PROPOSED GEOTHERMAL LEASING

RANDSBURG
SPANGLER HILLS
SO. SEARLES LAKE

FINAL ENVIRONMENTAL ANALYSIS RECORD

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
RIVERSIDE DISTRICT - CALIFORNIA
JULY, 1976

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UNITED STATES

DEPARTMENT OF THE INTERIOR

FINAL

ENVIRONMENTAL ANALYSIS RECORD

FOR

PROPOSED GEOTHERMAL LEASING

IN THE

RANDSBURG-SPANGLER HILLS-SO. SEARLES LAKE AREAS

CALIFORNIA

PREPARED BY

BUREAU OF LAND MANAGEMENT

RIVERSIDE DISTRICT OFFICE

FINAL

Environmental Analysis Record
for
Proposed Geothermal Leasing
in the
Randsburg-Spangler Hills-So. Searles Lake
Areas
California

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1.0 DESCRIPTION OF PROPOSAL AND INTRODUCTION

1.1 PROPOSED ACTION

The action proposed herein is the leasing of Federally-owned potential geothermal resources within the Randsburg Known Geothermal Resource Area (KGRA) and adjacent and nearby lands considered valuable prospectively for geothermal resources. In addition to leasing, the proposed action contemplates the exploration and development of geothermal steam for the purpose of generating electrical energy for local use and possible export.

The implementation of the Federal geothermal resources leasing program is governed by the Geothermal Steam Act of 1970 (Public Law 91-581, 84 Stat. 1566, 30 USC 1001 - 1025) and is carried out in accordance with the geothermal leasing and operating regulations in 43 CFR Part 3200 and 30 CFR Parts 270 and 271. This Environmental Analysis Record (EAR) analyzes the possible impacts of such leasing and development.

1.2 INTRODUCTION

The area considered in this Randsburg - Spangler Hills - South Searles Lake EAR includes the 12,880 acres of the Randsburg KGRA and approximately 73,140 acres of land surrounding the KGRA and in the nearby Spangler Hills and South Searles Lake areas (Fig. 1-1)*. Approximately 134 square miles are under consideration for leasing, and these are segregated into three lease units. It should be

*During the Draft EAR review period, it was learned that approximately 5,120 acres or 8 square miles of national resource lands in the extreme southern portion of the South Searles Lake lease unit were no longer under lease application. All pertinent references and maps in this Final EAR reflect this change.

noted that where appropriate, and to facilitate ease of reading, these three areas will be addressed collectively as the "area" or the "EAR area". Where this treatment is inappropriate, however, each area will be addressed separately.

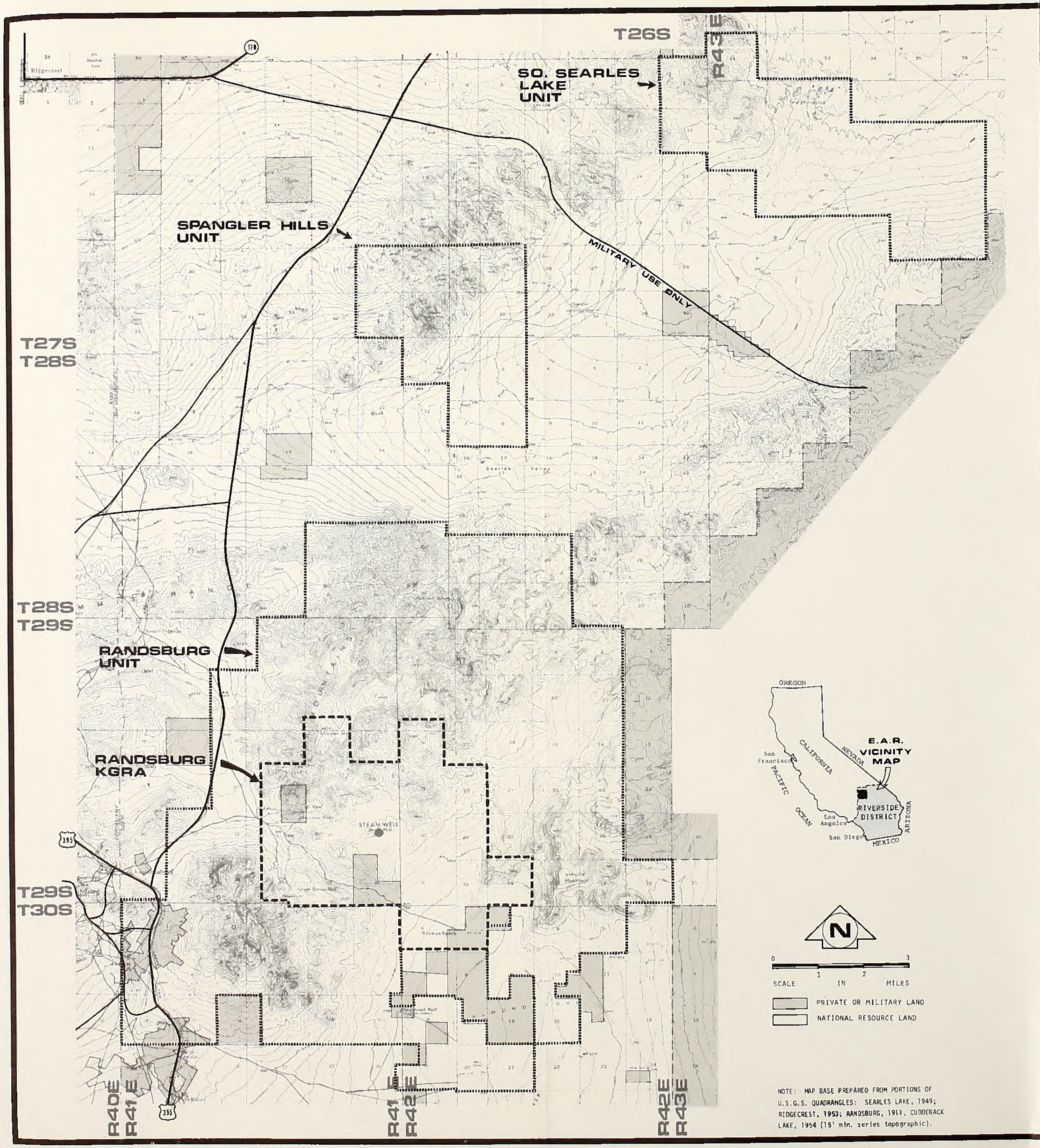
National resource lands within the area are subject to a total of 37 non-competitive lease applications and one area of competitive interest (KGRA). Competitive lease sales take place in all areas designated as KGRA's, with leases awarded to the highest bidders. Leasing on all other eligible lands takes place on a non-competitive basis - - the qualified person first making application for the lease is entitled to the lease.

The Randsburg KGRA was defined as such on the basis of overlapping competitive interest, pursuant to 43 CFR 3200.0-5 (k)(3). The system here is considered an intermediate hot-water system with an assumed average reservoir temperature of 125° C (White and Williams, 1975). Measurements from a well drilled in 1960 to a maximum depth of 772 feet indicated a temperature of 116° C (McNitt, 1963). Data from the older Randsburg Steam Well (Fig. 1-1), at 415 feet deep, indicated a surface temperature of 96° C. Geothermal evidence also exists in the form of hydrothermal alteration west and northwest of the steam well.

Heat from the well is presently being used for space heating in a single dwelling located a few dozen feet from the well itself.

1.3 THE GEOTHERMAL RESOURCE

Geothermal resources may be defined, according to White and Williams (1975) as "...stored heat, both identified and undiscovered, that is recoverable using



-LEGEND-

-------- KGRA BOUNDARY

.... NON-COMPETITIVE LEASE UNIT BOUNDARY

SITE LOCATION MAP

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FIGURE 1-1

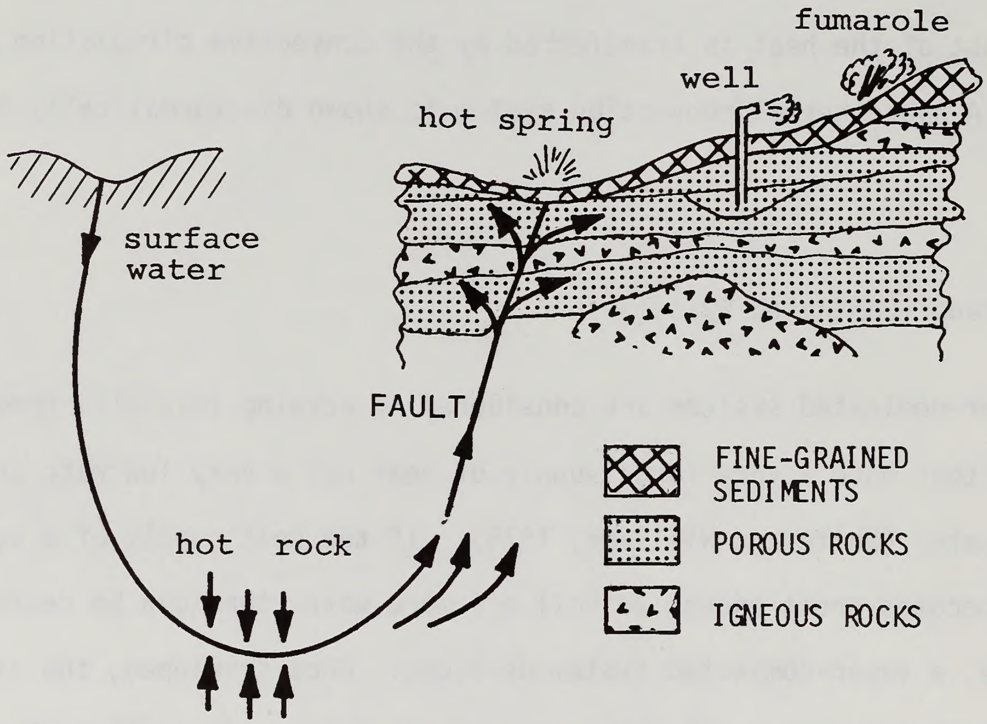
current or near-current technology..." These resources can occur in essentially four different types of geothermal systems: vapor-dominated systems, hot-water systems, geopressured reservoir systems, and hot dry-rock systems. The systems with which we are most familiar are the vapor-dominated or dry steam system and the liquid-dominated or hot-water system.

Both of these types are associated with hydrothermal convection systems, in which most of the heat is transferred by the convective circulation of water or steam. A hydrothermal convection system is shown diagrammatically in Figure 1-2.

1.3.1 Vapor-Dominated Systems

The vapor-dominated systems are considered to develop initially from hot-water systems that have a very large supply of heat but a very low rate of recharge of new water (White and Williams, 1975). If the heat supply of a developing system becomes great enough to boil off more water than can be replaced through recharge, a vapor-dominated system develops. Once developed, the steam phase controls the pressure. When the pressure is decreased, as through a well bore, the contained heat dries and superheats the steam.

The vapor-dominated system is a relatively rare one and many aspects of the system are not well understood, giving rise to divided opinion as to origin and fundamental characteristics. The Geysers, California, is the only example of a large vapor-dominated system extensively drilled in the United States.



DIAGRAMMATIC CROSS-SECTION SHOWING
TYPICAL HYDROTHERMAL CONVECTION SYSTEM

Diagram modified from Ellis, 1975.

FIGURE 1-2

1.3.2 Hot-water Systems

Hot-water systems are dominated by circulating liquid which transmits most of the heat and largely controls subsurface pressure (in contrast to the vapor-dominated system) (White and Williams, 1975). Thermal energy is stored both in hot rock and in the water and steam which fills the pore spaces and voids in the rock. Tapping of the circulating and upwelling waters by drill holes results in a portion of the fluid flashing to steam due to the pressure decrease brought about by the drill bore. The steam fraction is separated from the liquid portion at the surface.

Various thermal surface phenomena are usually associated with these systems. The upwelling hot water often penetrates the surface and results in hot springs and geysers and other phenomena.

At the present time, hot-water systems are the most common systems known.

Table 1-1 is a general summation of selected characteristics pertinent to both the vapor-dominated and hot-water geothermal systems.

1.3.3 General Resource Utilization

The full development of geothermal resources involves the harnessing of the natural heat energy sources in the earth for the generation of electric power and the production of commercially valuable by-products.

Although geothermal steam as a source for electrical generation is the most actively pursued use, knowledge of geothermal resources is still, in large

TABLE 1-1

SUMMARY OF SELECTED CHARACTERISTICS COMPARING VAPOR-DOMINATED AND HOT-WATER GEOTHERMAL SYSTEMS

Hydrothermal Convection Systems (relatively high temperatures at shallow depths)	General Environment of Occurrence	Temperature Characteristics	Nearby Surface Spring Discharges (liters per minute)
A. Vapor-dominated systems	Relatively tight, incompetent rocks that do not permit large quantities of recharge water to penetrate deep into their systems	240° C	100*
B. Hot-water systems	Permeable sedimentary or volcanic rocks and competent rocks such as granite that can maintain open channels along faults or fractures		Typical system discharges range from several hundred to several thousand liters per minute (lpm)
1. High-temperature systems		150° C	
2. Intermediate-temperature systems		150° to 90° C	
3. Low-temperature systems		90° C	

*Data from surface springs at The Geysers, California only.

Data generalized from: White and others, 1971; White and Williams, 1975.

part, in the investigative stages. Commercial geothermal development in the United States to date is limited, existing only at The Geysers, in California, and there only since about 1960. By contrast, developments have existed in Italy since about the turn of the century.

Potential uses of geothermal resources are varied and, in addition to electrical generation, include space heating, agriculture, refrigeration, industrial processing, the production of fresh water by desalination, and the production of by-product chemical, mineral, and gas resources (U. S. Dept. Interior, 1973). Following are examples of present geothermal resource uses worldwide:

Electrical Power

The Geysers, California
Larderello and Monte Amiata, Italy
Wairakai, New Zealand
Matsukawa and Otake, Japan
Cerro Prieto and Pathe, Mexico
Namafjall, Iceland
Pauzhetsk, USSR

Space Heating

Klamath Falls, Oregon
Boise, Idaho
Iceland
New Zealand
Hungary
USSR

Manufacturing and Processing

Iceland
New Zealand
USSR

Refrigeration

USSR

By-product Chemicals

USSR

At the present time, it is felt that the intermediate temperature system such as that at Randsburg is submarginal for the generation of electricity but can practically be used now for space heating and industrial purposes (White and Williams, 1975). However, for this analysis it is felt that a more comprehensive environmental assessment would result if the area were considered as potentially viable for the production of electricity. Should the area be found unsuitable for electrical generation, the impacts to the area would be proportionally less than those outlined in this EAR.

Because of the limited knowledge of the occurrence, location, and properties of geothermal resources within the Randsburg EAR area, it is not possible to specifically predict the success or failure of any lease site with regard to development or to make a categorical prediction about the program as a whole.

1.4 DEVELOPMENT MODEL

1.4.1 General

Geothermal energy is similar to other energy resources in that until actual exploration and development begin, it is difficult to quantify the resource potential and possible future intensified production measures necessary to develop it. A special problem exists with geothermal energy because it is a relatively undeveloped resource when compared to other resources. In order to assess environmental impacts resulting from an action as general and variable as geothermal energy exploration, development, and operation, it is necessary to assume given levels or intensities of such development.

On the basis of estimates of stored heat, recoverability factors, and utilization efficiency (White and Williams, 1975), it is not anticipated that the Randsburg KGRA or the nearby areas would be significant in terms of the production of electrical energy. It is therefore assumed on these bases that an appropriate model for development intensity would be one 50 MW electric generating plant on one 2,560-acre lease, for a total generating capacity of 50 MW. This serves as the baseline against which to analyze impacts upon the existing environment.

Also assumed are five stages of geothermal energy resource development and production: preliminary exploration, exploration drilling, field development, production and operation, and closedown. Each stage is dependent upon successful results in the previous stages. The model was developed for each stage of geothermal exploration and development.

1.4.2 Preliminary Exploration Stage

The techniques required during this stage of exploration involve activities ranging from airborne exploration, topographic and geological mapping, geophysical exploration, and geochemical surveys, to the drilling of shallow ($\pm$500 feet) seismic and temperature gradient holes. Most of these activities involve a small crew (two to three people) and small trucks for transporting the crew and hand-held equipment. These vehicles may be accommodated by poorly-developed roads and trails.

Airborne exploration involves a series of techniques including:

(1) Aerial photography for geologic interpretation.

(2) Infrared imagery to detect heat differentials; microwave imagery to detect soil moisture differentials.

(3) Airborne magnetometer surveys to measure variations in the magnetic intensity of the earth.

(4) Airborne gravimeter surveys to measure differences in the specific gravity of the earth.

Each of these techniques is used to gain data on the subsurface geology of an area, and the data may supply clues as to areas deserving of more detailed studies.

Topographic and geologic mapping involves the use of one or more small vehicles to transport surveyors, geologists, and their equipment to the work area.

Geophysical exploration activities are conducted to obtain information on subsurface geology:

(1) Ground gravity surveys obtain gravity readings.

(2) Magnetic variations in the earth are measured with a magnetometer.

(3) During seismic exploration, elastic shock waves are generated and then measured by receivers (geophones). The elastic waves are generated by: vibrations (produced by truck-mounted vibrators); thumping (produced by dropping a heavy weight or "hammer" on the ground); and detonation of five to 50 pounds of explosives in drill holes 100 feet to 200 feet deep.

(4) During microseismic exploration seismometers are buried at shallow depth and transmit evidence of extremely minor seismic activity to an amplifier on the ground surface.

(5) Induced polarization (IP) techniques are used to measure the resistance of subsurface rocks to the passage of an electric current by transmitting pulses of electrical current into the ground through two widely (two miles apart) spaced electrodes and recording the behavior of the pulses as they travel through underlying rock.

(6) Telluric exploration involves recording variations in the natural electrical currents in the earth.

(7) Radiometric surveys measure radioactive emissions (generally radon gas) as an indication of subsurface steam. Such measurements are usually made in the vicinity of hot springs.

Geochemical surveying includes the sampling of spring water to determine dissolved solid content, acidity, Na/K ratio, and silica content and the collecting of surface soil and rock samples to determine introduced mineralization and possible source areas for recharge.

Drilling carried out in the preliminary exploration stage includes that for seismic test holes and temperature gradient holes. During these operations, drill cuttings or chips may be removed from shallow holes by compressed air. For deeper drilling, a circulating medium of water or drilling mud (a suspension in oil or water of various finely divided substances, each possessing specific properties) is pumped through the drill pipe and returned up the annular space between the hole wall and the outside of the drill pipe. This circulating medium also cools and lubricates the bit and helps prevent caving by plastering and consolidating the walls of the hole with a clay lining, thereby making casing unnecessary during shallow drilling.

Seismic test holes, generally 100 feet to 200 feet deep, are drilled with small truck-mounted rigs; cuttings may be removed by compressed air. The surface area disturbed is about 30 feet by 30 feet and no drill pad is constructed.

Temperature gradient holes, generally from 300 feet to 500 feet deep and four inches to six inches in diameter, are also drilled with a small, truck-mounted rig. Mud is employed to remove the cuttings; a portable metal mud pit is used to contain the mud. An area about 30 feet by 30 feet is disturbed.

Upon completion of drilling, the hole is capped and is allowed to stand for about a week. Water in the pipe is heated by the surrounding rock and the temperature at different depths is then measured by a thermister probe on a cable.

1.4.3 Exploration Drilling Stage

Exploration drilling includes drilling of geologic information holes and exploratory wells.

Geologic information holes are similar to those drilled for temperature gradient purposes except that larger equipment is employed and a surface area of about 40 feet by 60 feet may be used. Because these holes may extend to 1,000 feet or more, a larger mud pit is needed. Typically, this pit is scooped out with a bulldozer and may be 10 to 20 feet wide by 30 to 50 feet long by 3 to 6 feet deep, depending on the terrain and the depth of the information hole.

Where the objective of drilling is to collect data on thermal gradients or geologic structure, and steam zones will not be penetrated, small diameter (six inch to 24 inch) boreholes may be put down by small or medium-sized drill rigs to a depth of up to 2,000 feet. Test wells to investigate the potential reservoirs may have larger diameters and be deeper; the deepest drilling will probably be in the 5,000 foot to 10,000 foot range. Pits to contain waste fluids and drill cuttings may range in size from 75 feet by 150 feet to 150 feet by 300 feet. The size is dependent on the depth of the hole and whether or not it is planned to test the reservior directly into the pit. When testing two or more wells, only two disposal ponds would probably be needed since a disposal (injection) well would probably be utilized.

Current drilling equipment, technology and methods for geothermal exploratory wells are similar to those used in oil and gas operations. Test drilling equipment often used includes a portable drilling rig and possibly a truck-mounted air compressor, if the drilling is done with air, or a water tank truck, if the drilling is done with water.

An exploration drilling model modified from data by the U. S. Department of the Interior (1975a) is shown in Table 1-2. This table lists the maximum degree of surface disturbance expected during this stage. The table tends to maximize the degree of surface disturbance which might occur. For example, fewer than five exploration wells may be needed, one acre per drill site could be used rather than three acres, disposal ponds may not be needed or could be smaller, and fewer access roads may be needed when roads into the area already exist.

TABLE 1-2

APPROXIMATE SURFACE DISTURBANCE EXPECTED TO RESULT FROM EXPLORATION DRILLING ON ONE 2560-ACRE LEASE

UNIT	NO. OF ACRES DISTURBED PER UNIT	NO. OF UNITS	ACRES DISTURBED
Well	3	6	18
Disposal Pond	1	2	2
Access Roads	1.5	5	8
Total	5.5	13	28 or 1.1% of total lease area (2560 acres).

1.4.4 Field Development Stage

Favorable exploration and test drilling will probably lead to the decision to develop a producing geothermal field. The field development stage includes all activities from the initial decision to develop a field up to the point where commercial power generation and transmission occur. Field development in a large field can continue for many years as new wells are developed.

The development stage includes road development, drill-site development, construction of geothermal pipelines, a power generation plant and transmission lines, and rehabilitation of disturbed areas. Many of these operations normally take place concurrently.

Roads to drill sites, the power plant site, and along transmission line routes would be constructed. Roads to producing wells and the power plant would generally be permanent and may be surfaced and stabilized. The more heavily utilized roads may range up to 20 or more feet in width, and culverts would be utilized where necessary to avoid erosion. Temporary roads to drill sites and for construction of power lines would generally be built to a relatively low standard, remaining unsurfaced and ranging up to about 10 feet in width.

Test well drilling and intensive production testing would continue as the limits of the field are probed. With each well tested, uncertainties as to the depth of the producing zone and type of fluids to be encountered will be lessened.

About 500 to 1,000 barrels (1 barrel = 42 gallons) of water per day will be used in drilling a well. This water may come from water wells drilled in the immediate vicinity (about 60 gallons per minute (gmp) flow would be adequate) or it may be hauled in by truck.

The number of wells servicing a plant is dependent on the temperature of the wells and the characteristics of the geothermal reservoir. Generally 20 or more producing wells are used per power plant. To avoid interference of one well with another and to insure maximum production and efficiency, wells are normally drilled with a spacing of one well per 40 acres.

To determine the sustained flow characteristics of a well, and to clean out the hole, each new well is vented to the atmosphere for a period of time. Steam, fluids, and noise accompany production testing. The fluids consist mostly of water containing various amounts of sodium, potassium, lithium, chloride, bicarbonate, sulfate, borate, and silica and are generally directed into the reserve pit and contained. The steam is released into the atmosphere.

Noncondensible gases (carbon dioxide, methane, hydrogen, nitrogen, argon, carbon monoxide, hydrogen sulfide, radon, ammonia) and vapors (boric acid and mercury) are often contained in the steam. These vapors and gases generally make up less than three percent of the total steam fraction. Table 1-3 lists examples of gases associated with various geothermal systems.

If geothermal production releases substances found to be detrimental to the environment, these substances must either be removed or otherwise disposed of before surface disposal or reinjection occurs. If no harmful materials are present, or if these materials can be economically removed from the fluids, it is possible that fresh water can be produced with the energy. Conservation and utilization of such demineralized water will be required where such production is economically feasible. Measurements of the salinity of the resource in this area are not available at this time.

Table 1-4 lists the amounts of geothermal fluids that may be produced during testing of a 2,560-acre lease.

TABLE 1-4 QUANTITIES OF FLUIDS EXPECTED DURING TESTING OF GEOTHERMAL EXPLORATION WELLS - 15 DAY TEST ASSUMED*

Fluid Production per Test Well	-	10,050,000 gallons	(31 ac.ft.)
Amount Converted to Steam	-	2,010,000 gallons	(6 ac.ft.)
Amount Left for Disposal	-	8,040,000 gallons	(25 ac.ft.)

*Data modified from U. S. Dept. Interior, 1975a.

TABLE 1-3

EXAMPLES OF GASES ASSOCIATED WITH VARIOUS GEOTHERMAL SYSTEMS

	Geysers 1/ California	Larderello 1/ Italy	Natsukawa 2/ Japan	Namafjall 3/ Iceland
H_2O	98.045*	98.08	99.87	99.43
CO_2	1.242	1.786	0.18	0.18
H_2	0.287	0.037	0.01	0.19
CH_4	0.299			0.01
N_2	0.069	0.0105		0.05
A			0.03	
H_2S	0.033	0.049		0.14
NH_3	0.025	0.033		
H_3PO_4	0.0018	0.0075		

*All values in percent volume

Adopted from U. S. Dept. Interior, 1973.

1/ White and others, 1971.

2/ Nakamura and others, 1970.

3/ Lindal, 1970.

During the initial testing stage one well is likely to be tested at a time. Therefore, the quantities shown in Table 1-4 are likely to be spread over a period of time rather than, say, one two-week period.

If testing is successful and production goes forth, larger quantities of fluids will be produced. The following table (Table 1-5) summarizes the amounts of fluids which could be produced and disposed of each day for 60 producing wells.

TABLE 1-5 QUANTITIES OF FLUIDS EXPECTED DURING PRODUCTION AND OPERATION OF ONE 2560 ACRE-LEASE WITH 60 PRODUCING WELLS*

Fluid Production per Well per Day	-	670,000 gallons	(2 ac.ft.)
Amount Converted to Steam	-	134,000 gallons	(.4 ac.ft.)
Amount left for Disposal	-	536,000 gallons	(1.6 ac.ft.)
Fluid Production per Day for 60 Wells	-	40,200,000 gallons	(123 ac.ft.)
Amount Converted to Steam	-	8,040,000 gallons	(24 ac.ft.)
Amount Left for Disposal	-	32,160,000 gallons	(99 ac.ft.)

*Data modified from U. S. Dept. Interior, 1975a.

Depending on the amount of geothermal fluids produced, it also may be necessary to carry out an injection well drilling program in close coordination with production well drilling. Deep-well injection is the emplacement of wastes within the earth, usually below the water table and beneath a confining stratum which serves to isolate the wastes from potable water supplies or other valuable or potentially valuable resources. The feasibility of reinjecting liquid wastes deep within the earth is suggested by the enormous volume of subsurface storage space. The earth, however, contains little empty space so waste fluids may have to be accommodated by compressing or displacing existing fluids (including injections into depleted reservoirs) or by compressing or deforming the surrounding strata.

Pipelines 10 inches to 30 inches in diameter will be used to transmit steam or hot water from the production wells to the power plant, and to transmit waste fluids to the reinjection wells. The pipes are typically insulated with fiberglass or asbestos to minimize heat loss. Expansion loops or joints are placed at frequent intervals either vertically or horizontally to provide for the extreme expansion and contraction upon production startup (heating up) and shutdown (cooling down).

Under present technology, pipelines are constructed above ground to provide for expansion and contraction and to enhance maintenance and detection of leaks. Thus, in the producing area, the terrain is laced with exposed pipelines radiating out from the power plant to the wells. The lines form a radiating pattern on the surface, connecting wells with the power plant.

Geothermal fluids and steam can be economically transported only a distance of about one mile due to pressure and temperature loss factors. The greatest distance of any connected well currently is 1,200 feet in a straight line.

The power plant installation will be relatively small. The model developed for this analysis assumes a 50 MW plant. A typical power plant at The Geysers consists of two turbine generators housed in a single building with an adjoining structure housing cooling towers. The Geysers Units 3 and 4 are housed in a building 140 feet by 34 feet and 30 feet high. Adjoining is a cooling tower consisting of three shells 36 feet by 66 feet.

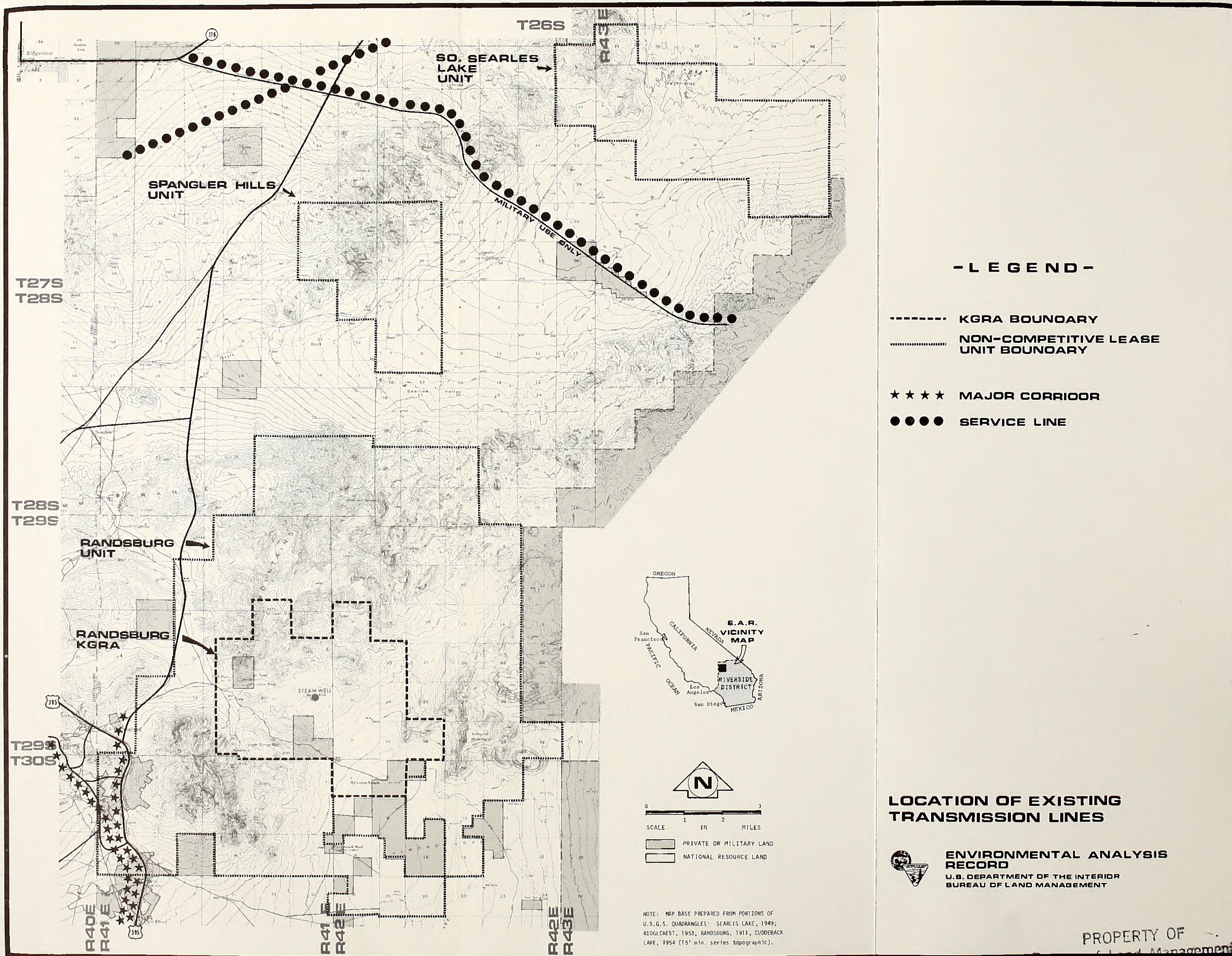
It is assumed, for the purpose of this analysis, that any electricity generated in the Randsburg EAR area would be exported to the Los Angeles Metropolitan Area. It is also assumed a power output of 50 MW electricity could be transmitted from the power plant along a 66 kilovolt (kV) wooden pole line along a 90-foot right-of-way. Figure 1-3 illustrates the location of corridors of existing transmission lines in the vicinity.

Construction of the transmission line would include: clearing of the right-of-way; construction of access roads, where necessary; hole drilling; emplacement of the poles; stringing the line; and rehabilitation of disturbed areas.

Table 1-6 lists approximate surface disturbances associated with construction of one 50 MW power plant and associated facilities.

Rehabilitation will be possible on disturbed areas not needed for continued production, commensurate with terrain, climate, and significance of the damage. Roads needed for maintenance and further development will not be rehabilitated. Temporary roads and trails can be scarified and revegetated.

After well completion, an area approximately 30 feet by 30 feet directly surrounding the well head will be needed for operation. An additional graded area about 50 feet by 100 feet may be needed for moving in a drilling rig to correct any problems which may develop during production. The reserve pit (sump) is generally dried out, filled, and graded. It and the remaining area of the drill site can be rehabilitated and revegetated.



LOCATION OF EXISTING TRANSMISSION LINES

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FIGURE 1-3

TABLE 1-6

APPROXIMATE SURFACE DISTURBANCE EXPECTED TO RESULT FROM DEVELOPMENT OF A 50 MW POWER PLANT ON ONE 2560-ACRE LEASE

UNIT	NO. OF ACRES DISTURBED PER UNIT	NO. OF UNITS	ACRES DISTURBED
Power Plant Complex	5	1	5
Well	3	30	90
Disposal Pond	1	2	2
Pipeline	1	25	25
Access Roads	2.4	30	72
Mainline Road	7.3	1	7.3
Transmission Line	4.8	1	4.8
			206.1 or about 8.0% of total lease area

Adapted from U. S. Dept. Interior, 1975a.

The area disturbed in constructing the generating plant and cooling towers can be rehabilitated and revegetated, and the buildings may be painted to blend with the surroundings.

Geothermal pipelines may also be painted to blend with the surroundings and any areas not needed for access may be revegetated.

Surface disturbance accompanying electrical transmission line construction may be rehabilitated with the exception of needed maintenance roads.

In any full-scale operation, the form that the system of wells, pipelines, power plant and power lines, and roads assumes will be fundamentally influenced by the nature of the geothermal reservoir. The surficial conditions - such as topography, nongeothermal land use activities and water supply for cooling - and progress in geothermal technology are also major factors.

1.4.5 Production and Operation Stage

During the production and operation stage, activities primarily will consist of the operation and maintenance of the power plant and existing wells, the drilling of new wells, waste disposal, and water utilization. Electrical energy generation during full-scale operations will be at its maximum and generally may be expected to continue at approximately the full-scale level for many years. The overall activity, however, will be considerably reduced over that required during field development and construction of power generation, power transmission, and related facilities.

Exploration and development are typically carried on in other parts of the geothermal field simultaneously with the operational and production activities.

Repair, maintenance, and monitoring of an operating field will require the periodic use of access roads to service the equipment. Existing wells will require occasional repair work or cleanout. The amount of this remedial work will depend upon the production characteristics of the field. Severe scaling and corrosion of equipment from chemicals encountered during development would require frequent remedial work. Normally one medium-sized drill rig would be required to drill new wells to maintain generating capacity.

Geothermal fields are long-lived resources. The Lardarello field has been in production since 1904 and The Geysers since 1958. The Geysers is estimated to have a minimum productive life of 30 or more years. Nonetheless, production slowly diminishes the heat flow at individual wells and additional wells must be drilled and completed to keep the generating plant operating at full capacity.

Additional wells may also be required to replace wells that have become inoperative and, if the waste waters are disposed of by injection, new injection wells may be drilled. The technique and effects of drilling these wells would be the same as for development wells.

The most significant waste disposal problem relates to handling the excess geothermal fluids. In vapor-dominated systems, as at The Geysers, about 75 to 80 percent of the water from the spent steam is consumed in the cooling towers, leaving 20 to 25 percent to be disposed of. In water-dominated systems, such as Cerro Prieto, Mexico, and most likely Randsburg, the reverse is true with 80 percent or more of the total well production requiring disposal.

Disposal techniques vary, depending on the quality and quantities of effluent involved. Any or a combination of the following techniques may be employed:

(1) Evaporation-ponds - Where water quality is satisfactory, such ponds may provide new aquatic habitat. Where water is toxic, special measures may be required to protect the ground-water supply, livestock, and wildlife.

(2) Natural drainage systems - High-quality water disposed of in this manner provides an additional resource for agriculture, wildlife, and other uses. Low-quality water may require extensive treatment before it is suitable for release into natural drainages.

(3) By-Product development - In some instances it may be economical to extract useful minerals or gases from the geothermal fluids. This could result in improving the waste-water quality so as to make it available for other purposes. Desalinization may also be feasible in some areas, providing by-product fresh water for other uses.

(4) Reinjection - With this technique, excess water is reinjected into nonproductive zones of the geothermal field. Successful reinjection is dependent on the quality of the waste water and the geologic characteristics of the geothermal field. Typical considerations would include: whether plugging and scaling problems will prevent the reservoir from accepting the fluid; whether fresh-water aquifers can be adequately protected from contamination by hot saline waste water; and whether the subsurface rock structure will adequately hold the reinjected fluids.

The work force (both construction and maintenance) for a geothermal power plant will usually be housed in the nearest town rather than a new town at the site. Thus, waste materials connected with human habitation will typically be handled in the local community.

At the plant site itself, sanitary facilities for workers would be provided. Solid wastes would either be disposed of in a dump developed at the site or trucked to the nearest established dump site.

Cooling towers consume about 40 to 45 acre-feet of water per year for each megawatt of plant capacity (U. S. Dept. Interior, 1975a). A 50 MW plant would thus consume about 2,300 acre-feet of water per year. The water may come either from steam condensate, waste geothermal water, or from any other available source.

1.4.6 Closedown Stage

This stage consists essentially of site abandonment and will occur when the geothermal resource is depleted. Geothermal steam reservoir knowledge has not advanced to a stage where a reasonable economic limit can be predicted, but for planning purposes years 30 to 50 years is assumed, which is merely the steam plant amortization period. In a sense, however, geothermal reservoirs may be somewhat renewable resources in that, after a long period of rest, the fluids may become reheated to temperatures that are again usable.

Discrete operations during the close-out stage include the removal of all surface facilities, abandonment and capping of wells, and surface rehabilitation. Remaining solid waste may either be disposed of in a dump developed at the site or transported to the nearest established dump. In addition, any electrical transmission lines no longer in use will be dismantled and removed.

During the abandonment and capping of wells, the bottom of the hole would be plugged with cement and the surface casing would also be plugged with about 20 feet of cement. The casing would be cut off below the surface and a steel plate welded over the hole. A vertical steel pipe and marker would be welded to the plate, and the location may be graded and revegetated. The marker will remain above ground to provide identification.

Surface rehabilitation will typically be a gradual process, taking place throughout the life of the field and culminating with the final abandonment. Access roads can be ripped up, landscaped, and revegetated, and power line rights-of-way can be landscaped and revegetated. Well sites and the plant site can be similarly treated. Because of the relatively large size of these sites, complete landscaping to approximate the original surface in steep terrain would not be feasible except in unusual circumstances.

2.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

2.1 NON-LIVING COMPONENTS

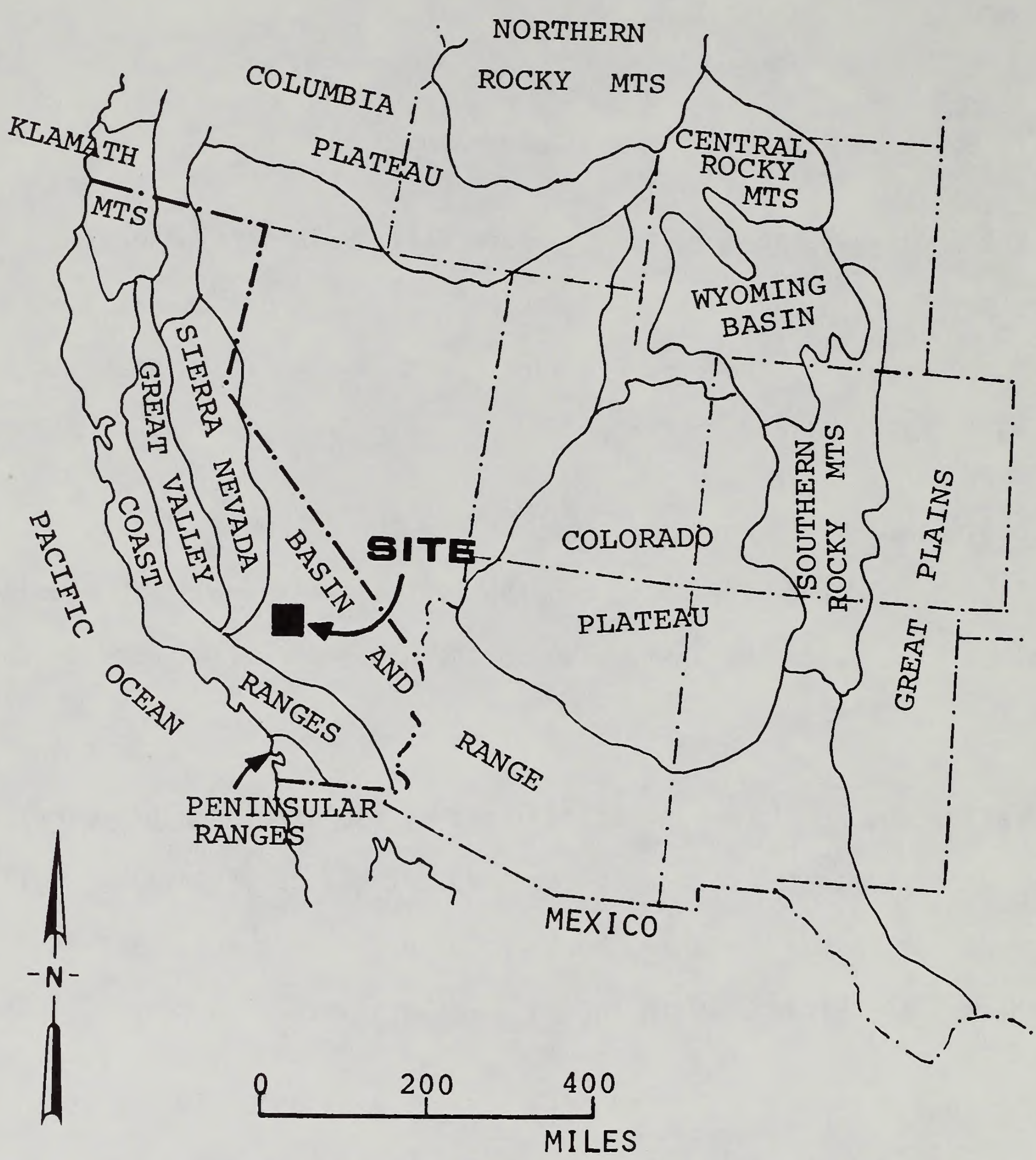
2.1.1 Regional Physiography and Topography

The EAR area is located in the southern California portion of the Basin and Range Physiographic Province (Figure 2-1). This Province extends from southern Oregon south to the U.S. - Mexico boundary. At its widest, it extends for several hundred miles.

The Basin and Range Province is bounded by the Columbia Plateau to the north, the Sierra Nevada to the west, and the Central Rocky Mountain Province and Colorado Plateau to the east. The southern boundary lies outside the United States.

Generally, the Province is distinguished by isolated, roughly parallel mountain ranges separated by nearly level desert basins (Fenneman, 1931). Various features within the province, however, make its northern, western, and eastern boundaries transitional with the adjacent provinces (Thornbury, 1965).

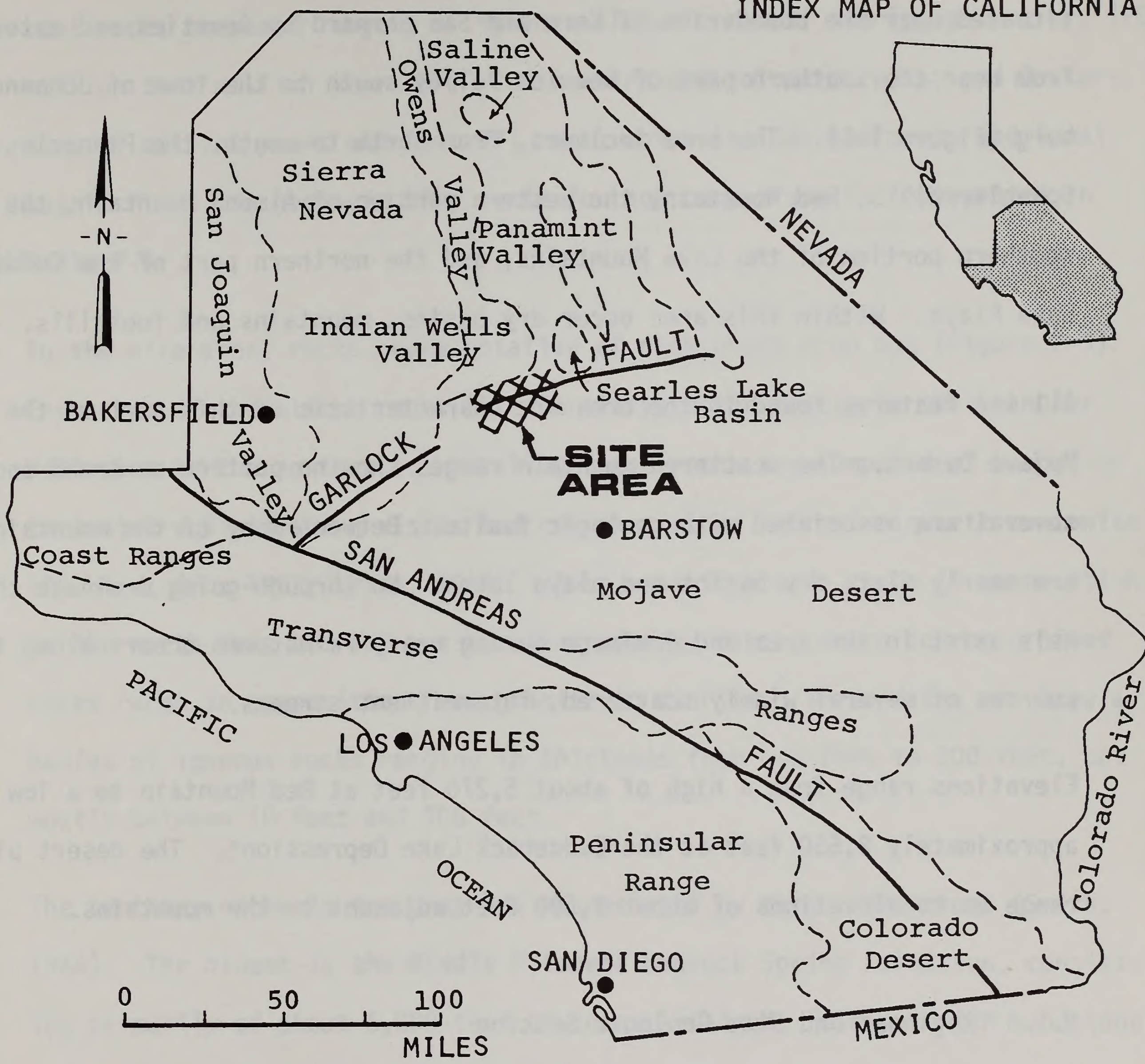
The Basin and Range is divided into several sections. Two of these are the Great Basin and the Mojave Desert, which are separated from each other by the Garlock fault. Most of the EAR area lies in the Mojave Desert section (Figure 2-2).



REGIONAL PHYSIOGRAPHIC MAP
SHOWING SITE LOCATION

Physiography modified from Fenneman, 1931.

FIGURE 2-1



GENERALIZED INDEX MAP OF SOUTHERN CALIFORNIA SHOWING SITE LOCATION AND LOCAL PHYSIOGRAPHIC FEATURES

FIGURE 2-2

2.1.2 Site Physiography and Topography

The specific areas addressed in this report include three separate lease units situated near the boundaries of Kern and San Bernardino Counties and extending from near the southern part of Searles Valley south to the town of Johannesburg (Figure 1-1). The area includes, from north to south, the Pinnacles, Spangler Hills, Red Mountain, the western portion of Almond Mountain, the southern portion of the Lava Mountains, and the northern part of the Cuddeback Lake Playa. Within this area occur dry basins, mountains and foothills.

All the features found in the area are characteristic of this part of the Mojave Desert. The scattered mountain ranges show no pattern or trend and several are associated with geologic faults. Between many of the mountains are nearly flat, dry basins and playa lakes. No through-going drainage channels exist in the area and drainage during heavy rainstorms occurs along the courses of several widely scattered, intermittent streams.

Elevations range from a high of about 5,270 feet at Red Mountain to a low of approximately 2,550 feet at the Cuddeback Lake Depression*. The desert plains range up to elevations of about 3,500 feet adjacent to the mountains.

