Boy Scouts. This property includes the Las Flores Adobe, or Ranch House, a historic landmark, and the Las Flores Asistencia, an old Spanish mission ruin. These facilities, discussed in Section 5. 3. 4, are planned to be restored by the Boy Scouts' organization.

On-base agricultural leases are an important function of the Camp Pendleton complex conservation program. There presently are 13 farming and 4 grazing leases comprising over 30,000 acres. The four grazing leases are for sheep. The farm crops, located in leases in the southern area of the complex and in the San Mateo basin, consist of diversified truck crops and a small acreage of lemon trees. In addition to private leases, the State Department of Agriculture leases some of the farming area for sample growing and crop disease monitoring.

Even with the existing leases, there are frequent pressures being placed on the Government for the release of lands in the Pendleton complex for recreational purposes. This is born out by the State Park System's coastal survey, some results of which were published in its California Coastline Preservation and Recreation Plan in 1971.[72] In the southern California area, there were the following existing and projected uses:

Use	Million Person Activity Days	
	1970	1980
Swimming/Wading	69.0	100.0
General Beach	73.0	93.0
Surfing	37.0	51.0
Total	179.0	244.0

It was reported that the State-owned or leased holding of effective swimming beach which is, or could be, developed is adequate to meet the demand for beach activities through 1980. The greatest local deficiencies, however, were stated to exist in southern Orange County and northern San Diego County, the area of Camp Pendleton. Further, the California Coastal Zone Commission noted in its plan[66] that it desires to acquire approximately 7 miles of beach frontage in the Camp Pendleton area to be added to San Onofre State Beach for general recreation. Therefore, there will continue to be public pressures placed on the U. S. Government to convert additional military lands in this area for public recreational use.

The Federal Government maintains a U. S. Customs inspection station and the California Department of Transportation operates a weight station along Interstate Highway 5, about 2 miles south of the San Onofre Nuclear Generating Station. It occupies a small acreage on the east side of the highway.

Judgement of the compatibility of each of the potential areas with nearby land uses can be done by assessing the sensitivity of nearby land uses to an adjacent nuclear power plant. Less compatibility, or greater sensitivity, exists if the plant would encroach on existing or potential public recreational use areas; areas of scenic, cultural, or historic values; or areas which inhibit normal or planned operational use of the adjacent land, particularly with respect to the magnitude of interference.

Encroachment on existing long term leases might be of particular concern when considering a plant location, although it might be possible to alter or cancel such leases, if agreeable to the parties, so long as compatibility would otherwise exist. Finally, some areas, particularly in the coastal zone, potentially have long range uses different from their use today, primarily because of the soil or weather conditions or other enhancing factors.

Following in Table 5-5 is an evaluation of the sensitivity levels to the impact on existing or planned land uses from a plant at each of the siting areas. These are expressed by category, then generally summarized.

5.3.3 Biology

5.3.3.1 Plant Communities. The natural vegetation of the Camp Pendleton complex consists of plants that are adapted to moist winters with mild, frost-free temperatures followed by dry summers.[6,57,62] Plants which grow during the rainy winter season become dormant in late spring when the soil becomes too dry to support plant growth.

The natural vegetation of the base is represented by a variety of species as seen on Figure 5-13. The vegetation is mainly comprised of two types, grassland and chaparrel. The grassland occurs in open areas with a large proportion of broad-leaf herbaceous plants which seasonally give a weed appearance. Perennial bunch grasses had decreased in the past, but are again increasing. Also there are annual grasses including Wild Oats, Soft Chess, Ripgut Brome, Filaree, and Bur Clover.

Chaparrel is represented by areas dominated with a cover of brush having thick, stiff, hard, usually flat, evergreen leaves and dense, rigid branching. Characteristic shrubs are Scrub Oak, Ceavothus, Toyon, Laurel Leaf Sumac, and Sugarbrush.

Coastal strand occupies the sandy beaches and small sand dunes along the coast. The plant cover is scattered and consists of plants such as Iceplant, Coast Verbena and succulents which can tolerate salt spray.

Coastal Salt Marsh occupies the tidal flats and margins or brackish sloughs. The plant cover is irregular and patchy, and consists of Picklewood, Iodine Bush, and other saline tolerant plants. Alkali Bubrush, other brushes, and Cattails grow in the shallow water of the estuaries and sloughs.

Coastal sagebrush areas are characterized by moderately open, occasionally dense, cover of brush with grayish leaves. The dominant shrubs are California Sagebrush and Flattop Buskwheat. Chamise, Sugarbrush, and other chaparrelshrubs may occur. Herbaceous ground cover consists of plants similar to those in the grassland community.

Oak-Savannah occurs in minimal quantities in the upland areas in conjunction with grassland.

Riparian vegetation occurs on margins of water courses and low valleys where undersurface water occurs. This plant community is characterized by such trees as Sycamore, California Laurel and White Alder, and such shrubs as Guatamote, Black Willow, and Elderberry.

The only known endangered or rare plant at the complex is Coyote Thistle, which is located in the Ysidora basin. None of the siting areas are located near this specie.

There are a number of conservation projects in effect at the complex to reduce soil erosion. Unnecessary vehicle roads and trails are being eliminated and the grassland there restored. Some riparian areas are being restored as well as grassland, brushland, and firebreaks, which have been eroded. Areas have been seeded and fertilized and trees have been planted as stabilizing mechanisms. Some rotational controlled burning of brushlands is accomplished to reduce the buildup in feed material for fires resulting from impact firing and other causes.

5.3.3.2 Wildlife. The variety and distribution of plant communities provide habitat for a large variety of wildlife.[6,57,62] The only big game at Camp Pendleton is the southern California Mule Deer. During the deer hunting season, the base conducts special deer hunts for civilians. Nearly 250 permits are issued annually for this activity which is operated in accordance with California State Code. The important native small game species are California Valley Quail and Cottontail Rabbit, as well as Opossum, Skunk, and Racoon. Approximately 1,000 military and 650 civilian hunters utilize the base for hunting activities.

There are a large variety of rodents and more than 15 species of snakes, including Rattlesnakes, King Snakes, and Gopher Snakes. There are abundant migratory game birds which spend part of each year on the complex. These include Mourning Dove, Bandtail Pigeon, and numerous waterfowl and shorebird species which occupy the coastal salt marsh and strand plant communities that provide food and cover. Other migratory birds include the endangered Least Tern and Belding Savannah Sparrow which nest in the Santa Margarita River basin area. Golden Eagles are known to have nests in the Ysidora basin, but have been seen throughout the complex. Other protected raptors identified throughout the complex include the White Tailed Kite, Redtail Hawk, other hawks, and owls.

The only significantly large number of mammal predators are the Bobcat and Coyote. However, several cougars are known to live on the complex. About 20 species of predatory birds make their home on the base.

Open water suitable for fishery management is limited to a few small man-made ponds. Lake O'Neill, the largest of these, covers 125 acres. The remaining ten are small farm pond variety, with two of these, including Lake Pulgas, providing fishing sport through a put and take trout planting program. Only warm water fish live in Lake O'Neill and the other small ponds. These include Large Mouth Bass, Redears, Channel Catfish, and Crappies.

The conservation program in effect at the complex has included the preservation of wildlife habitat at the Santa Margarita Estuary and adjacent bottomland, particularly since that area has qualified as a wildlife sanctuary. All training activity not absolutely essential in that area has been discontinued around the estuary. An exception is the use of tracked vehicles in the area where, in the nesting off-season, their track depressions have proven an enhancement to the nesting areas of the Least Tern. Barriers and signs are erected during the nesting season and vegetation is removed from the nesting areas. Also, the Belding Savannah Sparrow nests nearby the Least Tern. Barriers and signs also are provided during the nesting season to protect their nesting sites in the Santa Margarita River Estuary.

Several ponds are periodically drained and reshaped to provide deeper water for diving ducks and shallow ponds for puddle ducks and shore birds. Surrounding ground has been planted with trees and grass to enhance it for pheasants, other birds, and small mammals.

Other wildlife which has been encouraged include a small herd of buffalo, approximately 13 head, in the Case Springs area. Also, some years ago turkey was introduced into the Oak-Savannah area of Case Springs and has since reproduced.

The biota which are considered endangered, rare, or protected at the Camp Pendleton complex, and for which special precautions should be taken to protect their habitats, are:

Biota	Location
Least Tern	Santa Margarita River Basin
Belding Savannah Sparrow	Santa Margarita River Basin
Coyote Thistle (Plant)	Ysidora Basin
Golden Eagle	Ysidora Basin, Horno Canyon, and South Fork of San Onofre Creek
White Tail Kite	All
Red Tail and Other Hawks	All
Buffalo	Case Springs

Also, the marshlands at San Mateo and Las Flores Creek, outlets, as well as the tidelands at the Santa Margarita River are all areas inhabited by a variety of wildlife at various times of the year. They should be avoided as potential sites for power plants.

Potential power plant siting areas are evaluated in terms of their close proximity to endangered or rare species, particularly to their habitats, which represent more than just a few percent of the habitat at the base.

Area	Sensitivity			
	Very High	High	Normal	Low
San Mateo Canyon				X
San Mateo Hills				X
Santa Margarita				X
Pulgas Branch				X
Pulgas Lake				X
Las Flores North				X
Las Flores South				X

Area	Sensivity: Very High	High	Normal	Low
San Onofre Foothills				X
San Onofre Bluff				X
Las Flores North Bluff				X
Las Flores South Bluff				X

5.3.4 Cultural Resources

The Camp Pendleton complex contains many archeologic and historic features which are worthy of protection.[6,57] Camp Pendleton was commissioned in 1942 and was developed on one of California's old ranches, the Santa Margarita Rancho. It is not known just when Andres Pico was given a grant to the Santa Margarita Valley, but records show that the Pico family came to the territory before 1800. A concrete marker along the old road across Ysidora Flats states "Adobe of Andres Pico 1814."

The oldest structure at the complex is the Santa Margarita Rancho House Chapel. Part of it served as the temporary home for Pio Pico, brother of Andres, and his family when they moved the ranch house in 1828 from Ysidora Flats up the Santa Margarita River to its present location. After the family moved out, the temporary quarters were used as a winery. Today, the ranch house is the official residence of the Marine Corps Base Commanding General.

In 1864 Pio Pico sold the Santa Margarita Rancho to his brother-in-law, Don Juan Forster. Under Forster's ownership some of the Indians remained on the ranch as workmen. Following Forster's death in 1882 and that of his wife soon after, heirs sold the ranch to James C. Flood and Richard O'Neill of San Francisco. They turned their attention to diversified farming and ranching and Santa Margarita became a big business with 25,000 acres under cultivation and more than 1,500 persons employed there.

When the Santa Margarita Rancho was dedicated by Franklin D. Roosevelt as a Marine Corps base, he suggested that the romantic flavor of the ranch should be preserved. The ranch house and adjoining buildings are the historic center of the old Rancho. The adobe buildings were restored to illustrate Spanish colonial architecture. Among the buildings selected to be rebuilt was the old winery. At first it was intended to be used as a museum; but as work progressed, it was decided to restore it as a chapel.

A historical museum is currently located in the bunk house directly across from the ranch house. The bunk house dates back to 1835 and was established as a museum in 1965. It is a repository for items of historic interest relating to the Camp Pendleton complex and the surrounding area from its earliest known times.

The Las Flores Adobe, a ranch house located in the Las Flores Creek area (see Figure 5-14), stands as a reminder of the past, along with the Las Flores Asistencia, an old Spanish mission ruin. Nearby, under control by the Marine Corps Base, is the Las Flores Indian Burial Site. These historic resources are located in the property presently under lease to the Orange County Boy Scouts.

Most of the artifacts which have been recovered at Camp Pendleton were found throughout the Las Flores Creek area to the coastal bluffs.

In the arbor entrance of the ranch house hangs a bell which was once used in the Las Flores Asistencia. It was given to the Marine Corps in 1943 by officials of the railway station at San Juan Capistrano where it had hung since 1887.

In 1956 the California State Historical Society placed a marker, La Cristianta, near the San Mateo Gate, as an honor to two of the Franciscan friars who conducted the first two baptisms in California in 1769. The site is near the Cristianitos area, which derived its name from the historic event.

On the lawn of the residencia stands a field piece which was donated by "Aunt Mary" Pendleton, widow of the late general for whom the installation is named. The weapon was captured by Major General Pendleton's force in 1912 during the Nicaraguan Campaign.

In 1969, while on maneuvers, several marines discovered a bone sticking out of the side of a washed out area and uncovered a human skeleton. Anthropologists determined the remains were of a La Jollan Indian of the culture which endured about 5,000 years ago. Future excavation of the site located at the outlet of Horno Canyon is under consideration. Plant sites in San Onofre Foothills area would best be located away from this potential excavation area, possibly farther to the northwest.

A fossil of a whale was discovered in an eroded sand terrace in the Edson Range area of the complex. This fossil is estimated to be 2 million years old. Its location in the Edson Range is not in close proximity to potential plant siting areas.

Over a long period, various base commanders have submitted nominations to the National Park Service, Department of Interior, for inclusion in the National Register of Historic Places. Three of the nominations, the Santa Margarita Ranch House, the Las Flores Indian Burial Site, and the Las Flores Adobe, have been selected to be placed on this register. The Las Flores Adobe also has been designated a National Historical Landmark.

Generally, the location at Camp Pendleton of archeological and historical features is tabulated below:

Feature	Location
Pico Adobe - Historic Site	Ysidora Flats
Santa Margarita Rancho House Chapel	Santa Margarita River Basin
Santa Margarita Rancho House	Santa Margarita River Basin
Las Flores Adobe	Las Flores Creek
Las Flores Asistencia	Las Flores Creek
Las Flores Indian Burial Ground	Las Flores Creek
La Crisitanitos Historic Site	Cristianitos Area
La Jollan Indian Archeological Site	Horno Canyon Area
Whale Fossil	Edson Range

The potential areas for nuclear power plant sites are evaluated in terms of their proximity to the specific archeologic and historic sites noted. Sites which are not relatively close to these features, or which permit plants to be located away from the cultural areas, are considered to be of low or nominal sensitivity to cultural resources.

Area	Sensitivity			
	Very High	High	Nominal	Low
San Mateo Canyon				X
San Mateo Hills				X
Santa Margarita				X
Pulgas Branch				X
Pulgas Lake				X
Las Flores North			X	
Las Flores South				X
San Onofre Foothills			X	
San Onofre Bluff				X
Las Flores North Bluff				X
Las Flores South Bluff				X

5.3.5 Aesthetics

Aesthetic considerations for sites at Camp Pendleton contain several factors which are specifically assessed. They include the interruption of the natural beauty of the area which might be caused by the installation of a plant, the plant as a visual object, or by the transmission lines emanating from the plant as a visual object.

The natural beauty in the Camp Pendleton area includes the distant horizon of the Pacific Ocean and the near-horizon provided by the landforms along the coast. Interruptions of these views, particularly of the ocean's horizon would be of great concern to many of those who pass through the area. That travel route would be mainly along Interstate Highway 5 which is elevated above the adjacent terrain.

Also in the coastal area, there are a number of interesting landforms which are visible from the Interstate Highway and adjacent areas.[73] These include the marine terraces, sandy beaches, marsh areas, and tidelands. Although varied in their appeal, these landforms would be generally considered aesthetically pleasing. Interruption of these views, where they presently occur, would be cause for concern by the public and are best avoided.

Additionally, location of a plant in a way which precludes access to the coastline where these aesthetically pleasing features occur would be undesirable. Such access could be incorporated in most plant designs where visibility of ocean horizon and shoreline features is not presently available from the highway, but could be provided.

Viewing the area landward, the Santa Margarita Mountains which parallel the shore and the coastal highway can be considered aesthetically pleasing. Interruption of their view, particularly the horizon provided by the highest elevations of the range anywhere along its length would be considered undesirable. In cases such as Pulgas Canyon where the natural canyon terrain and the erosion resulting from area drainage provide strong topographic contrast with the adjacent mountains, these views might be considered scenic. Installation of facilities in direct line with canyon profiles visible from the heavily traveled highway could be undesirable. However, where sufficient land is available to place plants away from canyon opening profiles, possibly within the profile of mountains in the immediate background, these locations could be aesthetically more acceptable.

The nuclear power plant facilities could be considered by some as aesthetically pleasing and by others as a typically unattractive industrial plant. Such opinions are of course subjective. Various treatments can be provided in the design of the facilities to architecturally improve the "industrial image." These include the design of pleasing building shapes or lines, selection of pleasing building materials color and texture, and the use of landscaping. The latter can be used to dress up the facilities to make them more pleasing or, if placed in the line of sight near the viewer, they can camouflage the facilities up to the point of inhibiting their view from heavily traveled roads.

With the varied terrain at Camp Pendleton, siting areas such as Pulgas Branch which are located within the coastal mountains would not be in view from public highways, or their view would be greatly minimized. Thus, locations of this type would avoid adverse criticism of plant architecture and would be considered more desirable.

Architectural design of transmission towers has provided the opportunity for improving their aesthetics. However, the interruption of horizons by the towers and close viewing of the transmission cables are aesthetic impacts which can be considered as potentially adverse. Plant locations which require transmission lines that are pronounced in their view from public areas would be less desirable than those where the lines are not in view. Lines which are distant and, therefore, not readily visible from public view, or are visually lost in the background of high landforms behind them are more desirable.

Within these guidelines, potential siting areas can be assessed on the basis of their sensitivity to adverse criticism of natural environment or plant aesthetics.