2.1.3 Regional and Site Geologic Setting

2.1.3.1 Stratigraphy and Lithology

In the northern and western Mojave Desert region, the rocks can be described

* Elevations referenced to United States Geological Survey (USGS) mean sea level datum, 1927.

in terms of three general groups (Dibblee, Jr., 1967; Mabey, 1960): Pre-Tertiary (older than 70 million years before present (BP)) crystalline basement rocks composed largely of igneous plutonic rocks; overlying Tertiary (70 million to 1 million years BP) sedimentary and volcanic rocks; and Quaternary (1 million years and less BP) rocks which include sediments and local basalt flows. A geologic time scale for age comparison is represented in Table 2-1.

In the site area, rocks representative of each group crop out (Figure 2-3). Exposures of the oldest rocks (Pre-Tertiary) occur mostly in the Spangler Hills and to the northeast. Locally, these rocks are composed of banded or laminated schists and gneisses and coarse-grained intrusive quartz monzonite (Dibblee, Jr., 1967; Smith, 1964). They exhibit a wide range in composition. In the north this bedrock has been intruded by dikes, whose coarse-grained rocks range in composition from granite to diorite. These dikes are tabular bodies of igneous rocks ranging in thickness from one foot to 200 feet, but mostly between 10 feet and 100 feet.

The Tertiary rocks in the area are represented by three formations (Smith, 1964). The oldest is the Middle Pliocene Bedrock Spring Formation, consisting primarily of about 5,000 feet of coarse-grained, feldspar-rich sandstone and conglomerate.

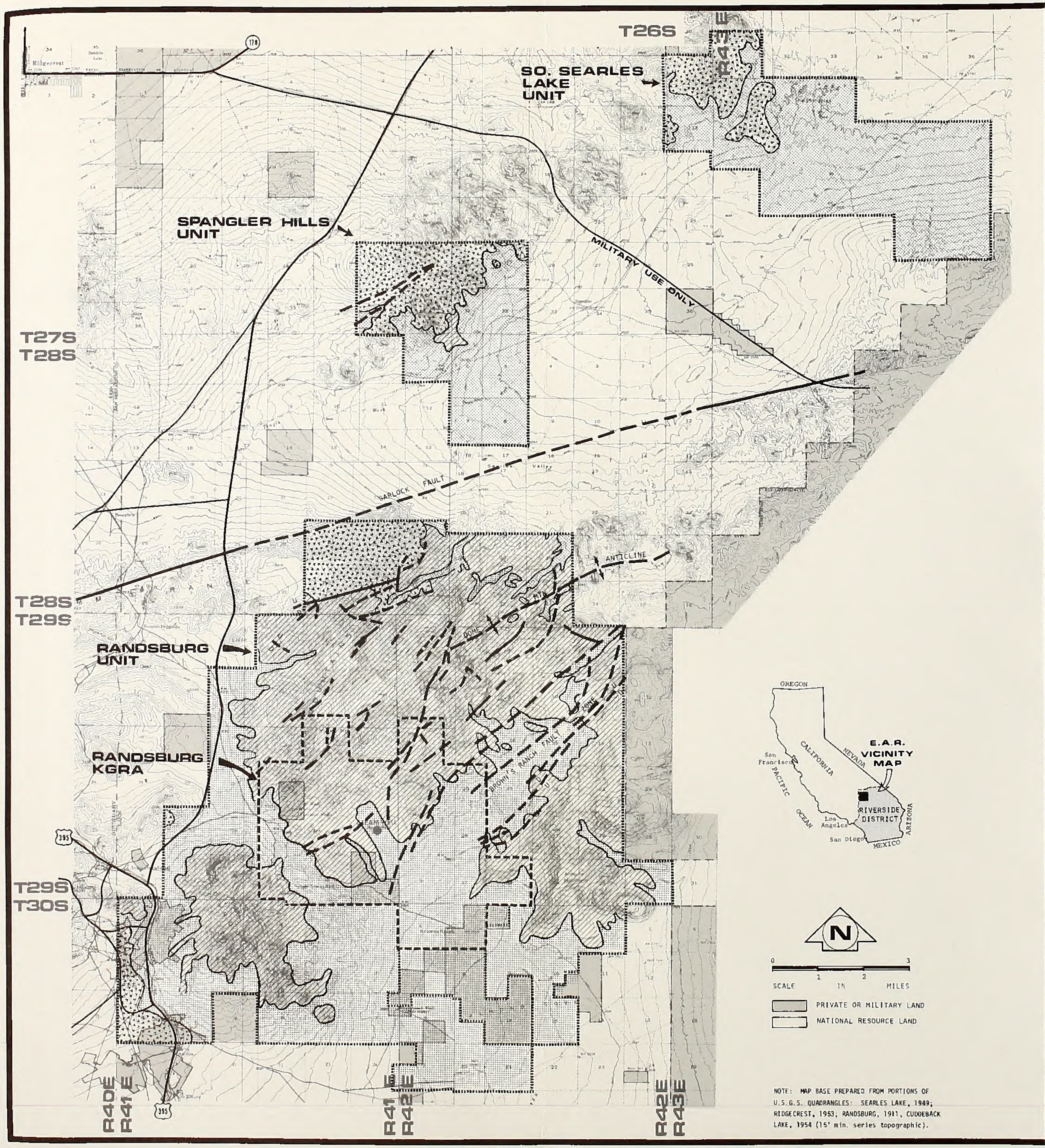
The Almond Mountain Volcanics of Late Pliocene age unconformably overlie the Bedrock Spring Formation, and consist of interbedded tuff, lapilli tuff, volcanic breccia, flow breccia, sandstone, and conglomerate. A large part of

TABLE 2-1

GEOLOGIC TIME SCALE

ERA	PERIOD	EPOCH	AGES IN YEARS BEFORE PRESENT
CENOZOIC	QUATERNARY	RECENT	10,000
		PLEISTOCENE	1,000,000
	TERTIARY	PLIOCENE	12,000,000
		MIOCENE	25,000,000
		OLIGOCENE	35,000,000
		EOCENE	60,000,000
		PALEOCENE	70,000,000
MESOZOIC	CRETACEOUS	130,000,000	
	JURASSIC	165,000,000	
	TRIASSIC	200,000,000	
PALEOZOIC	PERMIAN	235,000,000	
	PENNSYLVANIAN	260,000,000	
	MISSISSIPPIAN	285,000,000	
	DEVONIAN	325,000,000	
	SILURIAN	350,000,000	
	ORDOVICIAN	410,000,000	
	CAMBRIAN	500,000,000	
PRE CAMBRIAN TIME-AGE GOES BACK NEARLY 4-1/2 BILLION YEARS			

Modified after Strahler, 1960.



-LEGEND-

- KGRA BOUNDARY
- NON-COMPETITIVE LEASE UNIT BOUNDARY
- QUATERNARY ROCKS
- TERTIARY ROCKS
- PRE-TERTIARY ROCKS
- FAULT
  - U-UPTHROWN SIDE
  - D-DOWNTHROWN SIDE
- FAULT INFERRED, APPROXIMATELY LOCATED OR MAPPED FROM AERIAL PHOTOGRAPHS
- AXIS OF ANTICLINE

GENERALIZED GEOLOGIC MAP OF SITE AREA SHOWING FOLDS AND FAULTS

ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-3

the Almond Mountain Volcanics in the Lava Mountains and Red Mountain has been hydrothermally altered to propylite.

Smith's (1964) Lava Mountain Andesite occurs as flows, large domes, and small moundlike intrusives, and unconformably overlies the Almond Mountain Volcanics. Typically, it forms the caps of rolling or flat-topped hills. Andesite flows, flow breccias, and flow conglomerates can be observed.

Very few exposures of Tertiary rocks occur in the area north of the Randsburg lease unit.

The Quaternary rocks of the area are composed of gravels, sands, silts, clays, and tufa (calcium carbonate). The alluvium fills the valleys separating the mountain areas and is composed of unconsolidated detrital sediments derived from adjacent highlands. The tufa forms towers, mounds, and thin sheets located at the edges of an ancient Searles Lake (Trona Pinnacles). The Cuddeback Lake playa is occupied by generally fine, micaceous and alkaline lake clays (Dibblee, Jr., 1967).

2.1.3.2 Structural Geology and Tectonics

The western Mojave Desert is a wedge-shaped area bounded on the northwest by the Garlock fault zone and on the southwest by the San Andreas fault zone (Figure 2-2). Both of these zones are major southern California structures and within the wedge-shaped area they delineate are numerous northwest-striking faults of late Cenozoic age. These northwest-striking faults exhibit mostly vertical movement and dominate the Cenozoic structure of the Mojave Desert region (Dibblee, Jr., 1967; Garfunkel, 1974).

In the general site area, however, there occurs a series of relatively minor faults which trend approximately northeast, roughly parallel to the Garlock fault (Figure 2-3). The majority of these are closely aligned within and southeast of the Lava Mountains, and many are collectively grouped into the Brown's Ranch fault zone (Smith, 1964), as shown on Figure 2-3. Most of these faults are relatively straight. Some displace strata vertically by more than 100 feet and exhibit opposite types of separation at their two ends.

The faults of the Brown's Ranch zone have been active from the middle Pliocene into the Quaternary, but have been relatively quiet since the late Quaternary.

Several unnamed faults parallel the Brown's Ranch fault zone. They are concentrated in the Lava Mountains area and can be traced for a mile or more (Smith, 1964). No one direction of dip of the faults is predominant; some dip northwest, others southwest, and still others are vertical. (A fault dip is the angle between the fault plane and an imaginary horizontal line.) Most of the faults show movement parallel with the direction of the fault plane's strike, or bearing. In addition to lateral movements, vertical separations on some faults range from tens of feet to 1,000 feet.

Evidence for earliest activity on these faults indicates late Pliocene and the latest displacement was probably early Quaternary.

To the north of the Lava Mountains and the Summit Range is the Garlock fault, one of the dominant structural features of this part of southern California (Figure 2-3). In the site area the Garlock fault is a relatively simple fracture expressed as one or two adjacent breaks and an associated crushed or deformed zone (Smith, 1964). Alluvium lies on both sides of its trace, and evidence for both left-lateral and vertical displacement can be observed (Smith, 1964). Left-lateral movement has predominated.

Mapping of the Garlock fault by Clark (1973) shows fault scarps having vertical dimensions of one foot to three feet in the vicinity of the site area. His mapping also shows several linear ridges and notches indicative of geologically recent displacements. Horizontal displacements evidenced by offset streams indicate Quaternary displacements measurable in ten to hundreds of feet. Single-event displacements of about 20 feet were suggested by repeated measurements of this magnitude. Smith (1962) has postulated a displacement along the fault of as much as 40 miles based on apparent offset of dike swarms.

The Garlock fault has probably been active intermittently from the late Mesozoic or early Tertiary to the present.

The only other relatively major structural feature in this portion of the Mojave "Block" is the Dome Mountain anticline, the trace of whose axial plane nearly parallels the Garlock fault (Figure 2-3). Folding along the anticline began after the deposition of the Bedrock Spring Formation and continued during or until after the late Pliocene, when the Almond Mountain Volcanics were deposited (Smith, 1964). Folding may or may not have affected the Late

Pliocene Lava Mountain Andesites or the Quaternary volcanic and sedimentary material.

Smith (1964) has distinguished several other broad folds whose axial planes cannot be accurately plotted. Some of these parallel the Garlock fault and include in part an arched pediment or plain surface in the northwestern Lava Mountains. Others are unrelated to any major tectonic features.

The tectonic history of the Mojave Desert area began with extensive sediment accumulation during the earliest geologic time. Deformation and granitic rock intrusions occurred later and culminated in a mountain-building episode lasting millions of years. Wide-spread erosion and deposition then occurred, followed by widespread deformation and faulting. Structural features related to the San Andreas fault system apparently dominate the entire southern California region.

2.1.3.3. Seismology and Seismicity

The regional geologic structure of southern California is dominated by a system of faults related mainly to the San Andreas fault system. Because there seems to be a correlation between faulting and earthquakes in this region, knowledge of fault activity would help to determine the seismic activity of the area. Various geologic criteria for determining fault activity exist, and include strain accumulation data, historical records of earthquakes, and evidence of ground displacement.

Strain-release maps for the period 1934 to 1963 by Allen and others (1965) indicate the western Mojave Desert is an area of low seismic activity. Quaternary faulting has occurred along the Garlock fault, but the study of those fault scarps that cut alluvium indicates that many of these scarps may date from at least 50,000 years ago, rather than from the Recent Epoch, as previously thought. Examination by Smith (1960 in Allen and others, 1965) of offset drainage lines resulting from horizontal ground surface displacements also supports an earlier time of faulting.

Additional evidence for relative seismic stability is found in a study by Ryall and others (1965) for the period 1952-1961, which shows that although Quaternary faulting has occurred, the Garlock zone is a relatively "quiet" zone. They conclude that these quiet areas are not temporary ones, where strain is accumulating to produce an earthquake in the future, but are permanent. Activity within the quiet zones is due instead to the propagation of fractures into these areas from earthquake sources located in adjoining active areas.

Allen and others (1965) conclude that the triangular wedge of the western Mojave desert is probably relatively stable in comparison to adjacent areas. They also conclude, however, that adequate geodetic control and additional strain accumulation data are needed.

A recent report by the California Division of Mines and Geology (1972) indicates that the EAR area lies within severity zone III on a map of maximum expectable earthquate intensities. Earthquake intensities in this zone are expected to equate to intensity levels IX or X on the modified Mercalli scale. During the period 1934 to June 30, 1970, 83 earthquakes having Richter magnitudes greater than 4.0 occurred within a 50-mile radius of the center of the area. Seven of the earthquakes were associated with the Garlock fault. Ten of the earthquakes were within a 25-mile radius of the central part of the area.

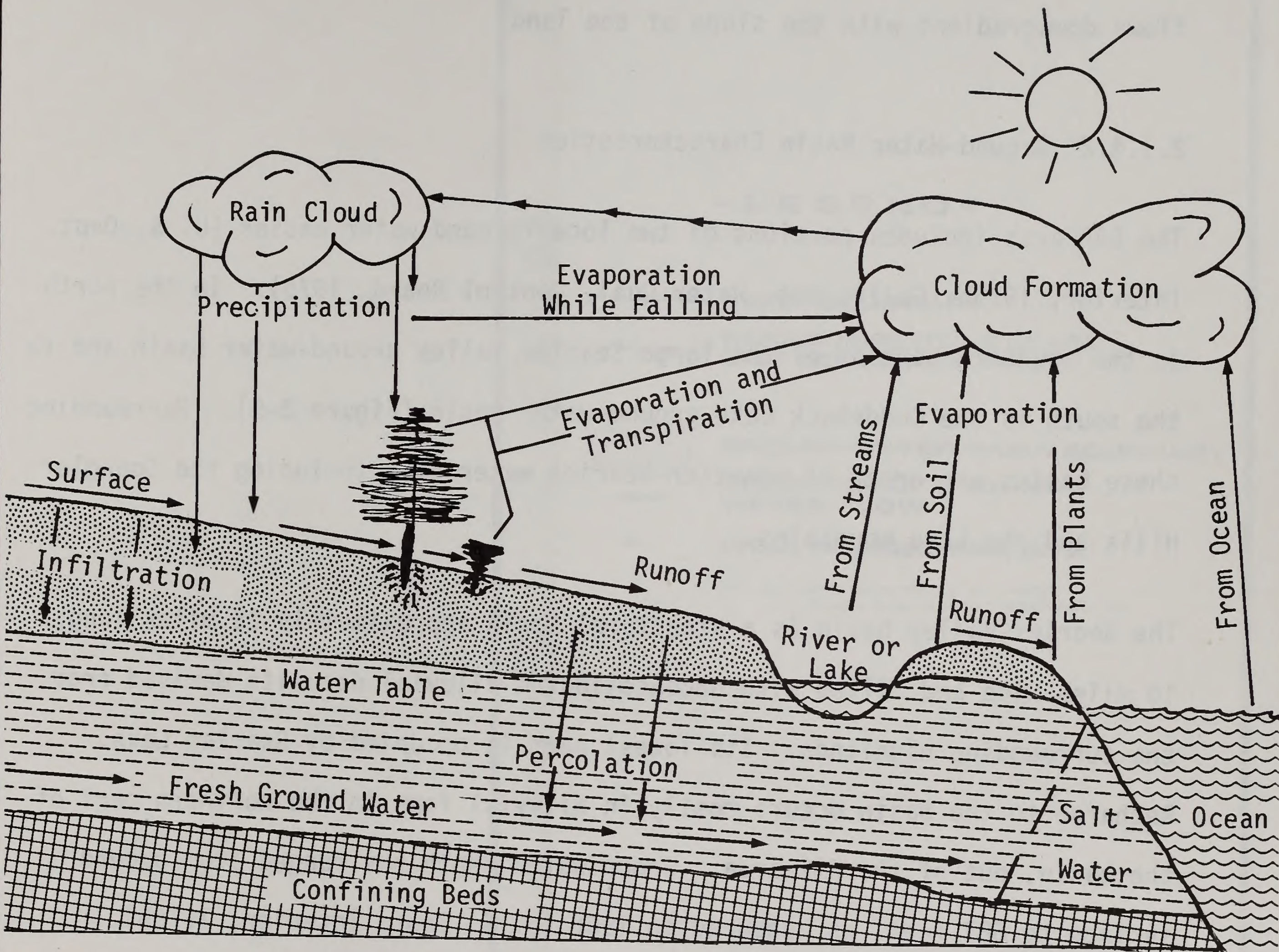
2.1.4 Hydrology

2.1.4.1 Introduction

The hydrologic cycle utilizes the processes of evaporation, precipitation, transpiration, infiltration, seepage, storage and runoff to circulate water from the oceans through the atmosphere and return it both overland and underground back to the sea. Figure 2-4 is a schematic diagram of the hydrologic cycle.

A major portion of the so-called Mojave "Block" is included in the California Regional Water Quality Control Board's (1975) South Lahontan Basin. This basin has been subdivided into several planning areas, one of which is the Searles Lake Planning Area. The entire EAR area is included in this particular Planning Area.

Within the Planning Area as a whole, precipitation accounts for most of the surface water. Smaller amounts are produced by springs and occasional snowmelt in the high mountains of the Sierra Nevada. Most runoff, however, is intermittent and ephemeral.



SCHEMATIC DIAGRAM OF THE HYDROLOGIC CYCLE

Modified from Ground Water and Wells, 1972

FIGURE 2-4

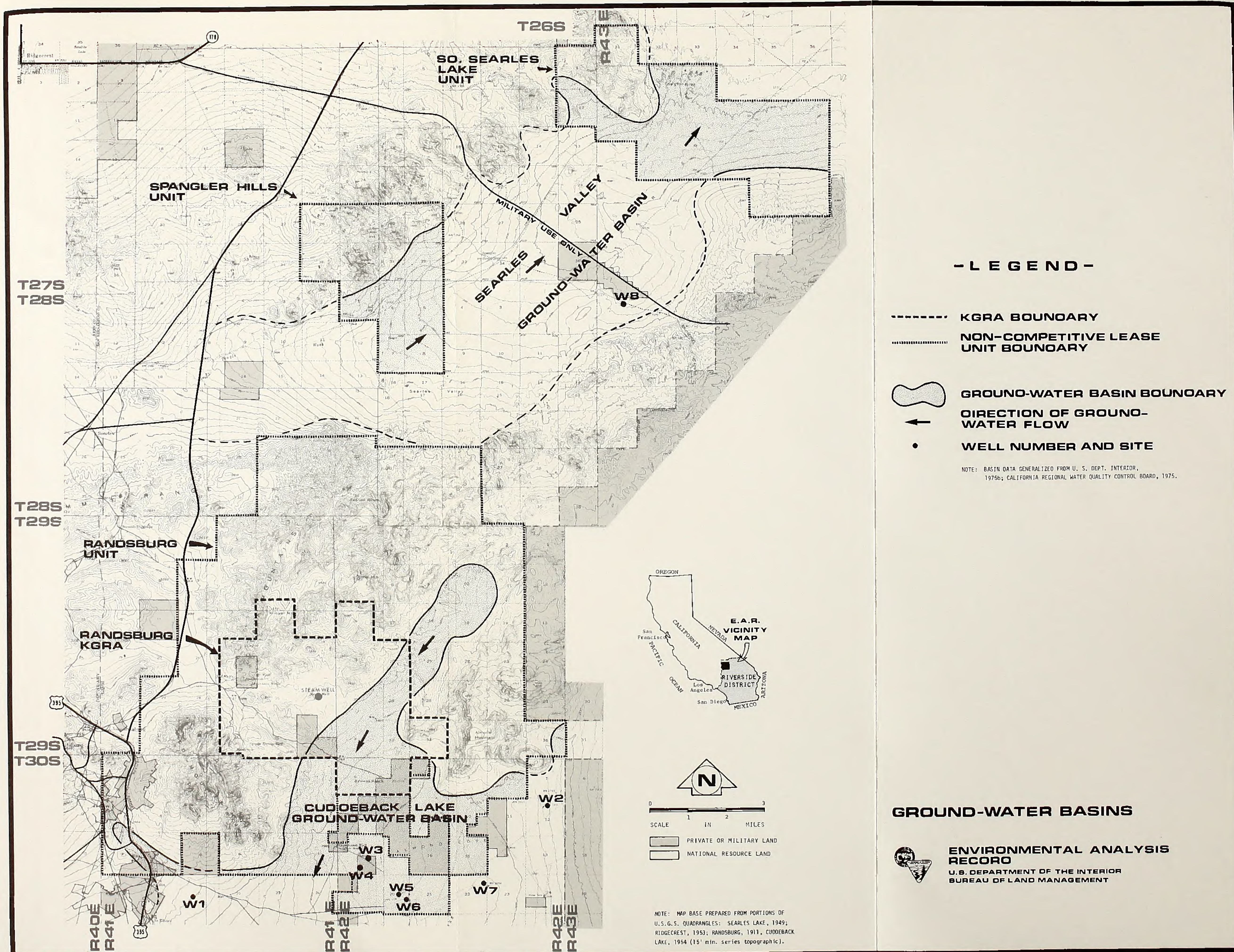
Unconsolidated Pleistocene alluvial deposits are the main source of ground-water in the Searles Lake Planning Area, with recharge occurring principally by percolation of surface runoff. The ground-water is chiefly unconfined and flows downgradient with the slope of the land.

2.1.4.2 Ground-Water Basin Characteristics

The EAR area includes portions of two local ground-water basins (U. S. Dept. Interior, 1975b; Calif. Reg. Water Qual. Control Board, 1975). In the north is the southern portion of the large Searles Valley ground-water basin and to the south is the Cuddeback Lake ground-water basin (Figure 2-5). Surrounding these basins are areas of nonwater-bearing materials, including the Spangler Hills and the Lava Mountains.

The Searles Valley basin is a structural basin approximately 25 miles long, 10 miles wide and filled with unconsolidated alluvial deposits derived from the surrounding highlands. Its lowest part is occupied by Searles Lake. Recharge to the basin occurs mostly in alluvial fans in the northern part of the basin, out of the EAR area. Groundwater depth has ranged from ground surface to 687 feet, as measured in 1966 (U. S. Dept. Interior, 1975b). This basin has no known outflow, and ground-water moves northeast, toward Searles Lake.

The Cuddeback Lake ground-water basin occurs in the extreme southern portion of the area. The basin is filled with loose alluvium shed from the surrounding mountains and the fine sediments of the Cuddeback playa. Recharge occurs along the alluvial fans on the east and west sides of the valley. In 1969 a



T26S
R43E
SO. SEARLES LAKE UNIT
SPANGLER HILLS UNIT
MILITARY USE ONLY
SEARLES VALLEY
GROUND-WATER BASIN
W8
T27S
T28S
T28S
T29S
RANDSBURG UNIT
RANDSBURG KGRA
STEAM WELL
T29S
T30S
CUDDEBACK LAKE GROUND-WATER BASIN
W1
W2
W3
W4
W5
W6
W7
R40E R41E
R41E R42E
R42E R43E
E.A.R. VICINITY MAP
OREGON
NEVADA
CALIFORNIA
San Francisco
PACIFIC OCEAN
Los Angeles
San Diego
RIVERSIDE DISTRICT
ARIZONA
MEXICO
N
SCALE IN MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
GROUND-WATER BASIN BOUNDARY
DIRECTION OF GROUND-WATER FLOW
WELL NUMBER AND SITE
NOTE: BASIN DATA GENERALIZED FROM U. S. DEPT. INTERIOR, 1975b; CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, 1975.
GROUND-WATER BASINS
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-5

maximum depth to water was measured at 358 feet. Ground-water moves south, away from the mountainous areas.

In general, ground-water moves to the north out of the Searles Valley basin and to the south out of the Cuddeback Lake basin.

2.1.4.3 Surface Water

Surface-water sources in the EAR area consist almost entirely of precipitation. Standing water is found only on occasion in Searles Lake and Cuddeback Lake and elsewhere only after heavy rains. Normally dry washes may be flooded during these storms.

Drainage lines in both basins consist of dry washes. Stream flow is nonexistent for most parts of the year, and floods can occur after sudden storms.

A bedrock spring exists on the northeast flank of the Lava Mountains. Surface flow along the drainage channel is intermittent, although minute quantities of surface-water discharge may occur perennially. At the time this report was prepared, seasonal conditions were such that an extremely small amount of water flowed onto the surface for only a few feet before seeping back into the subsurface.

Measurements of the quantity and quality of surface waters within the EAR area are not available due to the ephemeral nature of the surface water.

2.1.4.4 Ground-Water

The best aquifers in the area are the Pleistocene alluvial sands and gravels, when they are saturated (Moyle, 1974). Continental sedimentary rocks of Tertiary age may yield small quantities of fair quality water. The volcanic rocks of the area generally yield only small quantities of poor quality water, and hydrothermal fluids have been encountered in the Lava Mountains. The Pleistocene playa lake deposits yield water that has a high concentration of dissolved solids.

Data relating to ground-water quantity in the area are extremely limited. For the ground-water basins as a whole, however, storage capacity of the Searles Valley basin totals 2,140,000 acre-feet, while that of the Cuddeback basin totals 1,380,000 acre-feet (U.S. Dept. Interior, 1975b).

Water-level measurements indicate a ground-water barrier about 4 miles west of Cuddeback Lake (Moyle, 1971). The location of the barrier coincides with a southward projection of the Brown's Ranch fault zone (Figure 2-3). The barrier causes a head (fluid pressure) change of about 150 feet with the high head on the west. The barrier may result from silicification along the fault zone as noted by Smith (1964).

Selected well data for wells in the area are shown on Table 2-2 and the locations of the wells are illustrated on Figure 2-5. Water-quality data for samples from the above wells are shown on Table 2-3.

There are no known wells or springs within the Spangler Hills-Pinnacles areas. Water-quality data are available, however, for a 430-foot deep well in Section 6, T. 28S., R. 43E. (Well W8, Figure 2-5). Of special interest is the high boron content (193 mg/l). Boron levels of this magnitude would be

TABLE 2-2

SELECTED WELL DATA FOR WELLS IN THE EAR AREA

Well Designation	Depth of Well (feet below lsd)*	Elev. of lsd (feet)	Water Level (feet below lsd)	Elev. of Water Level (feet below lsd)	Date Measured	Pump Test Data		
						Drawdown (feet)	Yield (gpm)**	Specific Capacity - gpm/ft. of dd ***
W1	677	3060	358	2702	11-69	152	75.0	0.49
W2	-	2695	184	2511	8-68	-	-	-
W3	-	2635	99	2536	7-68	-	-	-
W4	278	2624	116	2508	7-68	-	-	-
W5	-	2565	52	2513	7-68	-	70.0	-
W6	-	2565	-	-	7-68	-	50.0	-
W7	29	2554	DRY	-	8-68	-	-	-
W8	430	2058	371	1687	7-50	-	20.0	-

Data from Moyle, 1969; 1971.

* Land-surface datum.

** Gallons per minute.

*** Drawdown.

TABLE 2-3

WATER QUALITY DATA FOR SHALLOW AQUIFER IN EAR AREA[1]

WELL DESIGNATIONS*								
W1	W2	W3	W4	W5	W6	W7	W8	Results in milligrams per liter (mg/l) except for iron and boron which are in micrograms per liter
-	-	66	-	-	50	85	19	Silica (SiO_2)
-	-	1400	-	-	-	50	Tr 2/3/	Iron (Fe)
76	40	171	174	567	464	69	8	Calcium (Ca)
31	9.0	31	28	13	85	12	1.3	Magnesium (Mg)
84	147	401	415	818	866	336	4490	Sodium (Na)
.8	8.0	-	12	18	15	-	-	Potassium (K)
192	165	138	122	95	88	188	2330	Bicarbonate (HCO_3)
0	0	0	0	0	0	0	288	Carbonate (CO_3)
240	68	35	20	37	56	74	2270	Sulphate (SO_4)
69	177	888	966	2220	2310	500	3330	Chloride (C_1)
.7	.2	-	.1	.2	.8	-	-	Fluoride (F)
.0	3.3	7.8	11	.0	5.0	3.5	-	Nitrate(NO_3)
270	600	-	1650	1950	1500	-	193 2/	Boron (B)
-	-	-	-	-	-	-	-	Dissolved Solids: Sum of determined constituents
670	556	1720	2130	4420	-	1190	-	Dissolved Solids: Residue on evaporation at 180° C
-	-	-	-	-	-	-	-	Hardness as $CaCO_3$
318	-	-	-	-	-	-	-	Noncarbonate hardness as $CaCO_3$
36	68	61	62	54	55	77	100	Percent sodium
998	1020	-	3520	3730	6880	-	18000	Percent conductance (micromhos at 25° C)
7.7	8.0	-	7.6	7.6	8.0	-	9.0	pH

*Well designations correlate with those shown on Figure 2-5

1/ Data from Moyle, 1969; 1971.

2/ Trace

3/ Results in milligrams/liter

toxic even to plants classified as boron-tolerant (Fed. Water Pollution Control Admin., 1968). Water level in the well has been measured at 371 feet below land surface. Recharge of the ground-water body in the area occurs by direct infiltration of rain and subsurface flow from adjoining areas.

A well drilled in altered volcanics in the Lava Mountains (Steam Well) as a prospect for mercury in 1920 encountered steam at a depth of 415 feet. The temperature of the steam at the surface measured 96° C. In 1960 a temperature of 97.8° C was recorded in this well, which is the boiling point at this elevation. Also in 1960, a new well was drilled to a depth of 772 feet near the earlier well and a maximum temperature of 116° C (McNitt, 1963) was measured. South and east of the Steam Well abnormally high temperatures were recorded in several wells completed in alluvium. These wells are downslope from the Brown's Ranch fault zone and the Steam Well. The wells range in depth from 60 feet to 160 feet and have recorded temperatures of 20-25° C. It is possible that the water is heated in the area of the Steam Well and flows downslope to where it is intersected by the drilled wells. If this is the case, then a near-surface permeable zone probably bridges the proposed ground-water barrier imposed by the Brown's Ranch fault zone.

Water of good quality and quantity within the EAR area is limited because the waters are highly mineralized. Most potable water supplies occur from sources in areas to the north of and outside the EAR area.

Ground-water in Searles Valley is highly saline and unsuitable for most uses. A reading of 350,000 milligrams per liter (mg/l) of dissolved solids was recorded at a location beneath Searles Lake (U.S. Dept. Interior, 1975b).

This is about 10 times as saline as sea water. Only small quantities of potable water have been found in the northern part of the basin, out of the EAR area. In general, water usage within the Searles Valley basin is intimately associated with the Indian Wells Valley area to the northwest, near Ridgecrest.

Water in the Cuddeback Lake basin is used primarily for domestic purposes and limited mining activities in the Spangler Hills and Red Mountain Areas. Very small amounts of water have been used for livestock during the winter months. The towns of Randsburg and Johannesburg are supplied with water from wells in this area.

2.1.5 Climatology

Detailed climatic conditions within the EAR area are not known because data have not been gathered in the area. Data have been gathered, however, at various civilian and military installations in the immediate vicinity, including China Lake Naval Weapons Center (NWC), Edwards Air Force Base, and Trona, California. For the most part, the data presented here relate to the surrounding areas and it is assumed for the sake of this analysis that very similar weather conditions exist in the EAR area.

2.1.5.1 Regional Wind Patterns

The climatic characteristics of the Mojave Desert in general and the EAR area in particular result from major, seasonally dominant climatic controls. Some of these controls are a function of the geographic position of California, and of the many controls the most significant are latitude, West Coast orientation, and topography.

The global circulation pattern is characterized by northeast "Tradewinds" between the equator and 30° N latitude, southwest "Prevailing Westerlies" between 30° and 60° N latitude and the northeast "Polar Front" between 60° N latitude and the North Pole. Air descends at about 30° N latitude from higher elevations and splits near the surface to form the Prevailing Westerlies and the Tradewinds. This descending ridge of air has lost a great deal of moisture, and the descending motion leads both to warming by compression at intermediate levels and a high pressure ridge. Because the Mojave Desert in general and the EAR area in particular occur near the 30° N latitude parallel (35° 15' N to 30° 45' N), these areas are characterized by an arid, or semi-arid climate (Namowitz and Stone, 1960).

The West Coast orientation of California and the Mojave Desert also affects climatic conditions. The region falls under the strong influence of a semi-permanent high pressure cell (Hawaiian High) located over the eastern Pacific Ocean (U.S. Dept. Interior, 1975b). The resultant air flow out of the high pressure cell is in a clockwise direction, with westerly winds prevailing most of the year. The primary effect of the high pressure cell is its ability to block the passage of westward moving cyclonic storms (cold fronts) in central and southern California. Thus, summers are characteristically dry in terms of both precipitation and humidity. During the winter, the Hawaiian High has migrated several degrees south, allowing portions of these cyclonic disturbances to affect central and southern California to a much greater degree than during the summer season. The result is a winter maximum of precipitation (U.S. Dept. Interior, 1975b).

Topographic factors play a major role in the climate of the Mojave Desert. Most dramatic in their effects are the mountain barriers which serve to effectively block most cyclonic precipitation from reaching the Mojave environs.

The mountain barriers consist of the southern and central Sierra Nevada and the Transverse Ranges (Figure 2-2). The central portion of the Sierra Nevada is oriented essentially north-south, or normal to prevailing west winds. The southern extremity of the Sierra block trends northeast-southwest, still blocking cyclonic precipitation. In addition, the southern boundary of the Mojave Desert is formed by the east-west trending Transverse Ranges, which also serve to prevent moisture-laden air from reaching the Mojave Desert.

The Mojave Desert is essentially a rainshadow desert, formed as a result of its location on the leeward side of two mountain systems. Mountain ranges within the desert do not play a major role in the precipitation regimes of desert locations (U.S. Dept. Interior, 1975b).

In the immediate vicinity of the EAR area, local wind direction is affected by the surrounding topography; however, data specific to the EAR area are unknown. Winds are generally from the south-southwest, however, and channeled between the Spangler Hills and Lava Mountains (Ouimette, pers. comm., 1975). These tend to back up at Trona in the north.

Because of the relative openness of the desert surface and the shallow pressure gradient between the Colorado Plateau and the desert, surface winds are normally low to moderate. Velocity measurements are not known for the EAR area, but near surface (3,000 feet mean sea level (msl)) wind velocities measured at the China Lake NWC west of the area indicate a mean velocity of less than 15 knots (17 miles per hour) throughout the year (Farnham, and others, 1959). It should be noted, however, that significant topographic features separate the two areas. Winds may attain a high velocity in the vicinity of Searles Dry Lake as shown by dust plumes pictured on satellite photography (U.S. Dept. Interior, 1975b).

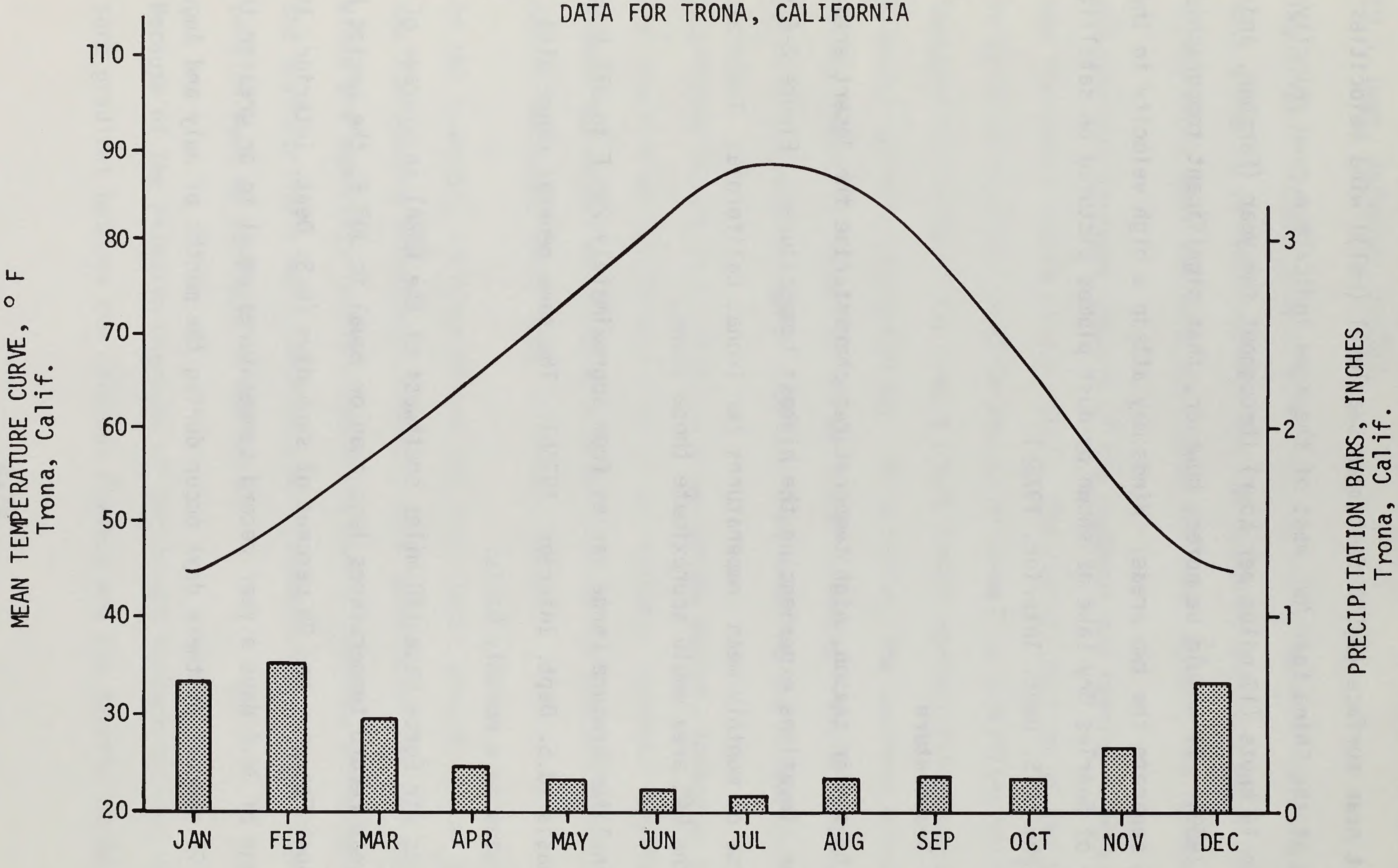
2.1.5.2 Temperature

During the summer season, high temperatures characterize the desert area with the lower elevations experiencing the highest temperatures. Figure 2-6 shows the course of monthly mean temperatures for Trona, California. Temperatures within the EAR area would approximate those shown.

The diurnal temperature range varies from approximately 25° F to 35° F on an annual basis (U.S. Dept. Interior, 1975b). The same general range also predominates on a monthly basis.

At Edwards Air Force Base (40 miles southwest of the KGRA) an average of 70.1 days a year record temperatures less than or equal to 30° F; the period November through February has 90 percent of such days (U.S. Dept. Interior, 1975b). An average of 36.5 days a year record temperatures equal to or greater than 100° F; 75 percent of these days occur during the months of July and August.

MONTHLY MEAN TEMPERATURE AND PRECIPITATION
DATA FOR TRONA, CALIFORNIA



Data from U. S. Dept. Interior, 1975b.

FIGURE 2-6

Temperature inversions do develop in low-lying areas (bolsons), especially during the winter season. The inversions are primarily a result of air drainage: cooler, denser air flows downslope and forces warmer, less dense air to rise. Thus, pockets of cool air settle in low-lying areas. These temperature inversions are temporary, and little data exist for mapping the actual inversions.

2.1.5.3 Precipitation, Humidity, and Evaporation

The EAR area is lacking in appreciable precipitation. The majority of precipitation falls during the winter months and may include a minimal amount of snow (U.S. Dept. Interior, 1975b). Precipitation recordings at Trona are shown on Figure 2-6.

During the summer, precipitation is negligible. The sources of moisture are the Gulfs of California and Mexico, but the area is too well protected by the Transverse Ranges to allow for a significant influx of moist air. At times summer convectional storms develop although not to the degree they do in the southern and eastern portions of the Mojave Desert, where summer precipitation tends to approximate that of winter.

Winter precipitation falls very lightly. Summer convectional showers, however, are likely to be associated with intense precipitation.

Humidity characteristics in the area follow a pattern similar to that of precipitation: a winter maximum and summer minimum. Relative humidity is greatest in the early morning and decreases during the day. Mean annual relative humidity in most of the area is on the order of 45 percent to 50 percent (U.S. Dept. Interior, 1975b).

Evaporation data is very limited for the immediate vicinity of the EAR area. Figure 2-7 does however show potential evapotranspiration for three stations near the area. These data may be underestimated by 30-50 percent because of inherent errors in measuring evaporation (U.S. Dept. Interior, 1975b).

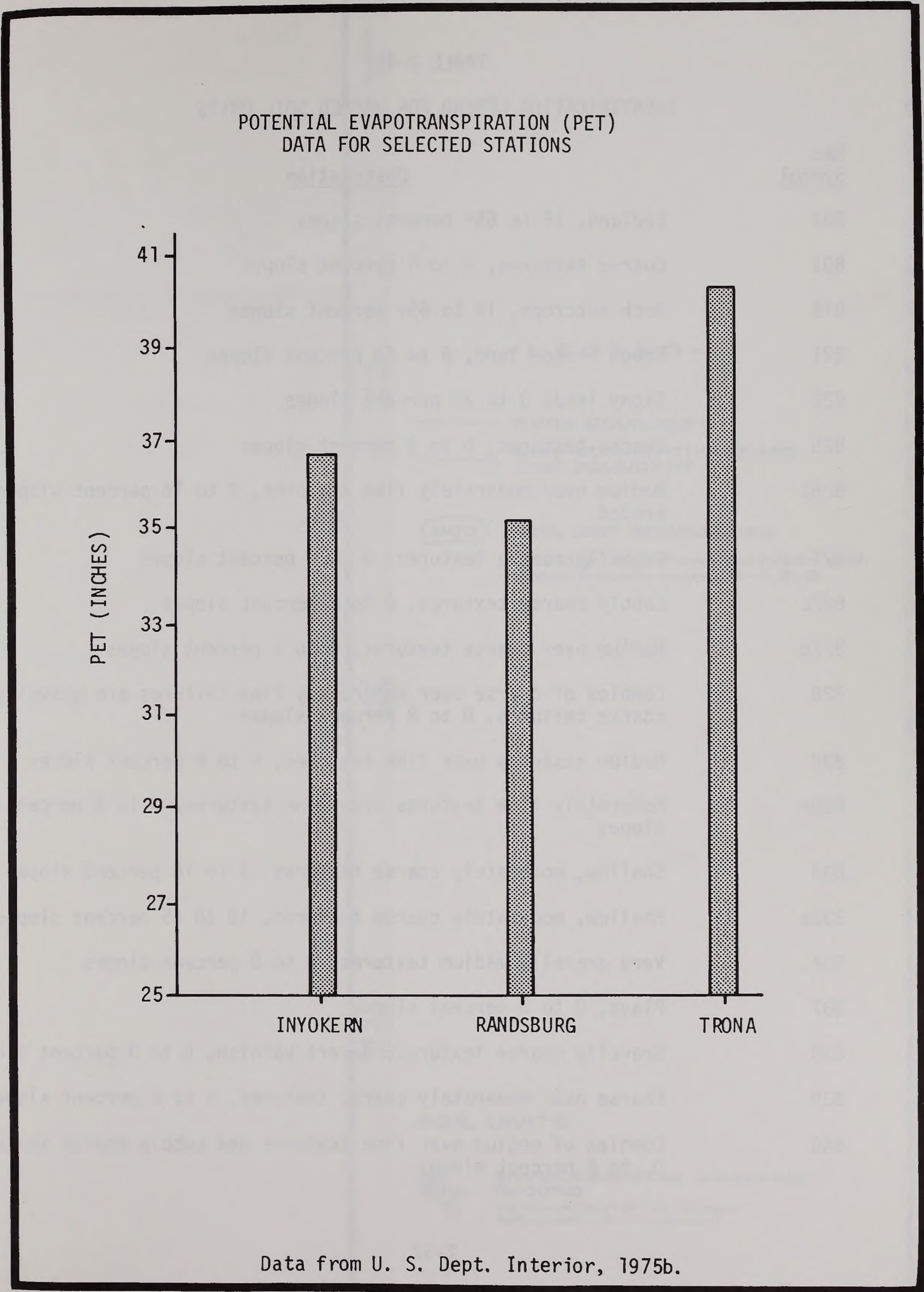
2.1.6 Soils

The soils in the EAR area have been classified and mapped on the basis of soil series. Eight different soil series occur in the area and from these eight series, 20 map units were established (Figure 2-8) (U.S. Dept. Interior, 1975b). Table 2-4 is an identification legend for each of the 20 mapped units.

2.1.6.1 Interpretive Ratings of Selected Properties

Interpretive ratings for selected soil properties and qualities were made for those soils found in the EAR area. These include permeability and erosion susceptibility.

Permeability is the quality that enables a soil to transmit water and air. It is expressed quantitatively in terms of the rate of water flow through a unit cross-section of saturated soil in a unit of time. The soil can have a permeability classed as "very slow" (0.66 inches/hour) to "very rapid" (10.00 inches/hour).



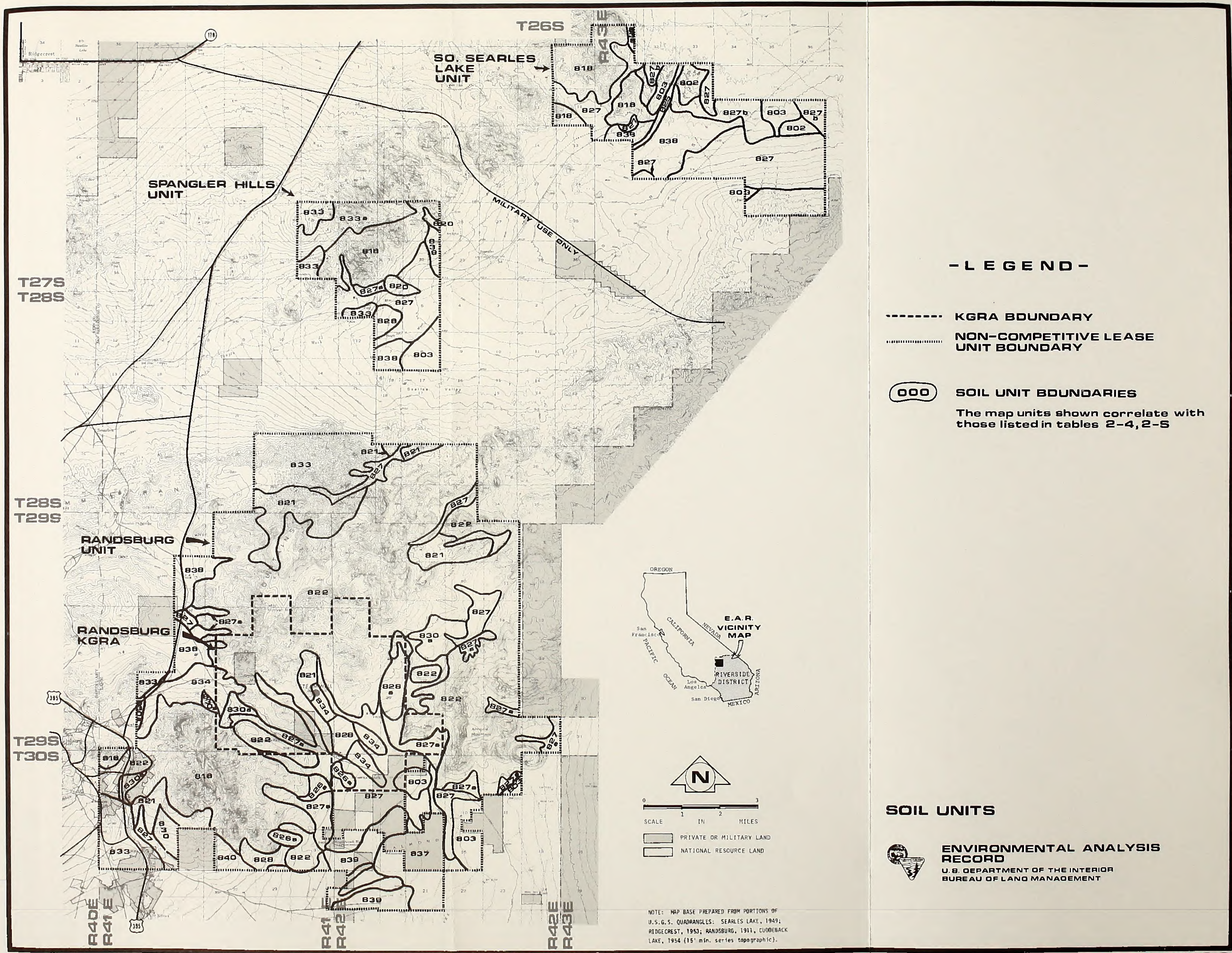
POTENTIAL EVAPOTRANSPIRATION (PET)
DATA FOR SELECTED STATIONS
PET (INCHES)
41
39
37
35
33
31
29
27
25
INYOKERN
RANDSBURG
TRONA
Data from U. S. Dept. Interior, 1975b.