	Aesthetics Sensitivity			
Area	Natural	Plant	Transmission	Total
San Mateo Canyon	Low	Low	Low	Low
San Mateo Hills	Low	Low	Low	Low
Santa Margarita	Low	Low	Low	Low
Pulgas Branch	Low	Low	Low	Low
Pulgas Lake	Low	Low	Low	Low
Las Flores North	Nominal	Nominal	High	Nominal
Las Flores South	Nominal	Nominal	High	Nominal
San Onofre Foothills	Nominal	Very High	Very High	High
San Onofre Bluff	Very High	Very High	Very High	Very High
Las Flores North Bluff	Very High	Very High	Very High	Very High
Las Flores South Bluff	Very High	Very High	Very High	Very High

TABLE 5-1: GEOLOGY/SEISMOLOGY SAFETY EVALUATION FACTORS

I. Quaternary Stratigraphy	Value
A. Extensive marine terraces (120,000 years or older)	50
B. Discontinuous marine terraces	30
C. Relatively continuous alluvial terraces (age to be established)	20
D. Fragmentary alluvial terraces	10
E. No stratigraphy present (area probably not feasible for licensing under present criteria).	0

IIa. Proximity to Faults Requiring Evaluation for Surface Rupture Hazard

Distance from Area	Value
A. More than 10 miles from area	1.0
B. 5 to 10 miles from area	0.8
C. Within 5 miles of area	0.4
D. Within zone requiring detailed faulting investigation or 1 mile, whichever is greater (ZRDFI as defined in Reference 3)	0.0

IIb. Faults and Suspected Faults Requiring Additional Evaluation	Weighting Factor
A. Santa Monica-Baja California Zone of Deformation	11
B. Las Flores lineament (suspected Quaternary fault, possibly longer than 10 miles, further investigation may be inconclusive)	9
C. Las Pulgas fault (suspected Quaternary fault maximum length 5 to 10 miles, most of length not accessible for exploration)	7

TABLE 5-1 (continued)

		Weighting Factor
IIb.	Faults and Suspected Faults Requiring Additional Evaluation (continued)	
D.	Stuart Mesa fault (suspected Quaternary fault maximum length 5 to 10 miles)	5
E.	Postulated onshore extension of Rose Canyon fault (probable pre-Quaternary fault, possibly longer than 10 miles)	5
F.	Minor breaks in marine terrace deposits (total length not known)	4
G.	Cristianitos fault (pre-Quaternary fault more than 20 miles long)	3

		Value
III.	Proximity to Photolineaments (Longer than 1,000 Feet) Expressed on Quaternary Deposits	
A.	None within 5 miles	15
B.	Five or fewer within 5 miles	12
C.	More than 5 within 5 miles	6
D.	More than 5 within potential area	3

TABLE 5-2: GEOLOGY/SEISMOLOGY EVALUATION

Factor	Area										
	San Mateo Canyon	San Mateo Hills	Santa Margarita	Pulgas Branch	Pulgas Lake	Las Flores North	Las Flores South	San Onofre Foothills	San Onofre Bluff	Las Flores North Bluff	Las Flores South Bluff
I Stratigraphy	20	0	10	0	0	50	50	40	50	50	50
II Faults											
A SM-BC	0	0	8.8	8.8	0	0	0	0	0	0	0
B Las Flores	7.2	7.2	3.6	0	0	2.4	1.6	3.2	3.2	2.4	1.6
C Las Pulgas	5.6	5.6	2.8	0	0	2.8	2.8	2.8	4.2	2.8	2.8
D Stuart Mesa	4	4	3	2	2	2	0	3	3	2	2
E Rose Canyon	5	5	1	4	4	4	3.3	5	5	4	4
F Sea Cliffs	3.2	3.2	3.2	1.6	1.6	1.0	1.6	1.6	1.6	0.8	1.6
G Cristianitos	1.2	1.2	3	2.4	2.4	2.4	2.4	1.2	1.2	1.2	2.4
III Photolineaments	12	12	6	6	6	3	3	6	6	6	6
Total Rating	58.6	38.6	41.4	24.8	16.0	67.6	64.7	62.8	74.2	69.2	70.4

TABLE 5-3: HAZARDS DISTANCES
(Miles)

Potential Area	Major Impact Zones (Sierra, Whiskey, Zulu)	Firing Ranges (X-Ray (Edson)	Aircraft Paths to Impact Zone	Support Aircraft Maneuv-ering	MCALF Paths	Com-mercial Airway Center-line	Ammu-nition Storage	Fuel Lines on Drainage Path
San Mateo Canyon	<1	9	<1	>1	>5	5	>1	<1
San Mateo Hills	<1	8	<1	>1	>5	4-1/2	>1	<1
Santa Margar-ita	2	<1	2	<1	1	7	>1	<1
Pulgas Branch	1-1/2	<1	1-1/2	>1	>5	5	>1	>1
Pulgas Lake	2	<1	2	>1	>5	4	>1	>1
Las Flores North	4-1/2	2	4-1/2	<1	5	2	>1	<1
Las Flores South	5-1/2	<1	5-1/2	<1	2	2	>1	<1
San Onofre Foothills	3	4	3	<1	>5	2	>1	<1
San Onofre Bluff	3-1/2	4	3-1/2	<1	>5	1-1/2	>1	<1
Las Flores North Bluff	4-1/2	3	4-1/2	<1	>5	1-1/2	>1	<1
Las Flores South Bluff	6	2	6	<1	2-1/2	1-1/2	>1	<1

TABLE 5-4: ANNUALIZED COST SUMMARY (1990)

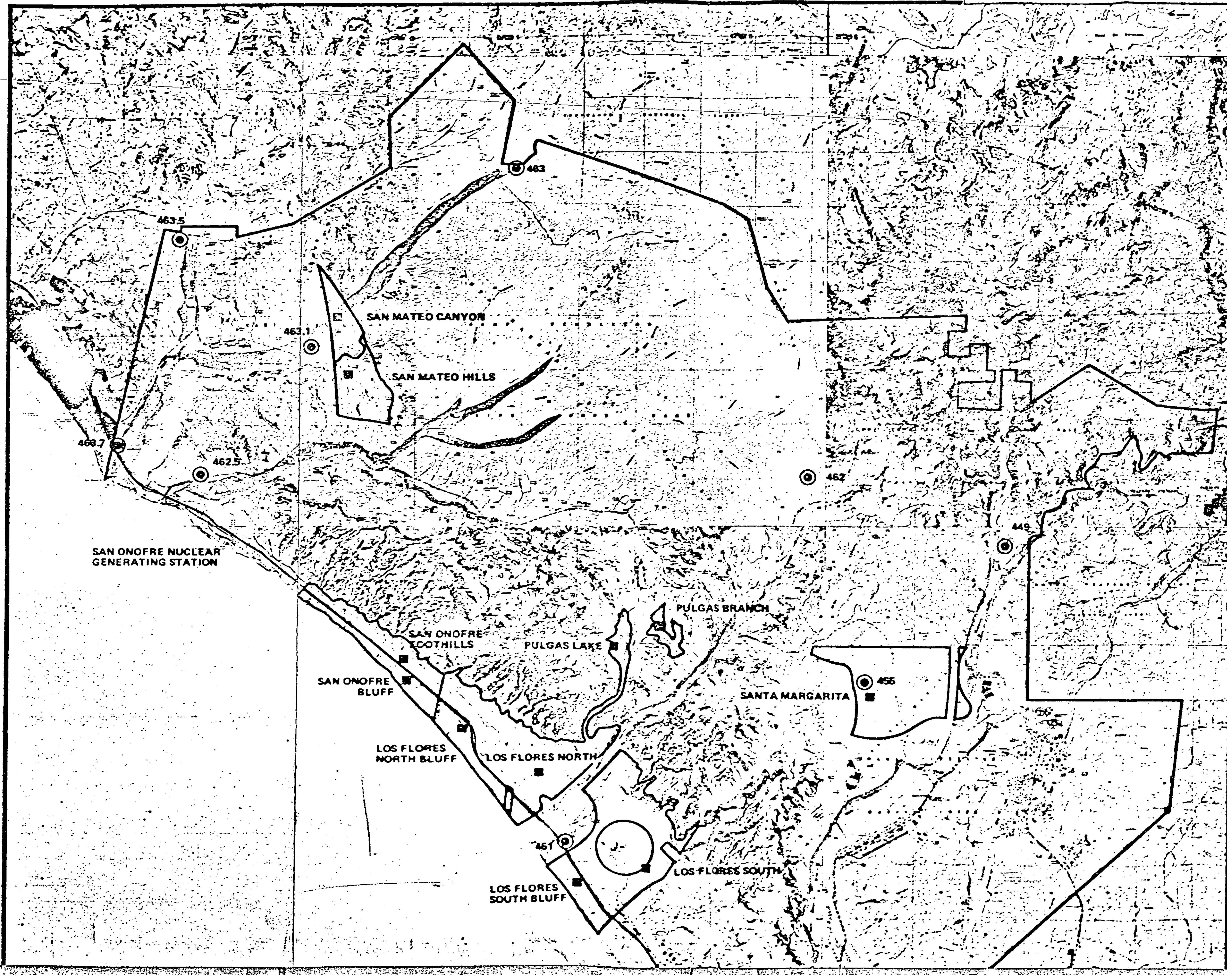
(Million Dollars/Year)

Area	Additional Requirements				
	Capital Construction	Maintenance and Operation	Subtotal	Basic Plant	Total Plant
San Mateo Canyon	36.3	18.0	54.3	349	403
San Mateo Hills	48.5	50.1	98.6	349	448
Santa Margarita	44.2	35.3	79.5	349	428
Pulgas Branch	35.3	29.8	65.1	349	414
Pulgas Lake	30.9	28.4	59.3	349	408
Las Flores North	12.6	13.8	26.4	349	375
Las Flores South	13.1	9.9	23.0	349	372
San Onofre Foothills	13.2	17.4	30.6	349	380
San Onofre Bluff	10.0	12.3	22.3	349	371
Las Flores North Bluff	9.4	11.0	20.4	349	369
Las Flores South Bluff	13.3	8.8	22.1	349	371

TABLE 5-5: SENSITIVITY LEVELS TO EXISTING/PLANNED LAND USES

Area	Recreational	Military Operations	Other (Special or Agricultural)	Existing Lease	Summary
San Mateo Canyon	Low	Nominal	Low		Low
San Mateo Hills	Low	Low	Low		Low
Santa Margarita	Low	Nominal	Low		Low
Pulgas Branch	Low	Nominal	Low	(2)	Low
Pulgas Lake	Nominal	Nominal	Low	(2)	Nominal
Las Flores North	Low	Low	Nominal	(3)	Low
Las Flores South	Low	Very High	Low		High
San Onofre Foothills	High[1]	Low	Nominal		Nominal-High
San Onofre Bluff	Very High	Low	Nominal	(4)	High-Very High
Las Flores North Bluff	Low	Very High	Nominal		High-Very High
Las Flores South Bluff	Low	Very High	Nominal		High-Very High

(1) For water transport lines only.
(2) Contained in grazing lease area.
(3) Boy Scout leased area nearby.
(4) State Department Parks and Recreation.


463.5
463
SAN MATEO CANYON
463.1
SAN MATEO HILLS
460.7
462.5
462
449
SAN ONOFRE NUCLEAR
GENERATING STATION
PULGAS BRANCH
SAN ONOFRE
FOOTHILLS
PULGAS LAKE
SAN ONOFRE
BLUFF
456
SANTA MARGARITA
LOS FLORES
NORTH BLUFF
LOS FLORES NORTH
461
LOS FLORES SOUTH
LOS FLORES
SOUTH BLUFF