FIGURE 2-7

TABLE 2-4

IDENTIFICATION LEGEND FOR MAPPED SOIL UNITS

Map Symbol	Description
802	Badland, 16 to 65+ percent slopes
803	Coarse textures, 0 to 8 percent slopes
818	Rock outcrops, 16 to 65+ percent slopes
821	Rough broken land, 8 to 65 percent slopes
822	Stony land, 3 to 30 percent slopes
825	Coarse textures, 0 to 8 percent slopes
826a	Medium over moderately fine textures, 3 to 16 percent slopes, eroded
827	Gravelly coarse textures, 0 to 8 percent slopes
827a	Cobbly coarse textures, 0 to 8 percent slopes
827b	Medium over coarse textures, 0 to 8 percent slopes
828	Complex of coarse over moderately fine textures and gravelly coarse textures, 0 to 8 percent slopes
830	Medium textures over fine textures, 0 to 8 percent slopes
830a	Moderately fine textures over fine textures, 0 to 8 percent slopes
833	Shallow, moderately coarse textures, 3 to 16 percent slopes
833a	Shallow, moderately coarse textures, 16 to 65 percent slopes
834	Very gravelly medium textures, 3 to 8 percent slopes
837	Playa, 0 to 3 percent slopes
838	Gravelly coarse textures, desert varnish, 0 to 3 percent slopes
839	Coarse over moderately coarse textures, 0 to 8 percent slopes
840	Complex of medium over fine textures and cobbly coarse textures, 0 to 8 percent slopes



T26S
R43E
SO. SEARLES LAKE UNIT
SPANGLER HILLS UNIT
MILITARY USE ONLY
T27S
T28S
T28S
T29S
RANDSBURG UNIT
RANDSBURG KGRA
T29S
T30S
R40E R41E
R41E R42E
R42E R43E
-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
000 SOIL UNIT BOUNDARIES
The map units shown correlate with those listed in tables 2-4, 2-5
E.A.R. VICINITY MAP
OREGON
NEVADA
CALIFORNIA
PACIFIC OCEAN
San Francisco
Los Angeles
San Diego
RIVERSIDE DISTRICT
ARIZONA
MEXICO
N
SCALE IN MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
SOIL UNITS
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-8

Permeability, to some extent, is influenced by run-off and drainage. Run-off is the measure of water removed by flow over the soil surface, and is classified as "ponded" (no water run-off) to "rapid" (large amount of precipitation will move rapidly over the soil surface). Drainage is classed as "very poorly drained" (water table remains at or near the surface a great part of the time) to "excessively drained" (water is removed from the soil very rapidly). These properties for the various soils are shown in Table 2-5.

Areas within the EAR area which may exhibit ponding due to slow permeability occur where soil units 830, 830a, 837, and 840 are found (Figure 2-8).

Erosion susceptibility is the potential of a soil to become eroded when no protective cover is present. Erosion can be influenced by the compaction of the soil and the frequency with which the soil is subject to flooding. The compaction ratings are based on the soil's susceptibility to a compactive force. Flooding frequency is classed as "none" (not subject to flooding) to "occasional" (frequency of less than once in five years) to "seasonal" (a frequency ranging from one or more times a year to once in five years).

The erosion susceptibility, compaction and flooding ratings of the soil units are shown in Table 2-5.

About 20 percent of the soils in the EAR area have severe erosion susceptibility and nearly all the soils are only slightly to moderately susceptible to compaction.

TABLE 2-5

INTERPRETIVE RATINGS OF SELECTED SOIL PROPERTIES

MAP SYM-BOL	SOIL NAME	PERMEA-BILITY	RUNOFF	DRAIN-AGE	EROSION SUSCEPTI-BILITY (CLASS)	COMPACTION SUSCEPTIBILITY	FREQUENCY OF FLOODING
802	Badland	Rapid to slow	Rapid	Well to excess	Severe	Slight to severe	None
803		Rapid	Slow	Excess	Moderate	Slight	None
818	Rock Outcrop	-	Rapid	Well to excess	Severe	-	-
821	Rough Broken Land	Rapid to moderately slow	Rapid	Well	Severe	Slight to moderate	None
822	Stony Land	Rapid to slow	Mod. rapid to rapid	Well to excess	Mod. to severe	Moderate	None
825		Rapid	Slow	Excess	Slight to severe	Slight	Seasonal
826a		Mod. over mod. slow	Med.	Well	Mod.	Mod.	None
827		Very rapid	Slow	Excess	Slight to mod.	Slight	None to seasonal
827a		Very rapid	Slow	Excess	Slight to moderate	Slight	None to seasonal
827b		Mod. over rapid	Med.	Excess	Moderate	Moderate	None
828		Rapid over mod. slow	Med.	Well	Moderate	Moderate	None
830		Mod. over slow	Mod.	Well	Moderate	Moderate	None

TABLE 2-5 (Continued)

MAP SYM-BOL	SOIL NAME	PERMEA-BILITY	RUNOFF	DRAIN-AGE	EROSION SUSCEPTI-BILITY (CLASS)	COMPACTION SUSCEPTIBILITY	FREQUENCY OF FLOODING
830a		Mod. over slow	Med.	Well	Mod.	Slight	None
833		Mod. rapid	Med.	Well	Mod.	Slight	None
833a		Mod. rapid	Rapid	Well	Severe	Slight	None
834		Mod.	Med.	Well	Mod.	Mod.	None
837		Rapid to slow	Ponded	Poorly	Slight	Mod.	Seasonal
838		Rapid	Med.	Well	Mod.	Mod.	None
839		Mod. rapid	Slow	Well	Mod.	Slight	None
840		Mod. over slow	Med.	Well	Mod.	Mod.	None

2.1.7 Air Resources

At present little specific data exist for air quality conditions for the entire EAR area. Certain studies have been conducted in specific locations, generally as a function of industrial land use. The near future, however, should see the collection of measureable data for analysis of comprehensive atmospheric conditions over not only the area but the entire western Mojave Desert. The Naval Weapons Center, for example, in concert with several other military installations, is initiating a visibility and air pollution study (U.S. Dept. Interior, 1975b). The results of this study will be made public.

Air quality in general is decreasing in the area as a result of the movement of polluted air from the Los Angeles basin into the area. The degree and extent of this air movement have yet to be determined.

2.1.7.1 Federal and State Air Quality Standards

Presently, certain air-quality standards are mandated by both the Federal and State governments (Table 2-6). The major objectives of these standards are to protect the public from any known or anticipated adverse effects from air pollution. These standards are generally set conservatively to allow a margin of safety.

Federal Primary Air Quality Standards are designed to protect the public health. When this goal is met the more stringent Secondary standards are to be strived for.

California air quality standards are based on health effects and represent desirable levels of air quality which, on the basis of present knowledge, are expected to prevent health hazards or incipient degradation of health due to air pollution.

2.1.7.2 Air Quality Contaminants

The closest monitoring station to the area that detects contaminants is located at Victorville, approximately 60 miles to the south and between the

TABLE 2-6

AMBIENT AIR QUALITY STANDARDS
APPLICABLE IN CALIFORNIA*

POLLUTANT	AVERAGING TIME	CALIFORNIA STANDARDS CONCENTRATION(7)	CALIFORNIA STANDARDS METHODS(1)	FEDERAL STANDARDS(4) PRIMARY(2)(7)	FEDERAL STANDARDS(4) SECONDARY(3)(7)	FEDERAL STANDARDS(4) METHOD(5)
Photochemical Oxidants (Corrected for NO_2)	1 hour	0.10 ppm (200 μg/m^3)	Neutral Buffered KI	160 μg/m^3(8)	Same as Primary	Chemiluminescent
Carbon Monoxide	12 hours	10 ppm (11 mg/m^3)	Non-dispersive Infrared Spectroscopy	—	Same as Primary Standards	Non-dispersive Infrared Spectroscopy
	8 hours			10 mg/m^3 (9 ppm)		
	1 hour	40 ppm (46 mg/m^3)		40 mg/m^3 (35 ppm)		
Nitrogen Dioxide	Annual Average		Saltzman Method	100 μg/m^3 (0.05 ppm)	Same as Primary Standard	Colorimetric Method Using NaOH
	1 hour	0.25 ppm (470 μg/m^3)				
Sulfur Dioxide	Annual Average		Conductimetric Method	80 μg/m^3 (.03 ppm)		Pararosaniline
	24 hours	0.04 ppm (105 μg/m^3)		365 μg/m^3 (0.14 ppm)		
	3 hours				1300 μg/m^3 (0.5 ppm)	
	1 hour	0.5 ppm (1310 μg/m^3)				
Suspended Particulate Matter	Annual Geometric Mean	60 μg/m^3	High Volume Sampling	75 μg/m^3	60 μg/m^3	High Volume Sampling
	24 hours	100 μg/m^3		260 μg/m^3	150 μg/m^3	
Lead (Particulate)	30-day Average	1.5 μg/m^3	High Volume Sampling Dithizone Method			
Hydrogen Sulfide	1 hour	0.03 ppm (42 μg/m^3)	Cadmium Hydroxide STRactan Method			
Hydrocarbons (Corrected for Methane)	3 hours (6-9a.m.)			160 μg/m^3 (0.24 ppm)	Same as Primary Standard	Flame Ionization Detection Using Gas Chromatography
Sulfates	24 hours	25 μg/m^3	-	-	-	-
Visibility Reducing Particles	1 observation	In sufficient amount to reduce the prevailing visibility(6) to less than 10 miles when the relative humidity is less than 70%				

NOTES:

(1)Any equivalent procedure which can be shown to the satisfaction of the Air Resources Board to give equivalent results at or near the level of the air quality standard may be used.

(2)National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health. Each state must attain the primary standards no later than three years after that state's implementation plan is approved by the Environmental Protection Agency (EPA).

(3)National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after implementation plan is approved by the EPA.

(4)Federal Standards, other than those based on annual averages or annual geometric means, are not to be exceeded more than one per year.

(5)Reference method as described by the EPA. An "equivalent method" of measurement may be used, but must have a "consistent relationship to the reference method" approved by the EPA.

(6)Prevailing visibility is defined as the greatest visibility which is attained or surpassed around at least half of the horizon circle, but not necessarily in continuous sectors.

(7)Concentration expressed first in units in which it was promulgated. Equivalent units given in parenthesis are based upon a reference temperature of 25° C and a reference pressure of 760 mm of mercury.

(8)Corrected for SO_2 in addition to NO_2.

* Data from San Bernardino County, 1974.

heavily populated South Coast Air Basin (Los Angeles Metropolitan Area) and the EAR area (after preparation of this document, it was learned that a new air monitoring station had been opened at Trona in March, 1976). Most measured contaminants (except suspended particulate matter) originate in the South Coast Air Basin and are then blown into the so-called Southeast Desert Air Basin, in which the EAR area is located (San Bernardino County, 1974). Because these contaminants dissipate as they move inland, Victorville would probably give a higher reading for these contaminants than would a station in the subject area.

The following data are extracted from the Report of the Air Pollution Control District for San Bernardino County (1974). Photochemical oxidants include several different pollutants but consist primarily of ozone. Ozone is the one oxidant that "...people most commonly refer to, and know as 'smog'". It is caused by complex atmospheric reactions involving oxides of nitrogen, reactive hydrocarbons and other organic gases which utilize the ultraviolet energy from sunlight to form the contaminant. About 90 percent of the photochemically reactive hydrocarbons in San Bernardino County are emitted by motor vehicles and gasoline marketing operations, and about 50 percent of the total emissions of oxides of nitrogen are from motor vehicles.

The number of hours/days in 1975 that State and Federal standards were exceeded for this pollutant in the Victorville area are shown below:

Month	Days/Hours (State)	Days/Hours (Federal)
January	0/0	0/0
February	1/2	2/9
March	4/20	8/45
April	1/1	3/11
May	1/1	10/33
June	9/40	11/82
July	16/47	27/121
August	9/26	21/74
September	6/10	11/28
October	0/0	3/3
November	0/0	0/0
December	0/0	1/1

Particulate matter is made up of solids or liquids such as iron oxides, soot, dust aerosols, fumes, and mist. Approximately 90 percent by weight of these emitted particulates are larger than 10 microns, but 90 percent of the known particles are less than five microns in diameter (a micron measures one millionth of a meter and a meter measures 3.28 feet). Natural activity, especially in the deserts and during high wind conditions, results in high loadings of dust particles in the atmosphere. Other sources include industrial and agricultural activities and fuel combustion.

No data are available for the number of days particulate matter exceeded Federal and State air-quality standards.

Carbon monoxide (CO) is a colorless, odorless, toxic gas produced by incomplete combustion of carbon-containing substances. Concentrations are generally higher in the winter. Primary sources are the internal combustion engine, various industrial processes and probably home heaters. In the desert area, over 90 percent of this contaminant is contributed by the automobile.

In the Victorville area, there were no days when either the Federal or State standards were exceeded.

Oxides of nitrogen (NO, NO_2) include at least seven different compounds. Of these seven, only two are important in air pollution control. These are: nitric oxide (NO), a colorless, odorless gas formed from atmospheric nitrogen and oxygen when combustion takes place at high temperatures and/or high pressures, and nitrogen dioxide (NO_2), a reddish brown gas formed by the combination of nitric oxide with oxygen.

Depending upon the combustion process, the exit gases from autos and industry contain from one percent to 10 percent by volume nitrogen dioxide and the remainder nitric oxide. Most of the NO is air oxidized to NO_2 within five minutes of emission - creating the reddish brown cloud that may be seen lingering at the 2,000 foot to 5,000 foot level as one approaches the South Coast Air Basin by airplane.

In 1974 nitrogen dioxide (NO_2) peaked for the county in the Victorville area in May (0.24 ppm) and Nov. (0.25 ppm). Neither of these concentrations exceeded State standards. In addition, both oxides (NO, NO_2) peaked in April (0.61 ppm) and May (0.39 ppm). The reading in April exceeded State standards.

Sulfur dioxide (SO_2) is formed primarily by combustion of sulfur-containing fossil fuels. It reacts with water vapor and ozone in the atmosphere to form sulfur trioxide and sulfuric acid mist. The acid reacts with other materials to produce sulfate particulates. Power plants and metallurgical plants are the major sources of SO_2. This contaminant, at present, is not a significant problem in San Bernardino County.

There were no days in 1974 that the State standard was exceeded.

Hydrocarbons are those compounds containing hydrogen and carbon in various combinations - especially those found in fossil fuels. They constitute a vast family of organic compounds which are measured as air contaminants. Some of these hydrocarbon compounds are major air pollutants, and those which can be classified as aromatics and olefins are highly reactive, participating with oxides of nitrogen to produce photochemical smog. The combustion engines of motor vehicles and gasoline marketing operations are the major sources of hydrocarbons in San Bernardino County. Minor amounts of these compounds result from the evaporation of organic solvents during industrial operations.

There is no State standard for this contaminant.

2.1.8 Noise

2.1.8.1 General Terms and Concepts

Sound results when a source sets a medium (air, water, etc.) into vibrations. These vibrations radiate out from the source in waves, much like the ripples created by dropping a pebble into a pond of water. The assessement of noise is based on both qualitative and quantitative inputs.

Noise is typically defined as unwanted or undesired sound that is unpleasant, irritating or painful to the ear. Qualitatively, noise is often a subjective response of an individual based on his own likes and dislikes. Quantitatively, sounds can be scaled based on their relative powers. The most commonly used scale is the decibel (dB) which gives an indication of the level or intensity of the sound. One decibel is the lowest sound that can be heard by a person with very good hearing under very quiet conditions. Decibels are scaled on a logarithmic scale which has properties different from those that measure temperature, which are linear scales. On the logarithmic scale, the actual sound pressure on the ear increases 10 times with each 10 decibel increase. Thus a level of 100 decibels is really 10 billion times as intense a pressure as 1 decibel (Robinette, 1972).

Attenuation refers to the reduction in the intensity of sound before it reaches the receiver. Normal attenuation is due to the reduction in intensity of a sound or noise over distance. In an open environment free from obstructions a sound or noise will decrease 6 dB for each doubling of the distance from the source. For example, a source emitting 100 dB at 50 feet would emit 94 dB at 100 feet. Other factors can also contribute to the reduction in the intensity of a sound, such as climatic conditions of wind and temperature, or the placing of barriers between the source and the receiver. These factors are defined as excess attenuation.

Desert environments are on the whole very quiet, noise-free places. This is so because sources of noise tend to be few and are separated by relatively long distances, sounds tend to be of low intensity, and distances and climatic conditions tend to contribute to normal and excess attenuation.

2.1.8.2 Background Noise in Similar Desert Environments

No data are available on ambient noise levels within the EAR area. A noise study has been conducted, however, in a similar area in the Mojave Desert, southeast of Barstow, California (Southern California Edison Co., 1973). Continuous, 24-hour ambient noise measurements were recorded at six dispersed locations on three days in March, 1973.

Noise was measured on the A-weighted sound pressure level (dBA), and results were reported in terms of a statistical-time-distribution that describes the percentage of time the ambient noise amplitudes exceed a chosen level within a given period. This description of ambient noise levels takes into account the constant variations in amplitude over both short-term and longer time intervals. Two descriptors of ambient noise levels were used: the 50 percent level (L_{50}) which describes the noise level that is expected to be exceeded 50 percent of the time; and the 10 percent level (L_{10}) which represents the peak noise levels experienced at a given location during a given time interval.

The L_{50} and L_{10} levels were averaged over the time period to provide a single number, ambient noise level descriptor for each location. The L_{50} range indicated that most of the time one can expect sounds no louder than a soft whisper or the backgound noise in an average residence. The L_{10} range indicated that the loudest noises one can expect infrequently will not be much louder than a private business office or light traffic (at a 100 foot distance)

(Robinette, 1972). Interpretations of measured sound pressure levels may be made by reference to Table 2-7.

TABLE 2-7

Typical Noise Levels 1/

dBA

RE 20 $_{u}N/M^{2*}$

	130	air raid siren (100')
THRESHOLD OF PAIN	120	jet aircraft (200')
	110	amplified rock music (5')
	100	power mower
	90	inside city bus
DANGER LEVEL	80	pneumatic drill (50')
	70	vacuum cleaner (10')
	60	normal conversation large store
	50	business office
	40	average residence, quiet room
	30	soft whisper (5') tick of watch (2')
	20	studio for sound pictures
	10	leaves rustling in wind
THRESHOLD OF HEARING	0	

1/ Compiled from Petersen and Gross, 1972; Robinette, 1972; and Hildebrand, 1970.

*The reference quantity when decibels are used to express noise level is a sound pressure of 20 micronewtens per square meter.

Extrapolating the findings reported above to the area is valid and practical. The major environmental factors affecting sound propagation and attenuation are comparable between the two areas. Climatic and weather conditions affecting propagation and attenuation are very similar. Also, the two regions have similar topographic features and vegetative associations making for reasonable comparisons along these dimensions. Therefore, for purposes of describing current ambient noise levels in the area, it is assumed that the range of single number ambient noise level descriptors measured south of Barstow, California, describe the limits of the range expected in the EAR area. Natural sound levels are relatively low, then, making for a quiet environment overall.

2.1.8.3 Existing Man-Caused Noise Sources

Man-caused noise sources in the EAR area fall into three categories: (1) noises generated by existing transportation systems, (2) noises generated by recreational activities, and (3) noises generated by military activities.

Two transporation systems producing noise are the Trona Railroad and the highway-road system. Noise measurements have not been made along the Trona Railroad right-of-way. Freight train noise in other studies has been reported to be 70 dBA at 100 feet (Peterson and Gross, 1972). Noise from the Trona Railroad is not a significant aspect of the ambient noise level in the area since the train only makes one daily round-trip on weekdays.

Trona Road is the primary automobile road passing through the area. The road is a lightly used, two-lane asphalt road maintained by San Bernardino County. Noise from the Trona Road is not a significant factor in the ambient noise level of the area. Other unpaved maintained and non-maintained roads are not significant throughout the area. Therefore, vehicle noise along unpaved roadways is not a significant part of the ambient noise level in the area.

The primary recreational noise sources are associated with motorcycle race events and off-road vehicle (ORV) pleasure riding.

Motorcycle race events are held in the Rand Mountain-Spangler Hills ORV open area north of the Lava Mountains, and in the north end of the Red Mountain-Cuddeback existing vehicle routes area south of Red Mountain (U.S. Dept. Interior, 1974a). As discussed in Section 2.5.1.2, this is one of heaviest recreational uses of the area. Although noise measurements have not been made, motorcycle noise has been studied under a variety of conditions. Results show that the range of sound levels varies from a low of 74 dBA to a high of 93 dBA at 50 feet. The range at ear level from a variety of motorcycles varied from a low of 85 dBA to a high of 110 dBA (Harrison, 1974).

Noise associated with motorcycle race events is most intense in camping, pitting and starting areas where use is concentrated (U.S. Dept. Interior, 1974b). The cumulative noise level in these areas is not the arithmetic sum of all sources, but rather a logarithmic sum calculated on an energy basis. Based on the intensity of motorcycle racing in the area and analyses of other motorcycle race events (U. S. Dept. Interior, 1974b) these activities contribute significantly to background noise levels sporadically throughout the year.

Noise from ORV pleasure riding tends to be dispersed. Types of vehicles include motorcycles, 4-wheel drives, dune buggies, and all terrain vehicles (ATV's). Studies of sound levels emitted from a variety of ORV's show a range from 100 dBA at 50 feet for a non-muffled, competition dune buggy, to 76 dBA at 50 feet for a stock, 4-wheel drive vehicle (Harrison, 1974). ORV pleasure riding contributes moderately to the background noise during recreational use periods.

Noise from low-flying military aircraft is pervasive on weekdays. The area is located between the two sections of the China Lake NWC. These areas are actively used for bombing practice and instrument testing on a weekly basis. Noise measurements of military aircraft overflights have not been made, but jet aircraft noise is typically measured at 120 dBA and higher. This is the most pervasive man-caused noise in the area.

2.1.8.4 Noise Sensitivity Zones

Sensitivity to noise may be based on the direct effects of noise upon resources (i.e., startling wildlife), or upon values inherent in the resources (i.e., primitive character, solitude). Three levels of noise sensitivity are defined for the area:

(1) Critical--Resources and values have the greatest sensitivity to impairment from noise;
(2) Subtantial--Resources or values are impaired to a considerable degree;
(3) Minimal--Impairment of resources or values is marginal.

The sensitivity levels can be mapped for the area as zones based on resources and values (Figure 2-9).

From Figure 2-9 there are two critical noise sensitivity zones:

(1) The central area of the Lava Mountains is a roadless, near-pristine environment of high primitive value. There are also known raptor eyries in the northeastern and southwestern portions of the range.

(2) The Trona Pinnacles is a significant scenic and geologic area that possesses high aesthetic values. Raptor eyries are also found in some of the pinnacles.

Three substantial noise sensitivity zones have been defined within the analysis area:

(1) Red Mountain is the site of two raptor eyries.

(2) The Lava-Almond Mountains are areas dominated by natural values of outstanding quality. The areas buffer the more primitive central portions of the Lava Mountains, and known raptor eyries are located close to the boundaries of the Lava Mountains critical noise sensitivity zone.

(3) The Searles Lake-Trona Pinnacles substantial noise sensitivity zone surrounds the Trona Pinnacles and also possess aesthetic qualities.

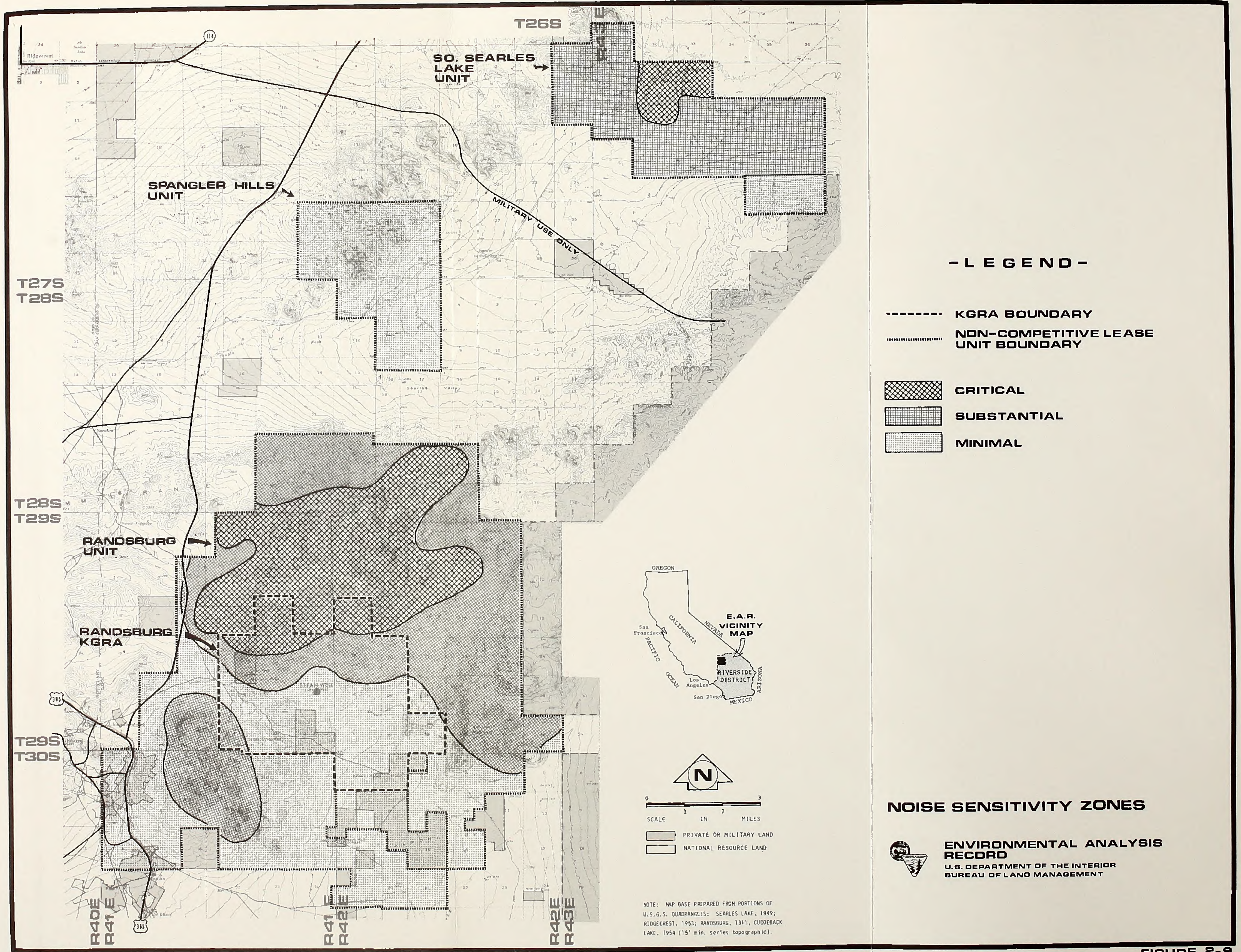
All other areas outside of the zones defined above are considered minimal noise sensitivity zones.

2.2 LIVING COMPONENTS

2.2.1 Vegetation

2.2.1.1 Plant Communities

The entire region around Randsburg is situated in the Hot Desert Biome as described by Odum (1971). Specifically, the EAR area is located in the Mojave (high) Desert.


T26S
R43E
SO. SEARLES LAKE UNIT
SPANGLER HILLS UNIT
MILITARY USE ONLY
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RANDSBURG UNIT
RANDSBURG KGRA
T29S
T30S
R40E
R41E
R41E
R42E
R42E
R43E
-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
CRITICAL
SUBSTANTIAL
MINIMAL
OREGON
NEVADA
CALIFORNIA
San Francisco
PACIFIC OCEAN
Los Angeles
San Diego
MEXICO
ARIZONA
RIVERSIDE DISTRICT
E.A.R. VICINITY MAP
N
SCALE 1 IN 2 MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
NOISE SENSITIVITY ZONES
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-9

The Bureau of Land Management's (BLM) Desert Plan Staff (DPS) intensely studied the vegetation in the vicinity of Randsburg during the fall and winter of 1974-75. They stratified the flora in the area into 187 different polygons, and a study transect was done in each polygon. For the purposes of this report, these polygons have been included in four plant communties. Three of these are described in Munz and Keck (1959), and will be subsequently referred to as Munzian communities. The fourth is an indistinct, transitional community that is probably more of a broad ecotone than an actual plant community.

The Munzian communities are Creosote Bush Scrub, Shadscale Shrub, and Alkali Sink. The other community has been arbitrarily named the Transitional Shrubland. Figure 2-10 shows the locations of these communities and those areas barren and devoid of vegetation.

The Creosote Bush Scrub is the largest and most important of the four communities. It encompasses approximately 51,860 acres, and is found between 2,000 feet and 4,100 feet of elevation on well-drained, slightly alkaline soils on low hills, pediments, and upper valleys (Figure 2-11).

Table 2-8 lists the DPS data on ground cover and species composition in the Creosote Bush Scrub. Vegetation is very sparse; most of the ground cover is composed of non-vegetative items such as broad expanses of exposed pebbles and stones (desert pavement), litter, and rock.

Creosote bush (Figure 2-12) is the dominant plant, accounting for nearly 37 percent of the species composition and 3.3 percent of the ground cover. It is

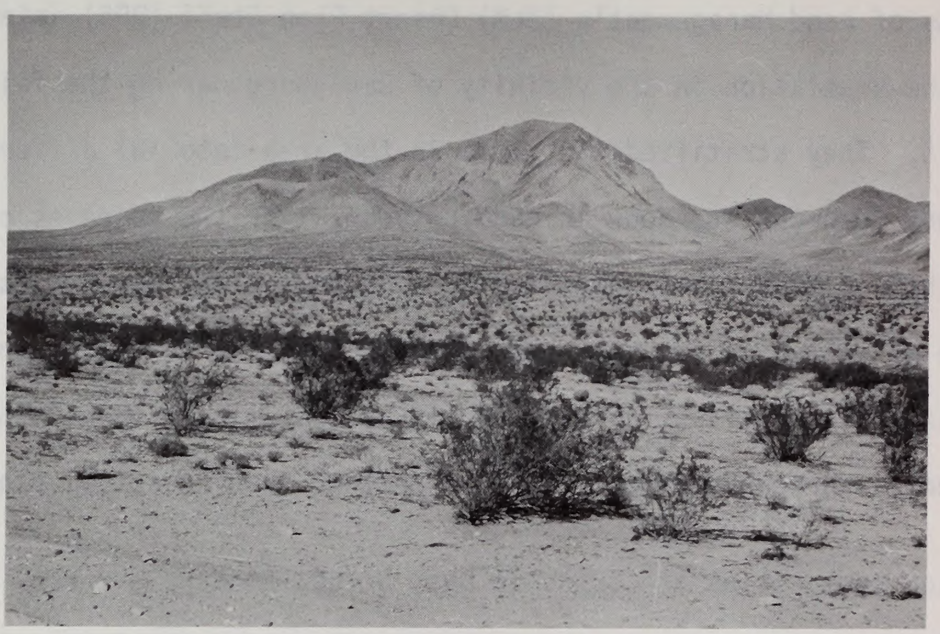
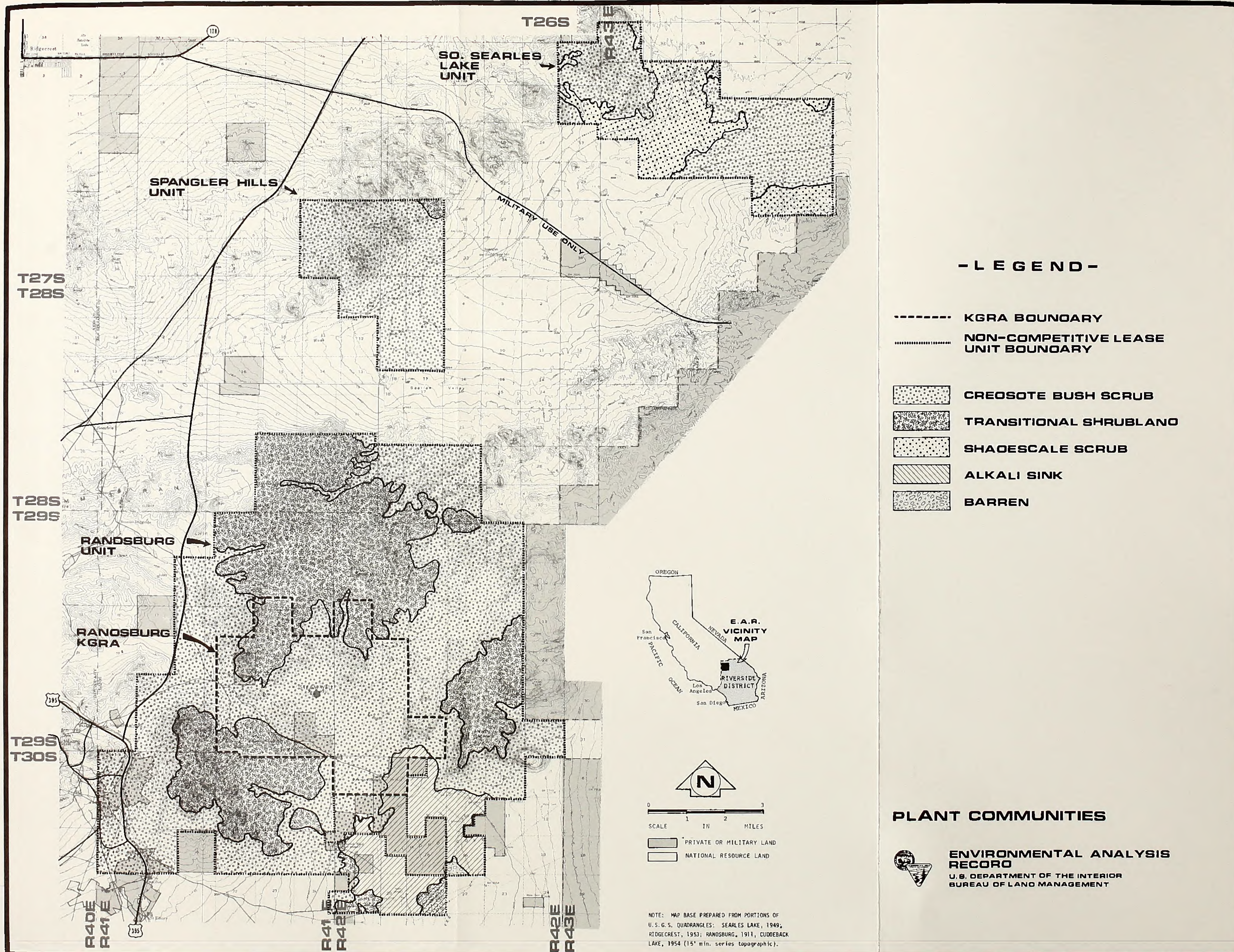


Figure 2-11. Creosote Bush Scrub Community.

Figure 2-12. Creosote Bush.

a large plant, sometimes growing to over 13 feet tall. This gives it the largest stature of any plant in the area, except for Joshua trees, which are very rare for the area.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SO. SEARLES LAKE UNIT
R43E
SPANGLER HILLS UNIT
MILITARY USE ONLY
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RANDSBURG UNIT
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OREGON
CALIFORNIA
NEVADA
E.A.R. VICINITY MAP
San Francisco
PACIFIC
OCEAN
Los Angeles
San Diego
RIVERSIDE DISTRICT
ARIZONA
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SCALE IN MILES
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PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
CREOSOTE BUSH SCRUB
TRANSITIONAL SHRUBLAND
SHADESCALE SCRUB
ALKALI SINK
BARREN
PLANT COMMUNITIES
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-10

TABLE 2-8

AVERAGE COVER AND PLANT COVER COMPOSITION OF THE MOST ABUNDANT PERENNIAL SPECIES IN THE CREOSOTE BUSH SCRUB
(100 Samples Taken)

	PERCENT GROUND COVER	PERCENT SPECIES COMPOSITION
Bare Ground	16.7	-
Litter	14.3	-
Desert Pavement	49.7	-
Rock	14.0	-
Creosote Bush	3.3	36.9
Bursage	.8	26.8
Cheesebush	.1	9.2
Hopsage	.1	3.9
Other	2.0	23.2

Bursage is virtually always associated with creosote bush (Figure 2-13). Often it is a codominant species and in the area accounts for about 27 percent of the species composition and .8 percent of the ground cover. Bursage's stature is much smaller than creosote bush. Both sheep and cattle find bursage unpalatable, but will eat the plant when more desirable forage is not available.

Two other shrubs, cheesebush and hopsage, are subdominants in the Creosote Bush Scrub. They generally make up a minimal percent of species composition and ground cover. They are most often shunned by grazing livestock.

Desert needlegrass is the most abundant grass. Other perennial grasses include Indian ricegrass, Malpais bluegrass, and squirreltail grass. The first two are important forage plants for livestock, but Malpais bluegrass and squirreltail grass are not.

Figure 2-13. Codominant Bursage.

Cacti are not common anywhere on this portion of the Mojave Desert. A few silver chollas, beavertail cactus, and cottontop can be found.

Only a few species of perennial forbs are found, but there is a spectacular display of ephemeral or seasonal annuals when precipitation conditions are favorable. Desert trumpet, white wishbone, desert aster, and desert globe-mallow are the most important perennial forbs. These provide colorful flowers in the spring, but are eclipsed by the annuals.

The Creosote Bush Scrub is very variable. It includes many small areas that are not actually Creosote Bush Scrub (inclusions) and at least two phases in addition to the major community described above; a Desert Holly Phase and a Desert Senna Phase.

The Desert Holly Phase of the Creosote Bush Scrub is situated in the northeast part of the area in Searles Valley. It is a gradation from Creosote Bush Scrub (Figure 2-12) to Shadscale Scrub (Figure 2-14) and is found on soils which become increasingly more alkaline. Again, vegetation is very sparse; less than four percent of the ground cover.

Figure 2-14. Shadscale

Creosote bush, bursage and desert holly are the dominant species, accounting for 17.8, 32 and 29 percent of the species composition, respectively. None cover more than two percent of the ground. The latter species is often dug up and utilized as a garden shrub.

A Desert Senna Phase of the Creosote Bush Scrub was noted in the vicinity of the Spangler Hills. Often it is found in large, sandy washes. Again, vegetation is very sparse, less than five percent of the ground cover.

Creosote bush, bursage, and desert senna are the dominant species, accounting for a total of about 93 percent of species composition.

Desert senna is a large shrub, growing to nearly five feet in size. It is quite non-descript, being leafless most of the year. Livestock find it unpalatable.

Most of the inclusions in the Creosote Bush Scrub are small washes where cheesebush dominates. A very interesting inclusion can be found in Golden Valley, just northwest of Almond Mountain. This area is almost completely devoid of woody vegetation and grasses. Forbs such as desert trumpet, little trumpet, and desert candle dominate (Figure 2-15).

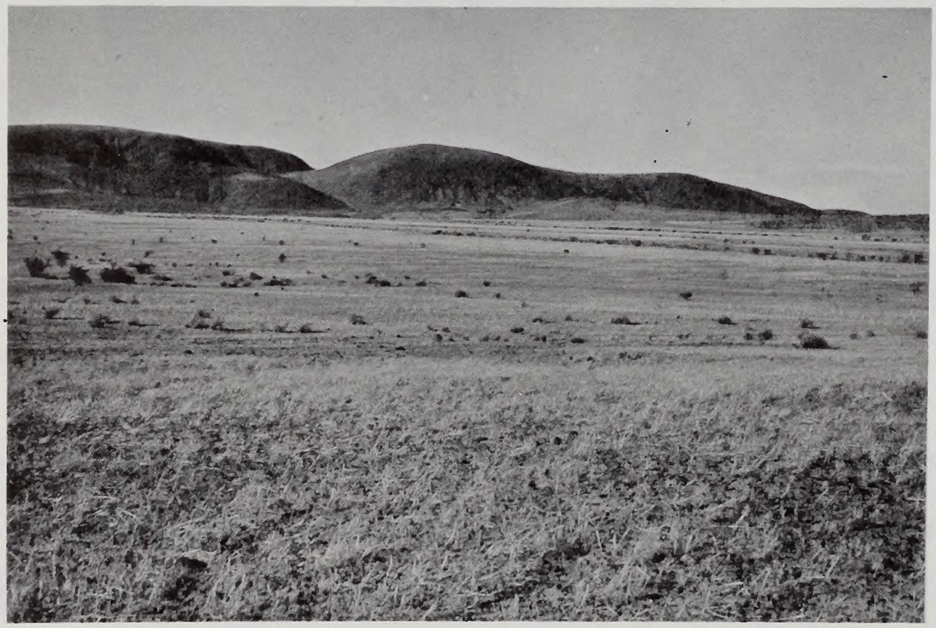


Figure 2-15. Forb Inclusion in the Creosote Bush Scrub Community.

Appendix A-1 presents a complete species list of all plants noted by the DPS in the Creosote Bush Scrub Community. It also gives percent presence, which is the percent of the total number of polygons in which a given species was noted.

The Transitional Shrubland is a heterogeneous area that cannot be placed in any Munzian community. It is possibly a broad ecotone between Creosote Bush Scrub and Joshua Tree Woodland, although the latter is absent in the EAR area.

This community covers all of the higher mountains, beginning at the top of the pediments and continuing to the mountain summits (Figure 2-16). Elevations range from 2,800 feet to 5,200 feet, and only rarely does it reach down the more rocky pediments into the valleys. It encompasses approximately 20,240 acres.

The Transitional Shrubland is more of a continuum than a distinct community (Figure 2-17). There are considerable amounts of creosote bush, bursage, Nevada Mormon tea and cheesebush at lower elevations, but these decline as elevation increases. California buckwheat and Mormon (mountain) tea are found at mid-elevations and increase toward the summits. Other shrubs such as boxthorn, hopsage, Mojave horsebrush, goldenbush, allscale saltbush, and bladdersage are more or less constant.

Figure 2-16. Transitional Shrubland Community. Note that it Covers the Mountains in the Background and the Rocky Pediment in the Foreground.

Figure 2-17. Close-Up of the Transitional Shrubland Community, Showing the Heterogeneous Mixture of Shrubs and the Rocky Character of the Land.

Table 2-9 lists the percent ground cover and species composition in the Transitional Shrubland. Like the previous community, vegetation is very sparse and most of the ground cover is composed of non-vegetative items.

TABLE 2-9

AVERAGE COVER AND PLANT COVER COMPOSITION OF THE MOST ABUNDANT PERENNIAL SPECIES IN THE TRANSITIONAL SHRUBLAND
(25 Samples Taken)

	PERCENT GROUND COVER	PERCENT SPECIES COMPOSITION
Bare Ground	14.5	-
Litter	17.4	-
Desert Pavement	44.2	-
Rock	18.7	-
Creosote Bush	.6	4.6
Bursage	.4	11.6
Cheesebush	.4	10.6
Boxthorn	.2	2.2
Hopsage	.8	9.0
Other	2.8	62.0

Creosote bush dominates at lower elevations, covering .6 percent of the ground and forming 4.6 percent of the species composition. Bursage (.4 percent ground cover, 11.6 percent species composition), cheesebush (.4 percent ground cover, 11.6 percent species composition), and hopsage (.4 percent ground cover, 9.0 species composition) often share dominance with creosote. As noted above, all but hopsage decline as elevation increases.

Boxthorn is the only other plant that covers a measureable amount of ground. It is a large extremely thorny shrub, growing to over six feet high and is all but unused by livestock.

Large clumps of desert needlegrass are often found in rocky places. Sometimes north-facing slopes have relatively large amounts of Malpais bluegrass. Indian ricegrass and squirreltail grass are found, but are quite uncommon.

Like the Creosote Bush Scrub, there is a spectacular display of ephemeral wildflowers during spring when conditions are favorable. Cacti are uncommon.

Appendix A-2 is a complete species list of plants noted on the Transitional Shrubland by the DPS.

The Shadscale Scrub Community differs from the community described in Munz and Keck (1959) in the fact that desert holly, rather than shadscale, its close relative, dominates. Otherwise it is much the same. It is found on well-drained alkaline sites in Searles Valley and in the vicinity of the Trona Pinnacles (Figure 2-10). Elevations range from 1,740 feet to 2,440 feet. The community occupies approximately 5,000 acres of the EAR area.

Vegetation is extremely sparse; less than three percent of the ground is covered by plants (Table 2-10). Desert holly is the most dominant species, with Shadscale the second most important. Bursage and inkweed are also important. Inkweed is a sparse, fleshy subshrub growing to nearly three feet tall. It has no value for grazing.

Grasses, perennial forbs and cacti are uncommon to non-existent in the Shadscale Scrub. As with the other communities, the ephemeral annuals are completely dependent upon the weather.

TABLE 2-10

AVERAGE COVER AND PLANT COVER COMPOSITION OF THE MOST ABUNDANT PERENNIAL SPECIES IN THE SHADSCALE SCRUB (25 Samples Taken)

	PERCENT GROUND COVER	PERCENT SPECIES COMPOSITION
Bare Ground	28.0	-
Litter	5.0	-
Desert Pavement	57.2	-
Rock	7.5	-
Desert Holly	.1	37.1
Shadscale	.1	19.5
Bursage	.1	10.7
Inkweed	.1	15.2
Other	1.9	17.5

Species associated with the Creosote Bush Scrub, such as creosote bush itself, bursage, and cheesebush are found on the edge of the Shadscale Scrub. This is a result of the broad ecotone between the Shadscale Scrub and the Desert Holly Phase of the Creosote Bush Scrub (Figure 2-18). As previously mentioned, they gradate slowly into each other; however, the creosote bush and cheesebush almost completely disappear near the center of the Shadscale Scrub.

Appendix A-3 lists all plants noted in the Shadscale Scrub by the DPS.

The Alkali Sink is approximately 6,288 acres in size. It is restricted to the extreme southeast portion, along the edge of Cuddeback Lake (Figures 2-10, 2-19). This is a poorly-drained, highly alkaline area with elevations ranging from 2,500 feet to 2,600 feet.

Figure 2-18. Gradation of Creosote Bush Scrub Community into Shadscale Scrub Community.

Figure 2-19. Alkali Sink Community.

Vegetation is again sparse, accounting for only about 8 percent of the ground cover (Table 2-11). The community is, however, highly variable. Species which are well represented in one polygon are absent in others. Allscale saltbush (Figure 2-20), the most important plant in most cases, is a fairly large shrub, growing to over six feet tall. Quite spiney, it usually does not hold much attraction to livestock as browse, but is very important in some areas as nesting cover for upland game birds.

TABLE 2-11

AVERAGE COVER AND PLANT COVER COMPOSITION OF THE MOST ABUNDANT PERENNIAL SPECIES IN THE ALKALI SINK
(17 Samples Taken)

	PERCENT GROUND COVER	PERCENT SPECIES COMPOSITION
Bare Ground	25.6	-
Litter	17.3	-
Desert Pavement	48.1	-
Rock	.5	-
Allscale Saltbush	3.8	38.8
Goldenhead	.4	9.7
Shadscale	1.7	28.3
Boxthorn	.1	1.6
Bursage	.1	4.9
Indian Ricegrass	.1	4.9
Other	2.3	11.8

Shadscale is the second most common plant; goldenhead, boxthorn, Indian rice-grass, Arabian grass and bursage are important members of this community, as are several alkali-tolerant annuals. As with the other communities, ephemerals are completely dependent upon the weather.

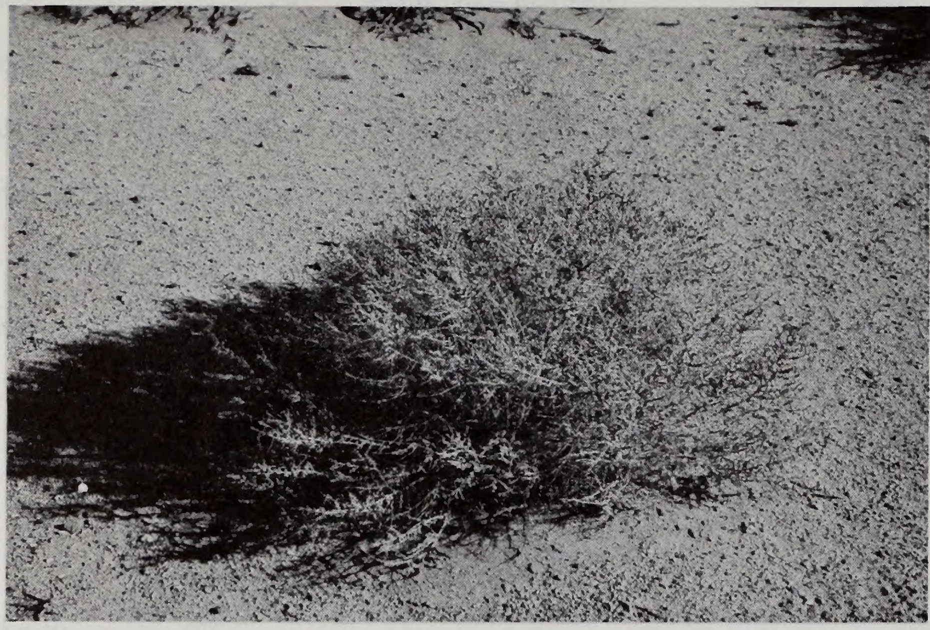


Figure 2-20. Dominant Allscale Saltbush.