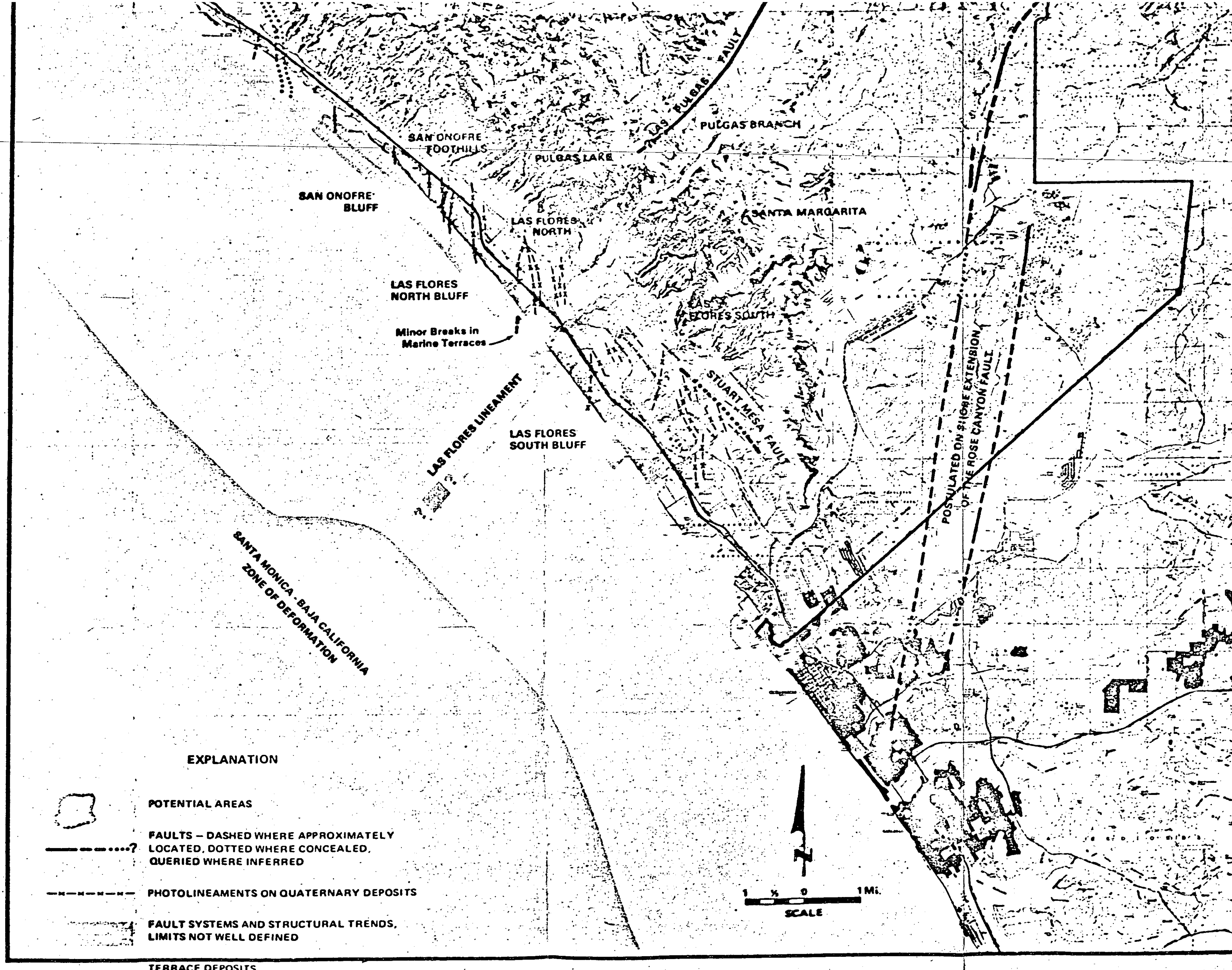


FIGURE 5-1: GEOLOGY/SEISMOLOGY EVALUATION FACTORS

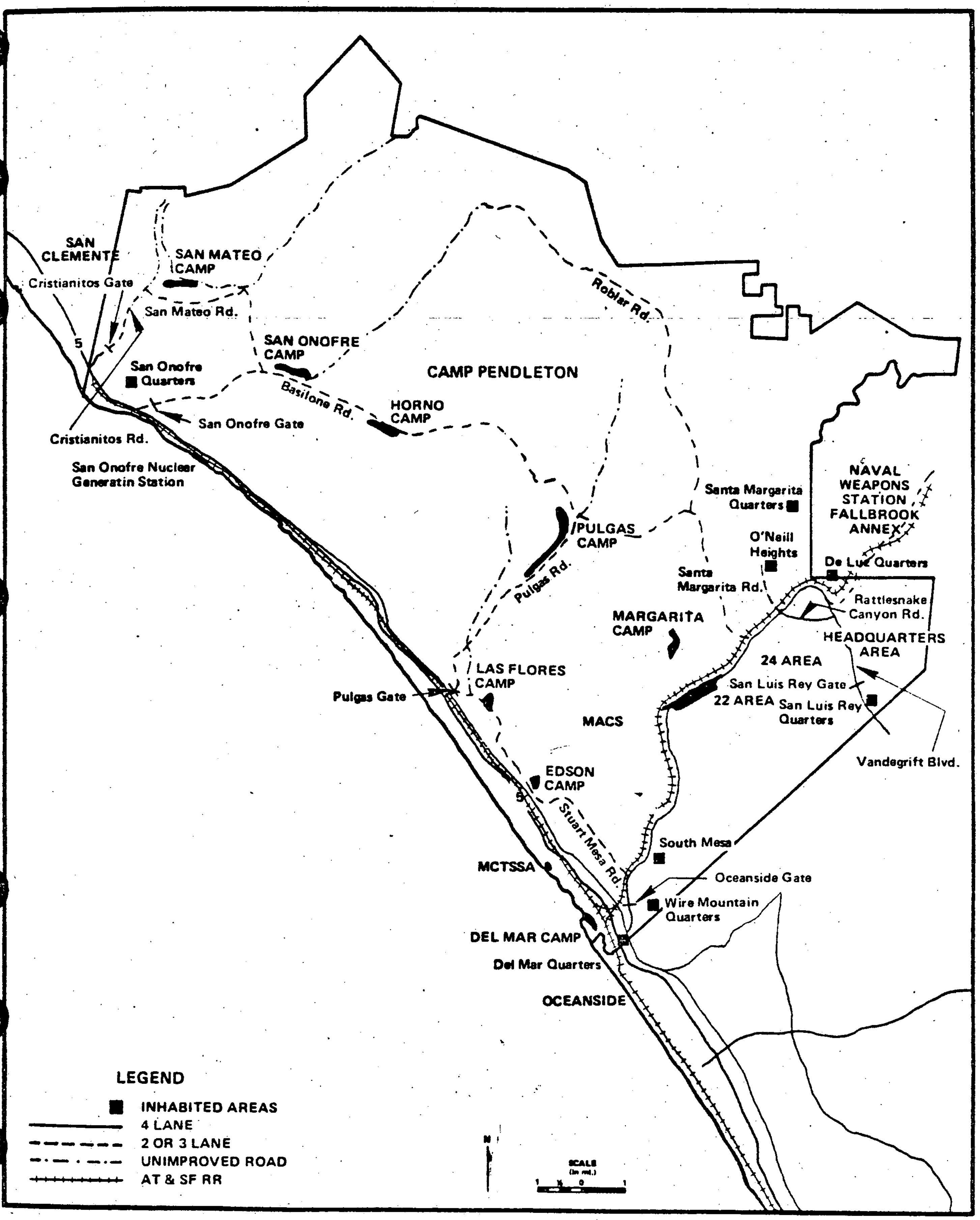


FIGURE 5-2: TRANSPORTATION NETWORK

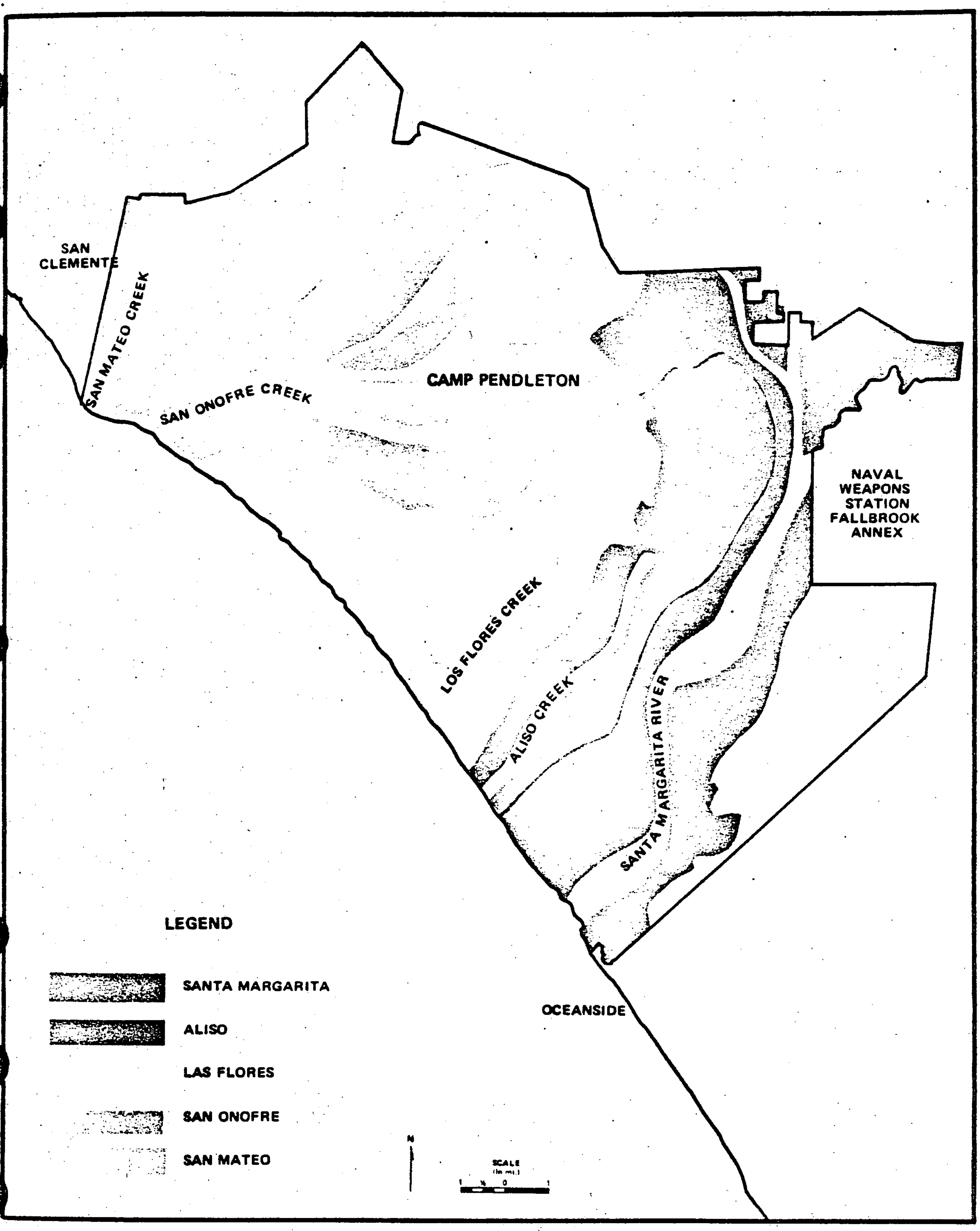


FIGURE 5-3: WATERSHEDS

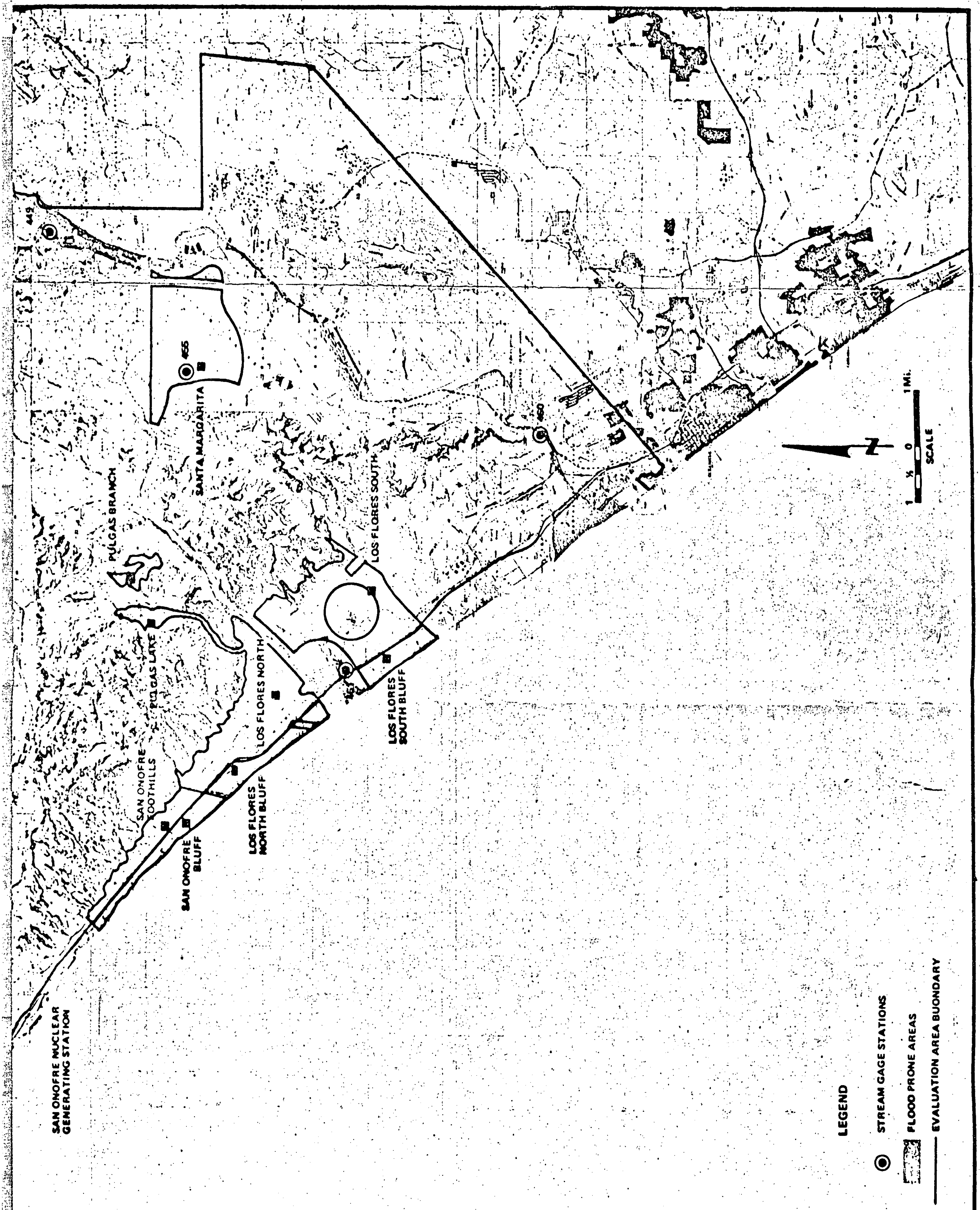


FIGURE 5-4: FLOOD PRONE AREAS

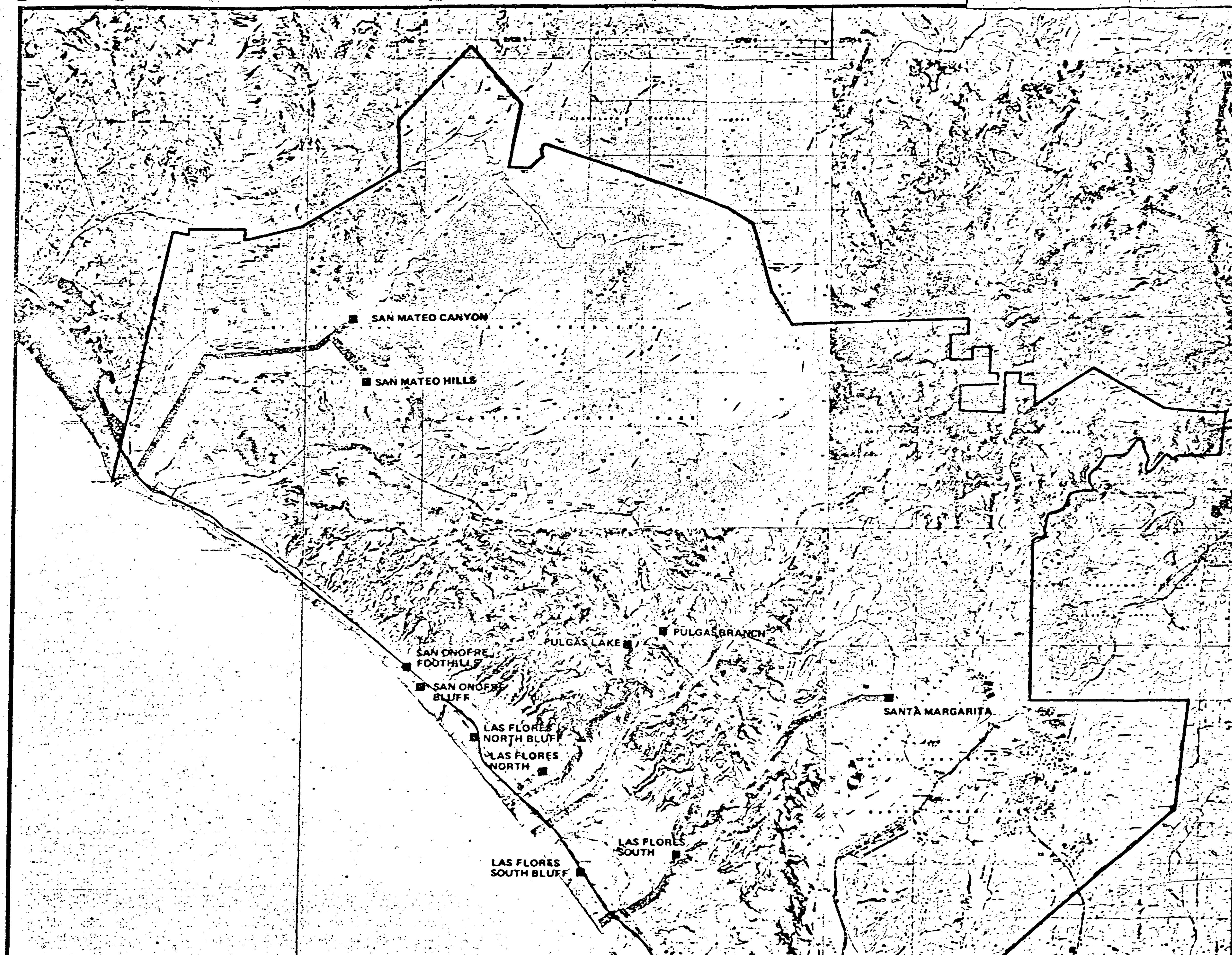

SAN MATEO CANYON
SAN MATEO HILLS
PULGAS BRANCH
PULGAS LAKE
SAN ONOFRE FOOTHILLS
SAN ONOFRE BLUFF
LAS FLORES NORTH BLUFF
LAS FLORES NORTH
SANTA MARGARITA
LAS FLORES SOUTH
LAS FLORES SOUTH BLUFF

FIGURE 5-5: COASTAL BLUFFS

FIGURE 5-6: BLUFF INSTABILITY

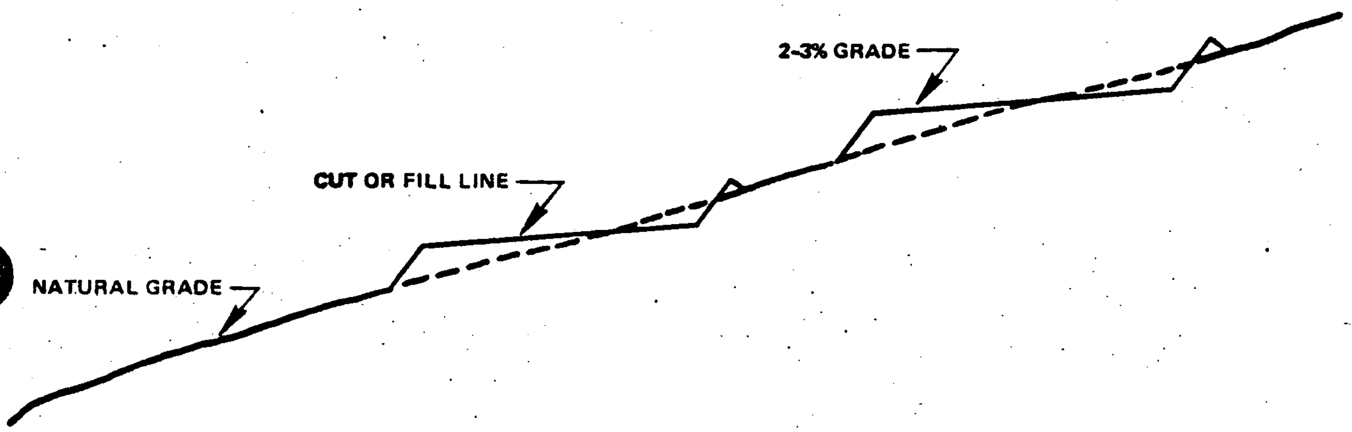


FIGURE 5-7: AREA EXCAVATION SECTION

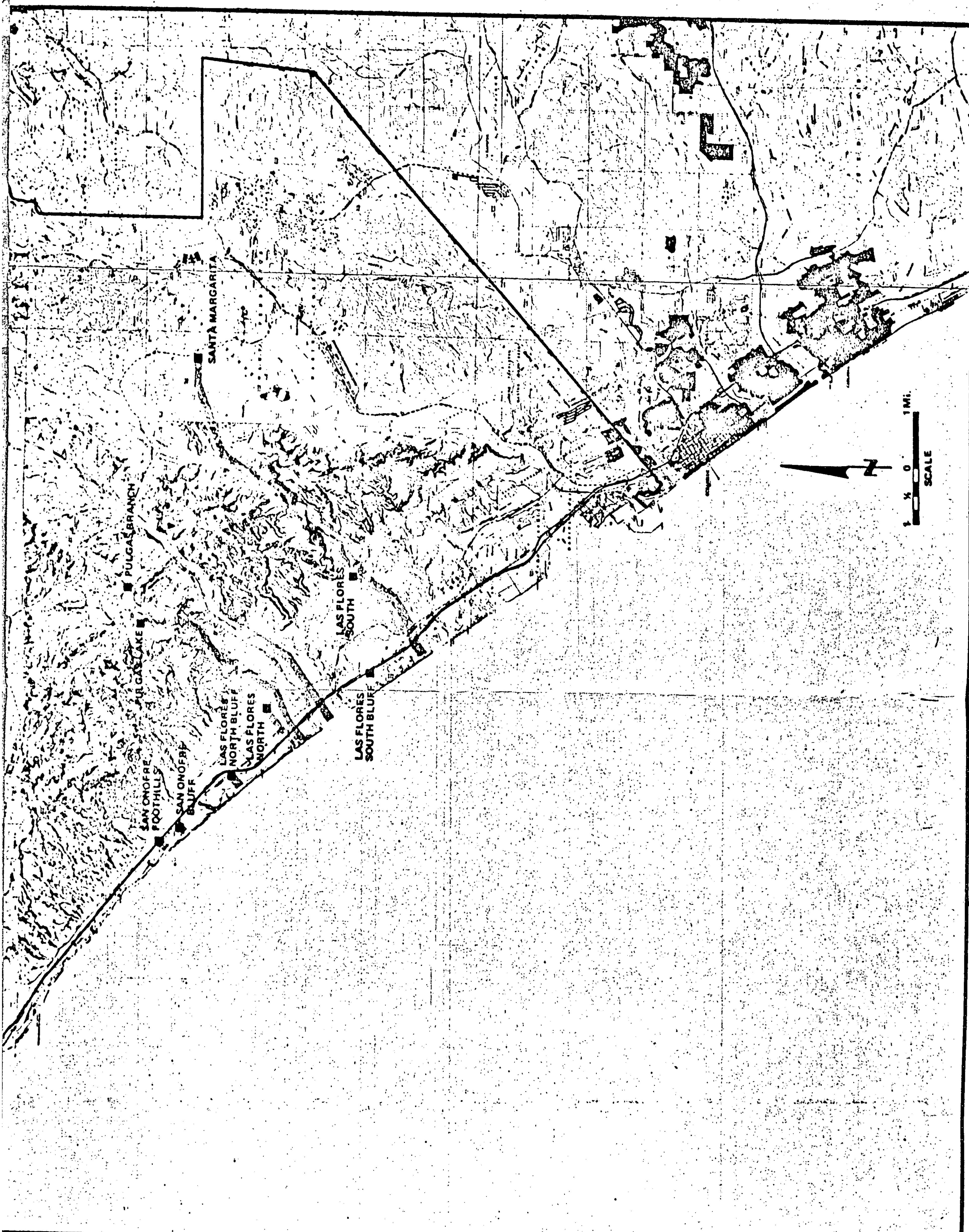
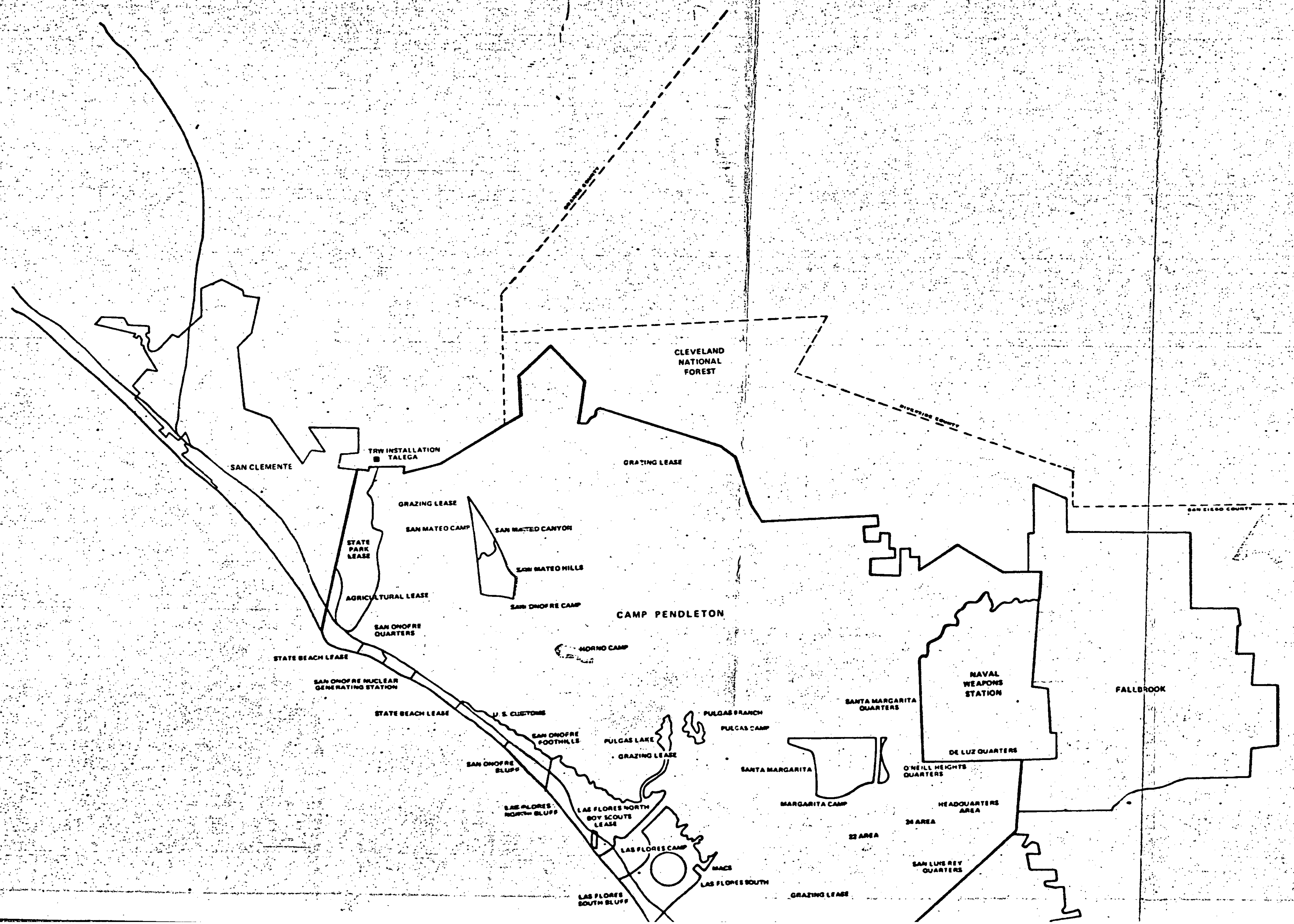


FIGURE 5-8: POTENTIAL WATER TRANSPORT ROUTES


CLEVELAND NATIONAL FOREST
SAN DIEGO COUNTY
TRW INSTALLATION TALEGA
SAN CLEMENTE
GRAZING LEASE
GRAZING LEASE
SAN MATEO CAMP
SAN MATEO CANYON
STATE PARK LEASE
SAN MATEO HILLS
AGRICULTURAL LEASE
SAN ONOFRE CAMP
CAMP PENDLETON
SAN ONOFRE QUARTERS
HORNO CAMP
STATE BEACH LEASE
SAN ONOFRE NUCLEAR GENERATING STATION
STATE BEACH LEASE
U.S. CUSTOMS
SAN ONOFRE FOOTHILLS
PULGAS RANCH
PULGAS CAMP
PULGAS LAKE
GRAZING LEASE
SAN ONOFRE BLUFF
SANTA MARGARITA QUARTERS
SANTA MARGARITA
NAVAL WEAPONS STATION
FALLBROOK
DE LUZ QUARTERS
O'NEILL HEIGHTS QUARTERS
MARGARITA CAMP
HEADQUARTERS AREA
LAS FLORES NORTH BLUFF
LAS FLORES NORTH
BOY SCOUTS LEASE
24 AREA
22 AREA
LAS FLORES CAMP
MACS
LAS FLORES SOUTH
SAN LUIS REY QUARTERS
LAS FLORES SOUTH BLUFF
GRAZING LEASE

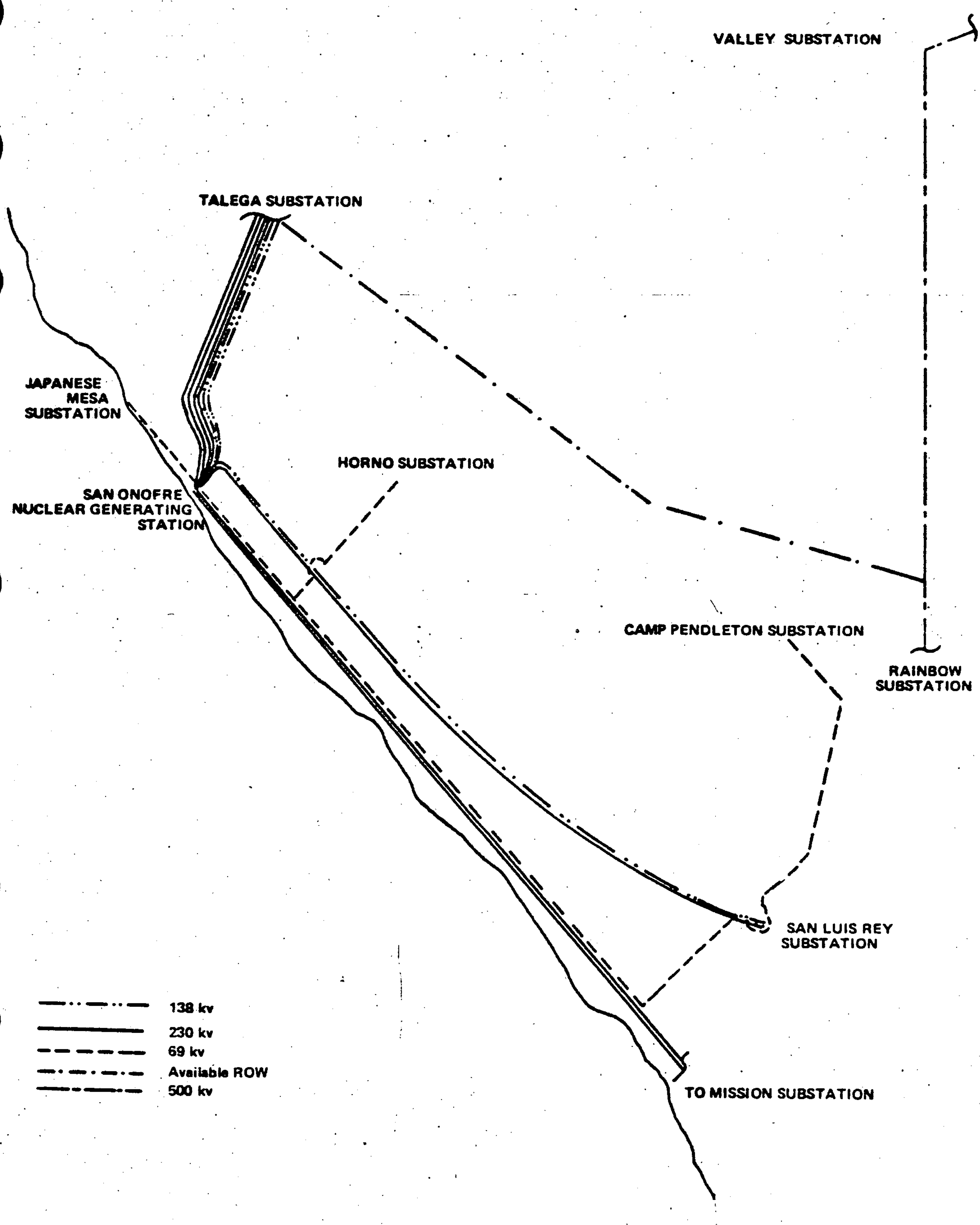


FIGURE 5-9: TRANSMISSION NETWORKS

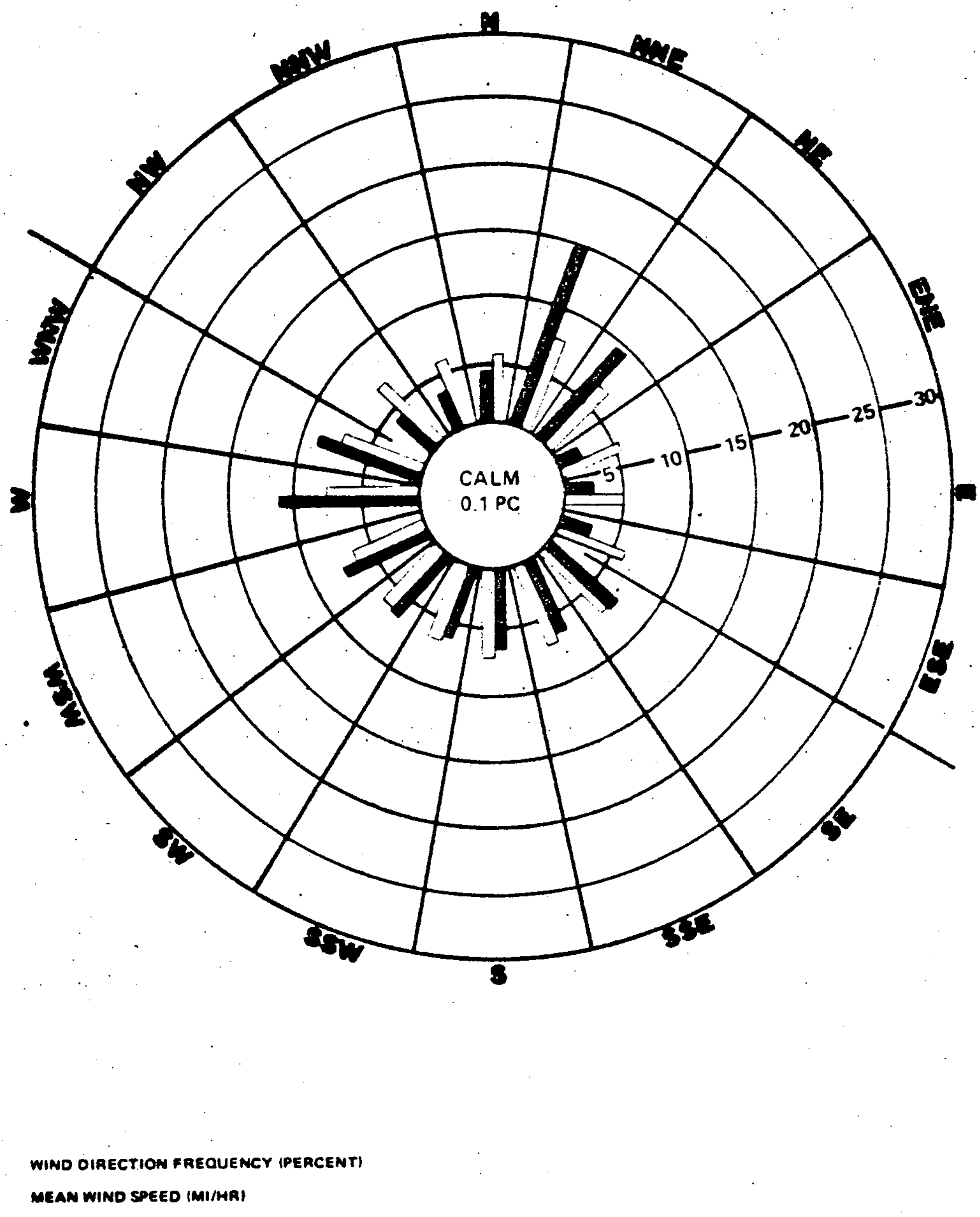


FIGURE 5-10: ANNUAL WIND ROSE – SONGS

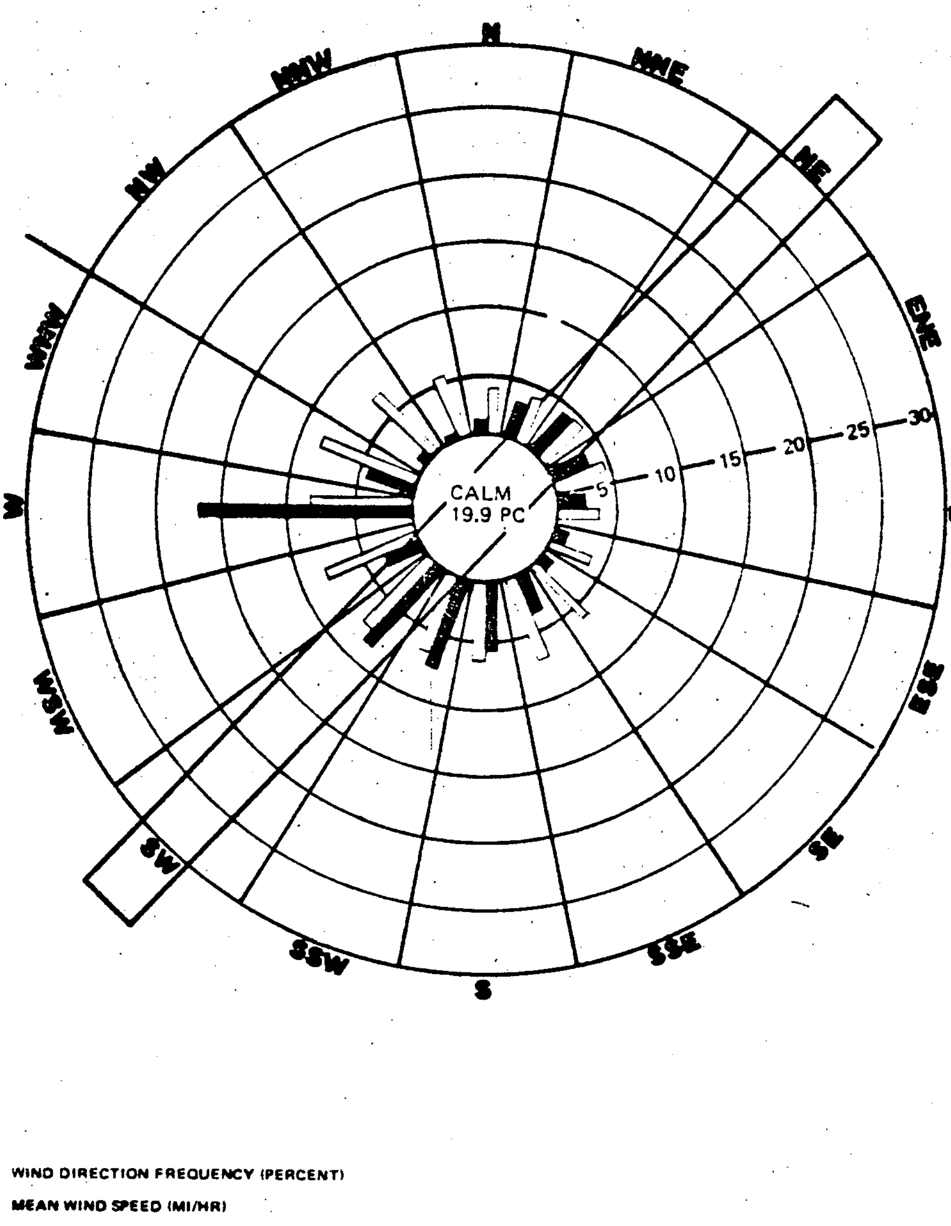


FIGURE 5-11: ANNUAL WIND ROSE – MCALF

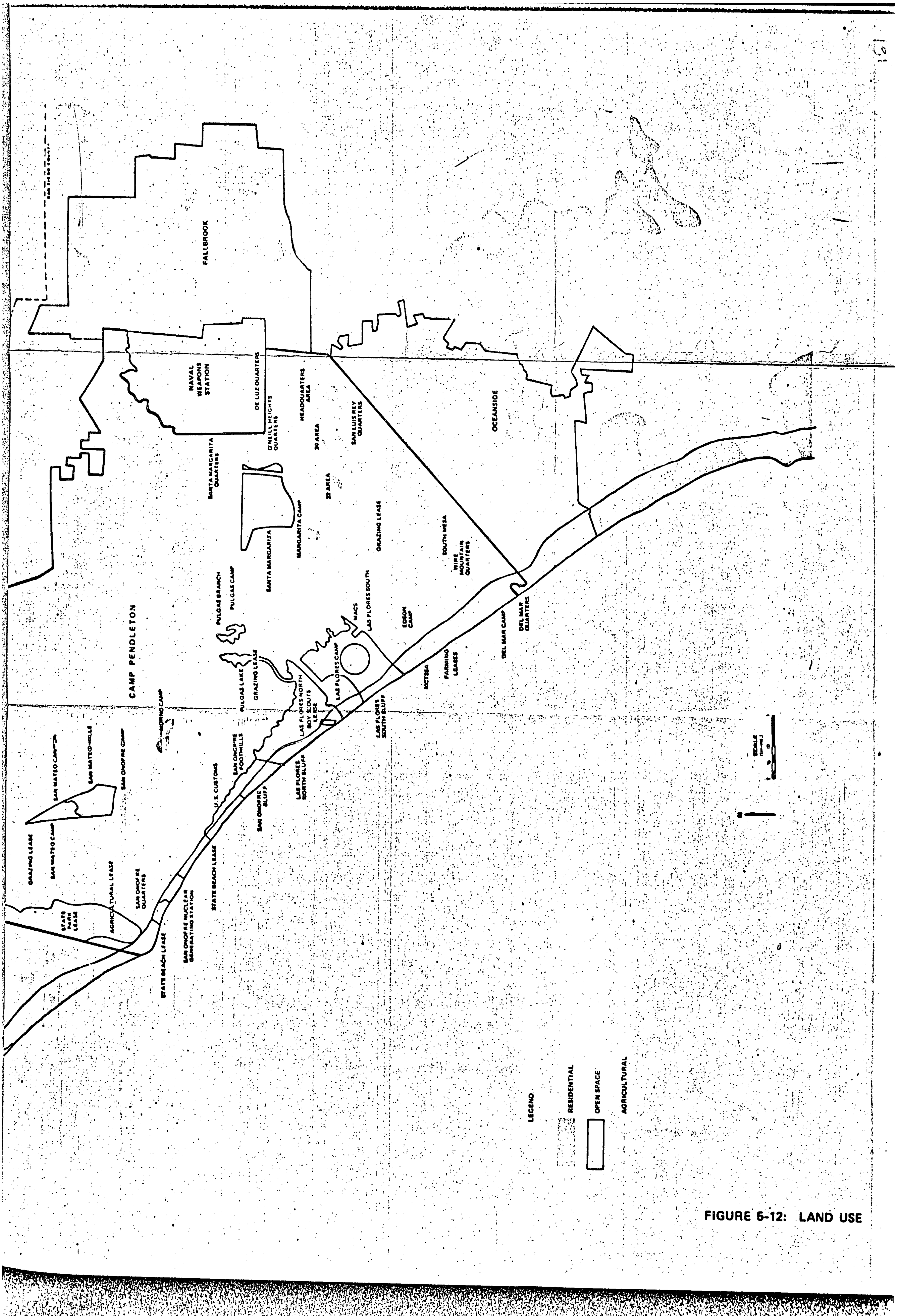


FIGURE 5-12: LAND USE

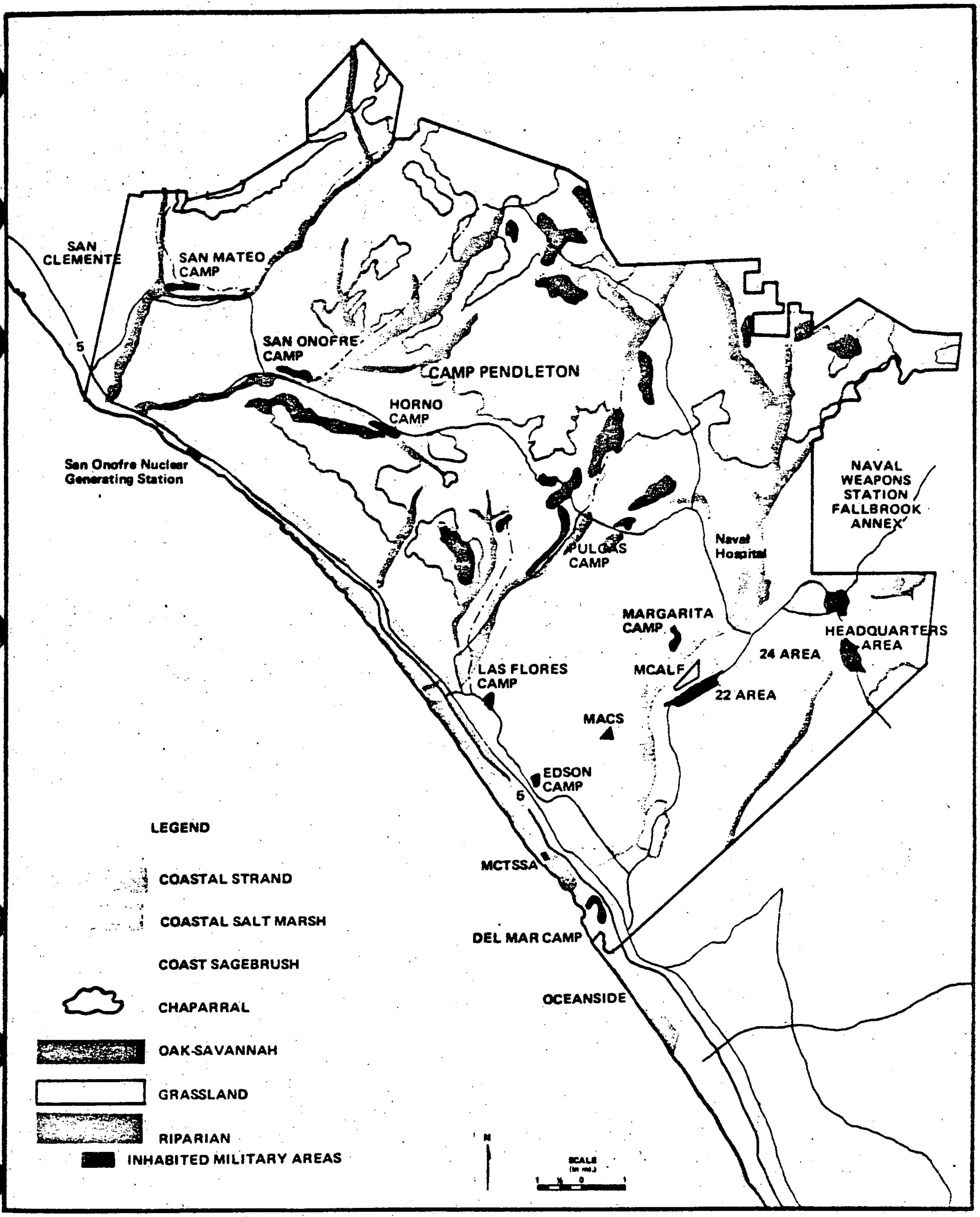


FIGURE 5-13: PLANT COMMUNITIES

FIGURE 5-14: LAS FLORES ADOBE

6. AREA RANKING

6.1 CLASSIFICATION AND RANKING SYSTEM

Section 5 included the rating of siting areas for each of the parameters examined. The combining of ratings for individual parameter assessments in a way which permits overall ranking of siting areas is discussed in this section.

There are many classification and ranking schemes used in site screening processes ranging from simple cataloging of assets and deficiencies, with subjective decision-making, to computerized numerical techniques which seek absolute rankings for the site decision. Techniques also include visual portrayals, using colors or similar techniques to reflect ranking. These visual schemes often are merely numerical ranking systems which have been translated into visual aids so that the siting recommendations appear to have less positive resolution than afforded by a numerical system. Some form of this latter approach has merit because a totally numeric system inherently requires the assignment of weighted values to each of the siting impacts in order for them to be combined to arrive at a single "ranking number."

In any case, a formalized process is warranted for measuring the various impacts and for viewing the impacts as a whole for each site, so that some type of ranking can be made. The system used in this study has a quantification foundation to achieve some objectivity, but provides ready visibility into the importance of contributing factors without force fitting those which are somewhat unrelated into a single value.

The rating of each area against the siting parameters examined in Section 5 was converted to a numerical value ranging from 0 to 4, where 4 represents the highest rating and 0 the lowest. In cases where assessments had resulted in high values indicating least preferred sites, such as in the case of hazards, the reciprocal of that value was the basis for conversion to values ranging from 0 to 4, so that higher values represent preferred sites. The values presented are comparative ratings only for the sites examined at Camp Pendleton. The values do not relate to sites off Camp Pendleton.

For each site, the rating for all parameter impacts is displayed in bar form, grouped by factors of safety, economics, and environment.

Displays of safety parameters are limited to geology/seismology and hazardous operations. Population is not considered in the ranking because all areas appear to meet guidelines. Hydrologic consideration from the standpoint of radiological safety is not expected to preclude use of any siting area and is, therefore, not considered in the ranking. Security requirements were considered the same at all sites and, therefore, also were not considered in the ranking process.

Economic parameters all have cost as the natural common denominator, so each of the individual economic parameters is proportionally contained in the rating displayed as a function of total annualized plant cost.

Environmental parameters have no natural common denominator and, therefore, each of them is displayed separately to provide visibility into their respective contribution to the total environment rating. Biota impact was considered the same at all sites and, therefore, is not displayed.

No attempt was made to assign different weights to each parameter, nor to the three principal factors since that process would be extremely subjective. Rather, the display identifies contributions of individual parameter ratings to the total.