Appendix A-4 lists all plants noted in the Alkali Sink by the DPS.

The Barren area is the playa of Cuddeback Lake* (Figure 2-21). It is completely devoid of vegetation or virtually so, and at 2,560 feet occupies the lowest elevations in the EAR area. Only 440 acres of barren area are included within the study area boundaries.

2.2.1.2 Rare and Endangered Plants

No rare and endangered plants have at this time been reported in the area. There is reported, however, a sighting of Linanthus arenicola in Poison Canyon, two and one-half miles northwest of the South Searles Lake lease unit. This

* A second, very small barren area is found near the Trona Pinnacles.

Figure 2-21. Cuddeback Lake Barren Area.

species is rare but not endangered. Its potential for extinction is low at present and the vigor of the species is stable or increasing. The single sighting of the plant occurred before 1945, and it has not been reported in the area since. The location of the sighting is not precisely known.

2.2.1.3 Poisonous Plants

There are several plants in the area that are poisonous to livestock, most abundant of which is Mojave horsebrush. It causes photosensitization - the sloughing off of sunburned skin - in sheep and cattle. However, Mojave horsebrush is extremely thorny; and there is little danger of animals eating quantities likely to cause problems.

Loco weed has a cumulative poison. It usually is unpalatable to livestock, but they can develop a fondness for it. It affects the central nervous system, causing animals to display crazed actions when enough is ingested.

Larkspur is extremely poisonous to cattle, but not to sheep. Lupine on the other hand is poisonous to sheep but not to cattle. While the entire larkspur plant is very poisonous until it has dried, at which time it seems to hold little danger, only the pods and seeds of the lupine are dangerous.

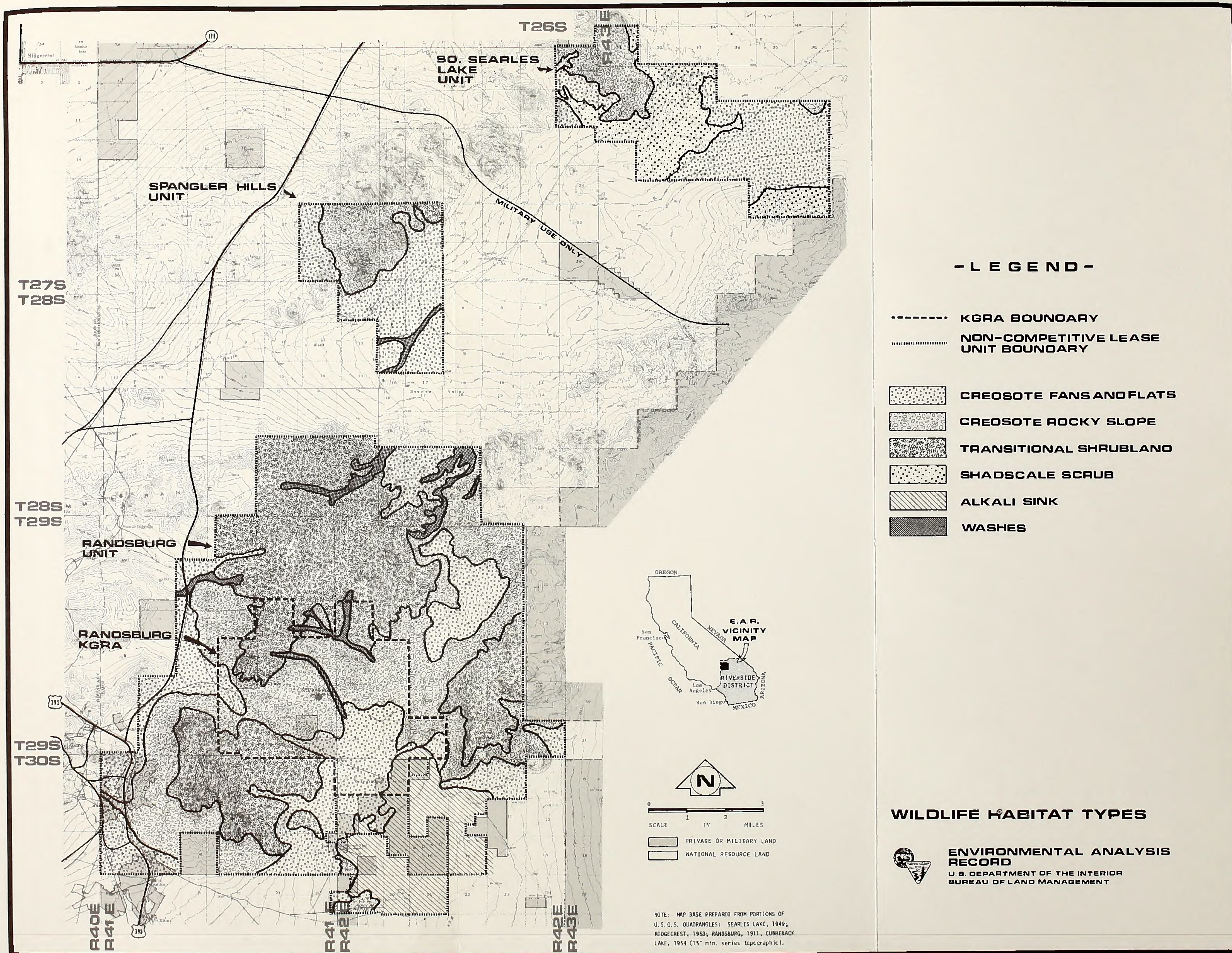
Prince's plume, sighted only on the alkali sink, collects selenium. This element is very dangerous to grazing livestock if the plant has collected large quantities.

None of the above plants hold much danger to human beings. Perhaps the only plant in the area that does is phacelia, which secretes a sticky, glandular material that causes a skin reaction similar to that caused by poison oak.

2.2.2 Wildlife

2.2.2.1 Habitat Types and Associated Species

Six habitat types have been identified in the EAR area (Figure 2-22). These are basically similar to the plant communities previously described except that two communities have been split into distinct habitat types. This was done because topographic features affect the distribution of animals even though vegetation is similar. The six habitat types are discussed below, and a list of vertebrate animal species occurring in each type is given in Appendix B.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OREGON
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E.A.R. VICINITY MAP
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SCALE IN MILES
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-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
CREOSOTE FANS AND FLATS
CREOSOTE ROCKY SLOPE
TRANSITIONAL SHRUBLAND
SHADSCALE SCRUB
ALKALI SINK
WASHES
WILDLIFE HABITAT TYPES
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-22

The Transitional Shrubland, Shadscale Scrub, and Alkali Sink habitats have been described in Section 2.2.1.1. Based on topography, the Creosote Bush Scrub community has been divided into habitat types; Creosote Flats and Fans Habitat and Creosote Rocky Slope Habitat. The third habitat type is the Wash Habitat.

The Creosote Flats and Fans Habitat Type is developed on well-drained soils composed of sand and loose rock. Slopes are generally moderate and elevations usually range between 2,500 feet and 3,200 feet. The vegetation is dominated by creosote bush with various proportions of other shrubby perennials including burrobush and cheesebush. In the west end of the Summit Range this community also contains Joshua trees, the only ones in the area. At higher elevations within this habitat type are numerous species which become dominant in the Transitional Shrubland, such as terete-leaved rubber-brush, Nevada joint fir, and spiny hopsage.

The Creosote Rocky Slope Habitat Type is found on the south slopes of the area's major mountains, on bedrock at elevations below the Transitional Shrubland, and on minor rock outcrops. The vegetation consists of a fairly sparse cover of creosote bush, burrobush, and other small shrubs growing on the steep rocky slopes.

The third habitat type is the Desert Wash. In the EAR area, washes are poorly developed and restricted in distribution. They are marked primarily by large creosote bush and increased densities of cheesebush. The better developed washes, found in the mountain canyons, contain rabbit bush and other shrubs with higher moisture requirements (mesic shrubs).

2.2.2.2 Evaluation of Habitat Quality

Each of the six habitat types within the area possesses its own unique combination of plant and animal species. Much of the area contains prime examples of these habitat types. In some areas habitat damage has been kept to a minimum, in others the habitat has been subjected to strong disruptive pressures. Disruption of these habitats often results in reduced plant and animal densities and diversity.

The main sources of habitat degradation within the area have been grazing, mining, and ORV use. Several portions of the EAR area appear to have completely escaped these disruptive influences. These areas have been protected primarily by their inaccessibility and include much of the Lava Mountains, Almond Mountains and portions of Red Mountain. Most of these areas are accessible only by foot. These mountainous areas are providing secluded nesting areas for many of the area's raptors, or birds of prey, including prairie falcons and golden eagles.

The more accessible portions of the EAR area have suffered the greatest degradation of habitat quality.

Grazing is one of the older and more widespread of these disruptive activities, having begun in this area in the late 1800's and continuing to the present. The grazing has been by both sheep and cattle and has usually been ephemeral. Evidence of past grazing shows in the plant species composition, the presence of hedged shrubs, barren areas, disruption and compaction of soil, and the presence of sheep trails in the more rugged areas. The Alkali Sink and Creosote Fans and Flats appear to have received the most intensive grazing pressure due to the accessibility of these areas.

The Brown's Ranch area north of the Cuddeback Playa in particular appears to have been heavily grazed. Much of the remainder of the area appears to be grazed heavily on an ephemeral basis. Other agricultural activities seem to have been confined to the Almond Cove area, in the vicinity of Brown's Ranch. Parts of this area were cleared and planted, but this effort, as well as that at Brown's Ranch, has now been abandoned. The cleared areas are now covered primarily by Schismus, an exotic, weedy, annual grass.

Mining has been another source of habitat damage within the EAR area. Intensive mining in the area began in the 1860's and continued through 1925, and has continued on a sporadic basis to the present. Most of the mining activities within the area have been in the vicinity of Red Mountain and in the Spangler Hills. Mining in these areas has resulted in many access roads, tailing piles, garbage dumps, mineshafts and abandoned buildings. In addition to this surface disturbance, concentrations of harmful elements or compounds may occur in some areas as by-products of refining. Mining activities have been concentrated primarily within the Creosote Rocky Slope and Transitional Shrubland Habitats.

ORV use is the most recent form of serious habitat disruption. It has been widespread throughout the area but is most heavily concentrated within the Summit Range and the Spangler Hills.

The Spangler Hills have been designated as an open area to ORV use by the BLM and sustain regular ORV use and competitive events on sponsor-designed courses.

The remainder of the area, including the Summit Range, is classified for ORV use on existing roads and trails (U. S. Dept. Interior, 1974a). Competitive events are also allowed in these areas on approved courses. ORV use within these areas has been primarily confined to dirt roads and motorcycle trails, and many of these trails have sustained serious damage due to motorcycle overuse. Off-trail use by motorcycles has also taken place, particularly in the Summit Range, in spite of these designations.

ORV's are capable of causing extensive damage to soils and plants and damage to the soil surface has caused erosion in many areas. ORV's compact the soils and break the fragile soil crust reducing the water-holding capacity of the soil. This hinders the germination of new plants and reduces available water to established plants. Established plants are also damaged directly by ORV's.

Outside of the Spangler Hills and the Summit Range, most ORV use has been confined to roads and trails. In some areas these trails receive heavy use, often due to competitive events, and are increasing in width as the original trails become overused and more difficult to negotiate. The trail through Golden Valley is an excellent example of this type of overuse.

The EAR area contains some good examples of several of the different habitat types found in the northwest Mojave Desert. The majority of available habitat within this area is in good condition and supports a diverse variety of plants and animals.

2.2.2.3 Significant Species and Sensitive Habitats

Several species in the EAR area are considered to be particularly significant. Some are limited in numbers or distribution and others are important for scientific, recreational or commercial reasons. Of the vertebrate species listed for the EAR area, one species is listed by the State of California as "Rare" (Calif. Dept. Fish and Game, 1974), while four species are fully protected, and sixteen are partially protected by the California Fish and Game Code (Calif. Dept. Fish and Game, 1973). In addition to these, there are eight birds on the Audubon Society's 1975 Blue List (Audubon Society, 1974), a list of diminishing bird species of the United States. There are no species presently listed on the Secretary of the Interior's Endangered or Threatened Species List nor are any listed as "Endangered" by the State of California. Following is a general review of the significant species and the more sensitive habitat of the area. Many of these species are limited in numbers and may become endangered in the future if not given adequate protection.

Desert Tortoise (Gopherus agassizi)

Significance. The desert tortoise is fully protected in California and it is illegal to disturb or remove a wild desert tortoise from its native habitat. Numbers are diminishing throughout the desert mainly due to the activities of man, such as urban growth, livestock grazing and ORV recreation.

Preferred Habitat. The desert tortoise is found primarily on firm (but not hard) soil into which it can easily burrow. Desert tortoises are found in all habitat types, but the highest densities are in the gentler terrain, particularly within the Alkali Sink and Creosote Flats and Fans Habitat Types.

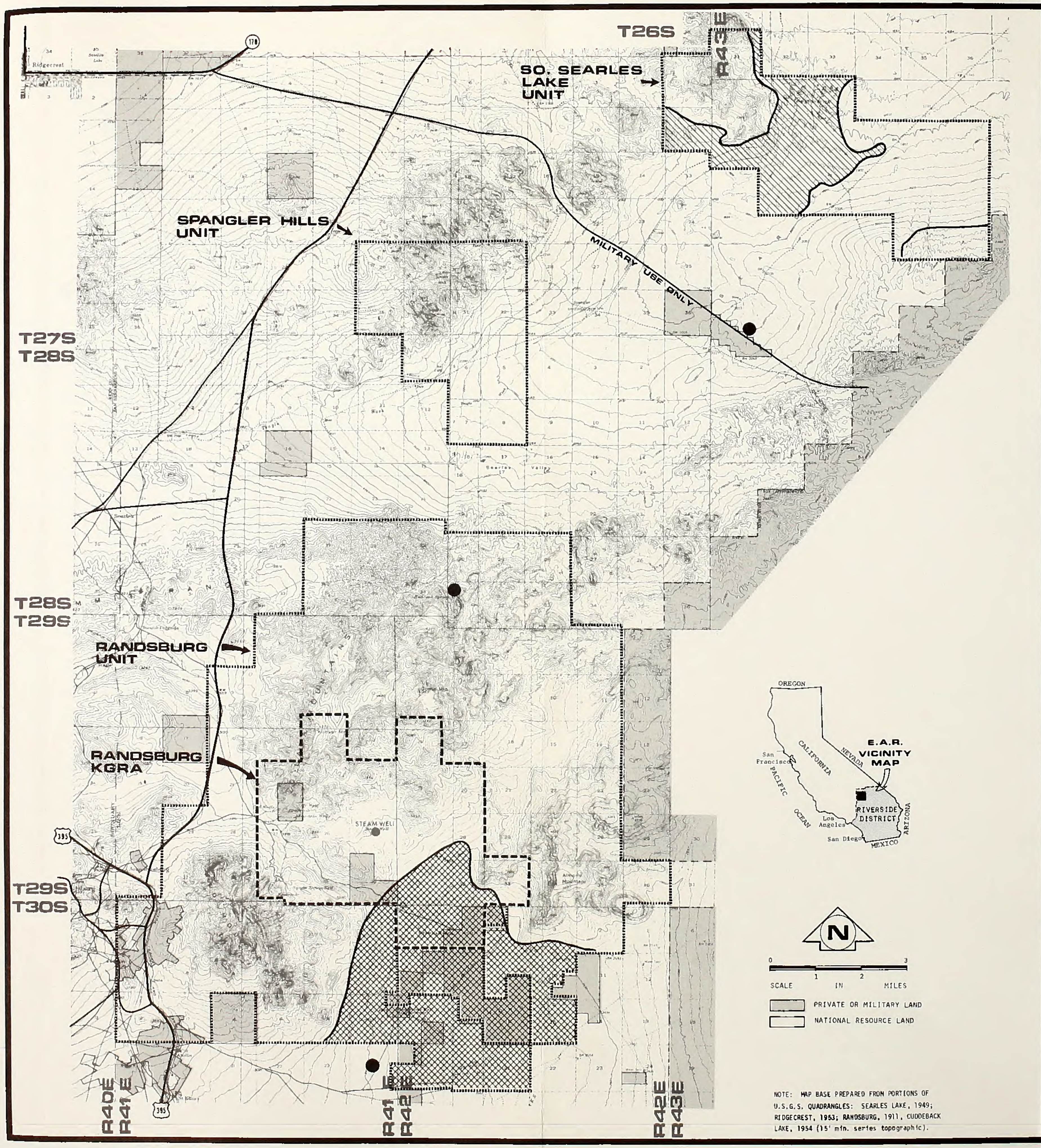
Status in EAR Area. Active burrows, tortoise remains, and tortoise scats as well as live tortoises have been observed. BLM inventory data for the Red Mountain Planning Unit (U. S. Dept. Interior, 1975b) indicated populations were less than 50 individuals per square mile and were generally restricted to elevations below 3,500 feet.

Sensitive Habitat. Sensitive habitat of the desert tortoise is closely associated with the Alkali Sink and Creosote Fans and Flats Habitats of Almond Cove (Figure 2-23). This area could have had as many as 100 to 200 individuals per square mile, but due largely to human activities, it now has an estimated population of less than 50 individuals per square mile. The Creosote Fans and Flats Habitat of the Spangler Hills area also had high population densities but presently is not considered sensitive habitat due to the high level of ORV activity.

Cooper's Hawk (*Accipiter cooperi*)

Significance. The Cooper's hawk is on the 1975 Blue List of the Audubon Society (Audubon Society, 1974).

Preferred Habitat. The species is generally found in open or marginal woodland and most often chooses nest sites in riparian growths of deciduous trees such as in canyon bottoms (Grinnell and Miller, 1944).



SENSITIVE DESERT TORTOISE AND MOJAVE GROUND SQUIRREL HABITATS

ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-23

Status in EAR Area. The species can be expected to fly over all of the habitat types. Population densities in the area are not known. As the EAR area is not preferred habitat, use of the area is probably minimal. There are no known nest sites in the EAR area.

Sensitive Habitat. The Cooper's hawk generally prefers to hunt in topographically flat, broad terrain or short rolling hills such as in Almond Cove, Golden Valley, Teagle Wash, Searles Valley and the valleys between Red Mountain and the Lava Mountains. These areas, however, are not considered particularly sensitive to this species due to their infrequent use of the area.

Golden Eagle (Aguila chrysaetos)

Significance. The golden eagle is fully protected by both California State law and Federal regulation (Title 16, U.S.C., 668a). Numbers are naturally low because the species is a predator at the top of the food chain. There were an estimated 500 nesting pairs in California in 1974 (Thelander, 1974).

Preferred Habitat. In the desert, the golden eagle is primarily associated with isolated desert mountain ranges. They nest in steep rocky canyons and cliffs, and hunt over flat terrain and broad valleys.

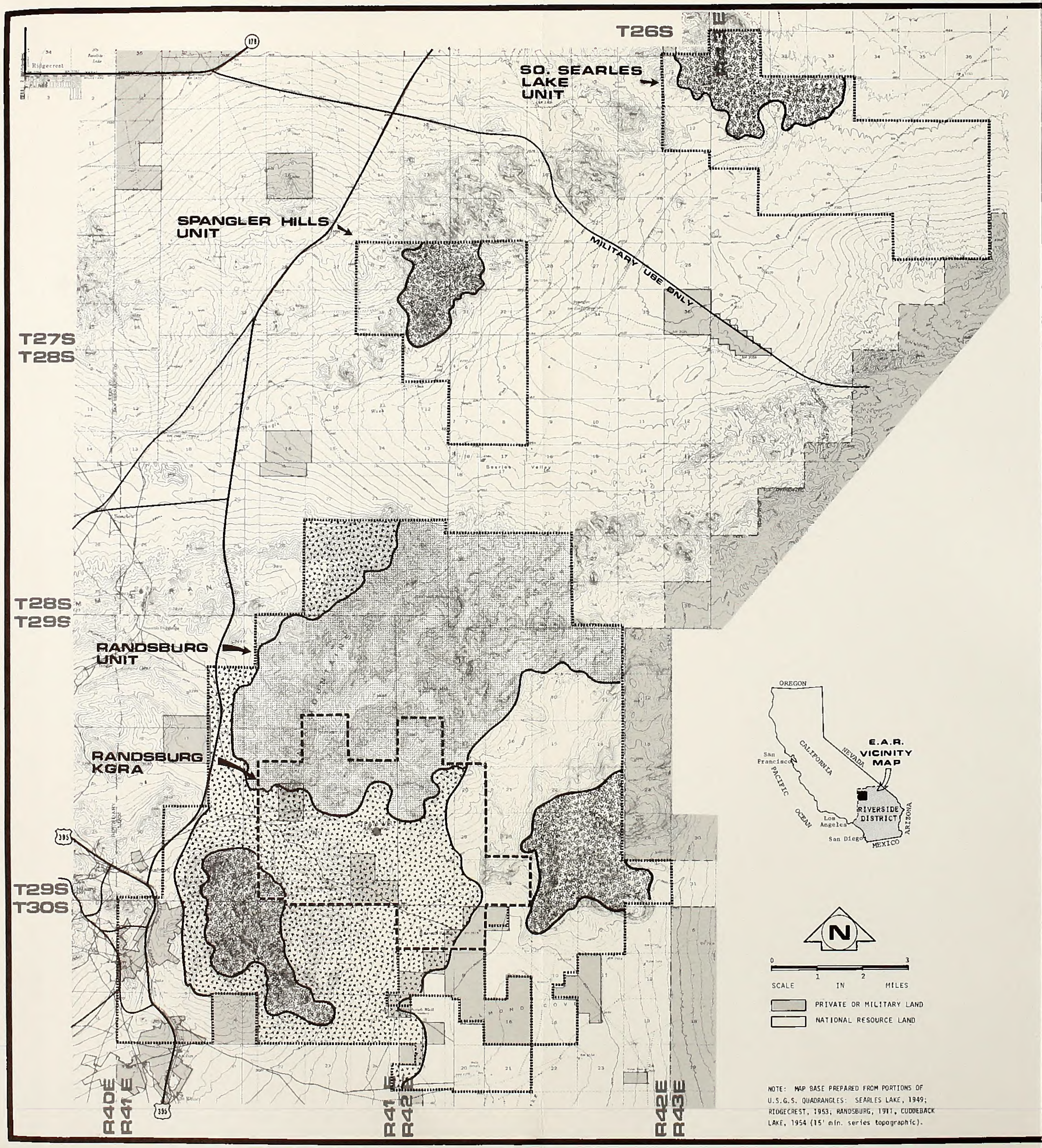
Status in EAR Area. Population densities are not known in the EAR area. However, golden eagles have been observed hunting over the Alkali Sink and Creosote Fans and Flats Habitats of the Almond Cove and Teagle Wash areas. Although not known in the area, the rocky areas probably contain some nest sites.

Sensitive Habitat. Although golden eagles utilize the entire EAR area almost yearly, sensitive habitat can be defined as nesting areas and areas of high prey species densities. The sensitive golden eagle habitat areas include the rough, steep, mountainous areas of Red, Almond and Lava Mountains, Golden Valley and Almond Cove. These areas are particularly sensitive during nesting periods (February - June) and human activity near eyries at this time will often result in abandonment of nests or nesting failure.

Golden eagles and many other raptors will reuse established eyries. An individual eagle may move its nest from year to year but will generally use established nesting areas. Often other raptors such as a red-tailed hawk or a prairie falcon will use the same eyrie when the eagles are not present. An established eyrie therefore is sensitive habitat to various raptors and from year to year may be of particular importance to different species. Sensitive raptor nesting and foraging areas are shown in Figure 2-24, and are discussed in more detail in following paragraphs.

Marsh Hawk (Circus cyaneus)

Significance. The marsh hawk is on the 1975 Blue List of the Audubon Society because numbers have shown significant declines in the United States (Audubon Society, 1974). Marsh hawks are fully protected under the Migratory Bird Treaty Act (Title 16, U.S.C., 703, 711).



-LEGEND-

KGRA BOUNDARY

NON-COMPETITIVE LEASE UNIT BOUNDARY

RAPTOR NESTING TERRITORIES

NESTING & FORAGING TERRITORIES

IMPORTANT FORAGING TERRITORY

RAPTOR NESTING AND FORAGING TERRITORIES

ENVIRONMENTAL ANALYSIS RECORD

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-24

Preferred Habitat. Marsh hawks are found most frequently near fresh and saltwater wetlands. However, they range over grassland, dry prairie, desert oases and sinks, and over mountainous areas near water (Grinnell and Miller, 1944).

Status in EAR Area. Marsh hawks were observed over both of the Creosote Bush Habitats. These birds were either migrants or associated with the riparian habitat south of the EAR area at Harper Dry Lake.

Sensitive Habitat. There is no particularly sensitive habitat for the marsh hawk in this area. The species does, however, generally prefer to hunt in topographically flat, broad terrain or short rolling hills such as in Almond Cove, Golden Valley, Teagle Wash, Searles Valley and the valleys between Red Mountain and the Lava Mountains.

Prairie Falcon (Falco mexicanus)

Significance. The prairie falcon is on the 1975 Blue List of the Audubon Society (Audubon Society, 1974). Prairie falcons are also fully protected by the Migratory Bird Treaty Act (Title 16, U.S.C., 703-711).

Numbers are naturally low because prairie falcons are at the top of the food chain. In California, the prairie falcon has declined in recent years (Garrett and Mitchell, 1973) and there are now only approximately 200 known occupied nesting territories in California.

Preferred Habitat. In the California Desert the prairie falcon can be found ranging almost anywhere, particularly in the winter months. They usually nest in steep, rocky canyons, around cliffs, or on high, projecting pinnacles.

Status in EAR Area. Prairie falcons were observed hunting in the Creosote Bush Fans and Flats and the Creosote Bush Rocky Slope Habitat Types.

Over 20 historical eyries are known from the EAR area and there are probably many more, particularly in the Lava Mountains. Most are within the Transitional Shrubland, Creosote Rocky Slope and Shadscale Shrub Habitat Types. The history of utilization of these nests is not known completely. Six of these known sites are on Red Mountain and these nests have been reported to be occupied and to have produced young rather consistently.

Sensitive Habitat. Sensitive habitat areas for raptors are shown in Figure 2-24. These areas include the known eyries and proximate feeding areas. Prairie falcons and other large raptors will forage up to 20 miles or more from the nest; therefore, birds nesting in the EAR area will forage outside of it. In addition, the EAR area provides foraging area for raptors that nest outside of the area. Therefore, simply designating the eyrie and the immediate vicinity as critical habitat is not realistic in that it does not provide for all the needs of the birds. Thus, critical or sensitive habitat must include foraging areas.

In determining critical or sensitive foraging habitat for prairie falcons as well as other raptors, many factors must be considered, including:

(1) proximity to nesting areas
(2) overall productivity of the habitat type, and
(3) density of favored prey species.

The sensitive habitat areas outlined on Figure 2-24 are described below:

Red Mountain - This area has consistently been occupied by prairie falcons and other raptors, and there is a high density of raptor eyries on the mountain. The whole area outlined has been identified by the California Department of Fish and Game as a productive area for chukar and Gambel's quail (Vernoy, 1976, pers. comm.). Both of these species are believed to be preferred prey species for prairie falcons where they are found in high densities. Therefore, any effort at protecting the habitat for these prairie falcons must also include protection of the habitat of this important food source.

Lava Mountains - This area has not been surveyed for raptors, but it has been reported to contain many eyries and high potential as a nesting area because it is still relatively undisturbed (U.S. Dept. Interior, 1975b).

Summit Mountains - The distinction between this area and the Lava Mountains is arbitrary. However, it differs in that the habitat has been heavily disturbed and degraded by ORV activity. With a decrease in ORV activity and no further disturbance, it could once again be a productive raptor area (Garrett, 1976, pers. comm.). This area has also been identified as good chukar habitat (Vernoy, 1976, pers. comm.).

Spangler Hills - This area had the potential for supporting more than one pair of nesting birds in the past, and there are several known eyries. However, the habitat has been severely disturbed by ORV and mining activity. The California Department of Fish and Game has identified this area as good chukar and quail habitat (Vernoy, 1976, pers. comm.)

Trona Pinnacles Area - There are several historical sites in this area, primarily on tufa pinnacles as opposed to cliffs. Productivity of prey species in the surrounding area is probably low.

Christmas Canyon - There is one historical eyrie in this area.

Almond Cove - This is an important foraging area for several species of raptors.

Almond Mountain - There are historical sites in this area, and it has been identified as one of the two areas in the Red Mountain Planning Unit with highest potential for raptor nesting (U.S. Dept. Interior, 1975b).

American Kestrel (Falco sparvenius)

Significance. The American Kestrel (or sparrow hawk) is on the 1975 Blue List of the Audubon Society because numbers have recently declined in isolated areas in the United States (Audubon Society, 1974). It is fully protected under the Migratory Bird Treaty Act (Title 16, U.S.C., 703-711).

Preferred Habitat. Kestrels occur over a variety of terrain in open and semi-open country. They often occur in large numbers in agricultural areas, especially where fence posts and telephone poles provide perches.

Status in EAR Area. The American Kestrel was observed over the Creosote Bush-Fans and Flats Habitat Type but can be expected to occur in all other habitats. Population density in the EAR area is not known and no nest sites have been identified.

Sensitive Habitat. There is no particularly sensitive habitat for the American Kestrel in the EAR area. However, the species generally prefer to hunt in topographically flat, broad terrain or short rolling hills such as in Almond Cove, Golden Valley, Teagle Wash, Searles Valley and the valleys between Red Mountain and the Lava Mountains.

Barn Owl (*Tyto alba*)

Significance. The barn owl is on the 1975 Blue List of the Audubon Society because numbers are decreasing over most of the United States (Audubon Society, 1974).

Preferred Habitat. The barn owl needs some type of thick foliage such as trees or brush for daytime roosting and cavities such as holes in trees, cliffs or earthen banks for nesting. It generally avoids open treeless desert and prefers canyons, cliffs, and escarpments, particularly near semi-permanent streams and springs where there might be some growth of vegetation such as cottonwood trees or willows for roosting areas (Grinnell and Miller, 1944).

Status in EAR Area. The barn owl was not observed in the EAR area but can be expected to utilize all of the habitat types on an infrequent basis. Population levels and nest locations are unknown.

Sensitive Habitat. There is no particularly sensitive habitat in the EAR area for this species.

Burrowing Owl (*Speotyto cunicularia*)

Significance. The burrowing owl is on the 1975 Blue List of the Audubon Society because recent declines in numbers have occurred in the United States (Audubon Society, 1974). The species is fully protected under the Migratory Bird Treaty Act (Title 16, U.S.C., 703-711).

Preferred Habitat. Burrowing owls prefer dry, relatively flat land containing suitable burrows. They are somewhat dependent on larger burrowing animals such as the desert tortoise, badger, kit fox, and coyote in that the owls utilize their burrows for shelter and nesting.

Status in EAR Area. The burrowing owl is considered uncommon in the EAR area although status and conditions of populations are unknown. The species has been observed in the Alkali Sink and Creosote-Fans and Flats Habitat Types and can be expected to occur in the Washes Habitat Type.

Sensitive Habitat. Sensitive habitat for the burrowing owl is associated with the Alkali Sink and Creosote Fans and Flats Habitat Types. A particularly sensitive area is in Almond Cove where there is a large density of burrows available and relatively little human disturbance.

Bewick's Wren (Thryomanes bewickii)

Significance. The Bewick's wren is on the 1975 Blue List of the Audubon Society due to population declines in many parts of the United States (Audubon Society, 1974).

Preferred Habitat. The Bewick's wren breeds in growths of pinon, juniper, mountain mahogany, Joshua tree, and other brushy shrubs. In the winter it is found in thickets of willow, mesquite, catclaw and other types of dense desert vegetation, particularly where they occur along washes (Grinnell and Miller, 1944).

Status in EAR Area. Status of the population in the EAR area is unknown. Bewick's wren was observed in the Wash Habitat Type.

Sensitive Habitat. Although data is not available to establish sensitive areas for this species, areas of particular importance include Teagle Wash, the large wash between the Summit Range and the Lava Mountains, and the larger washes around the Steam Well.

Loggerhead Shrike (Lanius ludovicianus)

Significance. The loggerhead shrike is on the 1975 Blue List of the Audubon Society because numbers are diminishing in the United States (Audubon Society, 1974). Numbers are naturally limited because shrikes are insectivorous and carnivorous and are high in the food chain.

Preferred Habitat. The species is found in open desert flats and mountainous slopes with well-spaced shrubs such as creosote bush, saltbush and sagebrush.

Status in EAR Area. The loggerhead shrike has been observed in the Creosote Fans and Flats, Creosote Rocky Slope, and Washes Habitats and can be expected to occur in all other habitat types. The species is considered to be common throughout the EAR area.

Sensitive Habitat. Although the loggerhead shrike is considered a diminishing species, it is fairly common in the Mojave Desert. The entire area therefore appears to be some of the better habitat available to the species but data are not available to establish any particularly sensitive areas.

Mojave Ground Squirrel (*Spermophilus mohavensis*)

Significance. The Mojave ground squirrel is listed as Rare by the California Fish and Game Commission (Calif. Dept. Fish and Game, 1974). It has a limited geographic distribution and is considered uncommon to rare throughout its geographic range.

Preferred Habitat. The Mojave ground squirrel is found primarily in Creosote Bush Scrub at elevations ranging from 2,500 feet to 4,500 feet, with some occurrence in Saltbush and Blackbrush Habitats (Berry and Wessman, in press).

Status in EAR Area. Mojave ground squirrels have been observed in the EAR area northwest of Cuddeback Dry Lake, near Bedrock Spring, and in Searles Valley, north of the Navy Road. It can be expected to occur in all habitat types throughout the EAR area, although population densities are probably low.

Sensitive Habitat. Basically, the entire Shadscale Scrub and Alkali Sink Habitats of the EAR area are sensitive Mojave ground squirrel habitat in that these habitats are more productive and thus probably support higher densities of this species. The same is true of the Creosote Fans and Flats Habitat of Almond Cove. However, the entire EAR area probably supports a low density population of this species.

Kit Fox (*Vulpes macrotis*)

Significance. The kit fox is fully protected in California by state law (Calif. Fish and Game Code, 1973).

Preferred Habitat. The kit fox is found in a variety of habitats including Creosote Bush Scrub and Saltbush Flats. Their basic requirements appear to be adequate supplies of kangaroo rats and pocket mice for food and soils suitable for excavation of burrows.

Status in EAR Area. The status of kit fox populations within the proposed area is unknown.

Sensitive Habitat. Sensitive habitat of the kit fox is unknown due to the lack of data. Den sites are particularly important but actual locations are unknown.

Ring-tailed Cat (Bassariscus astudus)

Significance. The ring-tailed cat is fully protected in California by state law (Calif. Fish and Game Code, 1973).

Preferred Habitat. The ringtail dwells in rocky and bushy areas such as canyons and cliffs, and are often found near water.

Status in EAR Area. The status of the ringtail in the EAR area is unknown, but it is likely to occur in the rocky areas of Red Mountain, Almond Mountain and the Lava Mountains. The species can be expected to utilize all habitat types except the Alkali Sink.

Sensitive Habitat. Sensitive habitat areas are unknown.

Other Significant Species

Sensitive habitat for the various other significant species is extremely varied and relatively unknown. The immediate area (within 200 yards) around any water catchment (guzzler) or spring, however, is sensitive habitat to many wildlife species, particularly the upland game birds. There are four water catchments, one active spring and one dry spring within the EAR area (Figure 2-25). These water sources are used year around and are especially important during the dry, hot summer months.

Within the EAR area there are 16 species of vertebrates that are partially protected by California State law (Calif. Dept. Fish and Game, 1974). Collection (or bag) limits and/or seasons (specific time of the year when the animal may be taken) have been established for each of these species. Following is a tabulation of these 16 species.

Reptiles (Collection limits)

Banded Gecko (*Coleonyx variegatus*)
Desert Iguana (*Dipsosaurus dorsalis*)
Chuckwalla (*Sauromalus obesus*)
Collared Lizard (*Crotaphytus collaris*)
Leopard Lizard (*Crotaphytus wislizenii*)
Desert Horned Lizard (*Phrynosoma platyrhinos*)
Rosy Boa (*Lichanura trivigata*)
California Kingsnake (*Lampropeltis getulus*)

Birds (Seasons and Bag Limits)

Gambel's Quail (*Lophortyx gambelii*)
Chukar (*Alectoris chukar*)
Mourning Dove (*Zenaida macroura*)

Mammals:

Small Game (Seasons and Bag Limits):
Black-tailed Jackrabbit (*Lepus californicus*)
Cottontail (*Sylvilagus audubonii*)

Furbearers (Seasons):
Gray Fox (*Urocyon cinereoargenteus*)
Badger (*Taxidea taxus*)

Other (Season)
Bobcat (*Lynx rufus*)

In the EAR area the three game birds, chukar, Gambel's quail, and mourning dove are of particular importance because of their recreational value. The former two are non-migratory species with limited home ranges, and all are limited to areas with free water available year round. Areas identified by the California Department of Fish and Game (Vernoy, 1976, pers.comm.) to have good chukar and quail populations are shown in Figure 2-25.

2.3 ECOLOGICAL INTERRELATIONSHIPS

2.3.1 Autecology of Major Species

2.3.1.1 Plant Autecology

Available moisture is usually the most severe limiting factor in the desert. Deserts, by definition, have low amounts of precipitation and extreme temperatures with evaporation rates usually very high due to long days with intense sunshine. Thus desert plants must be able to survive on relatively low amounts of moisture.

Odum (1971) states that there are three plant life forms that are found in deserts. These are ephemeral annuals, succulents, and desert shrubs that have a variety of adaptations to xeric environments. Perennial grasses make up a fourth form that is common in high deserts such as the Mojave.

Ephemeral annuals are completely dependent upon favorable precipitation. Without it, they do not appear; their seeds remain dormant for several years until there is enough moisture to soak through the seed coat and germinate the seed. Obviously, late winter and early spring rains are imperative. Recent research indicates that fall rains may be equally important (Beatley, 1974). It has been noted that spring rains without fall precipitation may not induce the ephemeral desert bloom.

Succulent plants store large amounts of water during moist periods and use these supplies slowly during dry times. Cacti, of course, are probably the best known of the desert succulents, but are not common in the EAR area.

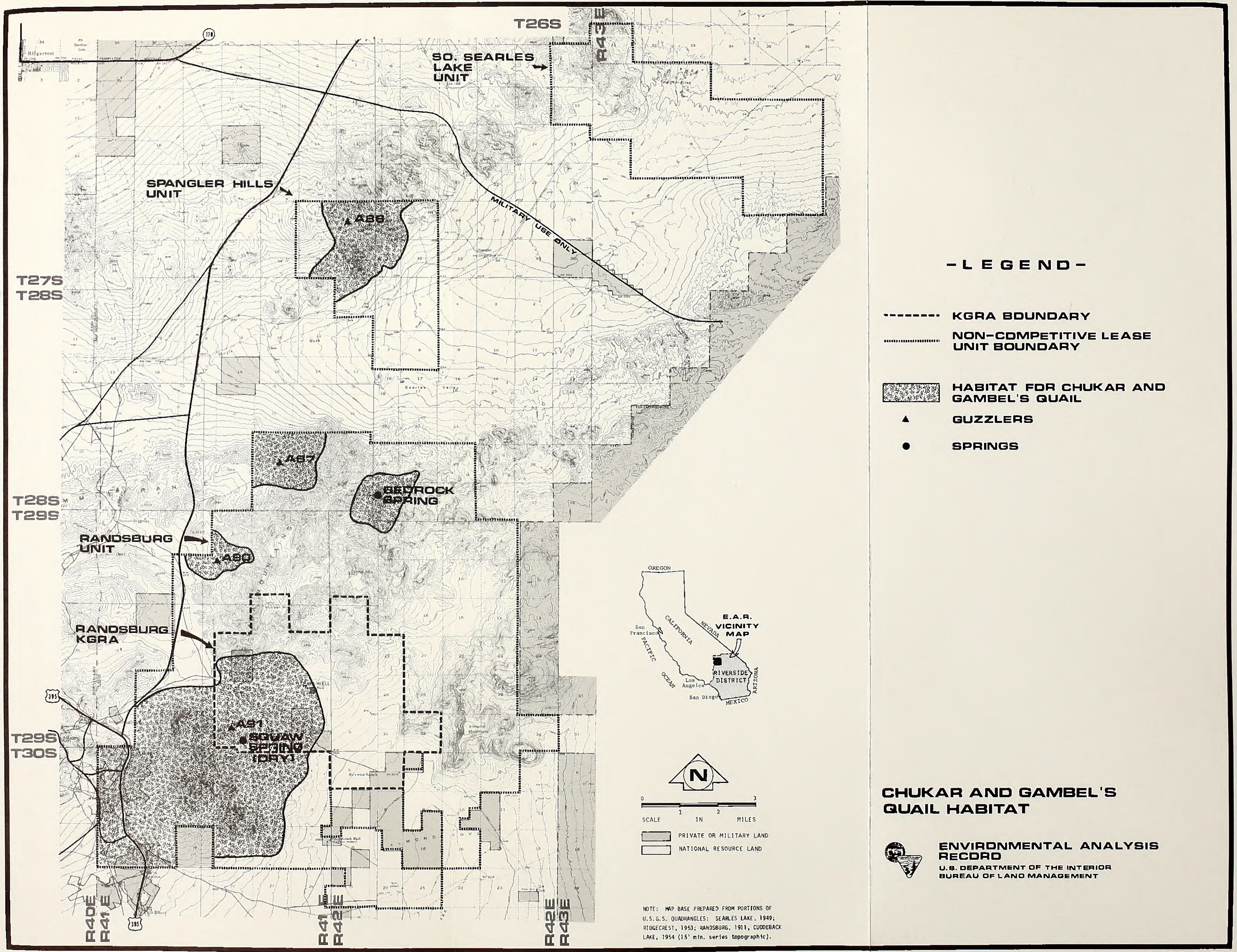

T26S
R43E
SO. SEARLES LAKE UNIT
SPANGLER HILLS UNIT
A86
MILITARY USE ONLY
T27S
T28S
A87
BEDROCK SPRING
T28S
T29S
RANDSBURG UNIT
A90
RANDSBURG KGRA
A91
SQUAW SPRING (DRY)
T29S
T30S
R40E
R41E
R41E
R42E
R42E
R43E
OREGON
NEVADA
CALIFORNIA
San Francisco
PACIFIC
OCEAN
Los Angeles
San Diego
MEXICO
ARIZONA
RIVERSIDE DISTRICT
E.A.R. VICINITY MAP
N
SCALE IN MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
HABITAT FOR CHUKAR AND GAMBEL'S QUAIL
GUZZLERS
SPRINGS
CHUKAR AND GAMBEL'S QUAIL HABITAT
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-25

Desert shrubs have developed many means of surviving in the desert. All have small leaves which have a minimum of transpirational surfaces. Thus they lose a minimum of water via evaporation and transpiration. Most have other adaptations which further reduce water loss, including waxy, water repellent covers on leaves and the loss of some or all of their leaves during dry seasons. Most shrubs have developed shallow root systems because most of the rain that falls on the area is light and does not penetrate deeply into the soil. An exception to this are the plants of the Alkali Sink which have developed longer root systems. Water is available here but it is quite alkaline, and plants must be adapted to make use of it.

Due to the small quantity of available water, all desert shrubs are very slow growing. For example, a mature creosote bush can be 500 years old; some may be several thousand years old.

Many shrubs have devices to protect them from animals. Creosote bush is extremely unpalatable to ungulates. Other shrubs, are armed. Examples of these are boxthorn, peachthorn, Mojave horsebrush, hopsage, and shadscale.

Cool season perennial grasses* such as desert needlegrass, Indian ricegrass, Malpais bluegrass, and squirreltail avoid the summer drought and heat by becoming dormant. Most of their growing occurs in the cool, moist spring, at which time they store starch in their roots. In late spring or early summer, when their seed heads are mature, they die back to their crown, living on the stored starch until growth is again initiated. This gives the grasses some protection from grazing. They cannot be harmed by grazing during dormancy

* No warm season grasses were observed in the subject area.

(late summer, fall*, and winter). They are, however, vulnerable to grazing animals in the spring, especially during their initial (incipient) growth period.

Sometimes these very adaptations to arid conditions make the plants vulnerable to disturbance by man. Once removed, the slow growing shrubs may take hundreds, even thousands of years to return (Vasek, and others, 1975a). The perennial grasses, simply because they can exist in the desert, are grazed by man's livestock. This, in itself, is not harmful, but overgrazing is detrimental.

2.3.1.2 Animal Autecology

Animals attempting to exploit the harsh desert environment face many unique problems. These include (1) the need to acquire food in an environment in which productivity is low, highly seasonal, and may fluctuate greatly from year to year; (2) the need to acquire and conserve water in a seasonally hot environment in which very few sources of free water are available; (3) the need for cover in an environment in which vegetation is generally sparse; and (4) the need to maintain body temperatures between well-defined physiological limits in an environment with extreme daily and seasonal temperature fluctuations. These problems and the physiological, anatomical, and behavioral adaptations that have allowed animals to overcome them will be discussed separately.

* Sometimes there is enough fall precipitation to initiate growth, but this "fall greenup is usually very minor".

Food - Food availability is a limiting factor for populations of many desert species. Plant productivity is not sufficient to support large populations of herbivores year round. Because food availability is greatest in the spring when annuals are growing and blooming, activity of herbivorous animals is highest during this season. For example, the Mojave ground squirrel is out of hibernation only during the spring and early summer. During this short period of high primary productivity this squirrel manages to reproduce and store enough body fat to maintain it through the summer, fall, and winter.

Herbivorous reptiles such as the desert iguana and chuckwalla are also most active at this time because their food supply is readily available.

Herbivorous desert rodents, such as kangaroo rats and pocket mice, are active throughout the year but become most active during the spring when seeds are readily available. Many migratory birds also utilize these seeds as a source of food in the spring.

Spring productivity and moisture also result in higher concentrations of insects as an available food source, and migratory birds as well as many lizards and small snakes utilize this food source. One rodent in the EAR area, the grasshopper mouse, is primarily carnivorous and feeds heavily on insects.

Populations of carnivores, such as coyotes, foxes, raptors, and snakes are regulated by the availability of prey. Coyotes and foxes are known to feed on almost any available source of animal matter, from large insects and lizards to carrion of large animals. Snakes feed primarily on large insects, lizards and rodents, all of which are more available during the spring. Raptors include eagles, hawks, falcons and owls. Eagles and hawks consume primarily the diurnal rodents and reptiles, whereas the prairie falcon will feed primarily upon birds where appropriate prey species are found in good densities. Owls feed on nocturnal rodents such as kangaroo rats, pocket mice and woodrats. Prey for all of these birds is more abundant and more readily available during the spring.

Unlike spring, the remainder of the year is the period of food shortages, with many desert animals becoming relatively inactive. Some, such as the Mojave ground squirrel, go into hibernation while others will greatly reduce their activities to conserve energy. Reptiles will usually become inactive during summer or early fall and not be seen again until the following spring.

Many birds inhabit the desert only during the more favorable times of year and migrate to more favorable areas as the food supply diminishes. Some birds, however, such as sage sparrows and horned larks remain in the desert year round and must cope with the less favorable seasons. During these seasons, these remaining birds must survive primarily on dried seeds, and insects. However, competition for this remaining food supply is reduced since most of the migratory birds are gone.

Rodent activity is somewhat reduced during these times but many rodents are out and utilizing whatever food they might find. Kangaroo rats, which are primarily seed eaters, often eat other plant materials as the dry seeds of summer become more scarce. Pocket mice become almost completely inactive during winter. Some rodents have developed the ability to use food sources not considered available to other animals. For example, the desert woodrat is capable of metabolizing the oxalic acid which makes cacti inedible to most other animals. Some mammals, particularly seed eating rodents, will store food in caches for periods of low food availability.

Migration and reduced activity greatly reduces the availability of prey for the carnivores and many raptors migrate to more favorable areas as the food supplies diminish. Snakes, like other reptiles, become inactive during these periods. Mammalian carnivores, such as coyotes and foxes, remain active throughout the year. These animals may forage over larger areas during this period and shift to less desirable food or to prey species that are more difficult to catch.