Two scatter diagrams were prepared showing all potential siting areas on each diagram. Safety parameters were considered as overriding considerations. Therefore, a plot of the average ratings for the safety parameters was made against the rating for economics, and another plot for safety against the average ratings for environmental parameters. Siting areas plotted in the upper right corner of both diagrams are preferred (see Section 6.3).

6.2 SITING AREA SUMMARIES

The major attributes and deficits of each site are summarized in this section. Site photographs and bar charts showing ratings are included. Figure 6-1 is an index of the photographs of the sites, indicating the location, direction, and reference figure for each.

6.2.1 San Mateo Canyon

Figure 6-2 is a view of the area. The location is about 5 miles distant from the most significant suspected capable faults in the region and rates higher than most sites in this regard. There is some datable stratigraphy around the site and that would assist in evaluating whether faults nearby are to be considered capable.

The area is adjacent to one of the major impact zones at the complex and is adjacent to the air route used by military aircraft approaching the impact zones. Sites considered in this area would be close to a petroleum line and would be subject to detailed analysis to prove that the line is not hazardous.

The location reflects high costs for cooling water transport due to elevation and distance from the shore. Some higher costs result from longer power transmission lines to the service area and from foundation construction in soils probably containing a high water table. Costs to locate here would be higher than for most of the other areas.

Land use compatibility considerations indicate that there would be a low sensitivity to the presence of the plant at this location.

Figure 6-3 presents impact charts for safety, economic, and environmental considerations.

6.2.2 San Mateo Hills

Figure 6-4 is a view of the area. The location is about 5 miles distant from the most significant suspected capable faults in the region and rates higher than other sites in this regard. However, the area appears to contain no stratigraphy for establishing minimum age of fault movement. Therefore, it is unfavorable in this regard and could only be considered if field investigations were to reveal that no faults exist there.

The area is adjacent to one of the major impact zones at the complex and is adjacent to the air routes used by military aircraft approaching these impact zones. Sites considered in this area would be close to a petroleum line and would be subject to detailed analysis to prove that the line is not hazardous.

The location reflects estimated costs for cooling water transport higher than any of the other locations. This is due to the high elevation at the site and, to a lesser degree, the distance from shore. Transmission line costs are also estimated to be greater than for the other locations considered. Costs to locate here would be higher than for any of the other areas.

Land use compatibility considerations indicate that there would be a low sensitivity to the presence of the plant at this location.

Figure 6-5 presents impact charts for safety, economic, and environmental considerations.

6.2.3 Santa Margarita

Figure 6-6 is a view of the general area and Figure 6-7 is a view of typical local conditions. This location contains little datable stratigraphy with which to determine whether faults are capable. Also, there are several faults and photolineaments within 5 miles that would require detailed investigation. On the other hand, the area is more remote than are most of the other siting areas from some of the known major faults in the region.

The area is located adjacent to a major impact zone, although the area is large enough to select sites which are a mile or so from the boundary. It is also located adjacent to the lesser impact area used in small arms firing. Sites considered in the area would have to be located sufficient distances from fuel lines located in the area so they would present no hazard to the plant.

Cooling water transport costs for this location are high as a result of elevation and distance from the shore. Some foundation cost increase is anticipated as a result of high water tables. However, transmission line costs from this location are less than for the other sites. In all, costs to locate here would be higher than for most sites.

Land use compatibility considerations indicate that there would be a low sensitivity to the presence of the plant at this location.

Figure 6-8 presents impact charts for safety, economic, and environmental considerations.

6.2.4 Pulgas Branch

Figure 6-9 is a view of the area. The location is along the projection of a suspected capable fault. Further, the area contains no datable stratigraphy with which to evaluate fault capability. Furthermore, there are other faults and photolineaments in close proximity to the area, and these also would have to be fully investigated. As a result, it is considered unlikely that this site could satisfy the geologic and seismologic licensing requirements.

Hazards at this location appear to be less than for most of the other siting areas.

Cooling water transport costs are relatively high due to the general elevation of the area and distance from shore. Some increased costs for foundation construction in a high water table area are also estimated. Costs to locate here would be higher than for most other areas.

Land use compatibility considerations indicate that there would be a low sensitivity to the presence of the plant at this location.

Figure 6-10 presents impact charts for safety, economic, and environmental considerations.

6.2.5 Pulgas Lake

Figures 6-11 and 6-12, respectively, are northerly and southerly views of the area. This area is along the projection of a suspected capable fault. Other faults and photolineaments in close proximity to the area would have to be investigated as well. Because the Pulgas Lake area does not contain stratigraphy suitable for demonstrating that faults are not capable, it is unlikely that it could satisfy the NRC geologic and seismologic licensing requirements.

Hazards at this location appear to be less than for most of the other siting areas.

The cooling water transport costs are estimated to be high as a result of elevation and distance to shore. A high water table adds to foundation construction costs as well. In all, costs to locate here would be greater than for most of the areas.

Land use compatibility considerations indicate that there would be a nominal sensitivity to the presence of the plant at this location. This could be reduced even more by avoiding the selection of a site which would preclude recreational use of Pulgas Lake.

Figure 6-13 presents impact charts for safety, economic, and environmental considerations.

6.2.6 Las Flores North

Figures 6-14 and 6-15, respectively, are northerly and southerly views of the area. The area is in close proximity to suspected capable faults. However, the area is surrounded by datable stratigraphy which might be used to demonstrate that faults in the site area are not capable. It is rated higher than most of the siting areas in this regard.

A fuel line crosses the area paralleling the highway. The area is sufficiently large to permit considering sites located at least one-half mile from the lines. Further, the location is in the military maneuvers area where troops, helicopters, and fixed-wing aircraft operate, but without ordnance firing. Plants located here would require restrictions of some ground military operations in the immediate area. Also, it might be required that the plant be analyzed for military helicopter and/or fixed-wing aircraft impact, and that some form of protective design be included before licensing.

Cooling water transport costs to serve the area would be less than for most locations because of the general lower elevations here. Transmission line costs would be about average for all sites considered. The net result of economic considerations is that additional costs to locate here would be less than for most of the areas.

Land use compatibility considerations indicate that there would be a low sensitivity to the presence of a plant at this location if the Boy Scouts' leased land and the Las Flores Adobe and the Asistencia de Las Flores ruins located nearby are avoided. Plant locations in this area should be as far removed as possible from these other uses and provide free access to them.

This area apparently was the location of past cultures and could be the source of additional discoveries in excavations made there in the future. Exercising care during excavations and preserving findings could alleviate this concern.

Figure 6-16 presents impact charts for safety, economic, and environmental considerations.

6.2.7 Las Flores South

Figure 6-17 is a view of the area. The area is in close proximity to several suspected capable faults and to photolineaments which would have to be investigated. However, the area contains datable stratigraphy that could be utilized to determine whether capable faults exist at a site.

The area is located adjacent to a small weapons range, but is sufficiently large that it contains sites which are not in immediate proximity to it. Also, a fuel line crosses the area, paralleling the highway. Again, the area is sufficiently large to permit considering sites located at least one-half mile from the lines. Further, the location is in the military maneuvers area where troops, helicopters, and fixed-wing aircraft function, but without ordnance firing. Plants located here would be cause to restrict military operations in the immediate area. Also, it might be required that the plant be analyzed for military helicopter and/or fixed-wing aircraft impact, and that some form of protective design be included before licensing would be authorized.

Cooling water transport costs would be less than for most locations because of the general lower elevations here. Transmission line costs would be about average for all sites considered. The result of all economic considerations given is that additional costs to locate here would be less than for most of the areas.

Land use compatibility considerations indicate that there would be a high sensitivity to the presence of a plant at this location, principally due to its use during military maneuvers involving beach landings, troop movements, and tank operations.

Figure 6-18 presents impact charts for safety, economic, and environmental considerations.

6.2.8 San Onofre Foothills

Figures 6-19 and 6-20, respectively, are northerly and southerly views of the area. The area contains datable stratigraphy that could be used to determine whether faults found in the area are capable.

A fuel line crosses the area, parallel to the highway. It might be necessary to locate the plant about one-half mile from the line or show by analysis that the line does not present a hazard from potential failures. Further, the location is in the military maneuvers area where troops, helicopters, and fixed-wing aircraft function, but without ordnance firing. Plants located here would be cause to restrict military operations in the immediate area. Also, it might be required that the plant be analyzed for military helicopter and/or fixed-wing aircraft impact, and that some form of protective design be included before licensing would be authorized.

Cooling water transport costs for this area are estimated to be less than for most locations because of the generally lower elevations here. Power transmission costs are higher than most because of the greater distance from the easterly boundary of the complex. The result is that additional costs to locate here would be about average for the areas.

Land use compatibility considerations indicate that these would be a nominal to high sensitivity to the presence of a plant at this location, principally due to the requirement for the cooling water transport lines having to cross State leased recreational beach areas to gain ocean access. The lines would be buried and thus reduce their interference with recreational land use. Further, they could be rerouted southward about one to two miles at some expense, to entirely avoid these beach areas.

This area at the outlet of Horno Canyon has been the source of a suspected La Jollan Indian skeleton and could be an area of cultural concern. Concern could be alleviated by taking precautions during excavation and by preserving any findings in the area.

Aesthetic considerations indicate that there would be a high sensitivity to the presence of the plant because the area is not very deep and a plant and transmission line would necessarily be in close proximity to the highway. A negative impact might be alleviated by use of planting along the highway to shield the view, or by special architectural and landscape treatment at the plant.

Figure 6-21 presents impact charts for safety, economic, and environmental considerations.

6.2.9 San Onofre Bluff

Figure 6-22 is a view of the area. Datable stratigraphy is in the area and could be used to determine whether faults found in the area are capable. This area is rated highest overall in regards to geology and seismology considerations.

The area is adjacent to a fuel line which parallels the highway. An analysis would be required to show that a plant located in such close proximity to the line would be capable of safe operation and shutdown in case of an accident or failure of the line. The location is in the military maneuvers area where troops, helicopters, and fixed-wing aircraft function, but without ordnance firing. Plants located here would be cause to restrict military ground operations in the immediate area. Also, it might be required that the plant be analyzed for military helicopter and/or fixed-wing aircraft impact, and that some form of protective design be included before licensing would be authorized.

Cooling water transport costs to serve the area are among the lowest for most locations because of the low elevation and close proximity to shore. Transmission line costs are higher than most because of the greater distance from the easterly boundary of the complex. The net cost differential for the area is that it is among the lowest of all the locations.

Land use compatibility considerations indicate that there would be a high to very high sensitivity to the presence of a plant at this location. This would result from the interference with the recreational use of the beaches in this area.

Aesthetic considerations indicate that there would be a very high sensitivity to the presence of the plant because of the close proximity to the highway and the plant's interference with the scenic view of the ocean's horizon. The impact from the public highway would be greater than at the San Onofre Nuclear Generating Station because of the higher ground elevation at this location. Also, because of its close proximity to the heavily traveled highway, the plant might require special architectural and landscape treatment to increase public acceptance.

Figure 6-23 presents impact charts for safety, economic, and environmental considerations.

6.2.10 Las Flores North Bluff

Figure 6-24 is a view of the area. The area is in close proximity to suspected capable faults. However, the area contains datable stratigraphy and therefore is rated higher than most of the other siting areas in regard to geology and seismology.

The area is adjacent to a fuel line which parallels the highway. An analysis would be required to show that a plant located in such close proximity to the line would be capable of safe operation and shutdown in case of an accident or failure of the line. The location is in the military maneuvers area where troops, tanks, helicopters, and fixed-wing aircraft function, but without ordnance firing. Plants located here would be cause to restrict military operations in the immediate area. Also, it might be required that a plant be analyzed for military helicopter and/or fixed-wing aircraft impact and that some form of protective design be included before licensing would be authorized.

Cooling water transport costs at this location are the lowest of all areas considered because of low elevation and close proximity to shore. Transmission line costs are among the lowest of all sites. However, a high water table at this location would probably result in high costs for foundation construction. In all, the additional costs for locating in this area are the lowest of the areas considered.

Land use compatibility considerations indicate that there would be a high to very high sensitivity to the presence of a plant at this location. This would result from interference with military use of the area, particularly troop movements from the beach landing area, and occasionally affecting aircraft operations that support major maneuvers in this area.

Aesthetic considerations indicate that there would be a very high sensitivity to the presence of the plant because of the close proximity to the highway and the plant's interference with the scenic view of the ocean's horizon. The impact from the highway would be greater than at San Onofre Nuclear Generating Station because of the higher ground elevation at this location. Also, the plant might be viewed as aesthetically undesirable and could require special architectural and landscape treatment to improve the close view by the public using the adjacent highway.

Figure 6-25 presents impact charts for safety, economic, and environmental considerations.

6.2.11 Las Flores South Bluff

Figures 6-26 and 6-27 are views of the area. The area is in close proximity to suspected capable faults. However, because datable stratigraphy is present, Las Flores South Bluff is rated higher than most of the other siting areas in regard to geology and seismology.

The area is adjacent to a fuel line which parallels the highway. An analysis would have to be performed to show that the plant located in such proximity to the line was capable of safe operation and shutdown in case of an accident or failure of the line. The location is in the military maneuvers area where troops, tanks, helicopters, and fixed-wing aircraft function, but without ordnance firing. Plants located here would be cause to restrict military ground operations in the immediate area, particularly inhibiting tank maneuvering operations. Also, it might be required that a plant be analyzed for military helicopter and/or fixed-wing aircraft impact and that some form of protective design be included before licensing would be authorized.

Cooling water transport costs at this location are the lowest of all areas considered because of low elevation and close proximity to shore. Transmission line costs are among the lowest of all sites. However, a high water table at this location would probably result in high costs for foundation construction. In all, the additional costs for locating in this area are among the lowest of the areas considered.

Land use compatibility considerations indicate that there would be a high to very high sensitivity to the presence of a plant at this location. This would result from interference with military use of the area, particularly troop and tank movements from the beach landing area, and occasionally affecting aircraft operations that support major maneuvers in this area.

Aesthetic considerations indicate that there would be a very high sensitivity to the presence of the plant because of the close proximity to the highway and the plant's interference with the scenic view of the ocean's horizon. The impact from the highway would be greater than at San Onofre Nuclear Generating Station because of the higher ground elevation at this location. Also, the plant might be viewed as aesthetically undesirable and could require special architectural and landscape treatment to improve the close view by the public using the adjacent highway.

Figure 6-28 presents impact charts for safety, economic, and environmental considerations.

6.3 AREA RANKING

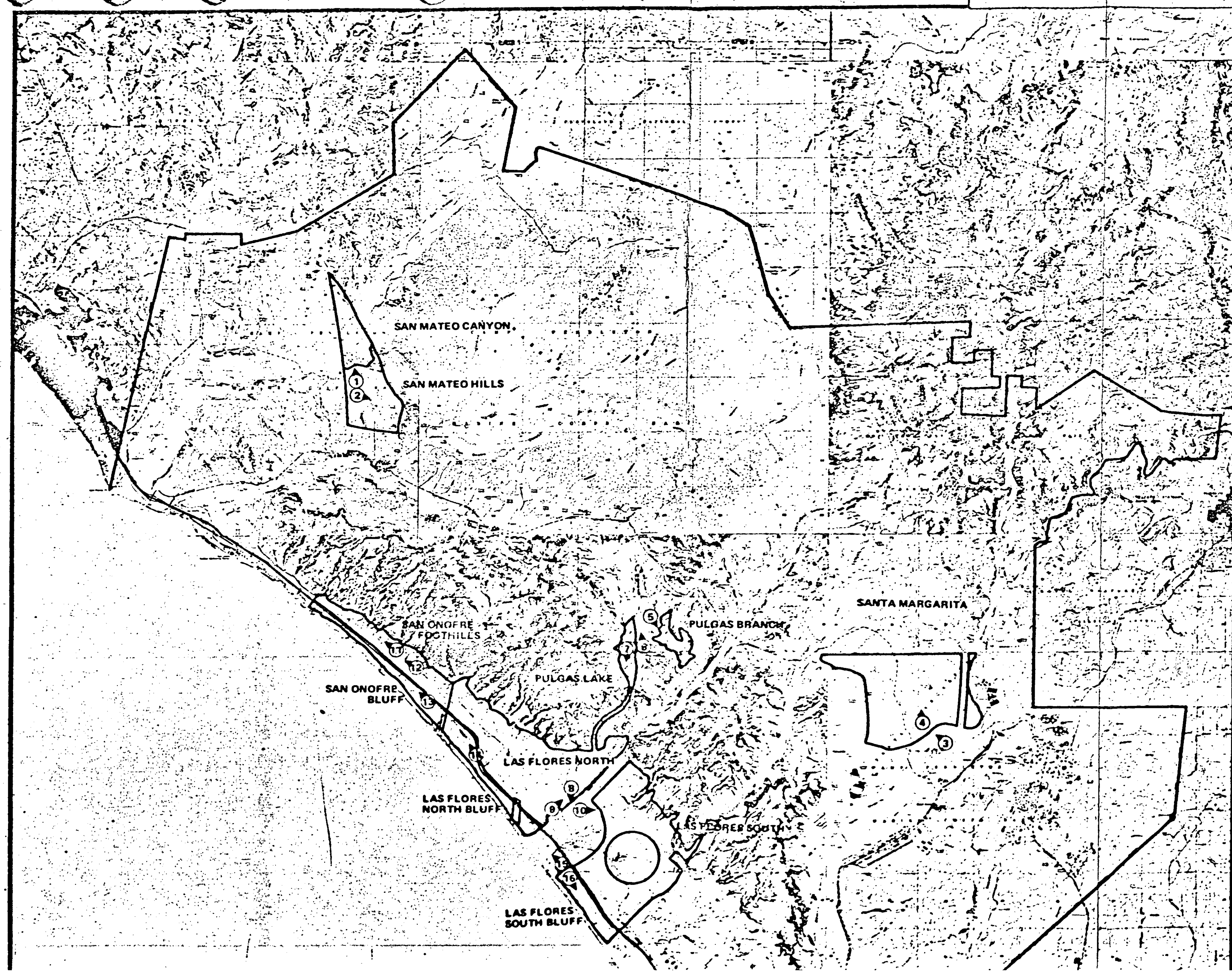
Scatter diagrams plotting safety considerations against economic and against environmental considerations are presented in Figures 6-29 and 6-30, respectively.

Figure 6-29 indicates that Las Flores North, San Onofre Foothills, San Onofre Bluff, Las Flores North Bluff, and Las Flores South Bluff siting areas are preferred when evaluating safety and economics. San Mateo Hills, Santa Margarita, and Pulgas Branch are least preferred. Figure 6-30 indicates that San Mateo Canyon and Las Flores North are preferred when evaluating safety and environmental parameters.

Las Flores North appears in both preferred groups and would normally be considered highest ranked. However, geology/seismology is one of the most significant evaluation factors and the southern portion of the Las Flores North is in close proximity to the Las Flores lineament which has evidence suggestive of a capable fault. Although no assurance could be given to its ability to be licensed, the northwestern part of the area would be preferred because it is 2-1/2 to 3 miles from the lineament.

San Mateo Canyon appears in the preferred group in Figure 6-30 and in the average group in Figure 6-29. Similarly, the areas other than Las Flores North that are plotted in the preferred group in Figure 6-29 all are in the average group in Figure 6-30. Of these, San Onofre Foothills is ranked higher than the other three areas. Therefore, San Mateo Canyon and San Onofre Foothills are considered to be the next preferred siting areas to Las Flores North. Of these two, San Onofre Foothills has more extensive datable stratigraphy that would be suitable for demonstrating faults in the area are not capable.

Considering all the above, on strictly a comparative basis within Camp Pendleton, the highest ranked siting area is located northwest of Las Pulgas Canyon and southeast of the existing San Onofre Nuclear Generating Station, inland of Interstate Highway 5. The location is designated San Onofre Foothills/Las Flores North and is shown in Figure 1-1. It provides an area of focus, should further studies be warranted.


SAN MATEO CANYON
SAN MATEO HILLS
SANTA MARGARITA
PULGAS BRANCH
SAN ONOFRE FOOTHILLS
PULGAS LAKE
SAN ONOFRE BLUFF
LAS FLORES NORTH
LAS FLORES NORTH BLUFF
LAS FLORES SOUTH
LAS FLORES SOUTH BLUFF

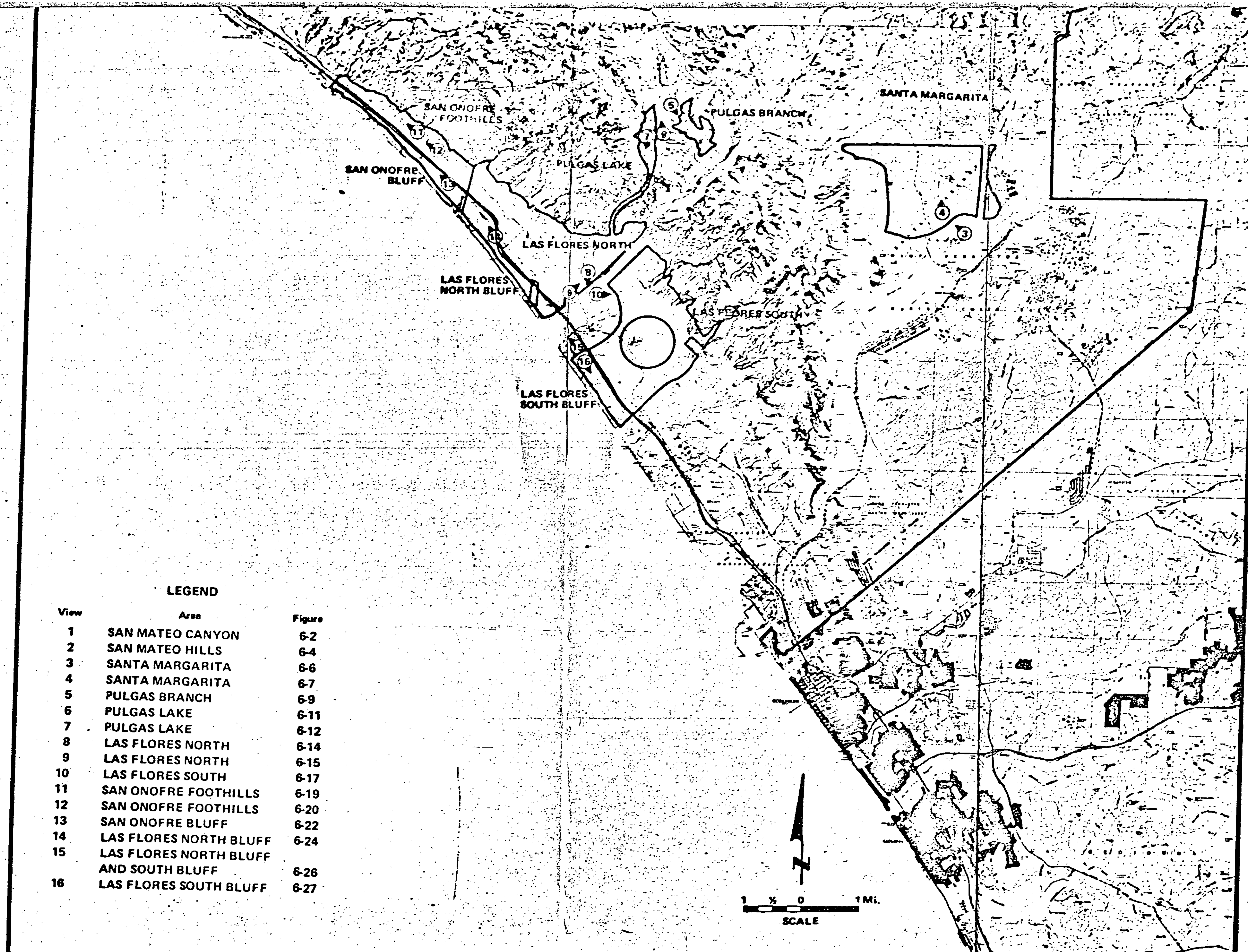


FIGURE 6-1: PHOTOGRAPH INDEX

FIGURE 6-2: SAN MATEO CANYON

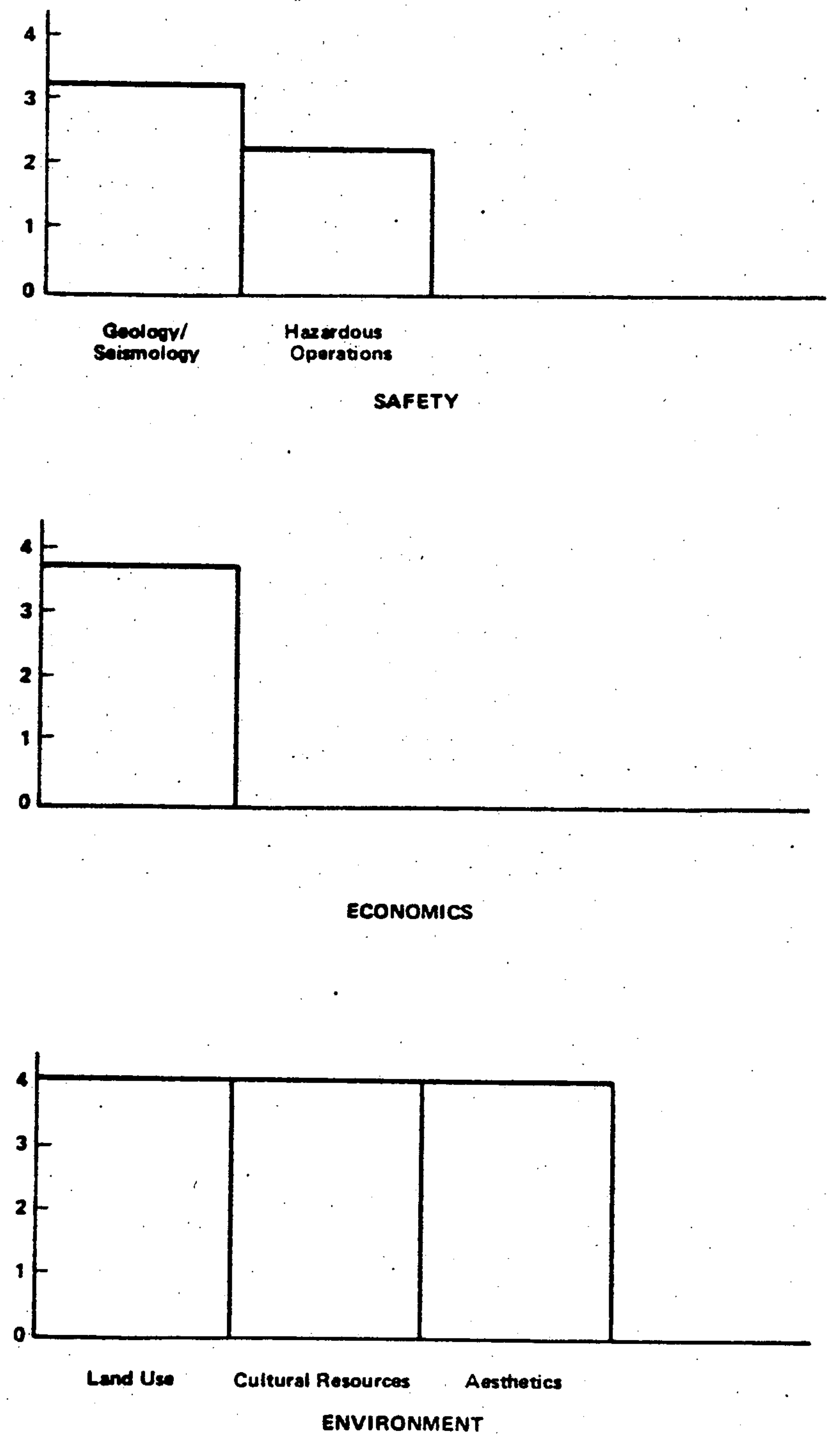


FIGURE 6-3: IMPACT CHARTS – SAN MATEO CANYON

FIGURE 6-4: SAN MATEO HILLS

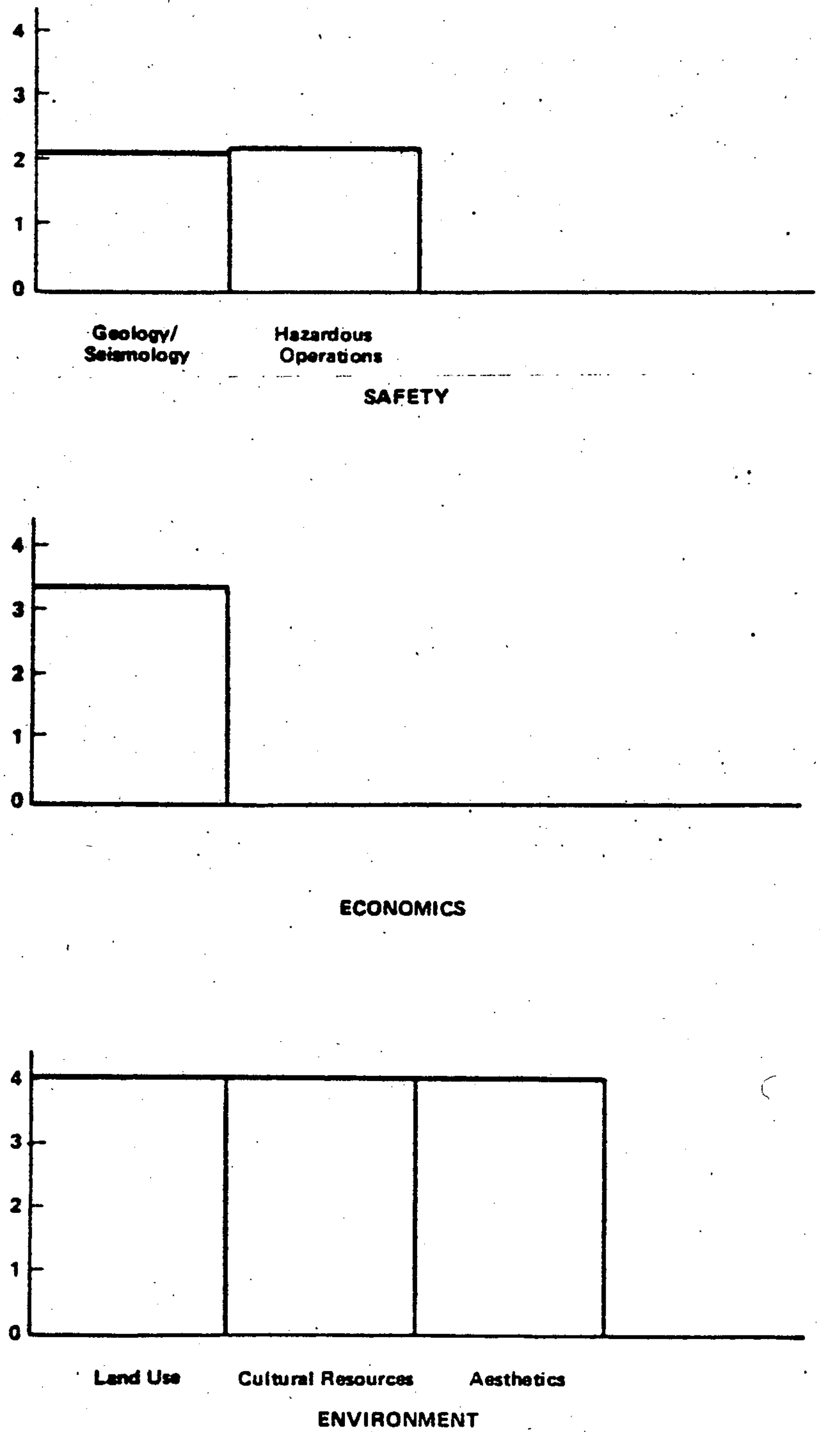


FIGURE 6-5: IMPACT CHARTS – SAN MATEO HILLS

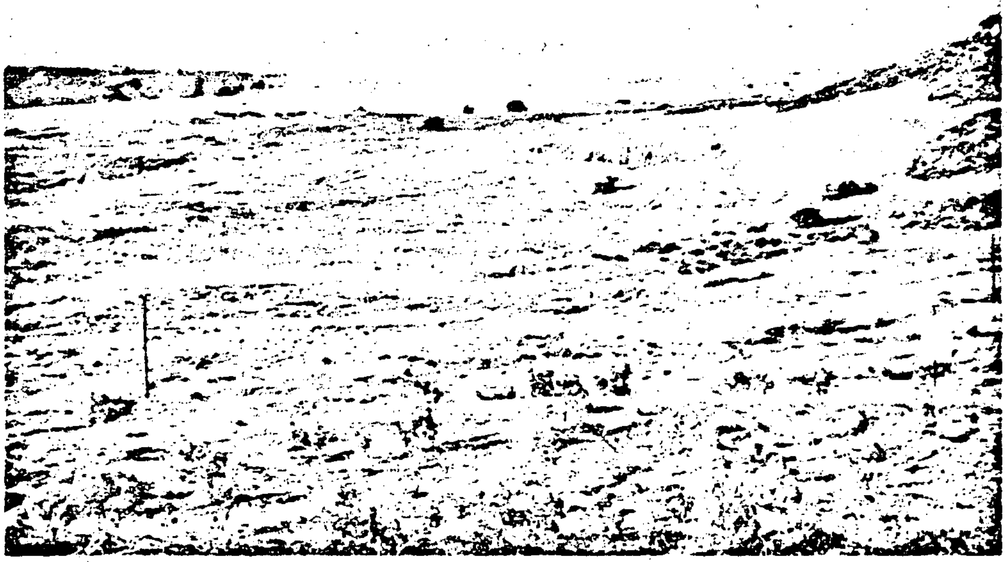


FIGURE 6-6: SANTA MARGARITA (GENERAL)

FIGURE 6-7: SANTA MARGARITA (LOCAL)

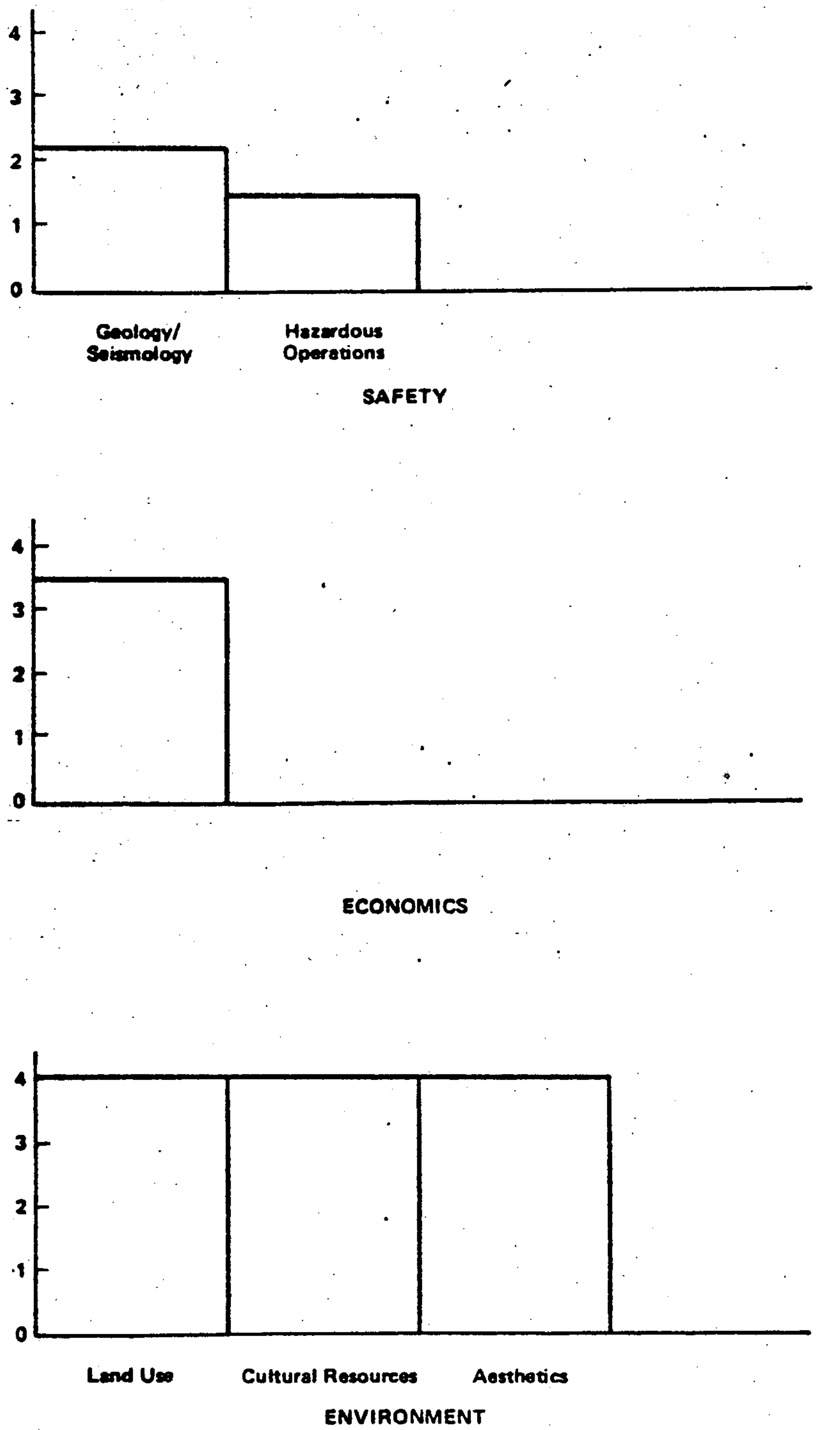


FIGURE 6-8: IMPACT CHARTS – SANTA MARGARITA

FIGURE 6-9: PULGAS BRANCH

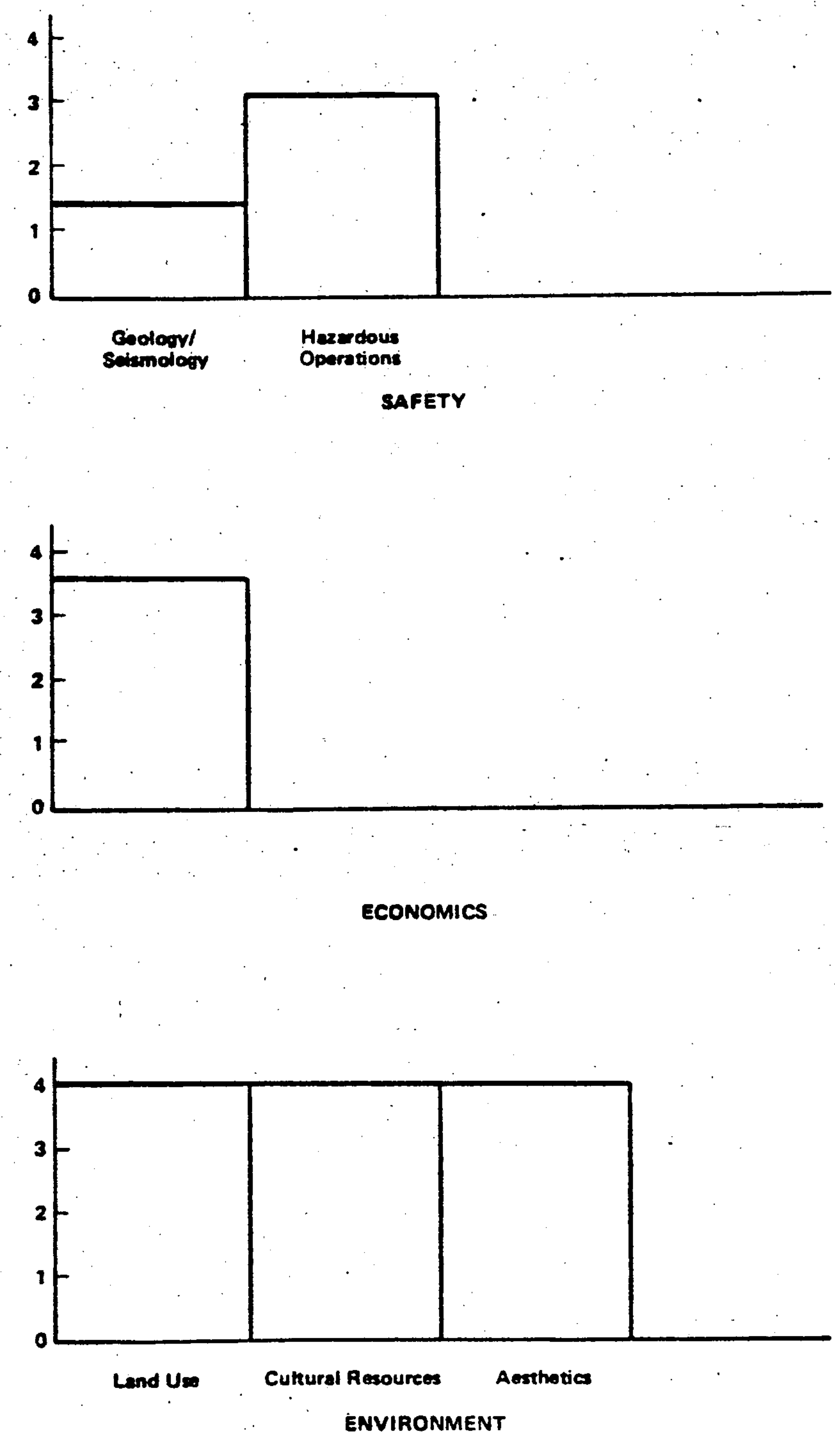


FIGURE 6-10: IMPACT CHARTS – PULGAS BRANCH

FIGURE 6-11: PULGAS LAKE (LOOKING NORTH)