Water - Throughout the EAR area free-water is scarce, and many desert animals obtain all the water they need from their diet. Others will drink water if it can be found even though they do not seem to require it. Some need to drink free-water at regular intervals in order to survive.

Most desert mammals and reptiles use very little water for evaporative cooling. Similarly, desert mammals, birds, and reptiles minimize water loss from excretion by excreting either highly concentrated urea (mammals) or uric acid (birds and reptiles).

Many desert animals are either nocturnal or active during the early morning or evening hours (crepuscular). This is true of most rodents, snakes, owls, and large carnivores. By remaining inactive during the hot dry daytime, loss of body water is minimized. Many animals spend the day in burrows in the ground, where the air is more humid and thus respiratory water loss is reduced. Then at night, when the animals are active, the humidity is higher and respiratory water loss is low.

Herbivorous lizards and many small rodents gain sufficient water from the plant materials they consume.

Insectivorous reptiles and birds can acquire significant moisture from the insects they eat. Birds will often supplement this moisture through drinking free-water when it can be found.

Desert carnivores, including coyotes, foxes, raptors and snakes can usually obtain all of the moisture they require from the bodies of their prey.

Many desert animals which require free drinking water can be found only within the vicinity of a water source. Thus natural springs and man-made water developments support a high density and diversity of animal species. In particular, many birds require free-water, and often require it daily during the summer. The game birds in the area all require free-water. Whereas, some species such as the doves will fly many miles to water, others such as the quail and chukar will not. Thus, the amount and distribution of sources of free-water can limit the distribution and density of these species.

Cover - Desert animals need cover not only to shelter them from the extreme heat of summer and the extreme cold of winter, but also for protection from predators. For many small animals, especially rodents, burrows provide a common form of shelter and provide a valuable source of refuge in the desert where above-ground shelter is usually limited. Burrows are dug into the damper earth and provide cool, humid shelter from the desert heat. They are most commonly dug around or underneath desert shrubs. These shrubs serve to conceal and protect the burrows from larger predators and provide cooling shade and a potential source of food. Some species of lizards, such as the desert iguana, are known to dig their own burrows, while others utilize abandoned rodent burrows. Snakes often seek shelter in rodent burrows and are known to enter burrows in search of prey. Burrow use among birds is not common, except for the burrowing owl. This small owl lives in the abandoned burrows of large rodents. Badgers and kit foxes are two larger mammals that dig and live in burrows.

Rocky areas in the desert can provide refuge for many animals. Some species of desert animals such as the chuckwalla and the canyon mouse are found exclusively within these rocky areas. Others such as the collared lizard, speckled rattlesnake, desert woodrat, and antelope ground squirrel commonly use rocky areas for shelter and/or hunting.

Birds will sometimes nest in rocky areas. Raptors in particular prefer to construct their nests on inaccessible rocky cliffs. Prairie falcons, in particular, only nest in specific cliff areas, which are used year after year.

<u>Thermoregulation</u> - Thermoregulation, the maintenance of an optimal body temperature, is a critical problem for wildlife in the desert. During the colder periods of the year most desert reptiles remain inactive and are generally unable to achieve a body temperature high enough for activity. As the season progresses and temperatures rise, reptiles can become active. Reptile activity during the day is dependent upon daily temperatures; however, reptiles can

often raise their body temperature above or below the ambient temperature through behavioral and morphological adaptation.

Most mammals and birds, on the other hand must maintain their body temperature within a fairly narrow range of temperatures. During cold times most desert mammals will utilize shelter as well as the insulating qualities of their fur and fat to minimize heat loss. Many desert mammals, including the Mojave ground squirrel, will go into hibernation during the more adverse times of the year. During warmer weather mammals must keep their body temperatures from rising while conserving as much moisture as possible. Many desert mammals, such as kangaroo rats, pocket mice, woodrats, coyotes and foxes are primarily nocturnal. This places their highest activity periods during the evening when temperatures are lower and they can avoid overheating problems. Diurnal animals, on the other hand must deal with extreme daytime temperatures. Diurnal species such as the antelope ground squirrel will utilize shade from the sun whenever possible; however, they rely mostly on a number of anatomical adaptations to survive direct exposure to the extreme temperatures.

2.3.2 Synecology

2.3.2.1 General

All living things are organized into mutually interacting ecosystems. Each biological organism, as well as non-living factors such as soil, climate, and atmosphere, are integral components of the ecosystem. All exert effects, either directly or indirectly, on all others. The biological components, whether plant or animal, all have limits of tolerance; limits within which they can be affected by other things and still be successful. These limits are termed limiting factors.

This discussion will first consider the major limiting factors in the area; those which impact all ecosystems. Then the specific communities will be treated individually.

Water, of course, is the most important limiting factor. All organisms must have adaptations to be able to successfully cope with the extremely xeric conditions in the desert. Some of these adaptions have been discussed above under autecology. In spite of nature's devices to enable plants and animals to live on small quantities of water, population densities are very low and plant cover is very low compared to non-desert areas. Animal populations are likewise small.

Radiant energy, in the form of light from the sun, is the ultimate source of all energy used by all biological components of any ecosystem. Green plants utilize photosynthesis to convert this radiant energy to chemical energy (starch, cellulose, etc.). Thus, they are the primary producers; they are at the bottom of the food chain. Not enough sunlight is rarely, if ever, a limiting factor in the subject area. The tolerance for sunshine is often exceeded, however, and too much radiant energy becomes a limiting factor. The vegetation uses a very small amount, and some is absorbed by the ground. Most, however, is dissipated as heat. This results in an extremely high rate of evaporation, thus aggravating the moisture limiting factor. Heat becomes intense, dessicating plants and making conditions deadly for animals. Fortunately, the vegetation that does manage to persist protects animals from the sun. They could not survive without it. Leopard lizards, for example, commonly sit in the sparse shade of a shrub until prey happens by and then attack. Still, all plants and animals must be able to withstand or avoid extremely high temperatures to be successful.

The sparseness of vegetation is a very severe limiting factor because animals depend upon vegetation for food and habitat. As stated above, plants are the primary producers. Primary consumers, the herbivores, must depend upon the plants for food. Antelope ground squirrels, for example, live on seeds and fruits from cacti, Russian thistle, four o'clock, and saltbush. Black-tailed jackrabbits live on foliage from grasses, buckwheat, saltbush, rabbitbush, and filaree.

Animal habitat provided by plants is perhaps equally as important as food. Small rodents make their burrows at the base of the larger shrubs, and the shrub roots hold soil in place, making the burrows easy to maintain. These roots may also slow predators' attempts to dig out the occupants in the burrows.

The relatively small population of herbivores is a limiting factor upon the secondary consumers, the predators. The amount of prey is very limited and therefore, there is enough food for only a few predators. Red tailed hawks are the most common raptor, yet there are probably less than a dozen of them in the entire area.

Domestic livestock are a new limiting factor. Introduced relatively recently (1860), they have significantly altered the ecosystems in the area. Grazing livestock are selective in their eating habits, eating one plant species and not another and giving the latter plant the advantage over the former. Cattle feeders found native Indian ricegrass extremely palatable. The high presence but low cover of this grass on some plant communities, notably the Transitional Shrubland and the Alkali Sink, suggest that there once may have been much more of this grass. Merino sheep from Spain carried the seeds of several exotic annual plant species in their wool, including red brome, cheatgrass and filaree. These vigorous, aggressive annuals quickly filled any niche left open by the loss of native species; they also may have exerted enough pressure on the native species to take over areas without any help.

The combination of grazing and pressure from exotics, notably red brome, may have greatly diminished the amount of Indian ricegrass. At any rate the introduction of exotic animals and plants has caused dramatic, irreversible changes.

Populations of plants and animals are kept low by limiting factors. It is of paramount importance, however, to realize that all ecosystems in the subject area are saturated by individuals of a given species at a given time.

2.3.2.2. Synecology of Creosote Bush Scrub Community

Soil, water and temperature are interacting limiting factors which are responsible for this large, heterogeneous habitat type. Its variability is due to the fact that there are many soil types present. These soils have in common the facts that they are unconsolidated alluvium, poorly developed, relatively shallow, coarse textured and have only a slightly basic pH. They become finer and more alkaline as the Creosote Bush Scrub grades into the Shadscale Scrub. Creosote bush and the plants associated with it are the most successful vegetation under these climatological and edaphic conditions and, therefore, these plants dominate.

This is the most important community in the area for livestock forage. The gentle topography and relatively high amounts of forage in favorable years are conducive to livestock grazing.

On the basis of the existence of known selenium-tolerant plants, it is speculated that the forb inclusion in the Creosote Bush Scrub may owe its existence to a high amount of selenium in the soil. Previous experience would indicate that the source of the selenium is the local, soil parent material; however, soil tests are needed to confirm this.

Selenium is toxic to most plants, as well as to livestock which ingest the resistant plants. A normal Creosote Bush Scrub Community is found on alluvial deposits that have covered the possibly poisoned soil.

Two major wildlife habitat types have been identified in the Creosote Bush Scrub Community. These are the Creosote Flats and Fan Habitat Type and the Creosote Rocky Slope Habitat Type. These will be considered separately.

The Creosote Flats and Fans Habitat Type probably has a higher primary productivity than the Creosote Rocky Slope with which it is associated. Many small rodents are found here, generally burrowing under creosote bush or other shrubs. Desert tortoises and Mojave ground squirrels are known to occur throughout the habitat type. Kit foxes, ringtail cats, and badgers are also to be expected. This habitat type is probably the major hunting area for hawks which nest on the slopes above.

The production of ephemeral annuals is very high during springs when favorable precipitation has fallen. There is an abundant supply of food for both wildlife and livestock. At other times forage is quite limited.

Primary productivity in the Creosote Rocky Slope Habitat Type is probably lower than any of the other habitat types in the area. Water availability is low on these slopes due to extremely high insolation (large amounts of sunlight on the earth's surface) and considerable water loss from evaporation and transpiration. Large amounts of bare rock in the habitat results in considerable water loss due to runoff. This effect may be reduced when there are cracks and sand-filled holes into which water may drain and be retained.

The cover provided by rocks, with their holes and caves, is very valuable to some types of animals. Non-digging carnivores such as ringtailed cats and spotted skunks utilize these places for dens and range into adjacent areas from these dens. Many reptiles utilize the rocky areas for feeding and shelter and they often spend the winter in deep fissures in the rocks. Several raptor eyries were located on larger rocks and cliffs in this habitat type.

The relative isolation from human disturbance is another value of this area. This isolation aspect is of particular importance to nesting raptors and other species that are easily disturbed by human activities.

2.3.2.3 Synecology of the Transitional Shrubland Community

This area is more mesic than the Creosote Brush Scrub. It has a higher elevation and often is situated on a north facing slope. Therefore, it has a greater plant diversity. Many of the plants in this community need more water than those in the Creosote Bush and plant growth is often extended longer into the summer than in the lower community. Soils are extremely thin and rocky. This community is important for wildlife but is generally too rugged for livestock grazing.

The Transitional Shrubland contains two major habitat types. The first is the Transitional Shrub Habitat Type, which encompasses most of the community, and the second is the Wash Habitat Type. This type is small but highly important from a wildlife standpoint.

The ecosystem of the Transitional Shrub Habitat Type is similar to the Creosote Rocky Slope. It provides feeding and refuge for many animals and, like the lower community, is generally inaccessible to vehicular travel and provides secluded nesting areas for raptors.

The Wash Habitat Type supports more luxuriant vegetation than surrounding areas because the washes are more mesic. More water is present and it is available for a longer period of time. The sand in these dry stream beds permits good water penetration and also acts much like mulch to prevent evaporation of soil moisture. The more constant moisture supply makes plant growth possible during the summer and fall when plants in the surrounding areas are dormant. This growth makes food available in washes to herbivores and insectivores during these seasons, and this results in higher animal densities. Washes also provide resting places for small migratory birds such as warblers, which frequent this habitat when food supplies elsewhere in the desert are scarce.

The washes are of particular importance during times of drought. Little or no plant growth will occur in the remainder of the desert, and this will cause animal populations to be decimated. Sufficient water for plant growth, however, may accumulate in the washes, and remnant populations of animals can therefore survive in them. These populations will serve to re-establish the species in surrounding areas when the drought ends.

Several species of birds known to occur in this region were sighted only in this habitat. A verdin nest was seen in a large creosote bush by a wash near the Steam Well. A Bewick's wren was observed in a rubber rabbitbrush bush in a wash extending north out of the Lava Mountains. This possibly delining species can be expected only in thick vegetation. The Mojave ground squirrel also occurs in this same wash.

In general, the same species of reptiles and mammals occur in washes as in neighboring areas although some lizards which prefer more open areas, such as the desert iguana and the zebra-tailed lizard, may be found along sandy washes in rocky canyons.

In summary, this habitat type is one of the most important in the subject area.

2.3.2.4 Synecology of the Shadscale Scrub Community

This community is situated on well-drained, moderately saline soils. Most of the salts are composed of sodium chloride and calcium carbonate. This is a major limiting factor here because only salt tolerant plants such as desert holly, shadscale, and inkweed can survive in much of this area. As discussed previously, there is no sharp hiatus between the Creosote Bush Scrub and the Shadscale Scrub. They grade into one another because the soil becomes saltier on a gradient. As the salt increases, creosote bush becomes more sparse and finally disappears. Conversely, desert holly and shadscale tend to increase.

The Shadscale Scrub is of minor importance for livestock because of the small number of forage species. This habitat type in turn comprises a single wildlife habitat type.

Due to the low cover of vegetation, this community supports a relatively low density of rodents and lagomorphs. Nevertheless, these animals provide an important source of food for carnivores such as kit foxes and golden eagles. Prairie falcons and Mojave ground squirrels, both rare species, also find habitat here. Two other species, the desert kangaroo rat and the Great Basin kangaroo rat, are also found on saline sites such as this and the Alkali Sink.

2.3.2.5 Synecology of the Alkali Sink Community

This habitat type is sharply distinguished from all others because of two limiting factors: extremely poor drainage and very saline soil. The salts, along with borax, severely limit vegetation in the area. Some plants such as shadscale and allscale saltbush are favored by these limiting factors because they are able to utilize alkaline water. There usually is a good supply of such water in this area.

This is a fair area for livestock grazing. Despite the alkali, many ephemerals can survive with favorable rainfall, and there is a moderate amount of Indian ricegrass.

It is also a fair habitat for wildlife. There is a moderate density of rodents and lagomorphs which in turn are an important food source for carnivores, especially raptors such as golden eagles.

2.4 HUMAN VALUES

2.4.1 Aesthetics

2.4.1.1 Visual Overview

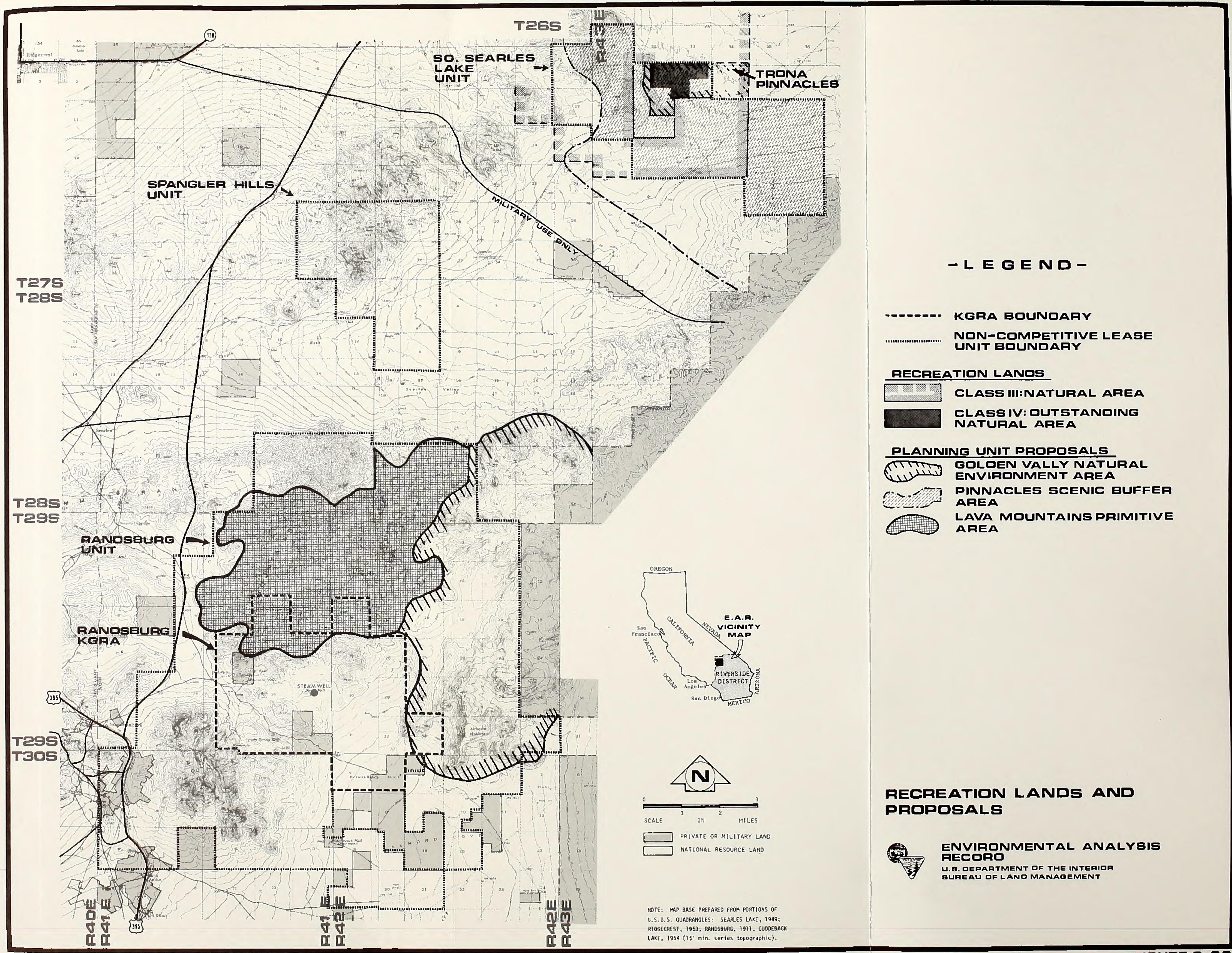
To provide a visual overview of the study area, identifiable features in the landscape have been catalogued with photographs and brief descriptions of location, landform, intrusions, and distinctive features. Figure 2-26 indicates the location of each landscape feature. The visual cones shown on Figure 2-27 indicate the location and orientation of each of the photographs which follow the map.

The EAR area is unique in the context of the California High Desert and includes several distinctive areas. One of these is the Trona Pinnacles, possibly the only pinnacles of their composition in the world. Another area

PHOTO 1

RED MOUNTAIN

LOCATION: One mile east of the town of Red Mountain, which is located on Highway 395.
LANDFORM: Mountainous with many and varied topographical features.
INTRUSIONS: None to speak of. A few roads into the foothills and a few abandoned mines.
DISTINCTIVE FEATURES: Outstanding coloration, lack of intrusions, and sheer physical presence.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RANOSBURG KGRA
STEAM WELL
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T30S
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R42E
R43E
OREGON
NEVADA
CALIFORNIA
San Francisco
PACIFIC OCEAN
Los Angeles
San Diego
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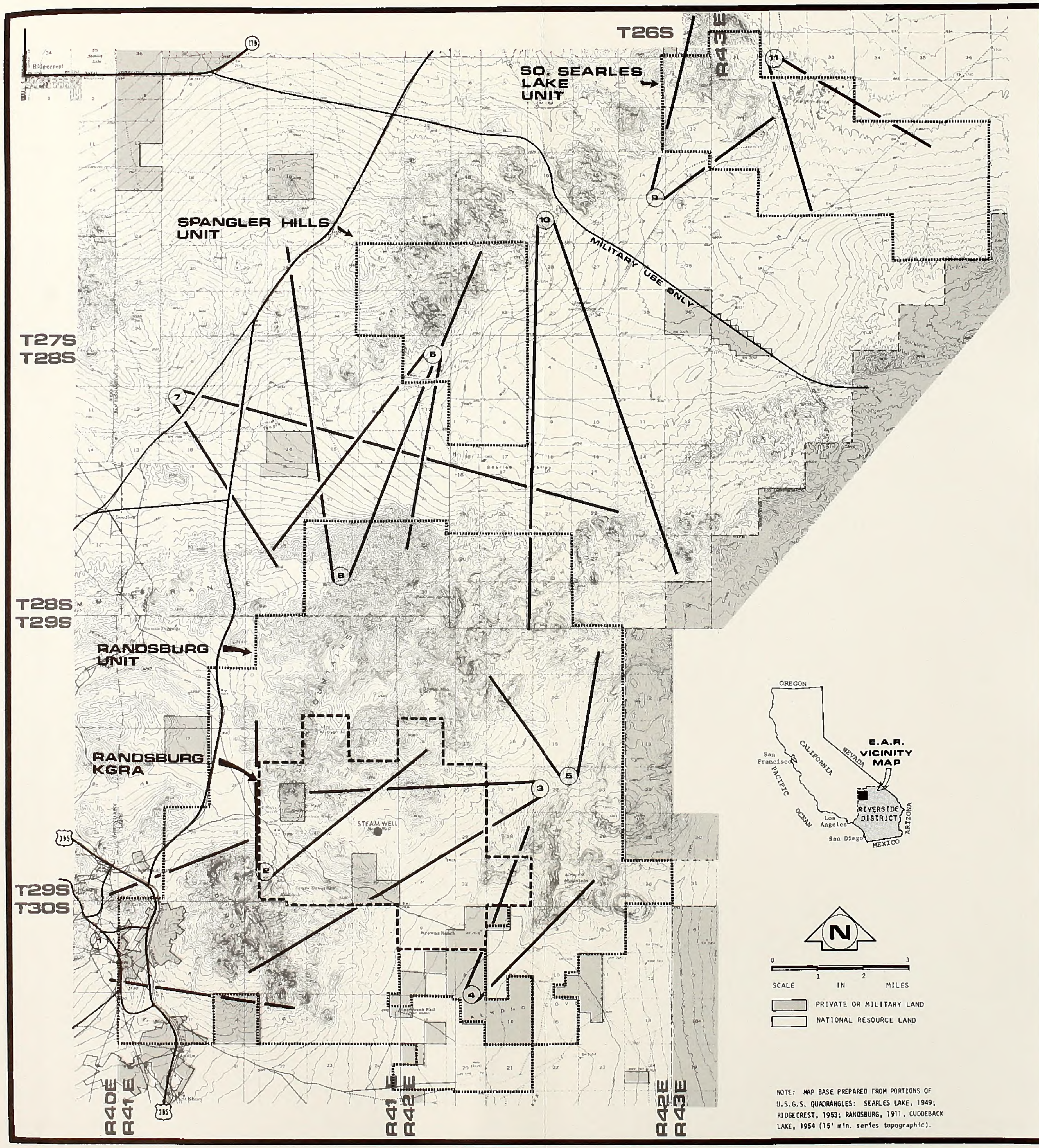
SCALE IN MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
-LEGEND-
KGRA BOUNOARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
RECREATION LANOS
CLASS III:NATURAL AREA
CLASS IV: OUTSTANOING NATURAL AREA
PLANNING UNIT PROPOSALS
GOLOEN VALLY NATURAL ENVIRONMENT AREA
PINNACLES SCENIC BUFFER AREA
LAVA MOUNTAINS PRIMITIVE AREA
RECREATION LANDS AND PROPOSALS
ENVIRONMENTAL ANALYSIS RECORO
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LANO MANAGEMENT

FIGURE 2-26



-LEGEND-

KGRA BOUNDARY

NON-COMPETITIVE LEASE UNIT BOUNDARY

VISUAL (photo) CONES

orientation of view in photo

Number of photo and location from which photo was taken.

LOCATION AND ORIENTATION OF PHOTO CONES

ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-27

PHOTO 2

LAVA MOUNTAINS

LOCATION: North of Red Mountain and bordered by Trona Road on the west.
LANDFORM: Mountainous with many and varied topographic features.
INTRUSIONS: None to speak of. A few roads into the foothills and washes on the northeast end.
DISTINCTIVE FEATURES AND REMARKS: Due to the pristine nature, excellent coloration, and diverse vegetation, the BLM's Red Mountain Management Framework Plan (U.S. Dept. Interior, 1976) has established the Lava Mountains Primitive Area (Figure 2-26) which limits allowable land-use activities in the area to those of a non-consumptive nature.

PHOTO 3

ALMOND COVE

LOCATION: Bordered by Red Mountain on the west, the Lava Mountains on the northwest, and Almond Mountain on the north.
LANDFORM: Large flat area sloping toward Cuddeback Lake to the southwest.
INTRUSIONS: Some roads, abandoned mines, ranching operations, ORV camping and staging areas and fairly heavy ORV activity.
DISTINCTIVE FEATURES: Excellent vantage point of the surrounding desert landscape.

PHOTO 4

ALMOND MOUNTAIN

LOCATION: Six miles east - northeast of Red Mountain
LANDFORM: Mountainous with some steep faces but generally of a rounded character.
INTRUSIONS: None evident.
DISTINCTIVE FEATURES AND REMARKS: Very dark coloration from basaltic origins. Essentially barren. Almond Mountain is included in the Golden Valley Natural Environment Area (Figure 2-26).

PHOTO 5

GOLDEN VALLEY

LOCATION: Between the Lava Mountains and Almond Mountain.
LANDFORM: Small, flat-bottomed valley surrounded by mountains and hills.
INTRUSIONS: One road and some evidence of ORV's.
DISTINCTIVE FEATURES AND REMARKS: Golden Valley is a unique landform with an outstanding desert wildflower display and appears to have largely escaped the impacts of visual intrusions. Golden Valley is included in the Golden Valley Natural Environment Area.

PHOTO 6

SUMMIT RANGE OF THE LAVA MOUNTAINS

LOCATION: Extends east-west on the northern end of the Lava Mountains and forms the southern boundary of Teagle Wash.
LANDFORM: Low rugged hills with deep drainages.
INTRUSIONS: Some roads, abandoned mines, motorcycle camping and staging areas, and evidence of very intense motorcycle activity.
DISTINCTIVE FEATURES AND REMARKS: The Summit Range is distinctive due to the landform itself and the presence of Joshua trees, which appear nowhere else in the surrounding area.

PHOTO 7

TEAGLE WASH

LOCATION: Extends west to east with the Summit Range on the south and the South Spangler Hills on the north.
LANDFORM: Wide, gently sloping drainage basin.
INTRUSIONS: Some roads, a single-track railroad, an underground pipeline, several motorcycle camping and staging areas, and evidence of very intense motorcycle activity are present.
DISTINCTIVE FEATURES: The landform itself. Teagle Wash with its consistent slope and texture gives one the impression of being horizontal and thus induces mild vertigo in some individuals.

PHOTO 8

SOUTH SPANGLER HILLS

LOCATION: South of the Navy Road and east of the Trona Road.
LANDFORM: Rolling hills with some steep faces and narrow passes and canyons.
INTRUSIONS: Many roads and abandoned mines. Evidence of intense motorcycle activity is present throughout the entire area. An underground pipeline is present along the western edge.
DISTINCTIVE FEATURES: Boulder fields and a motorcycle camping and staging area occur on the northwest side.

PHOTO 9

NORTH SPANGLER HILLS

LOCATION: South of Highway 178 and north of the Navy Road. Part of the western boundary of Searles Valley.

LANDFORM: Rolling hills with wide open slopes entering into and between them.

INTRUSIONS: Minimal impact by ORV's. Few roads and some abandoned mines are present.

DISTINCTIVE FEATURES AND REMARKS: Due to their location in the immediate vicinity of the Trona Pinnacles, parts of the North Spangler Hills are of special interest. (See following, discussion of Trona Pinnacles).

PHOTO 10

SEARLES VALLEY

LOCATION: Between Searles Lake on the north and the Lava Mountains on the south.

LANDFORM: Broad desert valley bordered by and including desert mountains and hills.

INTRUSIONS: Navy Road divides the valley with some roads on the north and more roads and heavy motorcycle activity on the south. A single-track railroad runs along the entire western side of the valley.

DISTINCTIVE FEATURES AND REMARKS: The Trona Pinnacles are located in Searles Valley. Thus, parts of Searles Valley in the vicinity of the Pinnacles are of special interest to the Department of the Interior and the BLM. (See following, discussion of Trona Pinnacles).

PHOTO 11

TRONA PINNACLES

LOCATION: South of the town of Trona in Searles Valley and directly to the east of the North Spangler Hills.

LANDFORM: Vertical spires of tufa projecting from an ancient lake bed.

INTRUSIONS: Minimal - some roads and a single track railroad nearby.

DISTINCTIVE FEATURES AND REMARKS: The Trona Pinnacles are best viewed from a distance because only from a distance can one appreciate the spectactular contrast of these spires against the broad flatness of Searles Valley. The integrity of Searles Valley with its general lack of intrusions is essential to the overall setting and significance of the Pinnacles.

The Trona Pinnacles have been designated by the Department of the Interior as Recreation Lands (43 CFR 2070). Within this designation the Pinnacles and their immediate vicinity, encompassing a total of 720 acres, are Class IV Recreation Lands (Outstanding Natural Area). The remaining 19,500 acres surrounding the Pinnacles, including parts of the North Spangler Hills and Searles Valley, are Class III Recreation Lands (Natural Environment Area, Figure 2-26). No specific land uses are stipulated for this area. However, implementation of the proposal by the BLM in their Red Mountain Management

Framework Plan (U.S. Dept. Interior, 1976), to establish a Trona Pinnacles Outstanding Natural Area and a Trona Pinnacles Scenic Buffer (Figure 2-26) stipulates limiting activities in these areas to strictly non-consumptive uses.

of interest is the Lava Mountains with its large roadless and essentially pristine areas. This is one of the few remaining areas in the desert which has thus far not suffered the widespread impacts of ORV's. Within the Lava Mountains are areas of unusual vegetative variety such as the ephemeral display in Golden Valley. These and other features make the desert landscape of the EAR area unique from an aesthetic viewpoint.

2.4.1.2 Concepts and Study Methodology

A three-phase inventory process has been used in this aesthetic evaluation: (1) an evaluation of scenic quality; (2) a determination of visual prominence zones; and (3) an evaluation of visual sensitivity. Also considered were the types of viewers and the number of viewers at various locations.

The scenic quality of this area is a function of the landscape features present (landform, vegetation, and water), the visual characteristics of those features, the extent to which they have been modified by human intrusion, and the relative uniqueness of these features within the region. This phase of the study is an evaluation of the relative inherent scenic quality of the physical landscape without consideration of the potential viewer.

The BLM's standard Recreation Information System (RIS) methodology for rating scenic quality was used for this portion of the aesthetic evaluation (Appendix C, Table C-1).

Determination of the visual prominence zones is important because the visibility of man-introduced features (visual intrusions) in the desert landscape are dependent in large part upon the type of topography they are situated in. For the purposes of this study three visual prominence zones have been identified. These three zones are: (1) high visual prominence; (2) moderate visual prominence; and (3) low visual prominence (Appendix C). Distance from the object being viewed also determines visibility. But because of the open nature of the desert and the great number of roads and viewing points, distance zones were not felt to be a valid determining criteria of visibility for this study.

Visual sensitivity is a measure of the related conditions about the viewer and the scene he views which contribute to the viewer's response to that scene.

Five criteria were identified as being key determinants of visual sensitivity for this study. These include: (1) highway and road-use volume; (2) recreation-use volume (trails, water bodies, facilities, etc.); (3) general social attitudes toward notable intrinsic resources (potential primitive, natural and cultural areas); (4) community land uses, relationships, attitudes, etc., considering all private uses of the land; and (5) relationships and plans of other governmental agencies (Table C-2).

Once the results of the inventory of the existing environment have been compiled and mapped, the Visual Resource Management (VRM) Objective Classes are determined. This is done by overlaying the visual prominence, visual sensitivity, and scenic quality maps and then analyzing the results with the use of a 3-way matrix (Appendix C). Each of the five management classes indicates a different level of management for the retention or rehabilitation of the existing visual qualities.

2.4.1.3 Inventory Results

The results of the inventory of the existing environment are presented in Figures 2-28 through 2-31.

Scenic quality classes are shown on Figure 2-28. Areas of Class A scenery (most scenic) abound in this part of the desert due largely to the uniqueness of some features and the inaccessibility and therefore pristine qualities possessed by others. The primary example of uniqueness in this area are the Trona Pinnacles. The Trona Pinnacles are best viewed from a distance because only from a distance can one appreciate the spectacular contrast of these spires against the broad flatness of Searles Valley. The integrity of Searles Valley with its general lack of intrusions is essential to the overall setting and significance of the Pinnacles. Therefore, this combined area has been rated as a Class A Scenic Quality Zone. This zone extends to a five-mile radius around the Pinnacles except where the view to or from the Pinnacles is broken by the existing landforms. The five-mile limit is based on the BLM's adopted foreground-middleground distance zone, within which views are most critical (U.S. Dept. Interior, 1975c, 6310.13).

Another area of Class A Scenic Quality is the Lava Mountains Area, encompassing the Lava Mountains, Almond Mountain, and Golden Valley. The minimal visual intrusions, excellent coloration, unique vegetation, and varied topography of this area make it outstanding in the desert landscape.

The only other area of Class A Scenic Quality is Red Mountain with its vivid and varied coloration and outstanding landform.

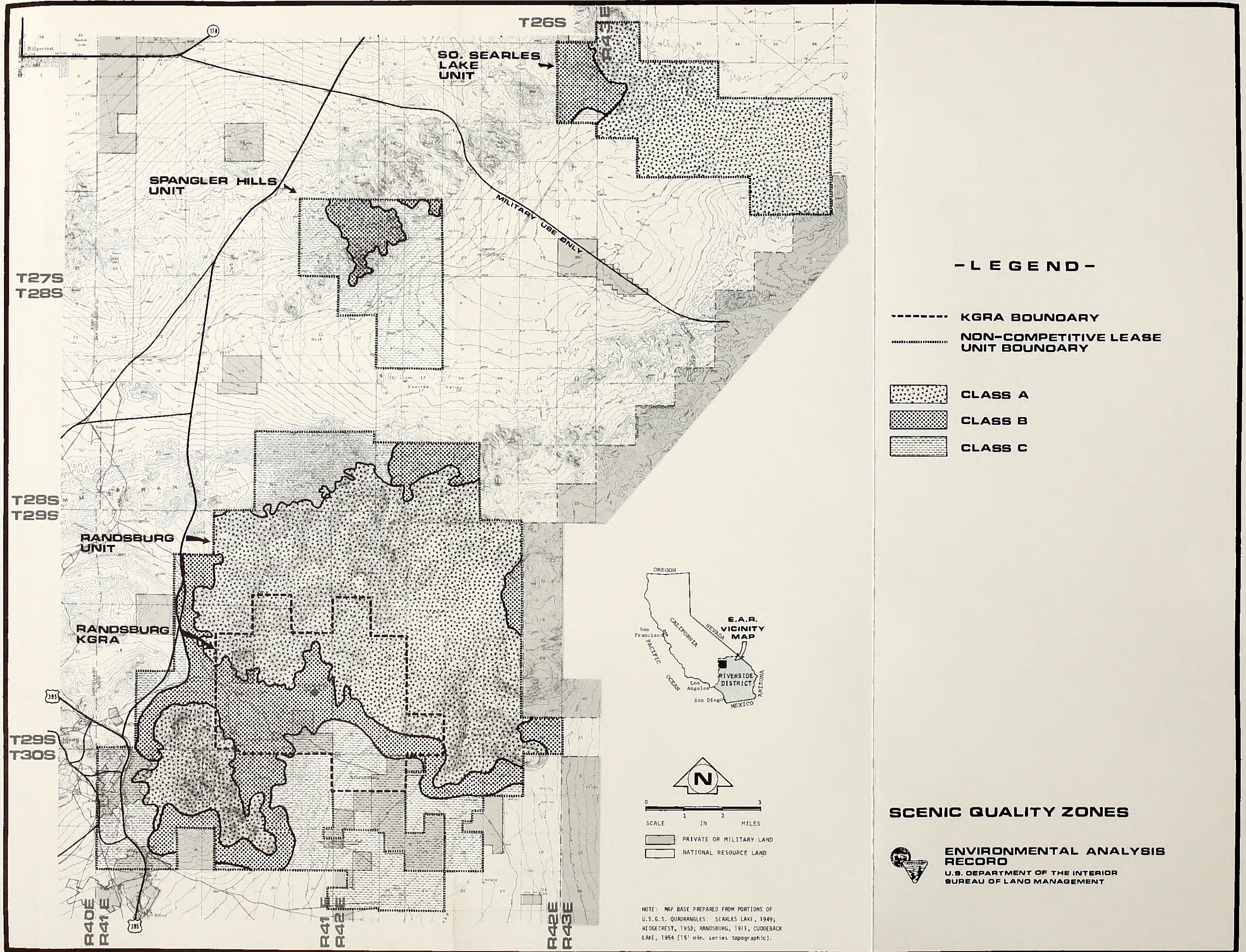
There are many examples of Class B scenery in this part of the desert. Characteristics commonly found among the different Class B areas are diverse vegetation, rugged terrain, vivid coloration, and close proximity to Class A scenic lands. Some of the Class B lands are of Class A quality except for high levels of visual intrusion. Examples of Class B scenic quality are the Spangler Hills and the area between Red Mountain and the Lava Mountains.

All other lands are of Class C scenic quality (lowest). These areas generally have few if any distinguishing scenic characteristics or else have been degraded by visual intrusions.

The visual prominence zones are shown on Figure 2-29. As would be expected, the zones follow topographic characteristics to a great extent.

The high prominence areas include the ridges, peaks and steep slopes of the Lava Mountains, Almond Mountain, Red Mountain, the Summit Hills and the Spangler Hills and other scattered areas on foothills and prominent rises.

The moderate prominence areas are essentially those lands that have no real slope. The largest areas of consistently moderate prominence lands are found in Teagle Wash, Searles Valley, and Almond Cove. These areas represent the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SPANGLER HILLS UNIT
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395
-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
CLASS A
CLASS B
CLASS C
OREGON
CALIFORNIA
NEVADA
E.A.R. VICINITY MAP
San Francisco
PACIFIC OCEAN
RIVERSIDE DISTRICT
ARIZONA
Los Angeles
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SCALE IN MILES
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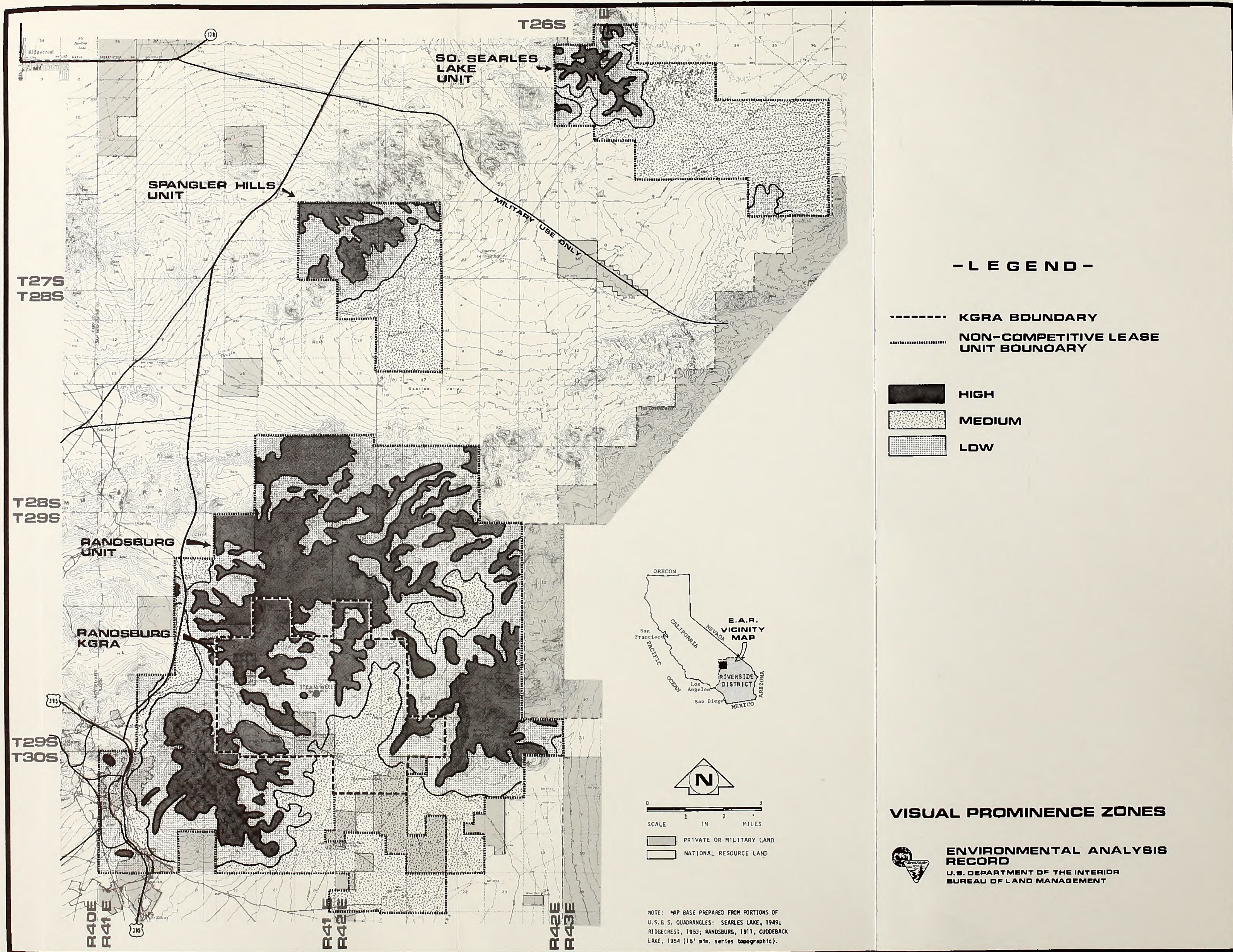
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
SCENIC QUALITY ZONES
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-28



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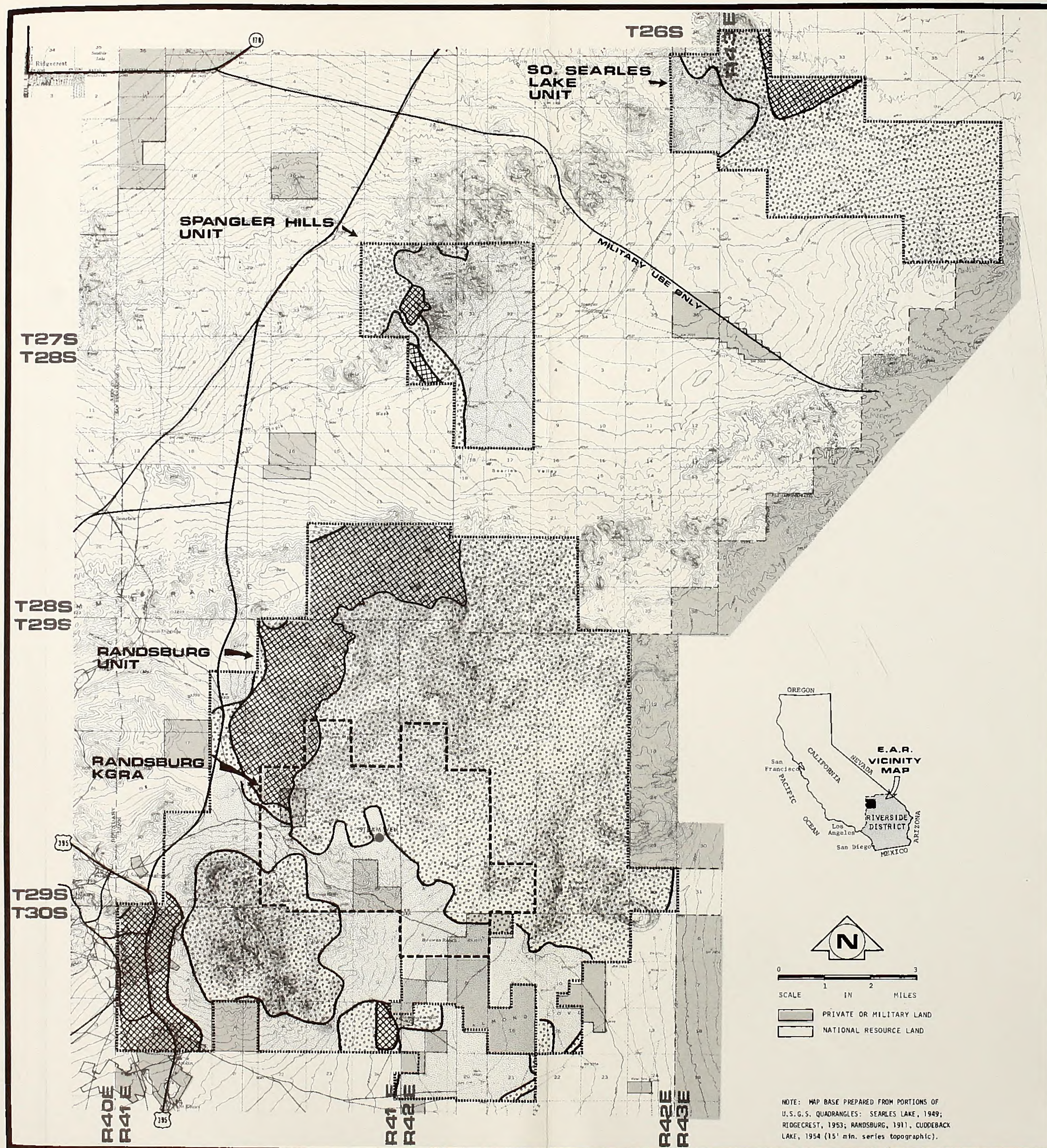
-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
HIGH
MEDIUM
LOW
E.A.R. VICINITY MAP
OREGON
NEVADA
CALIFORNIA
PACIFIC OCEAN
RIVERSIDE DISTRICT
ARIZONA
MEXICO
N
SCALE IN MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
VISUAL PROMINENCE ZONES
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

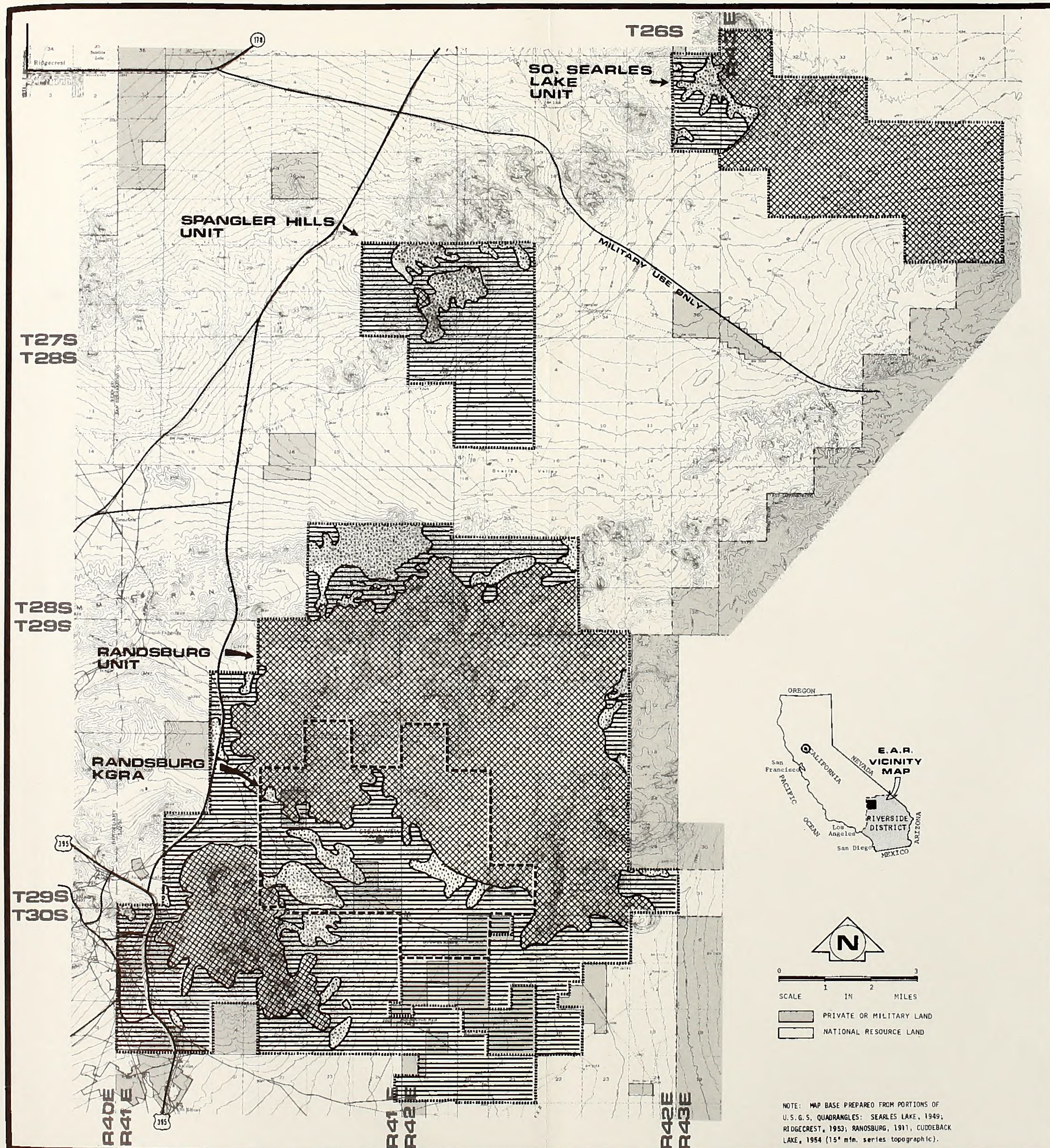
FIGURE 2-29



VISUAL SENSITIVITY ZONES

ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-30



-LEGEND-

KGRA BOUNDARY

NDN-COMPETITIVE LEASE UNIT BOUNDARY

CLASS II
CHANGES IN THE BASIC ELEMENTS SHOULD NOT BE EVIDENT.