FIGURE 6-12: PULGAS LAKE (LOOKING SOUTH)

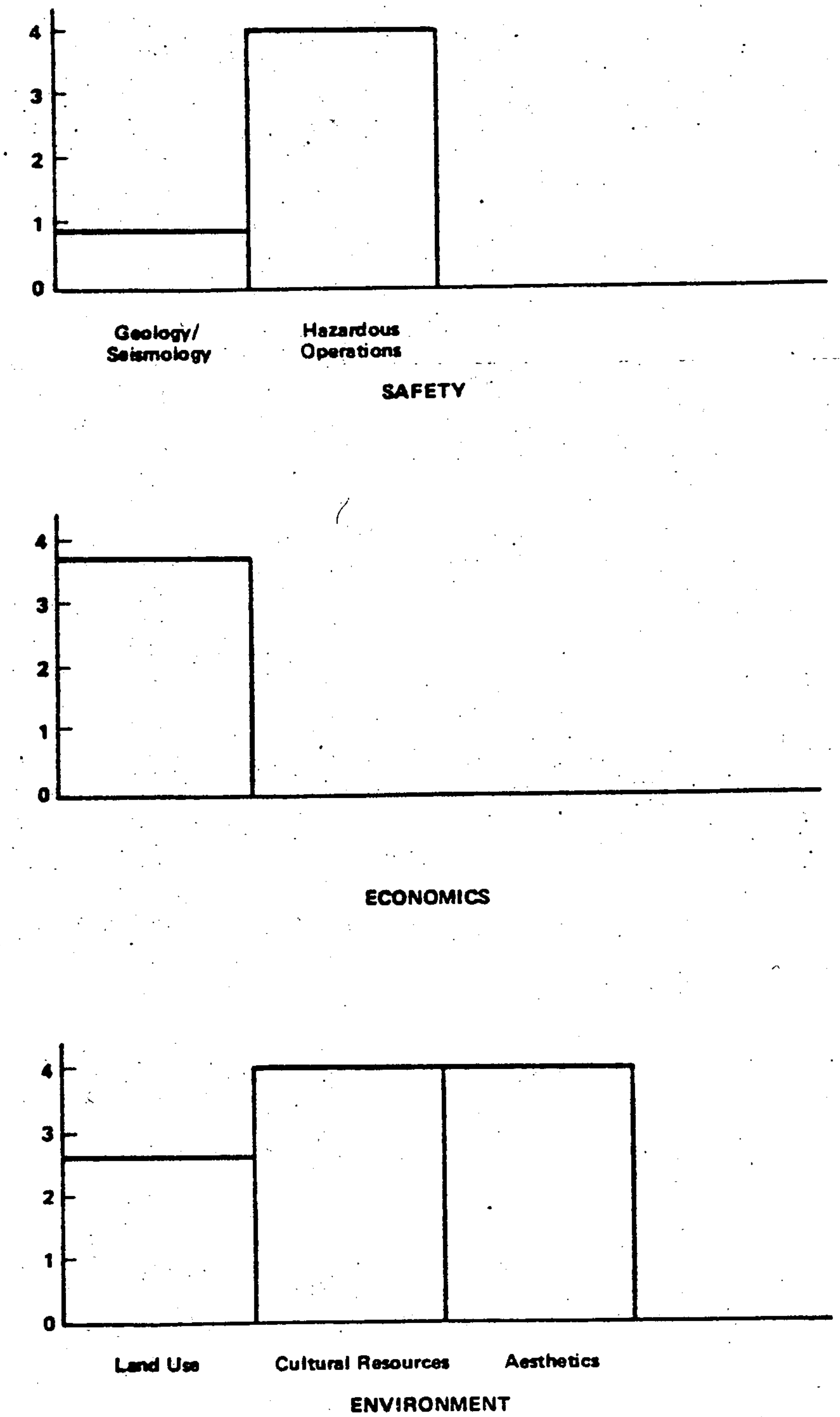


FIGURE 6-13: IMPACT CHARTS — PULGAS LAKE

FIGURE 6-14: LAS FLORES NORTH (LOOKING SOUTH)

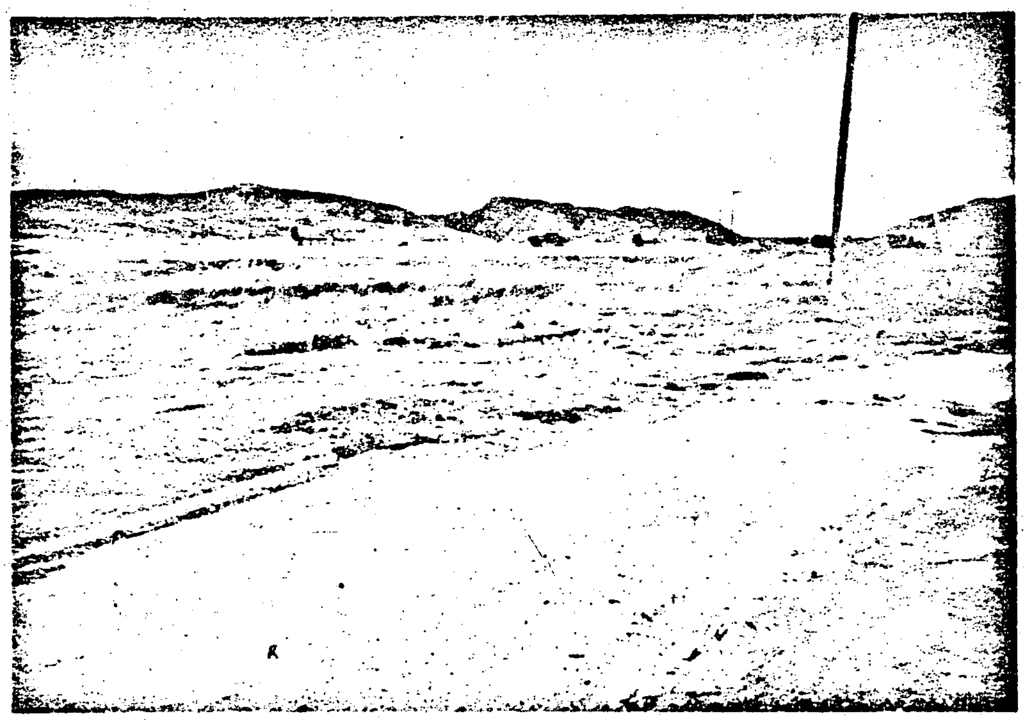


FIGURE 6-15: LAS FLORES NORTH (LOOKING NORTHEAST)

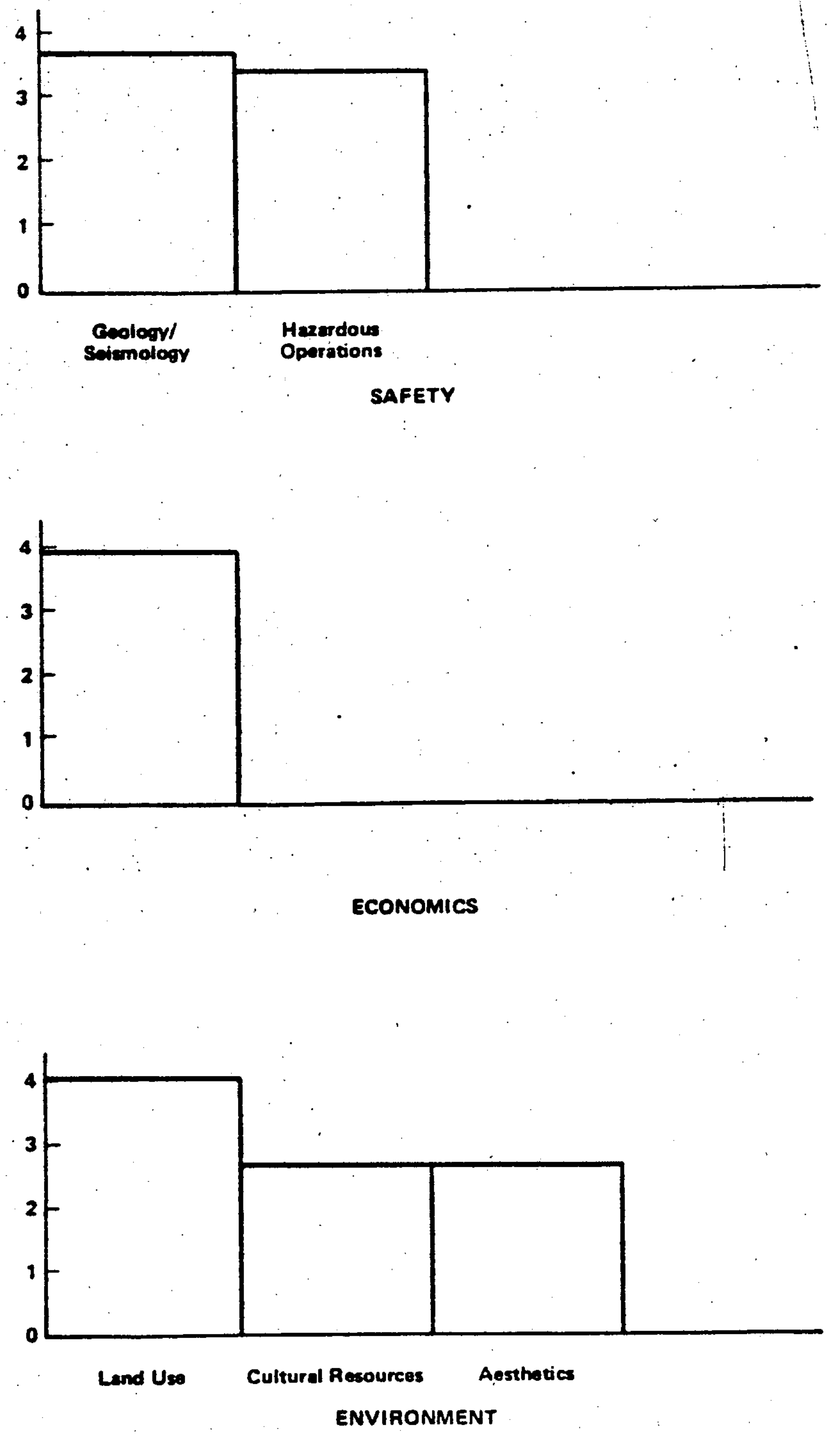


FIGURE 6-16: IMPACT CHARTS – LAS FLORES NORTH

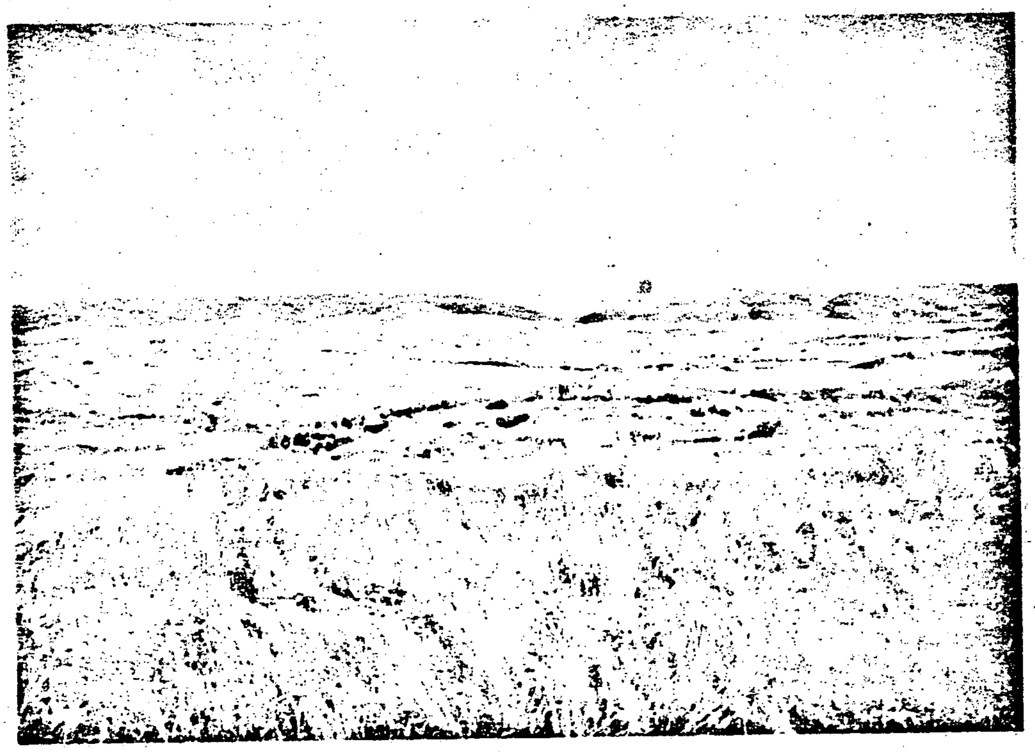
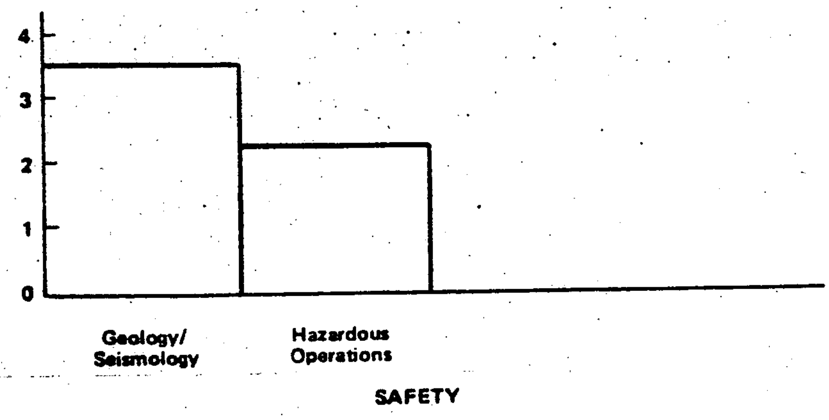
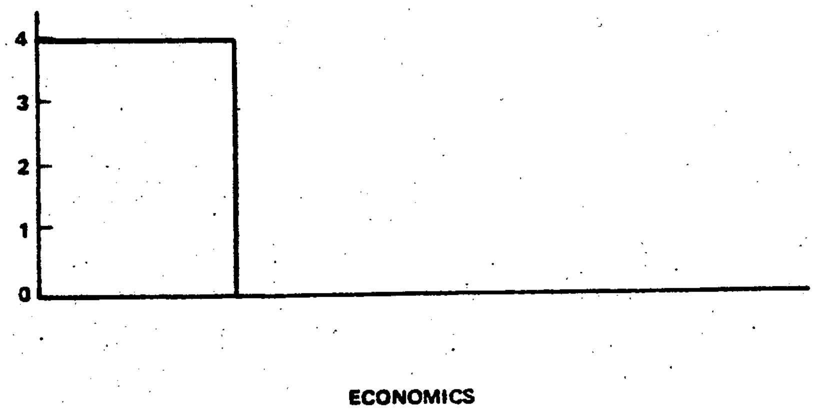


FIGURE 6-17: LAS FLORES SOUTH





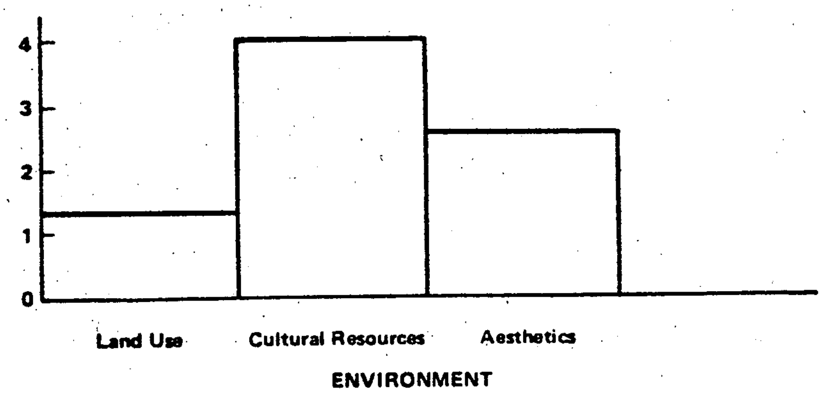


FIGURE 6-18: IMPACT CHARTS – LAS FLORES SOUTH

FIGURE 6-19: SAN ONOFRE FOOTHILLS (NORTH)

FIGURE 6-20: SAN ONOFRE FOOTHILLS (SOUTH)

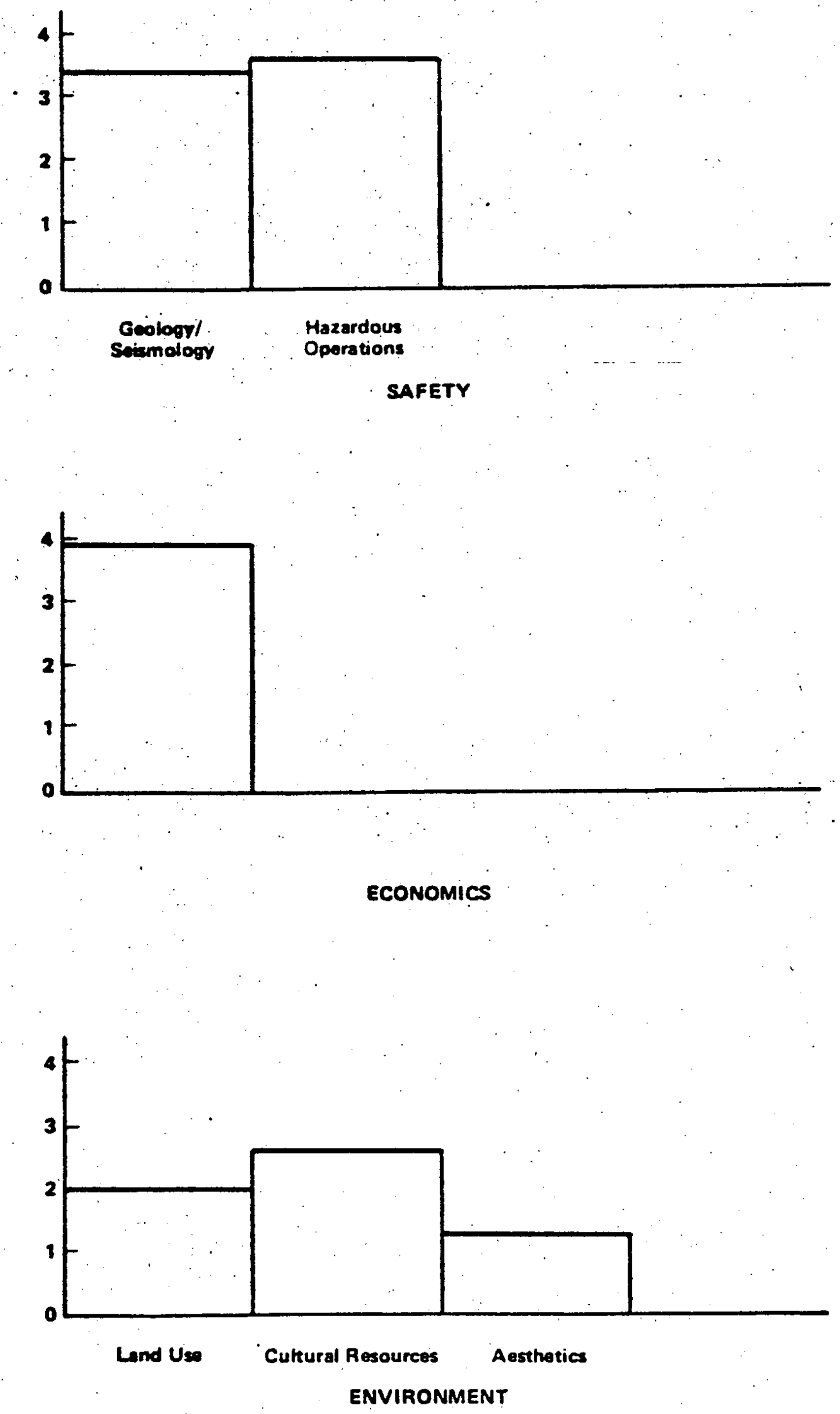


FIGURE 6-21: IMPACT CHARTS – SAN ONOFRE FOOTHILLS

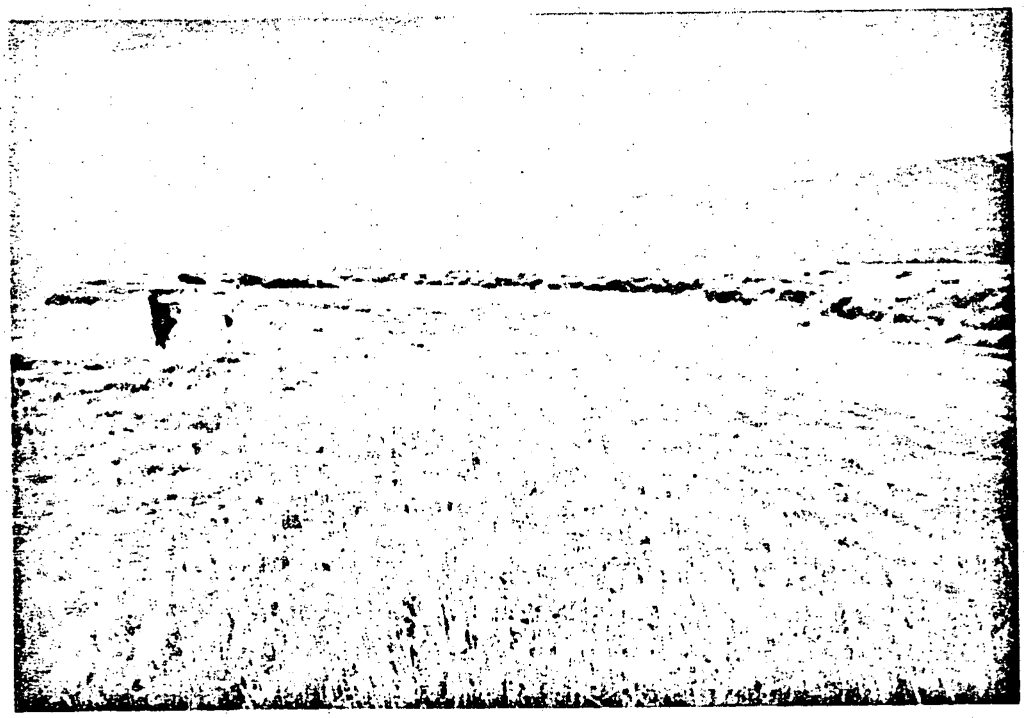


FIGURE 6-22: SAN ONOFRE BLUFF

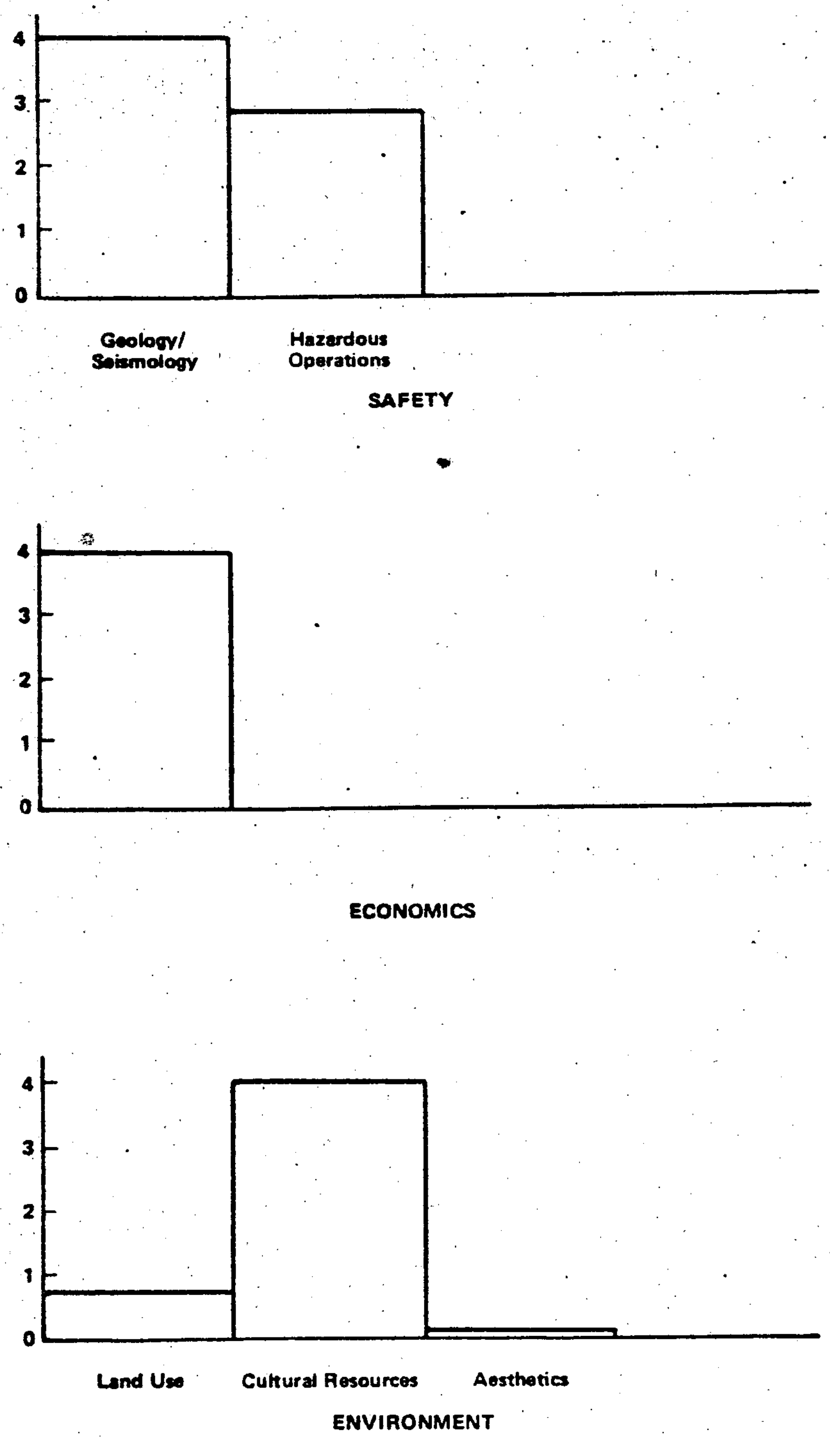


FIGURE 6-23: IMPACT CHARTS – SAN ONOFRE BLUFF

FIGURE 6-24: LAS FLORES NORTH BLUFF

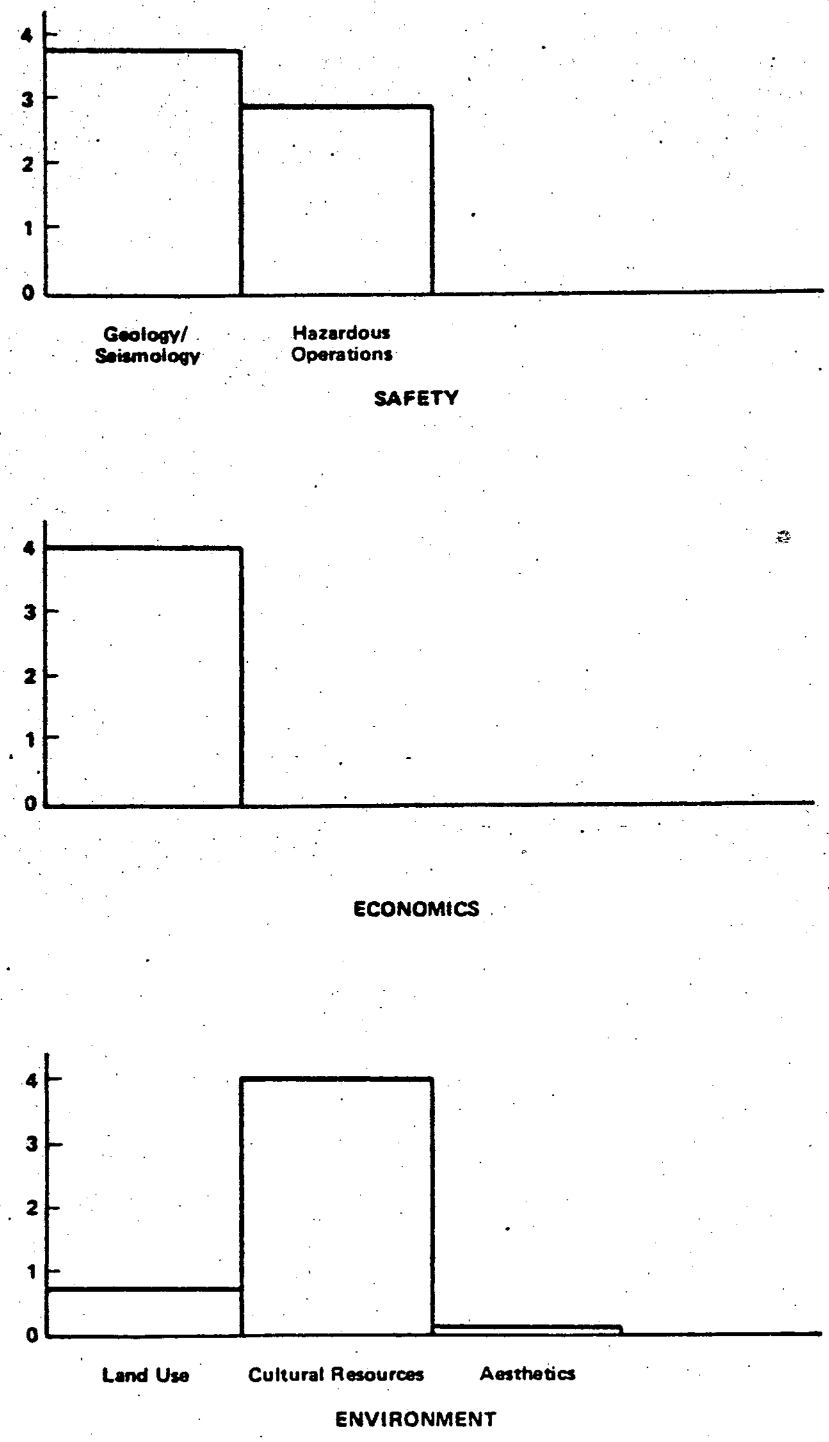


FIGURE 6-25: IMPACT CHARTS – LAS FLORES NORTH BLUFF

FIGURE 6-26: LAS FLORES NORTH BLUFF AND
LAS FLORES SOUTH BLUFF

FIGURE 6-27: LAS FLORES SOUTH BLUFF

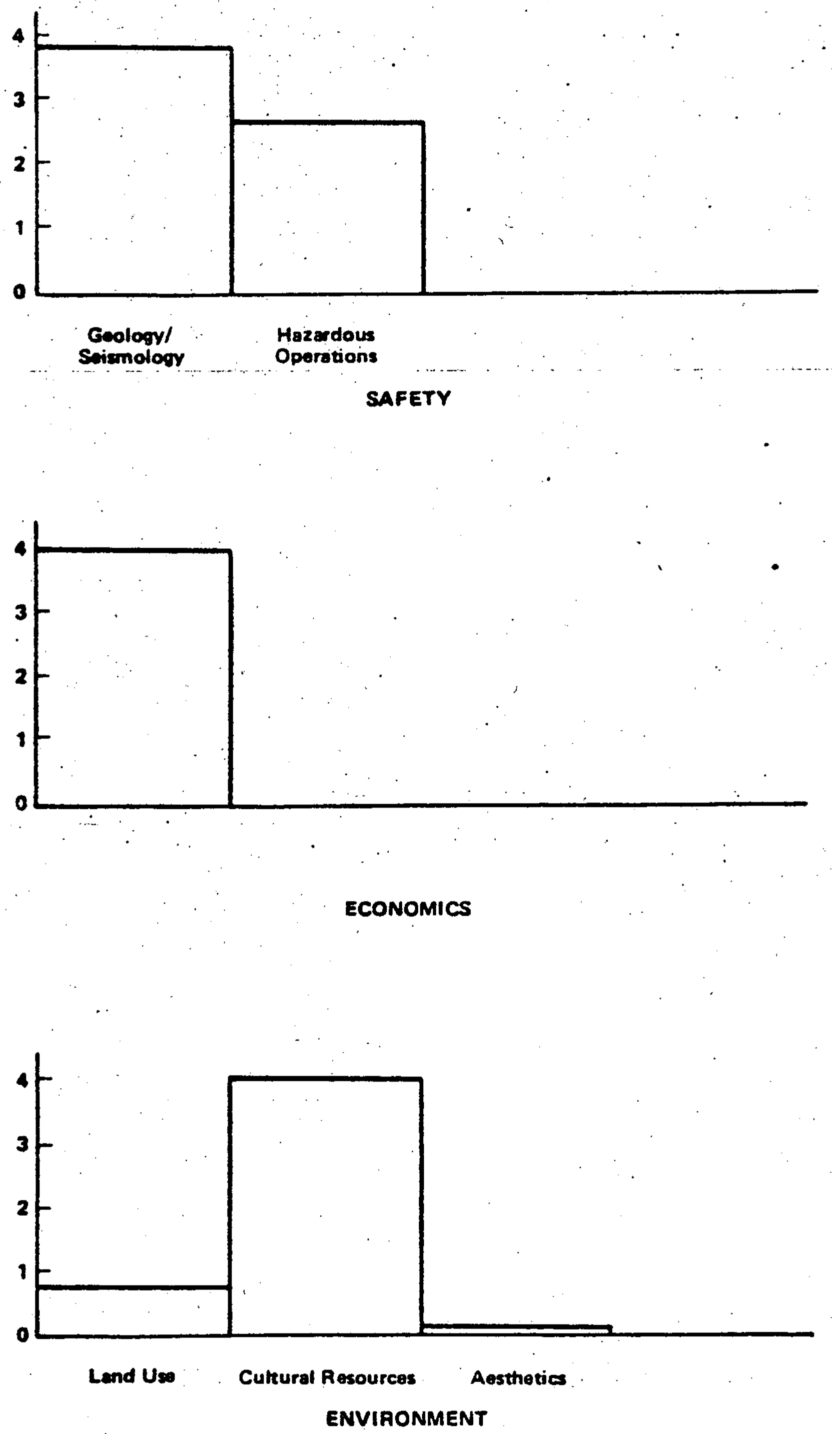
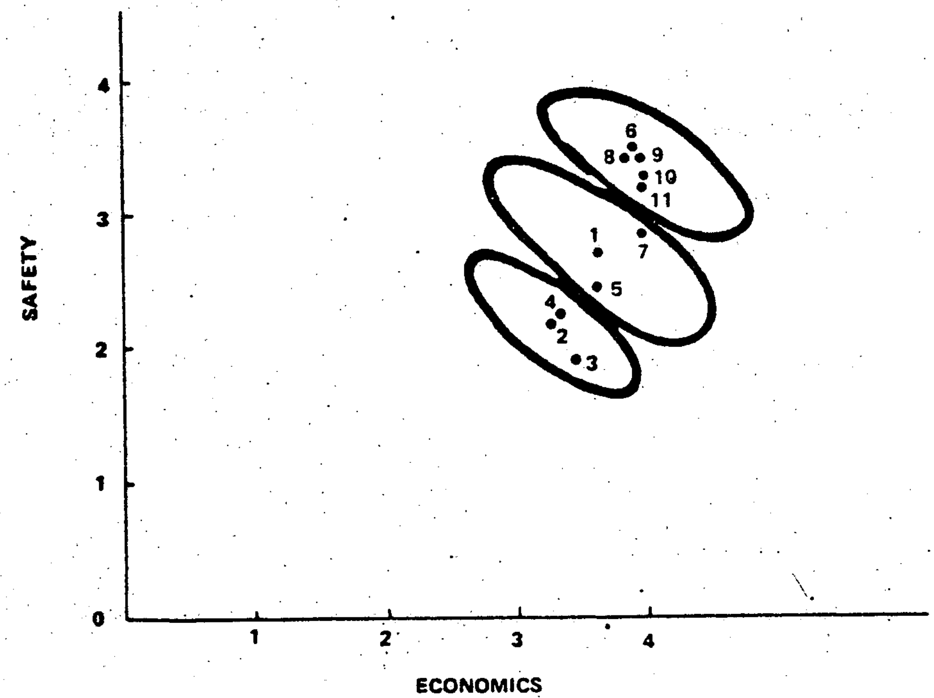


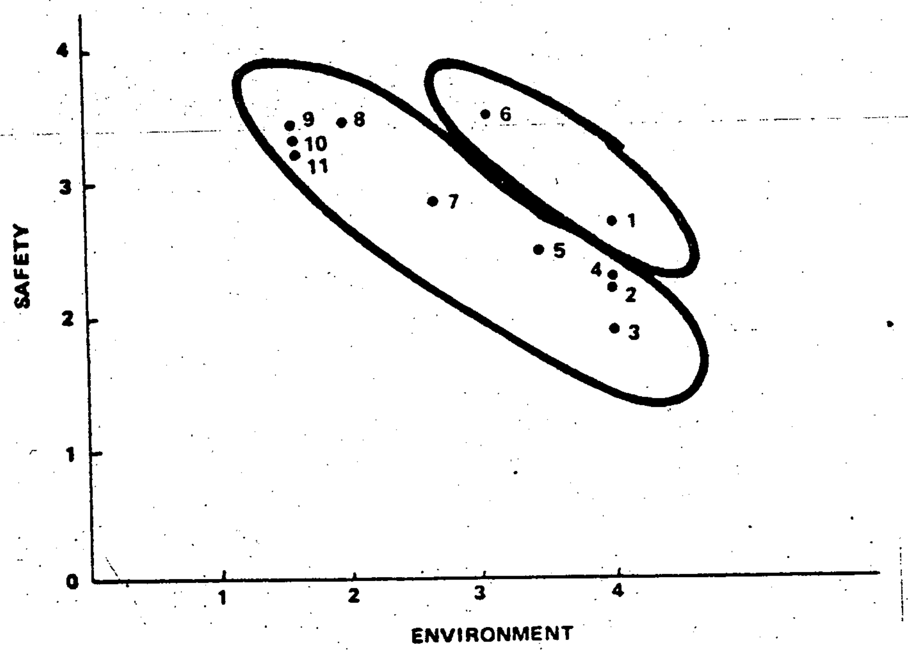
FIGURE 6-28: IMPACT CHARTS – LAS FLORES SOUTH BLUFF



LEGEND

1 San Mateo Canyon
2 San Mateo Hills
3 Santa Margarita
4 Pulgas Branch
5 Pulgas Lake
6 Las Flores North
7 Las Flores South
8 San Onofre Foothills
9 San Onofre Bluff
10 Las Flores North Bluff
11 Las Flores South Bluff

FIGURE 6-29: SITE EVALUATION
SAFETY AND ECONOMICS



LEGEND

1 San Mateo Canyon
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FIGURE 6-30: SITE EVALUATION
SAFETY AND ENVIRONMENT

APPENDIX

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