CLASS III
CHANGES IN THE BASIC ELEMENTS MAY BE EVIDENT, BUT MUST REMAIN SUBORDINATE.

CLASS IV
CHANGES MAY SUBORDINATE THE ORIGINAL COMPOSITION, BUT MUST REFLECT SOME OF THE BASIC ELEMENTS (LINE, FORM, COLOR AND TEXTURE) OF THE SURROUNDING LANDSCAPE.

VISUAL RESOURCE MANAGEMENT CLASSES

ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-31

bulk of the moderate prominence lands with the remainder being found in smaller valleys and passes, such as Golden Valley.

The low prominence areas make up the remainder of the land. These are the areas between the bases of the ridges and steep slopes, and the flatlands. Such areas are usually closely backdropped by a hill or mountain which does much to reduce visual impacts in the desert landscape.

The results of the visual sensitivity inventory (Figure 2-30) show that ratings of "High" are largely the result of highway travel on the Trona Road. The only area of high sensitivity not influenced by highway travel is the top of the Summit Range and the edge of the Lava Mountains directly south of the Summit Mountains. The high rating is the result of the highest recreation-use volume (which is medium in this study area) and high ratings in the intrinsic resource values and community land-use criteria.

Due to a combination of high highway volume and medium recreation-use volume, ratings of medium sensitivity are found in Teagle Wash in the vicinity of Trona Road. The Trona Pinnacles scenic area rating is high where it is affected by highway volume with the remainder medium. The Lava Mountains-Golden Valley-Almond Mountain area possess high intrinsic resource values, and is rated high in community land use but low in all other factors. The only other major areas of medium visual sensitivity are Red Mountain and the area between Poison Canyon and the North Spanglers. These areas have varied combinations of medium and high notable intrinsic resources and community land uses with highway volume influence on about 50 percent of the land.

The remainder of the land in this area is of low visual sensitivity. Common factors are little concern toward notable intrinsic resources and low recreation-use volume.

The Visual Resource Management Classes are shown on Figure 2-31. In this study area only three of the five classes are found: Classes II, III, and IV. Lands of Class A scenic quality are by definition designated Class II lands. Class II lands consist of the Trona Pinnacles Scenic Area, The Lava Mountains Scenic Area, the Red Mountain area and a small area in the South Spangler Hills. Approxmiately 45 percent of the land in the EAR area is Class II land.

Class III lands make up the smallest portion of the lands in the area, approximately seven percent. These lands are scattered throughout the study area and are generally located on the fringes of Class II lands.

Class IV lands make up the remainder of the area. Approximately 47 percent of the area is Class IV. These lands are generally composed of flat open spaces and the bases of hills and mountains.

2.4.2 Archaeology

2.4.2.1 Prehistory Synopsis

The following summary concerning the cultural history of the EAR area by Hall and Barker (1975) is consistent with the few documented accounts of cultural evidence within the area, and a larger data base available for adjacent areas.

Four localities of proposed Early Man are found near the study area (Hester, 1975). These are Manix Lake, Coyote Gulch, the Calico Hills, and China Lake. These localities exhibit data suggesting that Man existed in this region of the Mojave Desert since ca. 10,000 B.C., although the possibility of even earlier "pre-projectile point" cultures within the area exists. No such definitive evidence, however, has been located during surveys or reported by previous workers.

From 10,000 B.C. to 6,000 B.C. local prehistoric groups were concerned with the exploitation of resources associated with the pluvial lake margins in this region. Paleoecologic data from Searles Lake suggests that the area afforded aboriginal populations with a great abundance of water and vegetation, although salinity levels may have been high. It is yet to be determined whether the lake-associated (lacustrine) food sources or the large mammal (megafauna) food sources of the region were primary. There is a possibility that both were simultaneously exploited if neither the lacustrine nor the megafauna food sources represented any selective advantage.

From 6,000 to 4,000 B.C. less use was apparently made of lower elevations than higher elevations in the greater area. This may be attributed to a post-Pleistocene dessication period. However, more datable material is needed to complete an accurate temporal reconstruction of the period.

By 4,000 - 3,000 B.C. a basic food gathering system appeared which apparently continued into historic times. Such food processing tools as manos, metates, mortars, and pestles were present. Earlier stages are characterized by Humboldt, Pinto and Little Lake projectile points, and the more recent stages by the Elko-Gypsum series projectile points. The transition from larger, heavier projectile points to the smaller and lighter point types typical of the Rose Spring and Eastgate series may indicate the introduction of the bow as early as 2,000 years ago. The expansion and development of bow and arrow technology is additionally supported by the late prehistoric introduction of Desert Side-notched and Cottonwood points. The appearance of ceramics and an established trade system between the Great Basin and the Southwest and between the Great Basin and Central California have been tenuously correlated with these two late prehistoric point types. Table 2-12 illustrates a proposed culture history for this and adjoining areas.

2.4.2.2 Ethnography

The following is a capsule summary of the ethnography of the study area. The reader is referred to Background to Prehistory of the El Paso/Red Mountain Desert Region by Hall and Barker (1975) for more detailed information.

The area under consideration was occupied historically by the Koso and the Chemehuevi (Figure 2-32). Only the Koso appear to have used the area as a major resource base. The Chemehuevi, while having territorial claims to the southern portion of the study area, were centered east between Twentynine Palms and the Colorado River.

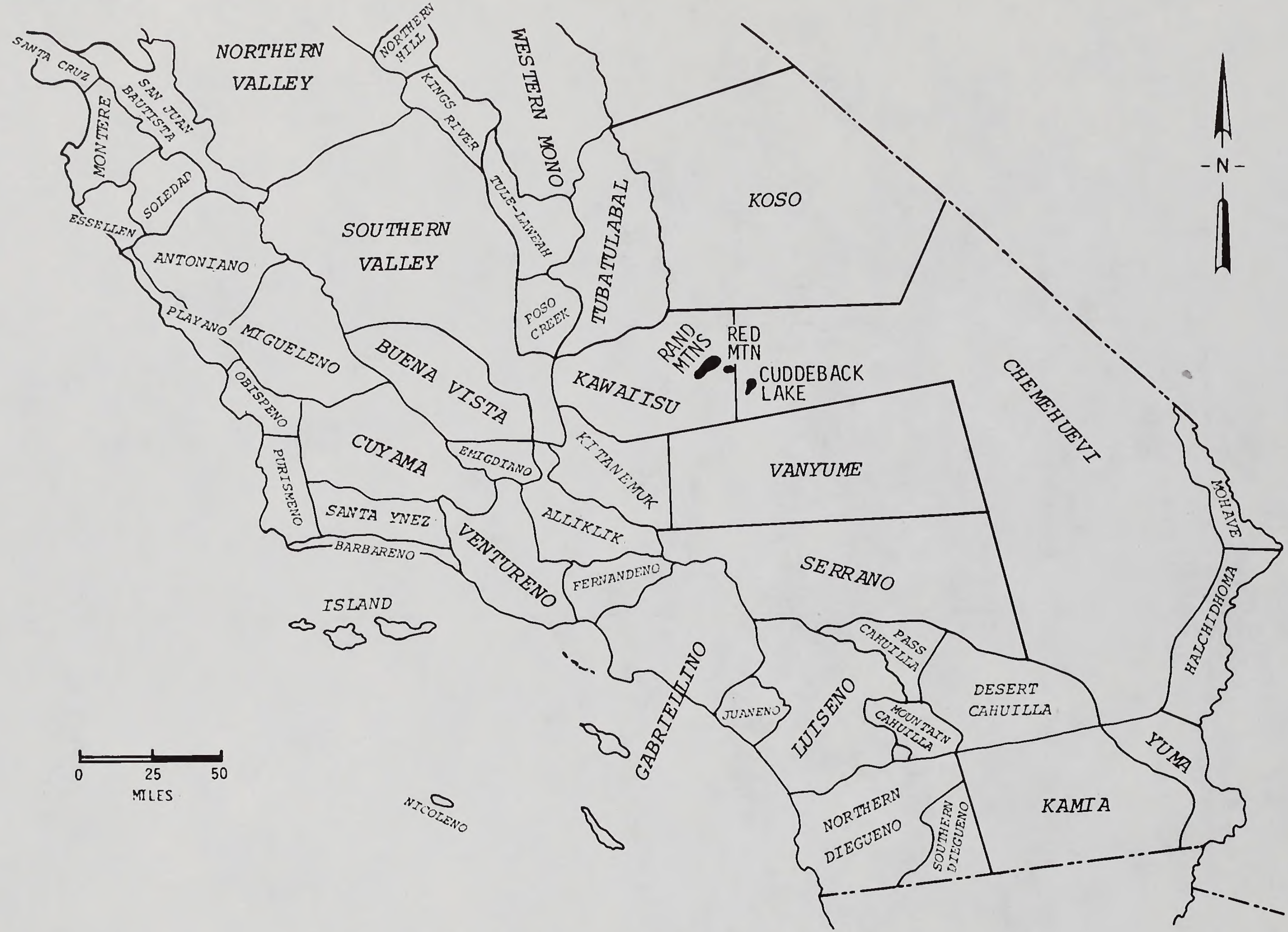
Both groups pursued a generalized hunting and gathering subsistence pattern. Seasonal movements were in response to differential ripening of major plant resources while hunting appears to have been carried out as an adjunct to gathering. Major utilized plant resources within the area (prior to European

TABLE 2-12

CULTURAL SEQUENCE

	Southwestern Great Basin	Local Phase Name	Diagnostic Artifacts
	LATE PREHISTORIC	Early Mohave Death Valley IV Early-Late Cottonwood Marana	Pottery Cottonwood points Desert Side-Notched points
1000	ROSE SPRING/ EASTGATE COMPLEX	Amargasa II Death Valley III ? Late Rose Spring Hoiwee	Rose Spring points Eastgate points
AD BC 0 1000 2000 3000 4000	GREAT BASIN ARCHAIC	Early Milling, Archaic Transition Little Lake and Newberry Early-Middle Rose Spring Death Valley II Pinta Basin	Grinding tools Elko points Gypsum Cave points Pinto/Little Lake pts. Humboldt points Silver Lake points
5000 6000	scanty occupation ?	none definite	Silver Lake points ?
7000 8000	WESTERN PLUVIAL LAKES TRADITION	Western Lithic Co-Tradition Death Valley I Lake Mohave Complex San Dieguito Complex	Silver Lake points Lake Mohave points Crescents/Transverse points
9000 10000	FLUTED POINT TRADITION ?	Fluted Co-Tradition	Folsom points ? Clovis points
	PRE-PROJECTILE POINT CULTURES ?		choppers teshoa flakes scraper planes

From Hall and Barker, 1975.



REGIONAL MAP SHOWING APPROXIMATE LOCATION
OF ETHNOGRAPHIC BOUNDARIES

Boundaries from Kroeber, 1925.

FIGURE 2-32

introductions and modifications) included bunch grass, chia, and thistle sage seeds, Mormon tea, Joshua tree pods and stalks and mesquite (?) beans. Mountain sheep, deer, rabbits, antelope, lizards and birds were among the animals hunted.

The following discussion centers on the Koso as they were apparently the main group utilizing the area. Based on current vegetation and climate, the Koso probably were using the area mostly during the spring and summer.

The winter months, from about mid-November to about the end of February, were the time of least food procurement activity in the seasonal round. Subsistence during this period was mainly dependent on stored foods, such as pine nuts and occasional supplements of fresh game. Villages were located on valley floors at the base of higher mountains in close proximity to a permanent water source.

By the end of winter, stored supplies would have run low or become exhausted. At this time, from about the end of February to about May, winter camps would have begun breaking up and the people would have split into smaller population units to begin food procurement activities. The major resources exploited during this early spring period probably were Joshua tree pods and stalks (*Yucca brevifolia*), mesquite beans (*Prosopis sp.*), and other early spring seeds and tubers. Tule roots, if available, also would have been heavily exploited during this period.

During late spring and summer, from about May to the end of July, the population would have been at its lowest density because nuclear family groups would be widely dispersed to exploit bunchgrass, perhaps centralizing periodically at small villages. Very temporary shelters and very short-term camps would also have been characteristic of this period. Food procurement activity was localized on large alluvial fans, particularly in the area south and east of Red Mountain. Because of the replacement of bunchgrass by introduced grasses, archaeological evidence of these camps and summer activities can be expected in areas which do not now have a bunchgrass cover.

During late summer and autumn, from about August through mid-October, the native population would have begun leaving the grasslands to gather for the pinon harvest, the bulk of which would have taken place during September and October. The people would have made temporary camps and conducted periodic trips to winter camp locations to store nuts. Most major hunting activities, such as communal rabbit, deer, and antelope hunts, would have been carried out during this period. The annual calendar round would have ended by about the middle of November. The population was then at its greatest and most sedentary concentration. Activity again centered on equipment maintenance and manufacture in winter villages.

The Koso used bows and arrows for hunting. While no ceramics are reported, there was extensive use of basketry. In fact one basket fragment was recovered from the area. There was a range of milling tools, including wooden mortars. The use of obsidian for flaked stone tools is also reported; apparently imported from Inyo County locations.

The Koso were involved in trade through exchanges of local goods with the Yokuts to the Northwest and groups in the Owens Valley. They also may have benefited from the extensive trade routes between the Southwest and the Pacific Coast.

The expected settlement pattern would include small villages or occupation shelters near major water sources and temporary campsites along routes of travel and at resource procurement locations. Task group locations and special use sites would be expected to occur at raw material sources, ceremonial spots and specific plant or animal habitats. Changes in this adaptive pattern through time would be anticipated as a result of environmental change and socio-cultural stimulus.

2.4.2.3 History

The following historical summary was taken from Hall and Barker's Background to Prehistory of the El Paso/Red Mountain Desert Region (1975) and Starry's Gold Gamble (1974). Greater detail and other references can be obtained from their works.

Mojave Desert history has been divided into three general periods. The Exploratory Period (1772 - 1844) includes events between the first Spanish contact in the area and the beginning of immigrant wagon crossings. The Immigrant Period dates from the first wagon crossings (1844) to the discovery of gold in the area (1860). The Mining Period starts in 1860 and extends to 1925, the end of large-scale mining operations.

In 1772 Pedro Fages made the first recorded journey along the edge of the Mojave Desert in pursuit of Spaniards who had deserted the missions. He probably did not enter the study area and only mentions a lack of water and the presence of Indian camps in the desert. Francisco Garces traveled across the Mojave Desert in 1776 but makes no mention of the study area in his diary. Most likely no vestiges of these early journeys remain in the area.

Three American explorers, Jedediah Smith, John C. Fremont and Joseph Walker may have crossed through or near the area between 1826 and 1844.

In 1843, Walker returned to lead the Joseph B. Chiles immigrant party to the California coast. Other immigrant groups followed, the most famous being the Bennett-Arcane Party of 1849.

There are no known remains of these early American expeditions in the area. The immigrant trains passed west of the area.

The Mining Period saw the most intensive occupation and activity within the area. Main mining activities were centered west of the area near Randsburg, Johannesburg, Garlock and Goler. The 1863 gold strike in the El Paso Mountains was followed by a rush in the Slate Mountains and the establishment of the Searle's Lake borate mines in the 1870's. In the 1880's the Harmony Borax Works at Death Valley replaced Searle's Lake as a major producer.

The Death Valley borax road ran across the southern portion of the study area. Here wagons drawn by the famous 20-Mule Team carried borax from Death Valley to the railroad at Mojave. Blackwater Well in the study area was a major watering stop. The route through the study area is currently a bladed road used by local residents and recreationists. Blackwater Well is still actively being used off and on as a water supply for grazing. The remains of "dry" camps (caches of water and supplies) along the borax road may still exist in the study area but none have been located.

The Rand Mining District was established in 1895. The Yellow Aster Mine above Randsburg was the largest operation in this district, producing gold well into the 20th Century. In 1896 the Spangler Mining District was formed by the Spangler brothers to exploit their gold strike. All that remains today in the Spangler Hills are over 4,000 feet of tunnels and shafts and miscellaneous structures and trash.

Speculators built the Randsburg Railroad in 1897 with promises of rail service from Kramer to Death Valley. The completed route only reached Johannesburg. Purchased by the Atchison, Topeka and Santa Fe Railroad in 1903, the route was used until its abandonment in 1933. Most of the road bed remains intact and crosses the western portion of the study area.

Lack of a reliable water supply plagued the mining towns. Johannesburg had the best water supply and sometime after 1898 a pipeline was constructed from Squaw Spring to Johannesburg to augment the supply from city wells. The remains of this pipeline, access roads and miscellaneous structures are still visible today along part of the route.

As the gold strikes began to play out, scheelite (tungsten ore) was discovered near Atolia (originally called St. Elmo) in 1906. Tungsten mining had its biggest boom during World War I, producing for the war effort. After the war the mines shut down due to a decrease in the price of tungsten.

In 1913 the Cuddeback Valley was opened to homesteading. Numerous 160-acre farms were started but the crops blew away the first year. Most of the homesteaders left immediately, but a few remained earning a living at the nearby mines.

In 1914 the Trona railroad was completed from Trona to the Southern Pacific line at Searle's Station. This spur line crosses the northern portion of the study area and is still used today. The remains of at least one railroad camp have been located along the grade within the study area.

In 1918 the last mining boom began with the discovery of silver ore near the present settlement of Red Mountain (formerly known as Osdick, Inn City or Hampton). The California Rand Silver Mine was the last large mine in operation, with activities peaking in 1922-23. It closed down in the late 1920's.

Today, Randsburg, Johannesburg, Red Mountain and Atolia are occupied by small-scale mining operators and weekend residents and scattered mining occurs throughout the region.

2.4.2.4 Archaeological and Historical Sites

<u>Sampling Mechanics</u>

In order to evaluate archaeological and historical remains within a large region, cultural resource specialists have found that a program of probabilistic sampling provides representative and reliable data within the bounds of restricted time, personnel and monetary resources. Such a program serves two ends: (1) It provides data essential to judging the cultural resource sensitivity of zones within the proposed area of impact and (2) it is compatible with scientific inquiry and insures adherence to a rigorous inductive-deductive method necessary to generate information on prehistoric social systems and environmental relationships.

Weide (1973) has proposed a scheme to the BLM for inventorying their planning units within the California Desert for cultural resources. This scheme seems generally applicable to the study area being discussed here. A detailed discussion of sampling mechanics and general methodology used in this study may be found in Appendix D-1.

Sample Results

For analytical purposes the archaeological sites have been broken down into 10 types: (1) villages or base camps, (2) probable temporary camps, (3) utilized shelters or caves, (4) milling stations, (5) quarries, (6) petroglyph sites, (7) hunting blinds, (8) isolated artifacts, (9) flake-detritus scatter, and (10) trails or alignments. Historic sites have been lumped into a single category. Appendix D-2 contains a definition of a site and each site type.

For purposes of testing, it is proposed that each site type corresponds to one or more sets of prehistoric activities ranging from one-day to intermittent use over many years.

A total of 158 sites have been recorded within the sample universe (Figure 2-33), of which 138 were inventoried in units within the probabilistic sample. The systematic inventory resulted in an average of 4.97 sites per square mile. Subtracting historic sites, this figure is 4.75. Furthermore, if both milling stations and historic sites are not included the figure is 2.70. These figures, of course, vary from location to location ranging from none to 15 per square mile. In a single half-mile section surveyed, 11 sites (mostly milling stations) were found. Number of sites per unit area, type of sites, diversity of cultural materials (and for management considerations, integrity, uniqueness, and scientific or educational value) are considered in defining sensitive - significant areas or districts, as discussed later.

Table 2-13 is a compilation of site type sums, average number per square mile surveyed, percentage of total sites in sample units and percentage of prehistoric sites in sample units.

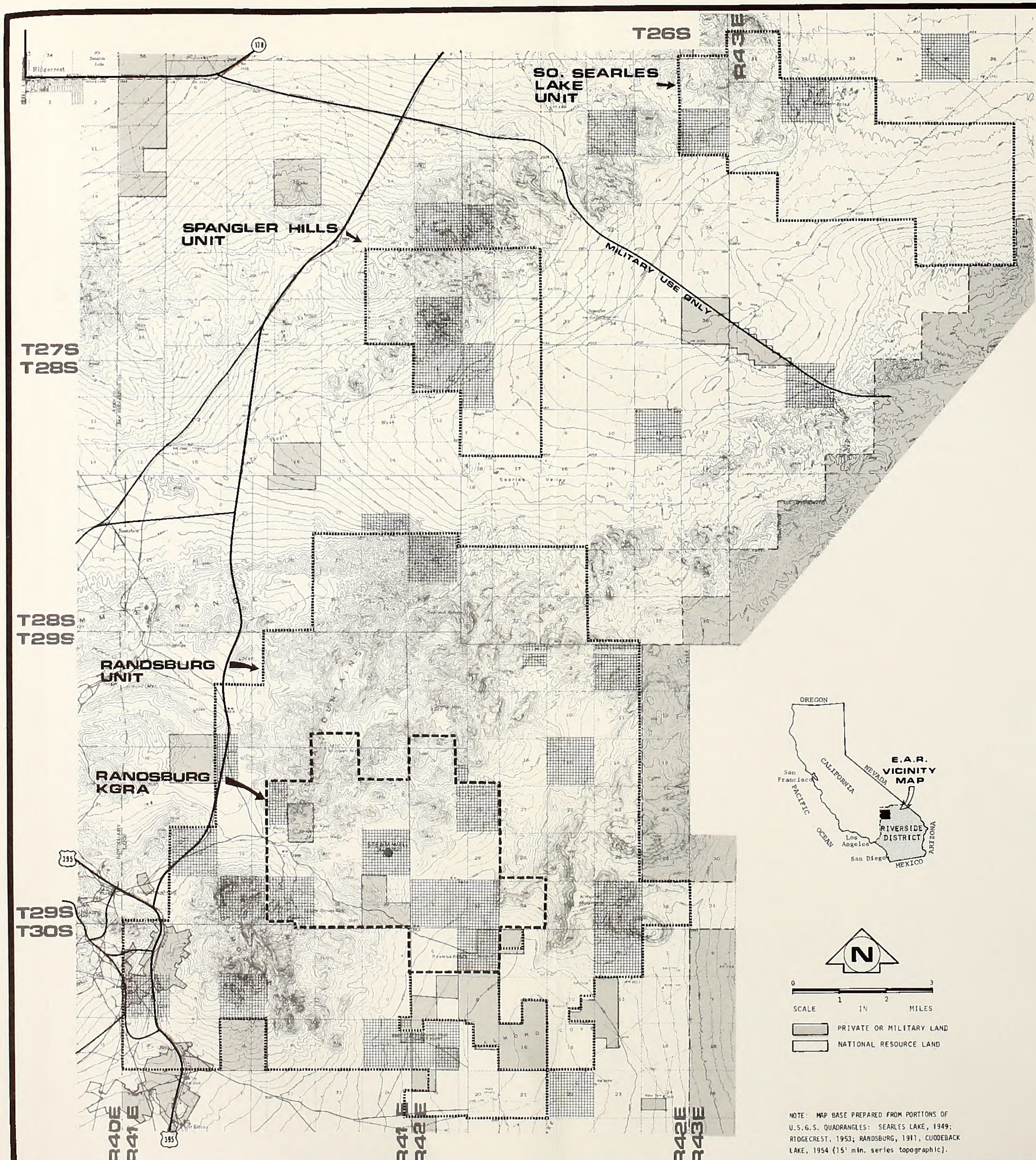
TABLE 2-13

CULTURAL RESOURCE INVENTORY DATA

SITE	TYPE	TOTALS	TOTALS IN SAMPLE UNITS	NO./1MI^2	% TOTAL SITES IN SAMPLE UNITS	% LESS HISTORIC SITES
1	Village	5	4	0.14	2.9	3.0
2	Temporary Camp	28	23	0.83	16.7	17.4
3	Shelter/Cave	21	12	0.43	8.7	9.1
4	Milling Station	61	57	2.05	41.3	43.2
5	Quarry	2	2	0.07	1.5	1.5
6	Petroglyph	5	5	0.18	3.6	3.8
7	Hunting Blind	3	3	0.11	2.2	2.3
8	Isolated Find	4	4	0.14	2.9	3.0
9	Flake Scatter	21	21	0.76	15.2	15.9
10	Historic	7	6	0.22	4.3	-
11	Trail/Alignment	1	1	0.04	0.7	0.8
	TOTALS	158	138	4.97/1mi^2*	100 %	100 %

*Less Historic Sites-4.75/1mi^2

Three main village complexes are known in the area (Figures 2-34, 35), although one contains three closely juxtaposed midden locations probably representing a single village complex. However, these three locations were given separate site designations.



-LEGEND-

- KGRA BOUNDARY
- NON-COMPETITIVE LEASE UNIT BOUNDARY
- AREA INTENSIVELY SURVEYED FOR CULTURAL RESOURCES 1975/76

AREAS SURVEYED FOR CULTURAL RESOURCES INVENTORY

ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-33

Figure 2-34. Archaeological Site RM-136. Midden-Village Located Near Bedrock Spring. Note Pothunting Damage. Proposed Bedrock Spring National Register of Historic Places Archaeological District.

Figure 2-35. Archaeological Site RM-161. Midden-Village Located Near Squaw Spring Well. View Easterly. Proposed Squaw Spring Well National Register of Historic Places Archaeological District.

For every village (using three for computation) there are 10-15 "temporary" occupation camps (Figures 2-36, 37) or "temporary" occupied shelters/caves (Figures 2-38, 39) and about 20 or more milling stations. This figure is slightly variable since some of the small shelters exhibit only slight evidence of occupation and could be storage shelters. Also, one major village is known which occurs outside the sampling units but which must be estimated in the figures because of its importance to the settlement pattern. Furthermore, both villages and many temporary occupation sites contain milling implements (Figure 2-37). About seven flake scatters (probable small lithic workshops) are found for every village or main base camp. The remaining site types are relatively rare in the sample area. However, the number of these specialized sites fits the expected pattern based on previous inventories in the Mojave Desert. All apparently functioned directly or indirectly in subsistence pursuits: hunting blinds for ambushing mountain sheep and deer (Figure 2-40), quarries for procuring raw material for tools (Figure 2-41), trails for aid in travel, communication and/or trade, and rock art sites (Figures 2-42, 43) for spiritual support; i.e. sympathetic magic of the hunt.

Other rare site variants are masked in these type categories. For instance, storage shelters are lumped into the shelter/cave type; thermal fractured rock scatters (ovens, roasting areas?) within the temporary occupation camp types; (Figure 2-36) and alignments within temporary occupation camp or trail categories (Figure 2-44). The site types could be broken down further according to size and individual elements, but until more adequate evaluation means are initiated, i.e. testing, these categories are hypothesized as adequate for developing an explanatory model of prehistoric adaptation. Appendix D-3

Figure 2-36. Archaeological Site RM-124. Concentration of Thermal-Fractured Rock. Probable Temporary Occupation Camp.

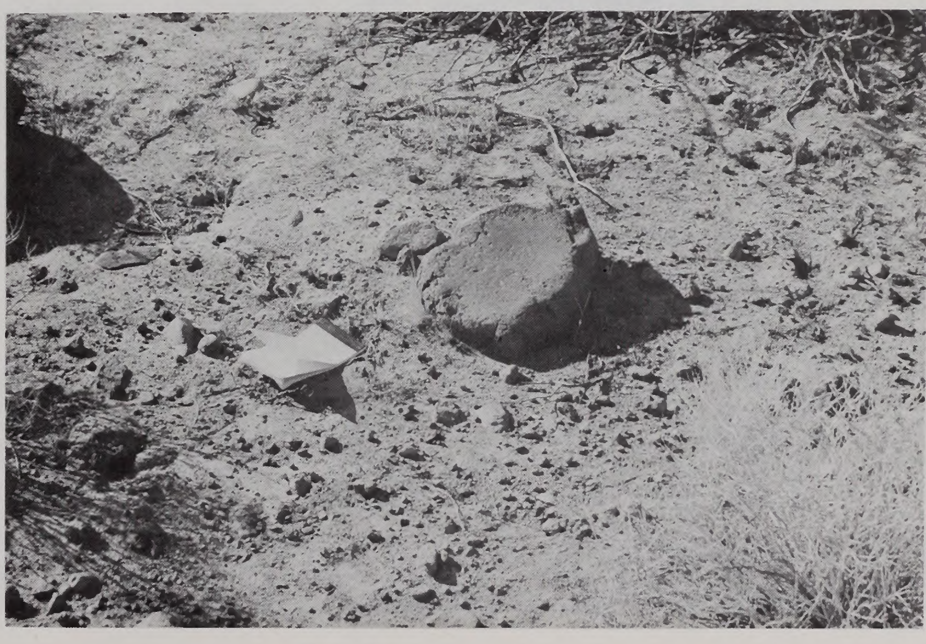


Figure 2-37. Archaeological Site RM-98. Metate and Flake Scatter. Designated Probable Temporary Occupation Camp.

Figure 2-38. Archaeological Site RM-143. Rockshelter in Lava Mountains. Looking North. Located in Proposed National Register of Historic Places Old Wells Archaeological District.

Figure 2-39. Archaeological Site RM-146 (Bird Roost Cave) Lava Mountains. Located in Proposed National Register of Historic Places Old Wells Archeological District.

Figure 2-40. Archaeological Site RM-210. Hunting Blind Located on Talus Slope of Red Mountain.

Figure 2-41. Archaeological Site RM-113. Prehistoric Quarry Site in the Spangler Hills. View to the Southeast.

Figure 2-42. Archaeological Site RM-21. Steam Well Petroglyphs. Proposed National Register of Historic Places site.

Figure 2-43. Archaeological Site RM-134. Petroglyphs Located Near Bedrock Spring in Lava Mountain-Summit Range. Proposed Bedrock Spring National Register of Historic Places Archaeological District.

Figure 2-44. Archaeological Site RM-189. Alignments and Cobble/Boulder Clusters on Small Playa in Golden Valley. Probable Temporary Occupation and Ceremonial Site. Proposed Golden Valley National Register of Historic Places Archaeological District.

details the cultural constituents of each site recorded in the area. Historic sites are so few in number that they were lumped. A further discussion of historic land use is presented in other sections.

Based on a generalized breakdown of certain environmental classes (Appendix D-4) a number of possible correlations are hypothesized, and predictions of activity zones within the study area, i.e. an approximation of settlement patterns, can be approached.

While we might cite the sample size as being inadequate to provide meaningful data in some cases, certain patterns appear evident. In terms of environmental correlates each site type will be discussed in turn. Appendix D-4 lists the environmental characteristics of each site.

Villages are found in Creosote Bush or Transitional vegetation communities on Tertiary bedrock units or on Quaternary deposits within hilly country on terraces or ridges. Villages were not found in mountainous terraces (over 4,000 feet), on alluvial fans or around playas. All villages occur in close proximity to springs.

Temporary occupation camps occur principally in Alkali Sink and Creosote Bush Scrub Communities, and in fewer numbers in Transitional and ecotonal situations. They were found most frequently in areas of Quaternary deposits; less often in Tertiary bedrock zones and not at all in pre-Tertiary bedrock areas. In terms of landforms these sites are found on ridges and hills, on playas, fans and terraces, but not in the mountains or in or adjoining canyon/barrancas.

Shelter/caves were located only in Creosote Bush Scrub or Transitional vegetation communities in association with Tertiary bedrock units exposed in hills and canyons and ephemeral or intermittent channels. It is possible that springs or seeps now relict were found closeby.

Milling stations occurred in every vegetation community but were dominant in Creosote Bush Scrub and Alkali Sink Communities, and the ecotone area in between. They were exclusive to the Cheesebush Intrusive. Interestingly, this site type was not abundant in the Transitional Community where grasses and other seed-bearing plants were apparently diverse and plentiful. However, in terms of a small survey sample in this community, a higher number of temporary campsites and one village were found with many milling tools present at each. Also, much of this vegetation community is in steep or rough terrain.

We must also consider the possibility that population levels were such that there was no need for women gatherers to venture into rough terrain when adequate resources were at hand on the fans and around the playas.

Quarries are apparently rare in the area, found only in the Creosote Bush Scrub Community; in one case in Pre-Tertiary bedrock, in another in Tertiary bedrock. Each site is on a ridge or ridge-saddle within hills quite distant from any permanent water source. More quarries may be present in the central Lava Mountains which were not surveyed.

Petroglyphs are usually associated with villages in Creosote Bush Scrub or Transitional Communities. All are in areas of Tertiary bedrock on the side of hills or ridges near springs.

Hunting blind sites follow the same pattern as petroglyph sites except they occur both in hills and mountains, generally on talus slopes and away from fresh water sources such as springs.

Most isolated finds occurred in association with the Cuddeback playa near clumps of <u>Atriplex</u> <u>sp</u>. The geologic unit is Quaternary in age, and either lacustrine or alluvial in origin.

Flake scatters occur almost exclusively in the Creosote Bush Scrub Community on Quaternary fans, ridges and hills. But in almost every landform situation analyzed they are near intermittent or ephemeral drainages or near a playa.

Historic sites (Figures 2-45, 46) associated with mining or the railroad most likely were fortuitously associated with Creosote Bush Scrub or Transitional Communities. Pre-Tertiary bedrock masses (with gold-bearing quartz veins) or Quaternary fans (to be crossed by the railroad or other roads and trails) were more important. Springs were developed into wells for water supplies.

The single aboriginal trail/alignment cross-cuts Creosote Bush Scrub-covered Quaternary alluvial fan deposits and extends northeast through Golden Valley. Undoubtedly trails occurred throughout the region but have been mostly obscured or destroyed by erosional and depositional events.

2.4.2.5 Discussion

Based on the available archaeological data it is possible to begin building a model on regional settlement patterns and demography. At this stage in the analysis we are hindered by a lack of systematic analysis of the cultural consitutents of representative site types so that we must address ourselves more to generalities rather than specifics.

Villages or base camps were located around the periphery of the Lava Mountains and Red Mountain at the hill-fan interface where springs were present. Such sites are rare in the area indicating population density was not large, most likely no more than three local groups or bands and more likely only one or two. Such groups probably averaged around 25 persons based on analogy to historic hunting and gathering groups in the desert West (Martin, 1973) and latter discussion. The two main village complexes located during the survey

Figure 2-45. Historic Site RM-115. Mining Structure in Spangler Hills, circa 1920.

Figure 2-46. Historic Site RM-116. Tent Foundations at Proposed National Register of Historic Places Trona Railroad Camp, circa 1914.

are seven miles apart, separated by moderately rough terrain. Further discussion can be found in Appendix D-5.

A probable important food plant found in abundance in the Golden Valley area is chia (Salvia columbariae). The association of this plant with a dense and diverse record of archaeological activity, including both milling and temporary occupation sites, seems more than coincidental. Fresh water, other than small ephemeral playas, seems to have been a limiting factor to village-base camp setups.

Temporary campsites and lithic workshops appear to represent short term (1-2 day) forays for hunting and/or gathering away from the principal base camps. The richer location around the villages may have been exploited first with subsistence activities centered more frequently later in the season at more outlying areas as observed by Lee (1969) among the Bushmen hunter and gatherers of South Africa. If late spring or summer showers caused small water stands in channels, or tinajas or heavy winter rainfall created stands of water in playa situations, then temporary occupation at these locations may have occurred. Ethnographic information coupled with archaeological data suggests no fall or winter occupation is evident in the area.

Older occupation (i.e. pre-Cottonwood-Rose Spring point correlates) is evident in some petroglyph sites and in archaeological features (i.e. rock rings, alignments and tool patination) within Golden Valley. However at both locations a continuity in occupation into later time periods seems evident. No evidence of early occupation around the Cuddeback playa was evident, although erosion and deposition has been ongoing.

Other resource procurement activities, such as quarrying, were predicated by the geology. Outcrops of cryptocrystalline material, such as chalcedony, in the Golden Valley and Lava Mountains and a small quarry in the Spangler Hills apparently coincided, except in the latter case, with important plant and animal resources.

Petroglyphs, generally found near villages and springs, also coincide with probable big game hunting areas and in one case were associated with a hunting blind. In other cases they are near small canyons/barrancas or along present trails where game could be driven to ambush.

Little prehistoric occupation or activity is evident in the Spangler Hills-Teagle Wash-Searles Valley locations. The principal reasons appear to be (1) lack of permanent water, (2) lower vegetation density and less diversity of plants with some of the possibly more important plants (i.e. rice grass) rare and, (3) fewer big game animals and lower numbers of tortoises and cotton-tails. Rainfall was apparently lower here than other areas considered. Transitory use of the area is apparent.

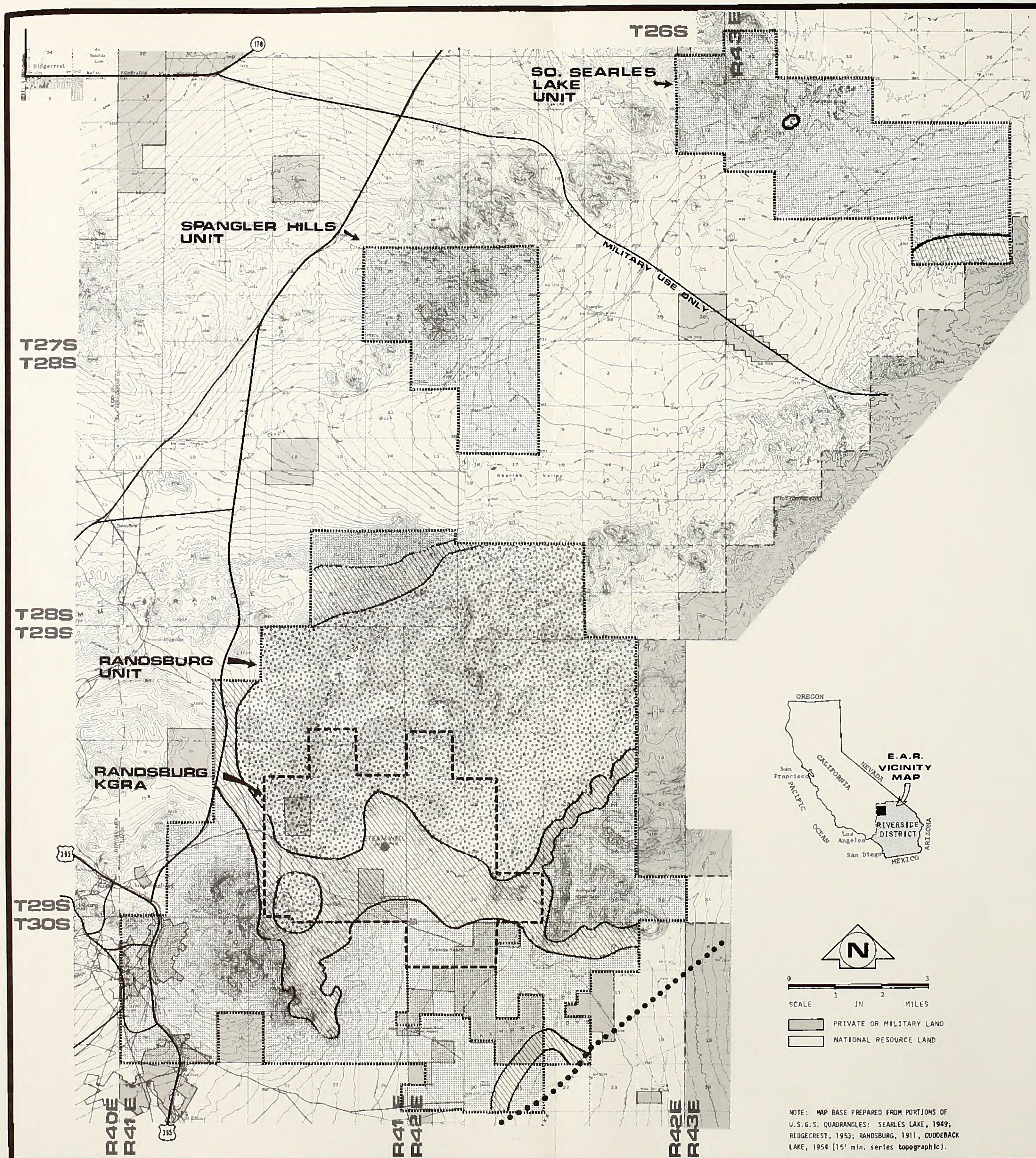
Historic patterns have been discussed previously. These sites clearly do not correspond to the prehistoric pattern with minor exceptions. For instance, the Spangler Hills were an important mining district with many associated sites such as mines, buildings, roads, wells and other features. The Teagle Wash-Searles Valley area is transected by a historic railroad with associated camps. Other areas of mining and well development are present in the Red Mountain-Atolia area. The 20-Mule Team road also transects a portion of the area.

The study area received little attention by archaeologists or historians until the BLM initiated intense management studies as a response to user-group concerns. Before that time the area was considered to be low in cultural resources with the exception of several petroglyph sites and a village location. Now it is obvious that major sections of the area contain diverse and abundant archaeological resources and that this area was given more than transitory interest by prehistoric inhabitants. For example, in comparing the results from this study with that from the Red Mountain Unit Resource Analysis (URA) and the adjoining El Paso URA (U.S. Dept. Interior, 1975b), only 1.8 sites per square mile were found in the former and 2.26 in the latter compared to 4.97 for this study area. Close comparisons are, however, evident between this study area and the El Paso Mountains, an area also high in resource value.

A further study of the history of this region would be worthwhile and productive, and there are indications of important historic developments in the area.

2.4.2.6 Cultural Resource Sensitivity Areas

The cultural resource survey of the study area provided (1) a reconnaissance of approximately 25 percent of the area, yielding a known resource base from which (2) the type and density of archaeological and historical locations could be predicted for contiguous and surrounding zones. Based on known and predictive data the relative sensitivity of the entire area was ranked according to a High, Moderate or Low rating (Figure 2-47).



-LEGEND-

KGRA BOUNDARY

NON-COMPETITIVE LEASE UNIT BOUNDARY

HIGH

HIGH (20 MULE TEAM ROAD)

MEDIUM

LOW

CULTURAL RESOURCE SENSITIVITY ZONES

ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-47

It must be emphasized that during the survey sections were evaluated by a series of sweeps on foot and some minor sites may have been missed. It should also be noted that sites which were recorded in the survey were not always totally studied. It is probable that most sites (except perhaps isolated milling stone stations and artifacts) when further studied would reveal more site features, and consequently more potential site interpretation data. Sites where middens occur can be more fully understood by excavation. This may also be true for some so-called surface sites which may exhibit subsurface remains.

The following is an attempt to assign relative scientific, educational and interpretive significance or value to sub-areas of the larger study area. A Low-value area may contain significant sites and vice-versa. Known environmental and cultural site constituents serve as elements for ranking site sensitivity for known areas and for predicting the extent of cultural resources (and their sensitivity) in unsurveyed parts of the study area.

The first methodological stage used to develop an evaluative scale for the relative sensitivity of sub-areas has been to assign a number value to three sets of site data. These are (1) site type, as discussed in Appendix D-1; (2) site element, meaning various cultural elements or constituents noted for each recorded site; and (3) site size, or the estimated area of cultural activity per site. Table 2-14 lists these various site types, elements and sizes with their respective value assignments. It should be noted that these relative numerical values are arbitrary judgments based on knowledge and comparisons of presently known cultural resources for this particular study area, as well as

TABLE 2-14

CULTURAL RESOURCE SENSITIVITY EVALUATIVE SCALE

1. Site Type

Site Type	Value
Village	5
Temporary Camp	4
Shelter/Cave	4
Petroglyph	3
Hunting Blind	3
Quarry	3
Trail/Alignment	3
Flake Scatter	2
Milling Station	2
Historic	1
Isolated Find	1

2. Site Elements

Site Elements	Value
Midden	10
Ceramics	5
Faunal/Flora Remains	5
Rock Alignments/Circles	*4
Hunting Blinds	*4
Rock Shelter/Cave	4
Quarries	4
Trails	4
Thermal-Affected Rock Concentrations	*3
Flaked Stone Tools	*3
Core-Detritus Area	3
Petroglyph Area	3
Milling Tools	*2
Historic sites	*1

3. Site Size

Site Size	Value
Over 1000 sq. meters	10
251-1000 " "	8
51-250 " "	6
11-50 " "	4
0-10 " "	2

*Value per unit

on past professional experience, and knowledge that sites doe have variable scientific, educational and interpretive utility. The rationale behind assigning a number value to both site type and site element (which are often the same) is to prevent masking of site complexity and constituent quantity, as is the case when only simple site type designations such as "village" or "temporary camp" are the only differential basis. By assignment of a value per site type, site element, and site size, sites of larger size and greater complexity (villages, campsites, etc.) receive a high rating value while single-element sites (isolated milling stone stations, etc.) receive a much lower rating. Consequently site sensitivity for a given area is not determined solely on a site-per-square-mile or types-of-sites-per-square-mile basis. It must be noted that this system is used only as a mechanism to help determine site sensitivity and is applicable only to this study area. It is not proposed that all villages or temporary camps are more significant than a milling station, or that milling stations are not important.

The second stage in area sensitivity determination was to tally the total cultural resource "value" for each surveyed section. At this point site density (sites per square mile) was introduced and computed with the value figure to determine (1) average site value per square mile, and (2) average site element value per square mile (specific locations, figures and tables are available for inspection at the office of the BLM, Riverside, Ca.). The primary factor used in determining sub-area sensitivity is the total numerical value of site elements within surveyed sections. Translated into on-the-ground judgments of cultural resource sensitivity, sections with an element value of 100 or over are high, those from 99 to 30 are moderate, and those below 30 are low (Figure 2-47).

It is important to note again that the assignment of numerical values to sites and site elements should not be used in final evaluation decisions about the cultural resource value of a site or area. It is strongly emphasized that to avoid misuse of the scaling device, low ratings for a site or area are not to be interpreted as a rationale for allowing site disturbance or destruction without prior analysis and mitigation by professional, accredited archaeologists.

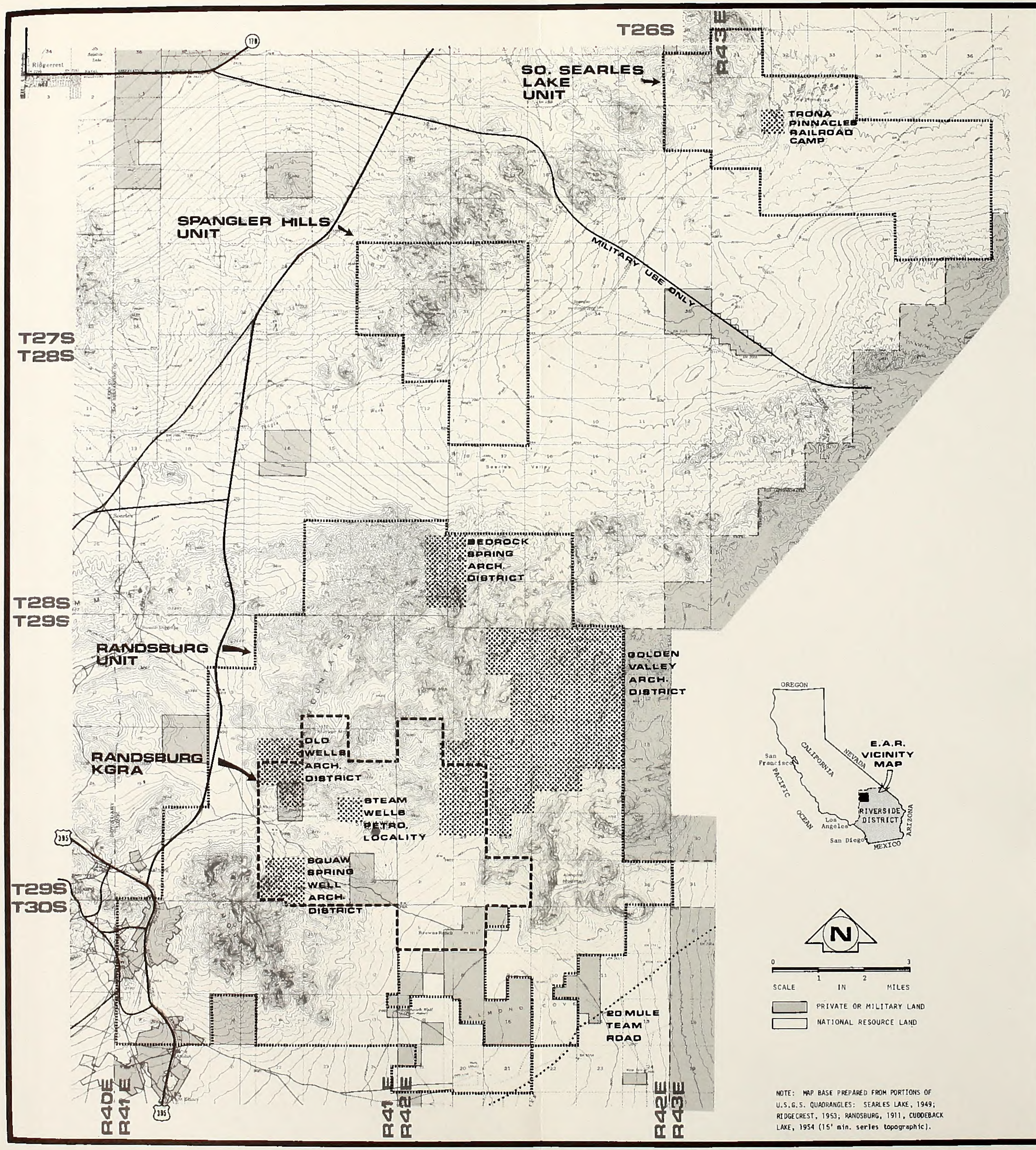
2.4.2.7 Potential National Register Properties

Seven properties within the area of potential impact appear worthy of nomination to the National Register of Historic Places (Figure 2-48). Such a register is a listing of distinctive cultural resources that are worthy of preservation because of their significance. Significance is derived from their intrinsic and/or exemplary value. Intrinsic value is that value ascribed to a cultural resource because of its relationship to important events, personages, and places; or because of its scientific importance; or because it contains important information. Exemplary value is that value ascribed to a cultural resource because of the uniqueness or representativeness which it portrays relative to a type, style, period, technique, etc. A National Register property must possess integrity of location, design, setting, materials, workmanship, feeling and association.

Based on a study of the area's prehistoric and historic remains the seven properties were singled out because of their scientific and informational value, the uniqueness of each situation to regional prehistory or history and the relative integrity of each value. It is predicted that other properties not yet identified probably are present, especially in the high sensitivity area. Each identified property is described below.

Golden Valley Archaeological District

This area of 12.5 square miles contains one of the densest and most diverse inventories of archaeological remains within the study region (Figures 2-49, 50, 51). Within this unique environmental zone 3.4 square miles were surveyed in the probabilistic sample. Thirty-nine archaeological sites were recorded,



-LEGEND-

- KGRA BOUNDARY
- NON-COMPETITIVE LEASE UNIT BOUNDARY
- CANDIDATE LOCATIONS

CANDIDATES FOR NOMINATION TO THE NATIONAL REGISTER OF HISTORIC PLACES

ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 2-48

Figure 2-49. Archaeological Site RM-184. Rock Circle on Small Playa. Proposed Golden Valley National Register of Historic Places Archaeological District.

Figure 2-50. Archaeological Site RM-191. Rock Ring (Probable Temporary Occupation Site). Proposed Golden Valley National Register of Historic Places Archaeological District.

Figure 2-51. Archaeological Site RM-184. Rock Ring in Golden Valley Disturbed by ORV Tracks. Specific Locus of a Larger Probable Temporary Occupation Camp. Proposed Golden Valley National Register of Historic Places Archaeological District.

averaging 11.6 sites per square mile. These included 18 tool and flake scatters, eight milling stations (over 100 milling tools noted in the zone), seven temporary camps, three shelter/caves, one quarry, one historic structure and one trail/alignment. Several of the temporary camps contain unique rock alignments and rock rings located in association with small playas. Hunting blinds and petroglyphs were also noted. Several of these sites cover many acres in size with thousands of cultural elements such as tools, flakes and bifaces present. Based on environmental variables as many as 150 sites are predicted for this district. Disturbance is limited to minimal collecting and pot-hunting and some ORV activity.

Sites from the sample within this proposed district include RM-69, RM-79-91, RM-170-181 and RM-182-195 (Appendices D-3, D-4). Other sites in the proposed district include RM-70-71 and 182.

Bedrock Spring Archaeological District

Six sites were recorded within this proposed district (Figures 2-34, 43). Three form a closely juxtaposed complex of midden-villages (RM-136-138), one (RM-134) is a petroglyph/milling station site and the other two (RM-135; RM-139) are milling stations. These sites all appear related to Bedrock Spring, a major fresh-water resource. Unique geologic and vegetation features highlight this proposed district; i.e. a contact zone between volcanic, granitic and alluvial units with Cheesebush Intrusive vegetation. One of the midden locations emanates from a rockshelter in front of which a stone wall, perhaps a windbreak, has been constructed. These three midden deposits all appear extensive and over three feet deep. Vandalism (pothunting) ranges from light on two of the deposits to moderate on the third. The small petroglyph site includes zoomorphs, a sunburst and several curvilinear and rectilinear motifs. No vandalism is evident here. Based on the area examined, terrain, hydrology and vegetation, it appears more sites with similar characteristics occur within about one mile of the spring. This village site complex probably served as the central occupational focus for prehistoric groups using the north end of the Lava Mountains and undoubtedly contains valuable materials from which information on prehistoric land use can be obtained.

Steam Well Petroglyph Locality

This location (Figure 2-42) has been previously identified as a potential

National Register property in the URA completed for this area by the BLM's DPS (U.S. Dept. Interior, 1975b).

The Steam Well petroglyph locality contains a cluster of three petroglyph sites with over 250 elements. These include mountain sheep ("early style" of Grant and others, 1968), possible vulva-form, crosses and curvilinear designs. Scattered finds of metates were made around the area. The significance of this site is that when coupled with the nearby Squaw Spring petroglyphs this is the major rock art location known in the greater area. Its elements appear to be basically Great Basin Curvilinear in style dating anywhere from 1000 B.C. to A.D. 1500 (Heizer and Baumhoff, 1962). They also contain some affinity with the Early Period of Coso Range petroglyphs at China Lake dating possibly from 1000 B.C. to 200 B.C (Grant and others, 1968).

Although the present petroglyph elements are in good to fair condition, the sites have been subjected to moderate to heavy vandalism in the form of chiseling, drilling, and spray painting. The west side of the middle petroglyph site (RM-21) has been extensively spray painted, covering any evidence of petroglyphs that may have been present. Camping, well drilling and mining activities have impacted the wash between the two main petroglyph sites (RM-21 and RM-22). There is a possibility a village site existed near these petroglyphs but only vestiges are present.

<u>Squaw Spring Well Archaeological District</u>

A one-mile block area surrounding Squaw Spring Well contains a wealth of prehistoric and historic remains (Figure 2-35). Fifteen prehistoric sites occur in this block including a major village-midden, rock rings, cairns and alignments, milling stations, rockshelters, lithic scatter and petroglyphs (RM-155-165; 169; 211-213). Materials recovered from the extensive midden include green slate pendants, exotic obsidian and red-ware pottery (possibly related to a southern Nevada type), and flaked and ground stone tools.

Petroglyphs are closely related to those at Steam Well and include geometric designs and at least one anthropomorph. Some vandalism and natural defacement is evident on the petroglyphs.

This complex of diverse site types appears to hold a great deal of scientific and educational material. The complex appears to represent an important facet of the settlement pattern in the Red Mountain region. The relationship to a possible village site one mile north (see next property description) has not been established but deserves exploration.

Historic remains include development of the spring about the turn of the century to provide water to the inhabitants of Johannesburg. Remnants of this construction activity include building foundations, a pipeline, tanks and wells, and roads, plus evidence of unrelated mining.

<u>Old Wells Archaeological District</u>

This district is one mile north of the previously discussed district and except for the lack of survey between sections could be part of a single larger district. Within the 1-1/4 square mile district (Figures 2-38, 39) are 13 archaeological sites (RM 140-148; RM 204-206 and SBCM-346). This lot includes 12 storage or occupation shelter/caves and one possible major village/petroglyph site which was not field checked.

Included among the rockshelters are Fallen Rock Cave (RM-145) in which a basketry fragment was recovered from the surface, Bird's Roost Cave (RM-146), and a large occupational shelter with extensive deposit present. Also present are other utilized shelters or caves exhibiting milling tools, flaked stone tools and ecofactual data on the surface. Most appear to be little disturbed and together form one of the densest shelter complexes in the region in a unique geologic exposure of volcanic agglomerates. Just to the south of this shelter complex, near Old Wells, an extensive village midden and petroglyph complex has been listed in the files of the San Bernardino County Museum (Smith, 1975, pers. comm.). It was not visited. The site record indicates there are several hundred petroglyphs here along with brown pottery, (not observed during the regional survey) obsidian and jasper projectile points, and scrapers and hammerstones found over an area greater than 500 feet in diameter.

Some pothunting has been reported from the site and other recent mining developments have apparently infringed on the deposit. These mining developments in themselves may represent important turn-of-the-century features. Several building foundations and shafts, trails and roads, and trash dumps are present.

This district appears to represent a major regional village complex and a unique occupational-storage area with preservation of perishables not afforded by other site types. Such perishables offer the possibility of gaining important information concerning technology and subsistence/economic pursuits.

<u>20-Mule-Team Road</u>

A portion of this important historic route traverses the southeast corner of the study area across the upper end of Cuddeback Lake. This road has been identified and described by cultural research specialists with the BLM's DPS (U.S. Dept. Interior, 1975b).

The Pacific Borax Company commenced operation on its deposits in Death Valley in 1883. The construction of a 164-mile wagon road was required to connect the mines with the railhead at Mojave. Special wagons capable of hauling up to 10 tons of borax were designed and built to serve this unusual venture. The wagons were so big they required teams of 20 mules.

The company ceased operations in 1887 thus bringing to an end a colorful period in the history of the Mojave Desert. The significance of the old road probably lies in the world-wide reputation brought about by the advertisement of "20 Mule-team Borax" soap and the "Death Valley Days" series on radio and television.

The road remains unimproved and is easily found on the ground and is well defined between U.S. Highway 395 and Cuddeback Lake.

The present condition of this road is fair. The road is listed on the Kern County Inventory of Historic Places.

<u>Trona Pinnacles Railroad Camp</u>

An extensive railroad camp is located on a small terrace adjoining the Trona Railroad (Figure 2-46). At least 13 tent foundations including a larger mess tent and smaller living tents are evident in the desert pavement. Associated artifacts are almost exclusively male-oriented and include numerous tobacco tins, suspender parts, buttons, whiskey bottles, tin cans, spoons, ironstone, square-cut and wire nails, stove parts, a shovel brace, window screening, nuts, bolts, sawn lumber, cinch rings, bailing wire, buckets and other items. Most appear to date to about the turn of the century. A detailed study of the placement and function of the many artifacts and features would provide important and significant information on early railroad activities and a micro-sociological analysis of life in a short-lived desert railroad camp.

This site has received little impact aside from several vehicles running over the location and a road along its edge.

The above properties represent those identified in the survey. We feel that more properties are present in the area, most likely in the Lava Mountains and less likely in the Cuddeback basin, around the south side of Red Mountain, around Almond Mountain or in the Summit Range, Spangler Hills, Teagle Wash-Searles Valley areas.

2.4.3 Paleontology

The area of the Lava Mountains is the only area where geologic formations occur which could contain fossiliferous remains. In the eastern portion of this area, over 24 fossil localities have been recorded. Mammalian fossil remains include those from camels, rhinoceros, and mastodon. In addition, occasional invertebrate fossil remains occur.

In the Lava Mountains, the fossil bearing horizons occur in the Bedrock Spring Formation (Smith, 1964), the most widespread sedimentary rock unit in the range. The formation consists primarily of coarse arkosic conglomerate, sandstone, siltstone, and claystone. The chief fossil sites are found in the siltstones and claystones.

Although general identification and location of the Lava Mountains vertebrate sources are tabulated below (Smith, 1964), significant paleontological material is almost certainly to be found in any of the area underlain by the Bedrock Spring Formation.

Sec. 36, T. 28 S., R. 41 E.
? Pliohippus cf P. leardi
? Megatylopus sp
? Pliauchenia sp
Fragment of canid jaw
Mastodon tooth enamel fragments

Sec. 32, T. 28 S., R. 42 E.
? Pliohippus cf P. leardi
? Megatylopus sp
Artiodactyls, undet.

Sec. 32, T. 28 S., R. 42 E.
Pliohippus sp
? Megatylopus sp

Sec. 3, T. 29 S., R. 42 E.
? Pliauchenia sp

Sec. 2, T. 29 S., R. 42 E.
Pliohippus cf. P. leardi
Pliauchenia sp
? Merycodus sp

Carnivore metapoidal fragment, undet.
Pliohippus cf P. leardi
Pliauchenia sp
Small camel, undet.
Merycodus sp

Sec. 2, T. 29 S., R. 42 E.
Cf Aphelops sp
Pliohippus cf. P. leardi
Megatylopus sp
Cervid metapodial fragment, undet.
Carnivore metapodial fragment, undet.

Sec. 2, T. 29 S., R. 42 E.
Mammal vertebrae, undet.

Sec. 2, T. 29 S., R. 42 E.
Cf *Merycodus* sp

Sec. 2, T. 29 S., R. 42 E.
Mammalian pelvis fragments, undet.

2.4.4 Socioeconomics

The communities within the vicinity of the EAR area are Searles Valley, Ridgecrest and Red Mountain. Included in the Searles Valley community are the settlements of Trona, Pioneer Point, Argus and Westend, all in San Bernardino County. Ridgecrest, in Kern County, includes the settlements of Ridgecrest and China Lake. The Red Mountain community is made up of Red Mountain and Atolia in San Bernardino County, and Johannesburg and Randsburg in Kern County (Figure 2-52). Only the settlement of Ridgecrest is incorporated, and of these three communities, Ridgecrest is by far the most populous (Table 2-15).

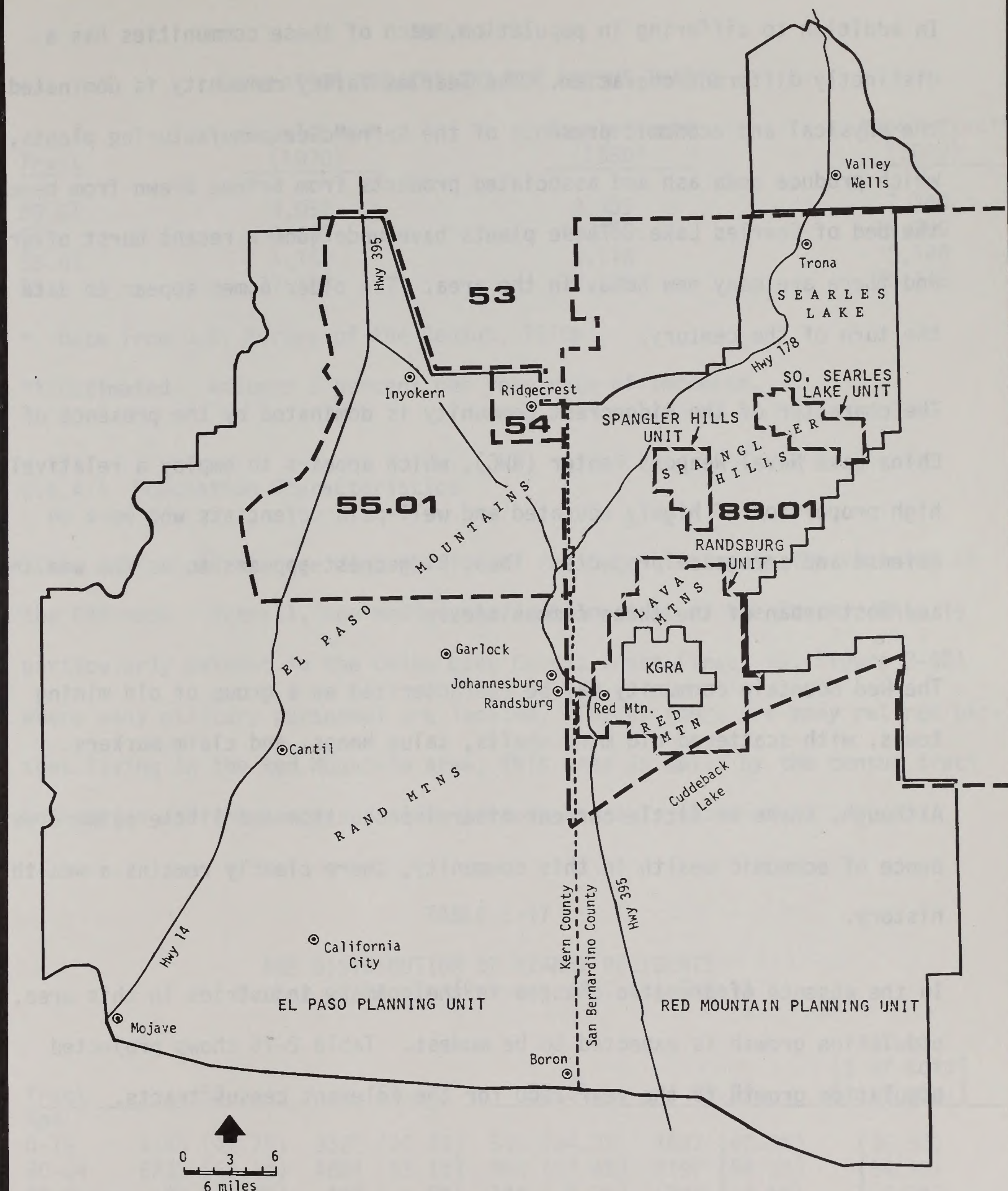
TABLE 2-15

POPULATION IN SETTLEMENTS (1970)

Searles Valley (Census Tract 89.01)	3,828
China Lake (Census Tract 53)	11,105
Ridgecrest (Census Tract 54)	7,629*
Red Mountain (Census Tracts 89.01, 55.01)	725 (est.)

* A highway sign indicated a population of 12,950 in March, 1976.

Data from U.S. Bureau of the Census, 1970a.



MAP OF RED MOUNTAIN AND EL PASO PLANNING UNITS SHOWING CENSUS TRACT BOUNDARIES

FIGURE 2-52

In addition to differing in population, each of these communities has a distinctly different character. The Searles Valley community is dominated by the physical and economic presence of the Kerr-McGee manufacturing plants, which produce soda ash and associated products from brines drawn from beneath the bed of Searles Lake. These plants have undergone a recent burst of growth and there are many new homes in the area. The older homes appear to date from the turn of the century.

The character of the Ridgecrest community is dominated by the presence of the China Lake Naval Weapons Center (NWC), which appears to employ a relatively high proportion of highly educated and well-paid scientists who work on defense and aerospace projects. Thus, Ridgecrest appears to be the wealthiest and most urban of the three communities.

The Red Mountain community may be characterized as a group of old mining towns, with scattered old mine shafts, talus heaps, and claim markers.

Although, there is little current mineral production and little outward evidence of economic wealth in this community, there clearly remains a wealth of history.

In the absence of dramatic changes in the primary industries in this area, population growth is expected to be modest. Table 2-16 shows projected population growth to the year 2000 for the relevant census tracts.

TABLE 2-16

POPULATION PROJECTIONS FOR CENSUS TRACTS

Tract	Population* (1970)	Population** (1980)	Population** (2000)
89.01	4,052	4,939	7,340
54	8,499	10,360	15,395
55.01	1,738	2,118	3,148
53	11,105	13,533	20,115

* Data from U.S. Bureau of the Census, 1970b.

** Estimated. Assumed 2 percent per year rate of increase.

2.4.4.1 Population Characteristics

Table 2-17 shows the age distribution of residents living in the vicinity of the EAR area. Overall, the median age is below that of the State. This is particularly evident in the China Lake Census Tract (Tract 53, Figure 2-52) where many military personnel are located. Though there are many retired persons living in the Red Mountain area, this area is split by the census tract boundaries and the number of older persons there is obscured.

TABLE 2-17

AGE DISTRIBUTION OF NEARBY RESIDENTS
Number of People (Percent of Tract Total)

Tract	53	54	55.01	89.01	State (% of total State pop.)
Age					
0-19	4745 (42.7%)	3322 (39.1%)	596 (34.3%)	1633 (40.3%)	(36.9%)
20-64	6232 (56.1%)	4684 (55.1%)	998 (57.4%)	2197 (54.2%)	(54.1%)
65-Over	98 (0.9%)	493 (5.8%)	144 (8.3%)	222 (5.5%)	(9.0%)

Data from U.S. Bureau of the Census, 1970b.

The population throughout this area is made up of a higher proportion of Whites than the State as a whole. The statistics also show proportionally fewer Spanish-Americans here than for the State (Table 2-18).

TABLE 2-18

ETHNIC COMPOSITION OF NEARBY RESIDENTS
Total Tract Population (% of Tract Total)

Tract Group	53	54	55.01	89.01	State (% of total State pop.)
White	10,491 (94.5%)	8256 (97.1%)	1719 (98.9%)	3993 (98.5%)	(89.0%)
Black	294 (2.6%)	130 (1.5%)	1 (0.1%)	18 (0.4%)	(7.0%)
Other	320 (2.9%)	113 (1.3%)	18 (1.0%)	41 (1.0%)	(4.0%)
(Spanish-American)*	710 (6.4%)	251 (3.0%)	26 (1.5%)	272 (6.7%)	(15.5%)

* Persons of Spanish language plus other persons of Spanish surname. This group is included in the total of the other groups.

Data from U.S. Bureau of the Census, 1970b, 1970c.

The available income data (Table 2-19) indicate that people in this vicinity generally have incomes as high as, or higher than, the California average. However, there is great diversity in incomes in this area. People living in the China Lake NWC (Census Tract 53) have the highest incomes in the area and exceed the State average income for families by 23 percent. In all of the tracts except number 53 the percentage of people with incomes below the poverty level, who are 65 years or older, exceeds the percentage of people 65 years or older in the total tract population.

TABLE 2-19

INCOME OF NEARBY RESIDENTS (1969)

	CENSUS TRACT 53	54	55.01	89.01	State
Mean income (families and unrelated individuals)	$12,105	$11,045	$8,794	$9,867	$9,848
Percent of families having an income of $15,000 or more	43.6	27.4	19.3	21.1	26.7
Percent of families having income below poverty level*	4.1	5.4	15.2	7.5	8.4
Percent of people with incomes below the poverty level* who are 65 years or over	0.0	23.3	20.6	18.6	14.4
Percent of total population with incomes below poverty level*	4.4	7.4	17.3	8.8	11.1

*Poverty level income varies from family to family, depending upon the number of family members and rural or non-rural residence.

Data from U.S. Bureau of the Census, 1970c.

Although it does not include any of the lease area, Census Tract 55.01 most nearly resembles the proposed lease area in socioeconomic character because it is not dominated by the populations of Ridgecrest or Searles Valley. This tract had a greater percentage of people living on incomes below the poverty level than tract 53 and the State. It had the lowest mean family income, (the only one of the four tracts below the State mean) and had the highest proportion of people 65 years or over. In addition it had the highest proportion of people below the poverty level who are also 65 years or older.

2.4.4.2 Industries and Employment

Even though their areas of influence overlap very little, two sectors dominate employment: manufacturing and public employment (Federal, State and local) (Table 2-20). These sectors are represented by the Kerr-McGee Chemical Corporation and the U.S. Navy.

TABLE 2-20

EMPLOYMENT BY ECONOMIC SECTOR - PERSONS 16 YEARS AND OLDER
(in percent)

	Census Tracts				
	53	54	55.01	89.01	The State
Manufacturing	0.9	5.1	8.7	44.7	21.6
Retail Trade	4.9	18.5	18.4	8.7	16.6
Public Employment	73.4	30.0	34.0	1.8	6.5
Other	20.8	46.4	38.9	44.8	55.3
Total	100.0	100.0	100.0	100.0	100.0

Data from U.S. Bureau of the Census, 1970c.

Kerr-McGee is located in the Searles Valley (in census tract 89.01) and employs most of the people involved in manufacturing in that census tract; this includes approximately 1,050 people at the Searles Lake facilities (U.S. Dept. Interior, 1975e). This company manufactures potash, borax, soda ash, and several related, minor co-products.

The China Lake NWC is a Navy facility that dominates employment in the Ridgecrest area. It is a research and testing facility for aerospace projects and approximately 5,500 people are employed at the facility, most of them civilians.

After manufacturing and public employment, the largest employment sector is retail trade. Ridgecrest, the trading center for the entire area, has more people employed in retail trade than in the other areas.

In the Red Mountain area mining provides some current employment, though how much is unknown. If the price of gold or tungsten was to increase sufficiently, mining employment would probably increase because of extensive reserves of low-grade ores in the Randsburg area.

Tourism is probably an important factor in employment due to U.S. Highway 395 which connects the Los Angeles area with Mammoth Mountain and Reno, Nevada. Employment data on this sector are not available; tourism affects mostly retail trade through motels, restaurants, and service stations, and employment due to tourism is not as great as in manufacturing and public administration.

Both the Weapons Center and Kerr-McGee have experienced recent bursts of growth. A Kerr-McGee plant expansion program, which has already resulted in increased employment, is underway at Searles Valley. Further increases may be expected as the expansion is completed. The Weapons Center may be the location of new research and development programs in the next five years which in turn would result in increasing increments to employment in the Ridgecrest area.

Current unemployment data for this area are not available. Though data for Kern and San Bernardino Counties are available, the data are dominated by the population concentrations far to the west of the EAR area. Such data are therefore not likely to be meaningful for the EAR area.

2.4.4.3 Housing

Existing housing varies from new-tract developments at Ridgecrest and Trona to uninhabited derelict structures generally throughout the area (Table 2-21). On the average the best housing appears to be in the Ridgecrest area. At the time of the last census, 1970, houses for sale there were more valuable than the average existing house in the area. Conversely, in census tract 89.01, which contains the proposed lease area, the value of houses for sale was less than the average; these houses tend to remain vacant longer before being sold. In all four census tracts the housing is newer than the State average.

The median gross rent (rent plus utilities reported for all four census tracts was less than the State average. In the China Lake NWC (Census Tract 53) no owner-occupied units were reported.

Housing is less valuable throughout these four tracts than the average California unit. The housing in the EAR area is probably the poorest of the four tracts, with low-value units offered for sale and a higher vacancy rate. New house construction is continuing in the Ridgecrest and Searles Valley communities to accomodate their expansion. This construction is expected to continue as the major employers expand.

TABLE 2-21

HOUSING STATISTICS (1970)

	Census Tracts				
	53	54	55.01	89.01	The State
Total Housing Units	3400	2973	680	1520	-
Vacant Units (for sale only)	0	38	6	16	-
(for rent)	228	90	10	140	-
Median Value (all owner occupied)	NA	$18,900	$12,900	$11,300	$23,100
Median Price Asked (vacant for sale only)	NA	$25,400	$15,600	$ 5,000	-
Percent of Structures Built in 1939 or earlier	0.7%	0.6%	7.4%	21.2%	24%
Median Gross Rent (renter occupied)	$98	$119	$90	$94	$126

Data from U. S. Bureau of the Census, 1970b.

2.4.4.4 Public Financing

San Bernardino County, which includes all of the proposed lease area, levied $57,090,000 in property taxes in 1973-74. The overall property tax rate was about average for California at $11.12 per $100 of assessed value. The net taxable assessed value was about 1.8 billion dollars for the entire county. San Bernardino County's payments for 1972-73 were over $171,000,000. The difference between the property tax receipts and the payments was made up through other taxes and Federal and State grants. In 1972-73 the county's receipts exceeded its payments.

2.5 LAND USE

2.5.1 Existing Land Use

The land base of the EAR area supports limited uses. The major uses are discussed in detail under the following headings: mining and mineral exploration; recreation; and grazing.

2.5.1.1 Mining and Mineral Exploration

Significant mineral production has come from two of the three proposed leasing areas. The most significant is from an area known as the Rand Mineral District. Most of the production from this district, however, occurred west of U.S. Highway 395, outside of the Randsburg KGRA and adjacent lease areas. The peak production period was from 1895 to about 1930, when approximately $25,000,000 worth of silver and gold were produced (Hulin, 1925).

The southern portion of the EAR area extends into the northern half of the Atolia-Red Mountain mineral area. This area occurs in Townships 29 and 30 south and Ranges 41 and 42 east, and is centered just to the south of Red Mountain. The major mineral resource is tungsten with minor amounts of gold and silver. Total value of tungsten produced probably exceeded $12,000,000 from 1895 to 1930, with sporadic but significant production during World War II and later. Gold production from the Atolia-Red Mountain District has been reported to be about $1,000,000 (Hulin, 1925).

In the Lava Mountains, gold mining has been attempted only in Christmas Canyon. This area was probably actively explored for gold and silver from the early 1900's to about 1930. Numerous small silver prospects occur within the Randsburg KGRA, mostly to the south and west of the Steam Well. Production from these areas has been insignificant (Hulin, 1925).

During the prospecting period for silver, exploration was also being carried out for mercury. The Steam Well was drilled as a mercury prospect.

Zeolites occur in an area of highly altered volcanic rock centered around the Steam Well. The zeolites occur with alunite, but the economic significance of these materials is unknown at this time (Smith, 1964).

The second area of significant mineral production occurs in the proposed Spangler Hills leasing unit. Gold is the major mineral resource in this area, and this region is characterized by numerous shafts and adits. Production from this area is unknown, but is not believed to be large. Exploration probably dates from 1890 and is active at the present time (U.S. Dept. Interior, 1975b).

Although a large part of the Spangler Hills and portions of the EAR area are covered by mining claims, the only current activity within the area is in the Spangler Hills. All of this activity is confined to prospecting and experimental testing of the older gold properties. There are also indications of prospecting activity in scattered areas surrounding the Steam Well, in and around the KGRA.

Approximately 290 mining claims exist within the EAR area. Of these, the greater Randsburg-Red Mountain-Atolia area contains 204, and 86 are found in the Spangler Hills. This may be a conservative estimate since the mining claim survey was conducted in early 1975.

Although no production exists now, the Atolia tungsten-gold district has by far the greatest potential for future activity. Large quantities of tungsten-bearing ore still exist in this area. In addition, large deposits of tungsten and gold-bearing alluvium extend practically to Cuddeback Lake.

Silver and gold production in the rest of this area is not likely. If any future production of gold and silver is to occur, it will probably be centered west of U.S. Highway 395, out of the EAR area.

The potential for discovery of any major ore bodies in the Lava Mountains is low. The zeolites and alunite could become commercial, but only after extensive exploration and testing. Smith (1964) estimates three million tons of alunite are available in the area immediately surrounding the Steam Well.

Activity in the Spangler Hills area will probably continue on a small scale. Some production could be realized from small, isolated mines, but major production from this area is unlikely.

2.5.1.2 Recreation

Recreation in the area includes a variety of uses ranging from competitive motorcycle racing to hiking and other solitude-seeking activities. Other major uses are ORV pleasure riding, rock collecting, hunting, sightseeing, and enjoyment of the remote, primitive appearance of parts of the area. Often these various recreation activities conflict with one another.

Much of the data on recreation activities in the area was gathered for the BLM's URA for the Red Mountain Planning Unit (U.S. Dept. Interior, 1975b). The data for the analysis were collected from users, motorcycle permit statistics, aerial counts, and from the two desert rangers who patrol the area. The aerial flight data have been updated and are taken from flights conducted during the period 12-1-74 through 11-31-75. The intensity of use table, (Table 2-22) and Figure 2-53 are derived from the aerial flight data.

Motorcycle Events

Motorcycle events constitute one of the heaviest uses of the area and account for two thirds of the recreation use in the planning unit (U.S. Dept. Interior, 1975b). These events usually consist of two areas of activities: the start and camping area, and a course consisting of one or more loops from 20 miles to 100 or more miles in length. Enduro motorcycle events involve a series of two to six riders, who start at set intervals; the object is to reach check points in a predetermined time interval with score points deducted for early or late arrival. Most other events involve one or more mass starts with the first person finishing declared the winner. The number of riders competing in each event ranges from less than 100 to almost 1,000; the average for 1973 and 1974 was 478 riders per event in the Red Mountain Planning Unit. There were 18 events held in this area in 1973 and 23 events in 1974. During these same years there were seven events around Fremont Peak south of the study area. However, some of these events used courses which extended into

TABLE 2-22

DEGREE OF RECREATION USE
For the Period 12-1-74 through 11-31-75

AREA # (See Fig. 2-53)	NAME	SQ. MILES	TOTAL ANNUAL VUD's	VUD's* SQ. MILE	DEGREE OF USE**
8	Charley's Place	1	3933	3933	Intense
3	Steam Well	0.5	441	881	Heavy
2	N. of Red Mountain	3.5	2498	714	Heavy
6	Summit Range	5	2394	479	Moderate
7	Teagle Wash	8	3637	455	Moderate
5	Trona Road	3	1025	342	Moderate
4	S W Trona Road	2	410	205	Moderate
9	Pinnacles	2	311	155	Moderate
1	Cuddeback Lake	17	536	32	Low

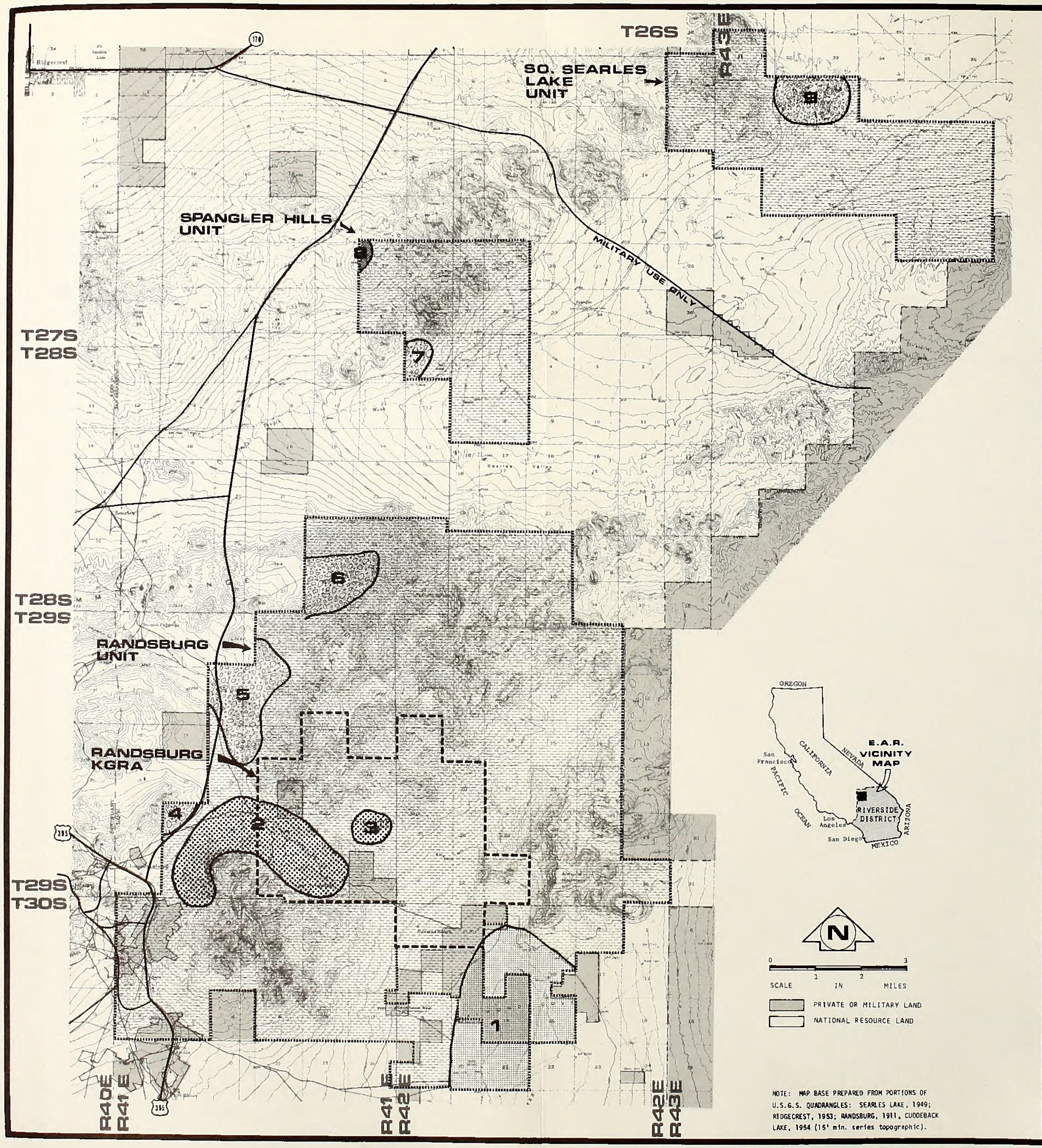
* Visitor Use Days

** Degree of use = Total Annual VUD's/Use Sector / Number Square Mi. in Use Sector

Degree of use is a good indication of the relative intensity of concentration of recreation visitors since it considers numbers of visitors in terms of time spent and spatial distribution.

NOTE:
- Intense = Over 1,000 Annual VUD's/Sq. Mile
- Heavy = 501 - 1,000 Annual VUD's/Sq. Mile
- Moderate = 101 - 500 Annual VUD's Sq. Mile
- Low = 100 - 25 Annual VUD's Sq. Mile
- Light = Under 25 Annual VUD's Sq. Mile

the EAR area. At the present time problems with gaining permission of private landowners have halted racing around Fremont Peak and added pressure to the Teagle Wash-Spangler Hills area, which is partially within the EAR area.



-LEGENO-

- KGRA BOUNOARY
- NON-COMPETITIVE LEASE UNIT BOUNOARY
- INTENSE
- HEAVY
- MOOERATE
- LOW
- LIGHT
- 1 AREA NUMBERS SHOWN CORRESPONO TO THOSE LISTED IN TABLE 2-22

INTENSITY OF RECREATIONAL USE

ENVIRONMENTAL ANALYSIS RECORO
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LANO MANAGEMENT

FIGURE 2-53

The majority of motorcycle races in the Red Mountain Planning Unit have had their camping and start areas in or near the north half of the study area. Almost all motorcycle events in the Red Mountain Planning Unit use the EAR area for their courses. Teagle Wash and Charley's Place in the Spangler Hills are the most often used camping and start areas.

ORV Pleasure Riding

The use of ORV's, including four-wheel drives, two-wheel drives, and motorcycles, for pleasure riding or play is one of the most frequently observed activities in this area and is often connected with motorcycle events. Intensity of ORV pleasure riding is much the same as overall recreation use, as shown in Figure 2-53.

ORV's are used to test both the driver's skill and the vehicle's capability. Drivers try to climb hills, drive cross country, or follow narrow trails or roads. This activity is often combined with other activities, such as various types of sightseeing.

At the present time, the area south of the Navy Road and north of the Summit Range is classified as open to vehicle use in any location; in the remainder of the area, vehicle use is restricted to existing roads and trails (U.S. Dept. Interior, 1974a). The area north of the Navy Road and south of Searles Lake, will be open to vehicle travel only on designated roads and trails after these roads and trails have been selected and designated. This area is now closed to competitive events.

Hunting

The principal species of interest to hunters in the area are chukar, dove, and quail. Chukar and dove populations are subject to climate fluctuations. If rainfall is abundant over several years, a flush of annual vegetation allows the game bird populations to build up to high levels. Large numbers of hunters from southern California are drawn to this area in good years.

Dove hunting is more sensitive to weather conditions immediately preceding and during the hunting season. Often, poor weather will drive the birds out of the area before or within a few days of the beginning of hunting season.

Much of the game bird habitat in this area has the potential for producing good populations of quail and chukar in good years and very high populations when conditions are optimum.

Jackrabbits, coyotes, and bobcats are non-game species which make up the other huntable animal population in the area. The jackrabbit population is cyclic, building up to high levels then dropping drastically as overpopulation allows disease to spread. At the present time the jackrabbit population is just beginning to build up from a low. The coyote and bobcat, predators of the jackrabbit, increase two or three years after the jackrabbit population increases. California Department of Fish and Game officials describe the coyote population as "average" and evenly spread over the planning unit and the bobcat population as "poor" (Moor, 1975, pers. comm.).

Most of the hunting opportunity in the area is in the Spangler Hills and the Lava/Red Mountains area. Ease of hunter movement is good except in the Lava Mountains, where terrain is rugged and steep.

Rock and Mineral Collecting

In general, the EAR area rates fair as a rock and mineral collecting area based on similar activities in other parts of the local region. The area to the west has excellent collecting opportunities and attracts more rock and mineral collectors.

The area around the Lava Mountains, especially to the north and east, affords the best collecting opportunities. Here, volcanic and hydrothermal activity have allowed for the concentration of numerous silica group minerals. Among those collected here are green onyx, chalcedony, white banded agate, green moss agate, red and yellow petrified wood, jasper-agate, honey onyx, and multi-colored agate. Collecting areas are concentrated at about a dozen sites in this area. Undoubtedly, there are additional potential collecting areas which are unused or little used because of vehicular inaccessibility in what is very rugged terrain.

Limited collecting occurs in the Spangler Hills for argentite and other minerals. Some dispersed collecting occurs throughout the Spangler Hills. Tufa ($CaCo_3$) has been hacked by collectors from the tufa terraces, which represent a shoreline of ancient Searles Lake and exist along the southeast border of the Spangler Hills. Chrysocolla also is found in the Spangler Hills.

In the northwest part of the Teagle Wash area, miscellaneous surface material is found on the Creosote Bush Scrub slopes draining northwest from Christmas Canyon and the Lava Mountains and includes agate, jasper, clear chalcedony, oolite, and palm root.

Botanic Sightseeing

Botanic sightseeing subjects in the area are almost entirely annual wildflower displays. These displays occur in the spring and vary from almost non-existent after a series of dry years to mass floral displays following wet winters.

While these annual wildflowers are found throughout the area, Golden Valley, east of Red Mountain, has the highest concentration. Probably most important in the yellow displays are desert dandelion and correopsis. Smaller, isolated patches of desert candle are also found here. Descriptions of Golden Valley appear in the literature but the area is not well known because it is hidden from the highway by Red Mountain and the Lava Mountains.

Geologic and Paleontologic Sightseeing

Most of the entire area, as with the desert as a whole, is of some geologic sightseeing interest as the often colorful layers of rock and soil are easily visible due to the sparse vegetation.

The Trona Pinnacles are large tufa pinnacles which have been called the most spectacular tufa formations in North America. A large part of their impressiveness is due to the vast, empty open expanse of Teagle Wash south of the Pinnacles. The Pinnacles are highly photogenic and arouse curiosity, and they afford an outstanding opportunity for interpretation of geologic events relating to the Searles Lake Basin.

Tufa terraces which represent the shoreline of ancient Searles Lake are found in the Spangler Hills, southeast of the Trona Pinnacles.

Vertebrate fossils were collected in the 1920's and '30's at the Red Mountain Fossil site, which is at the east end of the Summit Range.

Scenic Values

In general, the scenery of the EAR area is good. The more mountainous areas rate very high with the flat expanses being fair. Very pleasant expansive views highlight the subtle scenery of much of this unit.

The Trona Pinnacles are scenically unique and most impressive. Film and television program sets have been located here. From a distance in low light angles, the Pinnacles suggest a lunar landscape. At close range, the scenic impression, as it relates primarily to scale, changes for some viewers.

Outcrops of jointed and round-weathered granitic boulders characterize the scenery of the Spangler Hills. There is a gentle but consistent topographic expression to the landscape which adds to one's visual interest. Views from the promontories, especially those facing the Trona Pinnacles, are excellent.

The Lava Mountains and Golden Valley to the east rate as having excellent scenic quality. From a distance the Lava Mountains appear barren, black, and homogeneous. At closer visual range, they are exceedingly varied in color, texture, and topographic expression. The vast expanse and excellent views of Golden Valley help make the Lava Mountains a visual delight.

Primitive Values

The Lava Mountains/Golden Valley area has been rated as having the highest primitive value in the Red Mountain Planning Unit. The rugged, expansive Lava Mountains afford excellent primitive opportunities within this planning unit.

A few jeep roads penetrate the area but they are minor intrusions except for the motorcycle race course which runs north and south through Golden Valley in the heart of the Lava Mountains. Very few people have ventured into the exceedingly rugged terrain of Dome, Almond, and Klinker Mountains. Few, if any, roads penetrate these volcanic mountains and pristine values find their best expression here.

Other Recreation Activities

There are a number of other recreation activities which do or may occur in the area. Little is known about the extent of many of them.

Camping is an activity that takes place over much of the area and is usually connected with some other recreation activity. Most of the users camp overnight due to the distance traveled to reach the area. The degree of camping use is much the same as overall recreation use (Figure 2-53). There are no developed campsites in the area, but the amount of undeveloped camping suggests that campsites would be well used if developed here.

The Trona Pinnacles are used for picnicking by local residents. Other areas may also be used occasionally for picnicking.

The Lava Mountains are used for hiking and could also be used for backpacking. People also hike to the summit of Red Mountain for the view.

Golden Valley and the Spangler Hills are areas that are used for horseback riding, which is popular locally in the Ridgecrest and Trona areas. Groups have come from Barstow to ride in Golden Valley.

Raptor Canyon in the Lava Mountains contains a high concentration of nesting birds and offers an excellent opportunity for birdwatching.

Quite a few amateur reptile collectors (as well, possibly, as commercial collectors) catch snakes along the Navy Road from Ridgecrest to Christmas Canyon. This road has a reputation as a good collecting area among snake fanciers (despite the fact that it is closed to public use).

Photography and painting are possible anywhere. Popular subjects are the Trona Pinnacles, Golden Valley, wildflowers in season, and old buildings around Red Mountain.

2.5.1.3 Grazing

The grazing resource in the area is limited; however, it is important for the stabilization of several sheep operators. The entire area is classified as ephemeral range - it can be grazed only when enough precipitation has allowed growth of adequate amounts of ephemeral annual grasses and forbs such as red brome and filaree. Perennial forage species such as Indian ricegrass, desert needlegrass, and Malpais bluegrass also exist but not in sufficient quantity to make this perennial range.

Virtually the entire area is grazed by sheep. There are four sheep authorizations: the Cantil Common, the Spangler Hills Allotment (Saldubehere), the Lava Mountains Allotment (Etcheverry), and the Superior Valley Allotment (El Tejon Land and Livestock Company). Grazing on the Cantil Common, administered by the Bakersfield District Office, BLM, is by permit authorized under Section 3 of the Taylor Grazing Act. The latter three are grazing leases authorized by Section 15 of the Act, and are administered by BLM's Riverside District Office.

Sheep are mainly forb eaters, relishing such annual broadleafs as filaree. Primarily, they graze from March to June in this region, when the forage is green and nutritious.

This area is part of the famous "Thousand Mile Loop". Since 1860, sheep have been grazed along this loop. They start in the San Joaquin Valley, cross Tehachapi Pass, enter the Mojave Desert, move north into Owens Valley, and then cross the passes in the central and northern Sierra Nevada back to the San Joaquin Valley. Some herds graze as far north as Susanville and the Sacramento Valley.

Cantil Common. This is a large unfenced area that includes 364,800 acres of National Resource Land. Most of it is in Kern County, although it extends for several miles into San Bernardino County and encompasses most of the western half of the area. Sixteen operators graze sheep on the common, and these people have made informal agreements among themselves as to grazing locations. The Saldubehere Brothers, who also have the Section 15 Spangler Hills Allotment, usually graze sheep on the part of the Cantil Common that encompasses the EAR area. They usually graze 3,000 sheep for varying periods of time in the spring, the length of time depending upon the amount of available forage; for one year out of every three there is not enough forage to warrant any grazing, and one year out of every five is an exceptionally good year for grazing.

Spangler Hills Allotment. This lease is situated in the northern part of the area between Searles Lake and the Lava Mountains. It includes the Trona Pinnacles, Searles Valley, the eastern part of the Spangler Hills, and the northern part of the Lava Mountains. Much of the Spangler Hills Allotment is within the KGRA. Forage here is more dependable than in the other authorizations; sheep are allowed to graze almost every spring. Maximum use in the past has been 3,000 sheep for four months (2,400 animal unit months).

Lava Mountains Allotment. This lease lies entirely within the study area. It is bounded on the west by the Cantil Common, on the north by the Spangler Hills Allotment, and on the east by the Mojave B/Randsburg Wash Range Complex. Approximately 1,500 sheep graze here three out of every four springs.

Superior Valley Allotment. Only a relatively small part of this lease is located in the EAR area. It is situated east of the Cantil Common and south of Klinker Mountain. Sheep graze here three out of every four springs.

The only cattle operation in the EAR area, the Pilot Knob Allotment (Mendeburu), includes 120 acres in the extreme southeastern part of the area. The entire operation, however, is much larger, encompassing approximately 92,000 acres. Stockers (steers) are grazed, and the area is usually grazed one year out of every two. Approximately 1,000 animals are grazed for three months. The portion within the EAR area is used for distribution and collection of trucked steers.

2.5.2 Nature of Land Use

As previously stated the major uses of the area are mining and mineral exploration, recreation, and grazing. While these occur over most of the study area, there are areas of heavier concentrated use, such as mining in the Red Mountain area, and recreation in the Spangler Hills. The entire area is either under grazing lease or permit. Utility rights-of-way presently are concentrated in the western portion of the Randsburg lease unit near Red Mountain (Figure 1-3). These generally are portions of longer rights-of-way serving areas outside the unit.

2.5.2.1 Types of Users

In addition to mining, recreation, and grazing, land use demands exist for urban expansion, various rights-of-way, and the military. Extensive military withdrawals are located to the north and east of the EAR area. These withdrawals include the China Lake Naval Weapons Center (NWC) to the north and the Center's Mojave "B"/Randsburg Wash Range Complex, to the east of and adjacent to the EAR area. Activities related to the research, development, and testing of various weapons systems are conducted in these areas, sometimes utilizing highly sensitive and classified electronic equipment. There is also a minor withdrawal in the South Searles Lake lease unit for a road to assure exclusive military access to the Navy's Mojave B Complex. The Navy Road is for official Navy use only and can be physically closed to all other use at any time.

To the southeast of the area is the Air Force's Cuddeback Gunnery Range, which is heavily used for flight training operations. Because this Range is substantially smaller than the normal size for this type of facility, flight patterns frequently extend beyond the Range's boundaries, periodically overflying the KGRA, which at its closest point is three miles west of the Range.

The settlement closest to the area is Red Mountain; any expansion requirements here can easily be met. Rights-of-way for natural gas, water and oil pipelines, low and high voltage powerlines, telephone lines, railroads and highways are concentrated along the western boundary of the Randsburg lease unit. These land requirements and their influence upon the land base are minimal. The Trona Pinnacles is an important area to the advertising and motion picture industries.

2.5.2.2 Intensity of Use

The intensity of use in the past has been light. It has been increasing significantly since the early 1970's, however, generally due to the increased recreational pressures (see 2.5.1.2) of people from the heavily urbanized areas to the west. The Kerr-McGee Company is expanding its operations in the Trona - Searles Lake area and this will bring in additional people to increase the demands upon the land.

2.5.2.3 Short-Term vs Long-Term Use

Short-term use of and demands on the land are the most prevalent in the EAR area at this time. A minor portion of the area is suffering from long-term demands, such as existing rights-of-way. If conditions remain constant, there will be only a minimal increase in the long-term commitments of the land.

2.5.3 Long-Term Land Use Plans

The BLM has recently completed the Management Framework Plan (MFP) for the Red Mountain Planning Unit (U.S. Dept. Interior, 1976). The MFP, one step in BLM's long-range planning process, includes decisions that would directly affect the EAR area. Some of these decisions are: (1) establishment of utility rights-of-way in corridors along major highways; (2) creation of a buffer zone around the community of Red Mountain to insulate it from ORV noise and grazing; (3) management of Searles Lake primarily for its mineral resources; (4) management of the Red Mountain-Atolia and Summit Ranges primarily for mineral exploration and development; (5) protection of specific sites for their unique vegetation; and (6) establishment of a Lava Mountains Primitive Area. The MFP is a dynamic document subject to continual review, and amendments can be made at any time new data become available.

San Bernardino County has recently completed a land use plan for the area (<u>in</u> U.S. Dept. Interior, 1975b). It is very general with the major portion of the area considered a Resource Reserve Area, the exception being the northern half of the South Searles Lake lease unit. This is considered a Recreation Conservation Area. Current zoning is DL 40, Desert Living, on 40-acre-minimum parcels.

3.0 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

3.1 CRITICAL IMPACTS

Based on data gathered by the BLM and presented in their MFP for Natural Resource Lands in the Red Mountain Planning Unit (U.S. Dept. Interior, 1976), two areas within the EAR area are considered to be of a particularly significant value and, as such, would suffer significant adverse impacts should entry on these lands for geothermal exploration and development be allowed. These areas are the Trona Pinnacles and the Lava Mountains (Figure 1-1).

The bases for the value judgment of the Trona Pinnacles are its aesthetic and scenic qualities. The Pinnacles are thought to be unique in the nation and perhaps worldwide and as such are of scientific, educational, and recreational value.

Likewise, the Lava Mountains area is considered to possess high aesthetic and scenic values as a primitive area. The central portion of the Lava Mountains is roadless and pristine and, in addition, the general area contains unique wildlife resources.

An early review of the aesthetic and wildlife resources of these areas and the potential impacts that could result during geothermal exploration and development activities indicated that the only measure which would adequately protect the high resource values of these areas is the allowance of only exploration activities which involve casual use. Casual use means "...activities that involve practices which do not ordinarily lead to any appreciable disturbance or damage to lands, resources, and improvements. For example, activities which do not involve use of heavy equipment or explosives and which do not involve vehicle movement except over established roads and trails are 'casual use'". The areas therefore considered open only for these casual uses are shown on Figure 2-26 and include the Trona Pinnacles and the central Lava Mountains.

Detailed discussions to substantiate this conclusion are included in following portions of the report and the reader is referred to these sections. However, because the areas were initially considered closed for all but casual use activities, evaluation of the remaining resources in these areas was based solely on pre-existing published and unpublished data. No field surveys were conducted within the closed areas to ground-truth these data. Field surveys were, however, conducted in all other areas.

3.2 PRELIMINARY EXPLORATION STAGE

3.2.1 Non-Living Components

The impacts to the geologic resources that would occur during the preliminary exploration stage are negligible throughout the entire EAR area.

The various methods of seismic exploration which require vibratory impulses may cause local disturbance of geologic features in the vicinity of the Trona Pinnacles, particularly near borings utilized for explosive shot holes. Scholl (1960) has reported that many of the towers have formed on outcrops of basement rock. This would provide for a sturdy foundation; however, this same study indicates that some of these towers are made up of an outer core of highly porous tufa and an inner core of stony tufa. The outer core tends to break off, exposing the inner core. This core has in some cases developed horizontal and vertical fractures or joints, resulting in columnar sections toppling from the summits of some towers.

No impacts to the area's water resources or climate are expected during this stage of development.

Where new trails are developed or existing trails or roads are upgraded, soil erosion is possible. Incorrect construction of these roads and trails may cause a change in drainage patterns, thereby affecting vegetation. Any removal of soils would limit the productivity of the immediate area. However, at this stage of development, these impacts would probably be minimal.

The effects of geothermal development on air quality are not well understood. The Division of Biomedical and Environmental Research, Lawrence Livermore Laboratory, University of California (1975), is conducting an environmental baseline study in California's Imperial Valley for the U. S. Energy Research and Development Administration (ERDA). When it is completed, we should know more about many aspects of how geothermal development affects the environment, including air quality.

The main forseeable impacts to air resources caused by preliminary exploration and exploration and drilling activities would be internal combustion-caused pollutants and particulate pollutants. Both types of pollutants would originate from motor vehicles and drill rig engines.

Air blown dust would result from vehicle movement and land clearing operations. State and Federal standards for suspended particulate matter (100 micrograms/cubic meter for 24 hour period) could be exceeded for the local area during these times.

The effect of noise on wildlife and other animals has not been studied extensively as, "...a thorough search of the scientific literature from 1950 to the present reveals an almost complete lack of information concerning the effects of noise on wildlife. (Further) Scientific literature dealing with the effects of noise on laboratory and farm animals is sparse..." (U. S. Environmental Protection Agency, 1972). One can surmise that noise could have important effects on wildlife as, "Acoustic signals play a major role in animal species survival in terms of maintaining viable population dynamics and an individual animal's growth behavior. For example, a single startle event may stop the brooding cycle of wild game birds for an entire season. Continuous noise may mask the detection and avoidance relationship between prey and predator, causing huddling or panic-behavior, or may induce population dissipation and migration" (U.S. Environmental Protection Agency, 1972).

In order to assess the impact of noise associated with geothermal activities, reference is made to the noise sensitivity zones defined in Chapter 2 (Section 2.1.8.4). In both of the critical noise sensitivity zones within the EAR area, (Lava Mountains and Trona Pinnacles), or in their immediate vicinity, noise created by geothermal activity would impact the aesthetic values and would disturb nesting raptors. A more detailed discussion of these impacts on wildlife resources appears in Section 3.2.2.

In each of the three substantial noise sensitivity zones (Red Mountain, Lava-Almond Mountains, and Searles Lake-Trona Pinnacles), noise associated with geothermal development would disturb nesting raptors, as well as diminish the enjoyment of aesthetic qualities of the Trona Pinnacles.

Noise produced by geothermal exploration and development activities in the rest of the area, defined as minimal noise sensitivity zones, would have marginal impacts on resources and values.

Activities during the preliminary exploration stage may contribute to man-caused noise in the area through aircraft noises, vehicle noises, drilling machinery noises, and explosive noises from the detonation of explosive charges. Noise from these sources would tend to be intermittent and of short duration.

3.2.2 Living Components

The preliminary exploration stage would have only a minor overall impact on the vegetation in the EAR area. These minor impacts could be significant, however, in a few localized circumstances.

Impacts from ORV use would probably be minimal. Surveyors and geologists utilizing ORV's would use existing roads and trails whenever possible, but would have to travel in undisturbed areas under some circumstances, thus destroying some vegetation. Herbaceous plants, especially annuals, are very vulnerable to ORV damage. Exploration in the spring when there are large blooms of ephemeral plants would be especially damaging, particularly in the relatively flat areas of Creosote Bush Scrub and the Alkali Sink. The rough, rocky nature of the Transitional Shrubland would tend to minimize ORV travel off of existing trails. Shadscale Scrub land would not be as vulnerable to ORV use as the other communities because the vegetation is usually sparse.

The duration and intensity of exploratory ORV use would not be great because explorers will travel to a single given place generally only once.

Secondary impacts to vegetation could be greater than primary ones. Recreational ORV use might follow the trails left by exploratory ORV's, transforming faint trails into relatively deep, eroded gullies which might never revegetate.

The construction of a few new roads, the upgrading of existing trails, and the construction of drill sites for seismic test holes would result in the clearing of a small quantity of vegetation. If earth pits for drilling mud were dug, then a small quantity of additional vegetation would also be cleared. In all, each test hole would require the clearing of an area 30 feet by 30 feet.

Road development would also cause disturbance. Roads create a mesic microenvironment at their edges. Johnson and others (1975) compared the biomass of shrubs and the abundance of annual herbs along roads with undisturbed areas in the Mojave Desert. They found the shrub biomass along unpaved roads to be six times greater, and noted that the abundance of winter annual herbs*, especially filaree, Arabian grass, red brome and fiddleneck, was much greater. Some annuals, such as esteve pincushion, were present along roads but nowhere

* They did not measure summer annuals such as Russian thistle, doveweed, and jimson weed, but these, too, are known to be more abundant.

else. This proliferation of annuals completely changed the vegetative makeup of the area. Roads also cause accelerated erosion by collecting runoff water from the brief, intense, summer storms. This accelerates the speed of the water, thus destroying more vegetation near the road. These roads would remain in the area for a long time and because the desert heals itself very slowly, especially where the soil has been compacted, secondary impacts would be evident for this period of time.

The small areas cleared for drilling would be traumatized for a short time, because the drilling would probably only be done once in any one place. However, it would take a relatively long time for the roadbeds and these drill sites to recover naturally. The Creosote Bush Scrub would take the longest due to the extremely slow growth of its namesake shrub. Most desert shrubs grow very slowly, but creosote grows the slowest. Once established it might take up to 1,000 years for shrubs to equal the height of the surrounding shrubs (Vasek and others, 1975a). Where mud pits were dug and there was a great deal of soil compaction the original vegetation might never return.

The Transitional Shrubland would suffer the second highest impacts due to the steep, rocky nature of the land, requiring more intense clearing activities, such as extensive bulldozing.

Negative impacts on wildlife during the preliminary exploration stage would result from ORV use, road development, noise and vibration, and waste disposal.

ORV activities cause four types of impacts on wildlife and wildlife habitat. They reduce the density and diversity of plant species causing a reduction in both the primary productivity and stability of the plant community. This in turn reduces the amount and diversity of available food to animal populations and ultimately results in a reduction in the diversity and density of wildlife species in the area.

ORV's destroy cover such as shrubs and burrows that are used for nesting, roosting, hibernation, etc. In areas where cover is a factor limiting species populations, this destruction would reduce the density of certain species of wildlife and might ultimately reduce the species diversity in the area.

Animal kills by collision with ORV's is a third negative impact. This results in a short-term reduction in the population density.

Noise from ORV's and users disturbs animals and can interfere with necessary activities. With intensive or continuous disturbance, animals may abandon areas altogether, reducing available habitat. Similarly, the disturbance may disrupt a critical activity such as nesting, thus reducing the productivity of the site for the species affected.

These impacts have been discussed and documented by the Committee on Arid Lands of the American Association for the Advancement of Science (1974), Byrne (1973), Davidson and Fox (1974), Kuhn (1974), Luckenbach (1975), and Stebbins (1974a,b). Of the four impacts, the first two are generally most important since they will reduce the long-term productivity of the area, whereas the latter two would merely temporarily reduce the population aensity of a particular species. The latter two are important where the species in question is endangered and any reduction in its population density is critical.

The negative impact of ORV use during this stage is predicted to be low to medium in most habitat types, assuming that ORV activity would be light, that existing roads and trails would be used whenever possible and that habitat not suitable for ORV use, such as the Transitional Shrubland, would not be used to any great extent. If ORV's use the Transitional Shrubland heavily, then the impact would have to be considered high due to the fact that many species use this habitat for foraging, denning, nesting, etc. because of its inaccessibility.

ORV activities that result in development of new ORV trails in areas used by ORV recreationists usually cause long-term impacts. This occurs because an ORV road established by a geothermal crew would continue to be used by ORV recreationists after the crew has finished its work and thus a previously undisturbed area would be permanently affected. For these reasons, ORV activity can not necessarily be viewed as a temporary or short-term impact.

Geophysical exploration and the drilling of seismic test holes and temperature gradient holes could all require construction of new roads and upgrading of existing roads. The drilling of holes also could require the clearing of a 30 foot by 30 foot area for each drill site.

Road development would generally have the same type of impacts as ORV activity except that impacts would be more severe. Construction of new roads would cause total destruction of habitat and could provide access into previously undisturbed areas. Upgrading of existing roads would be less destructive but could still increase disturbance.

Road development could also change drainage patterns and thus alter the vegetation. This impact would be most severe in the Wash Habitat Type. Roads in and around this type, if not properly constructed, would alter the drainage, thus reducing the water available to vegetation. This could result in both a change in species composition and in a reduction in the overall productivity of the site.

Negative impacts of road development would also be expected to be severe in the more rugged and inaccessible habitats, particularly the Transitional Shrub and Creosote-Rocky Slope Habitat Types. Road building in these types would involve more surface disturbance and would provide access into less accessible areas.

The general vehicular activity that would occur during this stage would cause substantial noise and vibration. The effects of unnatural noises and vibrations on wild free-living animals are not well understood or documented. Unnaturally high noises have been demonstrated to physically damage and/or disrupt activites of many species of animals in laboratory or semi-captive situations (U.S. Environmental Protection Agency, 1971). Similar effects are expected to occur to animals in the wild.

Disturbance from noise or vibration would cause animals to temporarily or permanently abandon areas. This would be particularly serious in raptor nesting areas during the breeding season, as these birds are known to be sensitive to disturbance. Thus, noise would have a high negative but short-term impact in the Transitional Shrub and Creosote-Rocky Slope Habitat where most of the raptors nest.

Disturbance from noise in general probably is more detrimental to birds than to other groups. Birds use vocal communications for many activities including, among others, courtship and breeding, territorial defense, and transmittal of alarm signals. Continuous loud noise would interfere with such activities and would result in: (1) abandonment of the area by some species or individuals, (2) increased vulnerability to predators causing increased mortality, and (3) decreased effectiveness of foraging and reproductive activities resulting in lower natality. The overall result would be a decreased density and diversity of bird species in the area.

As noise associated with exploration would be short-term and not continuous, the overall long-term negative impact in most habitats would be low.

Drilling for seismic test holes and temperature gradient holes would leave small quanitites of solid waste, particularly drilling mud. As the amount of waste produced is expected to be small, the effects on wildlife and/or wildlife habitat would be negligible.

3.2.3 Ecological Interrelationships

The reduction of primary productivity and vegetative cover caused by vegetation destruction during road development and off-road driving would to some extent reduce animal populations. Since these activities would be limited in extent, however, they should not constitute major impacts at this time.

Even though no major changes in the pattern of ecological relationships are anticipated at this time there might be unpredictable long-range adverse impacts. However, most of the types of actions that occur at this stage have already occurred in the area probably to a greater degree than would occur as a result of the exploration activities.

3.2.4 Human Values

Various impacts to existing aesthetic values resulting from the preliminary exploration stage have been identified. The temporary physical presence of man and his aircraft, vehicles, and small, truck-mounted drill rigs with the associated dust and noise from their operation would be very obvious in the desert landscape. Resulting from these temporary presences would be lasting impacts caused by the surface disturbances discussed below.

New trails would introduce new elements of line and alter the texture and color of the existing landscape by removing vegetation and compacting and displacing surface materials. They are highly visible when they cross slopes or when observed from a superior elevation and would continue to be visible for years after they are no longer used. A secondary impact would be the probability of continued use of these trails by ORV's to gain access to previously untraveled areas and to create additional new trails.

Drill sites would alter the texture and color of the existing landscape by the removal of vegetation and displacement of surface materials. They are highly visible under the same conditions and time spans as are new trails. Other surface disturbances such as seismometer placement and electrode placement may also alter the overall landscape but to a very minimal degree.

Throughout this stage waste materials would be generated in the forms of drilling mud, drill cuttings and solid waste. If disposed of at the point of generation these wastes would alter the color of the existing landscape. In the case of drill sites, this impact would be highly visible under the same conditions and time spans as are new trails. Other impacts from these activities would be of relatively low visibility.

Although limited in extent, the cumulative impacts of the preliminary exploration stage would be significant in some aspects and can be therefore considered high on Class II lands and low on Class III and IV lands.

An evaluation of impacts anticipated from the various stages of the proposal was made with respect to the rated cultural sensitivity areas described in Chapter 2. Expected impacts from all combined stages would generally agree with the sensitivity rating, i.e., low, medium, and high. However, localized disturbance such as from the initial stages could be high on a single site located in a low or medium sensitivity area. Therefore, all due caution is expressed when using this system with respect to cultural resource sensitivity areas.

The areas listed in Table 3-1 have been rated as having a High cultural resource sensitivity based on three factors: (1) these areas contain a high density of

TABLE 3-1

HIGH CULTURAL RESOURCE SENSITIVITY AREAS

A. Pinnacles Area Railroad Camp
T. 27 S., R. 43 E., Section 5

B. The Squaw Springs Area north of Red Mountain
T. 29 S., R. 41 E., Section 34 - E 3/4 *
Section 35 - W 1/2
T. 30 S., R. 41 E., Section 2 - NW 1/4
Section 3 - NE 1/4

C. The Lava Mountain - Golden Valley Unit
T. 28 S., R. 41 E., Section 25 - SE 1/4

T. 29 S., R. 41 E., Section 1
Section 2
Section 3
Section 9 - SE 1/4
Section 10
Section 11
Section 12
Section 13
Section 14
Section 15
Section 16 - W 1/2
Section 21 - NE 1/4
Section 22
Section 24 - N 1/2
Section 24 - SW 1/4
Section 25 - NW 1/4
Section 26 - N 3/4
Section 27 - NE 1/4

T. 28 S., R. 42 E., Section 28
Section 29
Section 30
Section 31
Section 32
Section 33

T. 29 S., R. 42 E., Section 2
Section 3
Section 4
Section 5
Section 6
Section 7
Section 8
Section 9
Section 10
Section 11
Section 14 - N 1/2
Section 14 - SW 1/4
Section 15
Section 16
Section 17
Section 18
Section 28 - N 1/2
Section 28 - SW 1/4
Section 29 - N 1/2
Section 29 - SE 1/4
Section 30 - NE 1/4
Section 31 - N 1/2
Section 31 - SE 1/4

D. The Twenty-Mule Team Borax Road*

T. 30 S., R. 42 E., Section 15 SE 1/4
Section 21 SE 1/4

* Note: These portions of sections are only close approximations to the sensitivity boundary lines as illustrated in Figure 2-47.

sites which are identified as significant cultural resources worthy of preservation and protection; (2) a large percentage of the Lava Mountains-Golden Valley area may eventually be nominated to the National Register (see Section 2.4.2.7: and (3) the entirety of the Twenty-Mule Team Road has been recommended for nomination to the National Register by the BLM's DPS. If the proposed action is initiated, impacts to these areas would be great, the severity being in direct proportion to the intensity of surface disturbance (of any kind) and visual impacts, such as those from towers, transmission lines, and structures.

Environmental impacts expected from the preliminary exploration stage would be essentially the same for each succeeding stage. Only the extent of impact differs. Any disturbance of the surface would alter or destroy what cultural resources are present. The degree of impact correlates directly with the amount of new surface disturbance and the size of the site, cultural constituents and/or site density.

Mapping, geophysical exploration, geochemical surveys and drilling directly or indirectly alter the surface, either by establishment of new roads, by drill operations or through unauthorized collecting, increased accessibility (new roads) and increased worker/visitor use of the area. The major effect of these unregulated activities would be the partial or total destruction of existing archaeological or historical sites in the areas of surface alteration. The intensity of development relative to the location of archaeological and historical values would determine the degree of impact, which might range from little or of no significance to total destruction of such resource values.

By nature some types of archaeological sites are much more sensitive to activities than others. Due to their location, petroglyph sites for example would likely not be directly disturbed by most types of geothermal activity but could be impacted by destruction or alteration of their environmental setting. Milling station sites are normally of low sensitivity based on a low data potential and low mitigation cost. However, in terms of a settlement plan they could be important. On the other end of a site value continuum are village and temporary camp sites which usually display a complex surface and subsurface manifestation of artifact materials, features and activity areas. Various intra-site proximity patterns and material distribution arrangements are extremely fragile, and must be studied in great detail to obtain potential scientific and interpretive values. Such cultural evidence would be partially or totally destroyed by ORV use, road construction, drilling, and general geothermal site development. Once cultural materials are disturbed or removed from their original context their potential scientific value is greatly decreased.

Paleontological sites displaying surface fossil remains, particularly in outcrops of the Bedrock Spring Formation might be disturbed during the preliminary exploration stage. The degree of impact correlates directly with the amount of surface disturbance and the size of the site. The major effect would be the total or partial destruction of sites. In areas of surface alteration the intensity of development relative to the location of the paleontological resources would determine the degree of impact. This degree may range from little or no significance to complete disturbance or destruction.

The socioeconomic impacts from this stage can be expected to be minimal. Small crews of two to three people may be employed for up to six months to carry out the preliminary exploration. Even if these people were to live in motels in the nearby communities rather than commute from elsewhere, this would not constitute a noticeable impact except on the one or two motel operators and restaurants serving these people. No local employment would be expected at this stage.

3.2.5 Land Use

No impacts to mineral resources would be expected during this stage.

The primary impact of this stage upon the area's recreational aspects would be the surface disturbance. Recreationists in search of natural surroundings would find any surface disturbance, in addition to that which is already present in the area, offensive. Roads and trails built during exploration might be used by ORV enthusiasts and as part of some motorcycle race courses and might also provide more access to other recreationists such as hunters or rockhounds.

Any roads constructed during exploration activities would also increase vehicle access. This might be seen as beneficial by some people such as those seeking closer or easier access for rockhounding or hunting. However, this increased access might put a strain on the resources which they seek. In many of the other recreation activities, the naturalness of the environment is a positive factor in the recreationists' enjoyment of their stay. Persons seeking primitive values, botanic scenery, or other natural beauty would find roads an impairment to their enjoyment of the area.

Motorcycle racing and ORV pleasure riding would not be limited by exploration activities. Roads constructed for exploration activities might be used for motorcycle races or ORV pleasure riding, thereby increasing the number of routes available for these activities.

Primary impacts upon grazing would be very slight. There would be some disturbance of livestock and a very minimal loss of forage due to exploratory ORV activity, road construction, and drilling. These impacts would be negligible in most cases, however.

Recreational ORV activity, a secondary impact, could become very serious. The recreationists might follow exploratory ORV trails, creating a much heavier impact. With the new roads created for geothermal exploration, they also could gain access to country heretofore unharmed or lightly impacted by ORV's. Recreational ORV use is very disturbing to livestock, especially sheep and steers, and motorcycles are the most disturbing. Riders have been known to chase steers and drive through the middle of sheep flocks. Ewes may abandon their lambs, and steers may bunch up and travel off their owner's allotment, refusing to eat. Steers may be so frightened that they would go through barbed wire fences. Thus grazing can be completely disrupted by recreational ORV activity.

The preliminary exploration stage would have only minor impacts upon general land use. Very few people actually live in the subject area and only casual visitors are in the area during the week; however, on weekends the recreational pressures are heavy (Section 2.5.1.2). With the exception of the few people living in the immediate area most people would probably not be aware of any activity at this stage unless they were directly related to it. Work crews are small, (three to five people), very mobile and generally are not in an area over an extended period of time.

The operations of the military could be impacted somewhat during this stage. Some geophysical surveying equipment may cause electronic interference with critical testing at NWC and airborne exploration activities may jeopardize the safety of both military and civilian aircraft and personnel. This could be particularly critical in the relationship of these activities to the flight training operations centered at George Air Force Base. In addition the potential for a security compromise could be increased.

Another impact may result from the fact that electronic equipment used at NWC emits high intensity radiations which may be of sufficient strength to initiate explosive devices that might be used during seismic surveys and during later well drilling operations. This equipment may also effect measurements conducted during later stages of geothermal exploration and development.

The commitment of the land resource during this stage would be negligible and last for only the period of time the activities were being conducted.

3.3 EXPLORATION DRILLING STAGE

3.3.1 Non-Living Components

Very few new impacts to geologic resources would result during the exploration drilling stage. Just as during the preliminary exploration stage clearing for roads and drill sites occur, so would they be constructed during this stage. Now, however, the areal disturbance would be more intense and extend over a proportionally larger area to accommodate heavier and larger equipment.

The sudden release of subsurface pressure as may occur during an accidental well blow-out, may affect the surface expression of the geothermal field. The most immediate effect, however, could be the development of ground surface phenomena, such as cratering and peripheral cracking at the site of the developing vent. These manifestations would be most damaging to the features found in the area of the Pinnacles.

The impact on water resources during this stage of development would be minimal. Little water is used during the drilling stage except that required for the drilling process.

Grading for well locations and access roads could increase the potential for water runoff, erosion and sediment transport. Rainfall and runoff in the EAR area, however, are low.

Ground-water tables in this area are fairly deep, varying from 200 feet to 300 feet; thus any accidental surface discharge of geothermal fluids or drilling fluids would have little impact on ground-water.

The exploration drilling stage could have a minor effect on the area's microclimate. Steam venting could raise the temperature and humidity about the well site and emit various pollutants to the atmosphere.

Grading of roads and well sites and construction of ponds for drilling mud and geothermal solutions produced from wells during testing would be the principal effects upon the soils. Water erosion from construction activities would be slight due to low rainfall in this area; however, wind erosion of soils can be anticipated whenever surface disturbance occurs.

In addition to internal combustion exhaust emitted from operating vehicles, noncondensible gases would be released during well drilling and testing. This impact is discussed in greater detail below, in Section 3.4.

Noise sources during this stage would be primarily the drilling equipment and vehicles used to transport the drilling equipment. Noise would tend to be continuous for relatively long periods of time.

Venting and bleeding of steam as part of the resource testing program might also occur during this stage. From data gathered at The Geysers, California, area, noise levels from this activity may approach 100 dB(A) at a muffled testing well (U. S. Dept. Interior, 1973).

3.3.2 Living Components

The impacts to vegetation during this stage would be similar to those of the preliminary exploration stage, but would be of higher magnitude, intensity and duration. More roads would be necessary to move larger drilling equipment to and from sites decided upon during the preliminary exploration stage. These roads would be of higher quality than previous ones. Intensity would be higher also. The large drill rigs and heavy trucks carrying pipe, fuel, etc. to the drill sites would cause more compaction of the soil beneath the roads. Duration of the impacting activity would be longer because several additional weeks would be needed to drill the 5,000 foot to 10,000 foot wells required.

A large area about 300 feet by 300 feet would be cleared of vegetation for exploratory drill wells. Large mud pits must be dug, removing all residual plant roots and creating piles of soil. Soil at the site would be compacted by a great deal of vehicular traffic which would continue for a period of several weeks to many months. Trash accumulation on the drill sites would preclude any vegetal growth and oil and gas spills would sterilize soil.

Secondary impacts would be minimal. The water in the mud pit would cause a more mesic situation, but the activity around the pit would preclude vegetal growth. The pits would be sealed; therefore, there would be little chance of water escaping to the surrounding environment.

The soil in the cleared area would be compacted, sterilized, and turned up so that the subsoil was exposed. No new vegetation could get a foodhold under such conditions.

Again, the extremely slow growing creosote bush might be the last plant to revegetate . The Transitional Shrubland might suffer more, however, because this rough area would require a great deal of bulldozing to develop level drill pads and roadbeds.

Additional secondary impacts might result from geothermal steam escaping into the atmosphere from the wells. The chemical content of steam from other geothermal areas throughout the world varies considerably, and although the chemical content of steam from the EAR area has yet to be analyzed, it could contain relatively large amounts of hydrogen sulfide (H_2S) and boron suspended in water droplets. Both of these chemicals can injure vegetation. Studies at the Air Pollution Laboratory of the University of California at Riverside (Thompson, 1976, pers. comm.) indicate that H_2S is very toxic to plants. Concentrations of three parts per million (ppm) in the air can be fatal. Three hundred parts per billion (ppb) reduced growth of alfalfa by 60 percent and burned its leaves. This concentration also was detrimental to ponderosa pine, trees and grapes. Although no desert plants have been experimented with as yet, it is reasonable to assume that they will be very susceptible to H_2S. For example, desert holly is dying in Death Valley. Smog from the Los Angeles Basin is suspect. Boron is toxic to plants; only one ppm in water droplets causes leaf tips to burn.

Negative impacts on wildlife during the exploratory drilling stage would be from ORV use, road development, noise and vibration, clearing, preparation, and use of drilling pads, and waste disposal.

The impacts from ORV's at this stage would be similar to that of the preliminary exploration stage. However, most exploration drilling would require heavier equipment that would require improved roads and thus these impacts would be of less intensity. Therefore, negative impacts on wildlife at this stage from ORV activity can be expected to be low.

Because the equipment used at this stage would require developed roads, the negative impacts of road development would be high. Construction of new roads would cause total destruction of wildlife habitat along rights-of-way. Approximately one and one-half acres of habitat would be destroyed for every mile of a 12-foot wide road. In addition, construction of new roads would provide access into previously undisturbed areas. Upgrading of existing roads would be less destructive but could still increase disturbance.

Approximately three acres of wildlife habitat would be destroyed for each exploratory hole drilled. If five holes are required for each lease then 15 acres of habitat would be destroyed for drilling pads on each lease. The negative impact on wildlife would thus be both high and long-term.

In addition, each exploratory hole drilled would require approximately one acre for ponds to dispose of the solid wastes, primarily drilling mud. These pits would totally destroy the wildlife habitat and could also be an attractive hazard to birds if they contain both substantial amounts of water and toxic chemicals or oil. If each lease contains five exploratory wells then two ponds or two acres of habitat per lease would be destroyed in this manner. Again, the negative impact would be both high and long-term.

Data is limited regarding the toxicity of drilling fluids to plant and animal systems. These fluids may be simply clay suspensions in water or complex fluids composed of various chemical additives designed for specialized drilling operations. Depending on the composition, these fluids may range from not toxic to highly toxic (Land, 1974; Shaw, 1975).

For example, Land (1974) indicates that a suspension of bentonite, the clay most commonly used for general purposes, is not toxic to rainbow trout at 10,000 ppm after 96 hours. Shaw (1974) however indicates that many chemical additives are toxic to plant and animal life, while a few are not toxic or toxic only in very high and seldom used concentrations. For example, the clear water extracted from barium sulfate mud-weighting material or diatomaceous earth slurrys was found to be non-toxic while ammonium phosphate and ammonium sulphate, both used to inhibit clay swelling, are toxic at levels as low as 1 milligram per liter (mg/l). Thus an entire toxicity range exists depending on the fluids being used. It should be noted that although the studies were conducted primarily on aquatic biological systems, the results would seem useful here as a general indication of potential impacts.

3.3 3 Ecological Interrelationships

During this stage of exploration, there would be a finite reduction in primary production and cover which would reduce to some degree the numbers of animals present.

Disturbance would be increased considerably over the preliminary exploration stage. There would be more extensive elimination of habitat and of animals, with the possibility of long-range unanticipated adverse impacts greatly increased. It is possible that species which are rare or local in the area would be eliminated either by direct destruction or by disturbance associated with drilling. Most damage, however, would still be anticipated to be relatively minor.

3.3.4 Human Values

Impacts to existing aesthetic values resulting from the exploration drilling stage would include the temporary physical presence of workers, drill rigs, earth moving equipment, and service vehicles with the associated dust, noise and night lighting from their operation. These would be obvious in the desert landscape and from these temporary presences would be lasting impacts in the forms of surface disturbance, excavation and waste materials.

New dirt roads would introduce new elements of line and color into the landscape through the linear form of the roads and the introduction of gravel in some areas to stabilize the existing surface. The existing color and texture would be altered by the removal of vegetation and the compaction and displacement of surface materials. The roads would be visible on flat lands from approximately 1/4 mile away. In the case of either the roads or the observer being in an elevated position, the roads would be visible to the unaided eye for up to 12 miles. A secondary impact would be the probability of use of these roads by ORV's to gain access to previously untraveled areas with a high likelihood of the creation of additional new trails and further impacts to the area.

Creation of drill sites would alter the color and texture of the desert landscape, and would have the same visibility range and time span as new dirt roads.

Road grading and ditching would alter the form, line, color and texture of the existing desert landscape and the visual range and time span would be the same as for new dirt roads.

Drilling platforms and mud pits would also alter the form, color and texture of the existing desert landscape. Visual range and time span would again be the same as for new dirt roads.

Spent drilling mud, drill cuttings, and solid waste generated during this stage would be of uncharacteristic color and texture when placed in the desert landscape. Visual range and time span depend on treatment.

The cumulative impacts of the exploration drilling stage would be high on Class II lands, moderate on Class III lands, and low on Class IV lands.

Direct impacts to cultural resources would be expected from on-ground disturbances including vehicle travel, drill pad development and drilling and increased visitor use as discussed for the previous stage. If cultural resources existed at these locations of development then total or partial destruction or alteration would occur and the integrity and value of the resource would be lost.

Construction of roads and drilling sites could destroy paleontological sites in the Bedrock Spring Formation. In addition, increased human activity could result from new access roads into fossil-bearing areas.

Socioeconomic impacts would be minimal. Ten or fewer people would be employed for several weeks in exploration drilling of a single lease, and one or two of these employees might be local residents. This would be a minor increment to employment in the nearby communities (Searles Valley, Ridgecrest, and Red Mountain).

People living in the community of Red Mountain would be impacted if the drilling and well testing operations were carried out in and near the community. Table 3-2 indicates the impacts due to noise to be expected at various distances from these sound sources. In addition to the impacts from noise, the residents would be disturbed by any offensive odors released from the geothermal fluid during well testing.

TABLE 3-2

IMPACTS OF NOISE ON HUMANS FROM GEOTHERMAL WELL DRILLING AND TESTING*

IMPACT	DISTANCE IN FEET FROM SOURCES: WELL DRILLING	DISTANCE IN FEET FROM SOURCES: MUFFLED WELL TESTING
Interference with sleep (threshold level:55 dBA)	1,500	6,000
Interference with residential use (threshold level:65 dBA)	375	1,500
Hearing loss over prolonged period (threshold level:70 dBA)	187	750

* Data from Procunier, 1976.

3.3.5 Land Use

Some impact on local sand and gravel resources could occur if these materials were needed for road building, compaction and drill site development.

Road grading and ditching would alter the form, line, color and texture of the existing desert landscape and the visual range and time span would be the same as for new dirt roads.

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3.3.5 Land Use

Some impact on local sand and gravel resources could occur if these materials were needed for road building, compaction and drill site development.

The impact of the exploratory drilling stage on recreational aspects would be much the same as the impact of the preliminary exploration stage. However, impacts would be greater through construction of more roads and larger areas of surface disturbance for drill pads.

The impacts from this stage would be greater on grazing vegetation than the preceding stage, but they would still be minor. There would be more road construction but less exploratory ORV activity. More forage would be lost to road construction and drill pad construction, but this still would be minor. Likewise, disturbance of livestock would be minor.

Increased recreational ORV's would pose the greatest threat to livestock grazing.

Toxic gas in geothermal steam would pose no threat to livestock in that they would simply walk away from the foul smelling gas. Some forage plants, however, would be killed or injured by this gas.

Impacts to land use would result from more of the land base being committed from one use to another for longer periods of time. Larger equipment would be required and there would be an increase in the land base requirements . Each drill site might require a maximum of one to two acres, and additional access roads might be required in order to get the rigs to the desired locations. With this increase in activity and associated land requirements, existing uses could be restricted or denied in the exploration areas. Lessees might block off the areas in which they were presently working and this could be especially detrimental to the recreationist or the rancher if these were key areas to their operations.

Impacts to military operations in the area could increase in severity during this stage. Because of the number of non-military personnel and equipment that would be associated with this stage NWC feels the potential for the compromise of highly classified equipment would be increased. As the number of visitors increases so could the problems associated with the monitoring of these personnel.

Further impacts may result to Naval equipment and/or operations from emissions and dust associated with this stage. NWC is particularly concerned that concentrations of various gases, particulates and aerosols would be transported to test areas and corrode electronic relays and contacts, etch optic coatings and possibly reduce visibility. Personnel at George Air Force Base are likewise concerned about corrosion potential and particularly visibility as it may affect flight approach and weapon delivery patterns.

During this stage of development, impacts to personnel associated with development of the lease may also occur. The probability of military aircraft flying at low altitudes and high speeds results in intense sound fields with rapid onset, resulting in potential damage to sensitive equipment and startled personnel. Impacts to civilian personnel as a result of operations connected with the Cuddeback Gunnery Range center mainly on the potential serious safety problems related to proximity of personnel to the Range itself.

3.4 FIELD DEVELOPMENT STAGE

3.4.1 Non-Living Components

Those impacts incident to the exploration drilling stage would also occur during the time the field is developed, although the impacts would occur with greater intensity and probably more rapidly. This would be most obvious as access roads and clearings were prepared for pipelines and transmission lines.

As field development continues, new impacts might also be realized. During testing and production, the removal of substantial amounts of fluids from a porous reservoir might result in subsidence at the surface if pore space pressure exceeds lithostatic pressure in the undisturbed reservoir and the reservoir rock is poorly consolidated. Subsidence probably would not present a problem in the bedrock areas, such as Spangler Hills and in the main masses of Red, Almond, and the Lava Mountains.

It is possible, however, that any fluid extraction operations taking place in the areas covered with alluvium or in areas such as the Cuddeback Lake Playa would encounter subsidence problems. Of special concern would be the tufa towers in the Pinnacles area. Should subsidence occur over an area extending extensively beyond the immediate site development environs, it may be that those towers underlain by playa sands and silts may be effected.

Reinjection of waste water through wells completed in the producing zone or in another reservoir could lead to increasing seismicity. Experience in several parts of the world has shown that pronounced changes in fluid pressure in confined systems can lead to instability and subsequent earthquakes. The response of reservoirs in the EAR area to fluctuating fluid pressures and withdrawal and reinjection of fluids cannot be determined at this time.

During the construction of the power bloc and related facilities, substantial location preparation would be necessary and would require the removal of varying amounts of geologic resources, such as rock outcrops. The bedrock hills and the deposits which make up the Pinnacles area would again be most affected.

The impact of development on water resources would be in proportion to the scale of activity. However, dangers of pollution of ground-water by accidental release of geothermal fluid to the surface or rupture of waste-water pipelines, or geothermal fluid storage ponds would be slight because of the great depths at which ground-water occurs in this area.

The field development stage would have the same impact upon climate as the exploration and drilling stage, only the extent would be greater. This still would only affect the microclimate and not the overall climate of the area.

CO_2 emissions would probably be most prevalent at this stage but not significant. While CO_2 emissions have been suggested as eventually producing an adverse impact on the global climate, recent evidence indicates that most of the CO_2 emitted to the atmosphere is converted to increased biomass. A small increase in ambient CO_2 concentration may actually be beneficial to agriculture.

Impacts on soils would be more pronounced during the field development stage of geothermal operations. Access roads would be needed to the drill sites, and construction of these roads would involve displacement of soils, thus impairing their productivity. If the roads were not constructed properly, erosion could occur due to poor drainage. In addition to road construction, drill pad areas and power plant sites would be cleared of vegetation, thereby increasing the potential for erosion. An area of about three acres would be cleared for each drill site and about five acres per power plant site. At any time during any construction, soil is subject to wind erosion until disturbed areas have been stabilized.

Soil erosion could affect the visual appearance in the immediate area. Erosion could be particularly significant if construction were to occur within areas containing soil units 802, 818, 821, 822 and 833a which have severe erosion susceptibility (Figure 2-8).

Once the soil has been disturbed, the delicate balance of desert floral and faunal communities can be affected. Habitat in the immediate area of clearing would be destroyed, thus possibly limiting or changing species numbers and types (see impacts on wildlife). Removal of the top layers of soil would have a major impact on the ability of the area to recover from disturbance.

The magnitude of air pollution would be larger than in the preceding stages. Large amounts of exhaust emissions would be introduced into the atmosphere by the large construction equipment. This equipment would also cause considerable volumes of air-blown dust.

In addition, air quality would be impacted during this stage as more geothermal wells were drilled and tested. Noncondensible gases would be released, the most obvious of which is H_2S.

H_2S is detectable by odor at 3ppb, and exposure to this or higher concentrations for a period of time tends to temporarily anesthetize the sense of smell. Table 1-3 quantifies gases associated with geothermal fields in other selected areas.

The fate and conversion rates of H_2S in the atmosphere are not well known. It is believed to be converted to SO_2 and SO_3 at rates which may be highly dependent upon the concentration of oxidants and particulates. The fate and conversion rates of atmospheric H_2S are under study at the University of California, Riverside (Kats, 1976, pers. comm.).

The synergistic effect of SO_2 and SO_3 is known to be greater than their additive individual effects. Sulfuric acid is formed by the combination of SO_3 with water; sulfuric acid can further combine with other pollutants such as ammonia (NH_3), an effluent from geothermal and agricultural operations, to form sulfate salts leading to the formation of sulfate aerosols. Such aerosols are implicated as important determinants of visibility reduction and pollutant health effects.

The emission of H_2, CH_4, and N_2 are not considered to be of significance.

Radon emissions are currently being measured at The Geysers; it is indicated that it is not a significant problem. Confirmation studies will be made in the Imperial Valley by Lawrence Livermore Laboratory (University of California, 1975).

There is also evidence that volatile compounds of mercury and arsenic are present in the gaseous effluent from geothermal areas, and the presense of volatile compounds of selenium, thallium, and other toxic elements has been postulated. Lawrence Livermore Laboratory intends to measure the impacts of such emissions (University of California, 1975).

The field development stage is the "noisiest" stage in the development of a producing geothermal field. Noise sources include heavy equipment and machinery, drilling machinery, venting of wells to the atmosphere, and a variety of construction related noises. These noise sources would tend to be continuous for long periods. Thus, other resources, such as aesthetics and wildlife, might be severely affected.

3.4.2 Living Components

This stage would have the heaviest impact upon vegetation in terms of both magnitude and intensity. It would require more road construction than any other stage. Roads to permanent facilities would be surfaced and some might be paved. Roads to temporary facilities would probably be rudimentary.

These roads would have a heavy primary impact upon vegetation. The surfaced roads might be as much as 20 feet wide and would vary from one half to several miles long. If borrow pits were located within the lease area to supply portions of the surfacing materials, the area of disturbance would almost double. Thus, large amounts of vegetation might be removed for road construction.

Secondary impacts would be great also. New roads, especially high quality ones, would open large areas to the general public. Recreational ORV occurrence would increase many-fold. The illegal collection of desert plants such as cacti and desert holly would increase.

Roads would have enhancing effects on vegetation also. Road edges are more mesic than the surrounding area, especially in the case of paved roads. Johnson and others (1975) found more than six times the shrub biomass along unpaved roads as in undisturbed areas and 18 times the shrub biomass along paved roads as in undisturbed areas. Annual flora were enriched in both quantity and species more so than along unpaved roads.

There would be significant cumulative impacts upon the vegetation because of roads. The entire character of the vegetation could be changed. It would be removed in some places and it would be more abundant and have more mesic species in others. The heaviest impacts would be caused by destruction of vegetation by ORV's.

As previously discussed, the Creosote Bush Scrub would suffer the most because of the slow growth of its dominant shrub. The Transitional Shrubland would also suffer greatly because of clearing for road construction. Parts of this area also would be very attractive to hillclimbing ORV use, thus increasing impacts on vegetation.

Impacts to vegetation during development of drill sites would be greater than during exploratory drilling due to a greater number of wells being drilled; thus more vegetation would be destroyed.

Impacts to vegetation from pipeline construction would be similar to those of construction of unpaved roads. However, vegetation would be allowed to regrow beneath the pipeline.

The actual construction of the power plant would have a more significant impact on vegetation than any of the other activities due to magnitude, intensity, and duration. The primary impacts would involve clearing the entire plant site of vegetation. Surfacing for roads and sidewalks, etc., would be necessary, and construction of cooling towers and buildings to house generators, etc., would also occur. Vegetation would be completely destroyed and the character of the site completely changed, perhaps for a very long time. Thus, these impacts would be cumulative as well as primary.

Emplacement of transmission-line poles would necessitate removal of some vegetation around pole bases and result in the inadvertent crushing of vegetation by equipment used to set the poles. Vasek and others (1975b) found that after 33 years vegetation had significantly recovered at the bases of towers along a Mojave Desert power line, although it had not healed completely. However, they found that the vegetation under the central wire between the towers was enhanced, perhaps due to condensation of moisture on that wire.

Impacts on wildlife and wildlife habitat during the field development stage would occur from road building, site development, pipeline construction, powerline construction, noise, general human disturbance, and waste disposal.

Impacts of road building at this stage would be similar to those in the earlier stages, resulting in destruction of 1-1/2 acres for every mile of road, alteration of drainage patterns, and an increase in disturbance of previously inaccessible areas. The negative impact of this activity would be high in all habitat types, but highest in the Wash Type and in the more rugged, inaccessible Transitional Shrub and Creosote-Rocky Slope Types.

Roads would be required at this stage both for access to drill sites and also for maintenance for pipelines and powerlines. With an estimated 30 units per lease, 90 acres of habitat per lease could be destroyed by roads.

Site development would destroy habitat by clearing land for wells and a power plant complex. It is estimated that each well would disturb three acres and that a powerplant complex would disturb five acres. Thus a lease with 30 wells and one power plant could virtually destroy approximately 95 acres of wildlife habitat. General site development might also necessitate the removal of artificial watering devices (guzzlers), thus disrupting some established animal activities.

The impact of site development would thus be high or extremely high in all habitat types. It would be extremely high in the Wash Types due to the small size of the area and the sensitivity of this type. Site development would also be extreme in the Cresote-Rocky Slope and Transitional Shrub Habitat Types because site preparation would require a more drastic alteration of the environment in these types.

Pipeline construction would permanently destroy additional habitat. A lease with 25 pipelines would destroy approximately 25 acres of habitat for pipe-lines and maintenance roads. In addition pipelines have the potential for restricting the mobility of animals as well as altering drainage patterns if they are not constructed properly. Impacts of pipeline construction would thus be medium to high in all habitat types.

Construction of transmission lines would destroy or disturb approximately five acres per lease. This includes only lines within the boundaries of the lease block. The extent of damage due to transmission line construction outside the lease block cannot be predicted at this time.

In addition to destroying habitat, powerlines would cause electrocution deaths to birds, particularly the larger raptors such as eagles. Construction of powerlines would be most destructive in the more rugged Creosote-Rocky Slope and Transitional Shrubland Habitat Types. Electrocution losses would be expected to occur in all habitat types.

Clearing of drilling pads, drilling of wells, road building, and construction activities would all cause substantial levels of noise. The impacts on wildlife would be similar in nature to those from preliminary exploration and exploratory drilling, but would be more severe in their impacts.

Disturbance from noise and vibrations would disrupt activities and cause some animals to abandon some areas. This would be particularly serious in raptor nesting areas during the breeding season, as these birds are known to be sensitive to disturbance. Thus, noise would have a high but short-term impact in the Transitional Shrub and Creosote-Rocky Slope Habitats where most of the raptors nest.

As with earlier stages, noise impacts would be expected to be most detrimental to birds, and would be mostly short-term.

It has been assumed, for the purposes of this analysis, that workers and their families would reside off the lease site. However, a great deal of disturbance to wildlife could result both from direct habitat destruction and general human activities on the lease. Many animal species cannot tolerate much human activity even though all their habitat requirements are apparently present. These species are often replaced by exotic species such as starlings, house sparrows, and rock doves that have adapted to human communities. Activities that would disrupt wildlife include such things as noise from generators, and recreational ORV use by workers.

Solid waste disposal would cause negative impacts on wildlife by requiring destruction of wildlife habitat for development of disposal areas and possibly also by exposing wildlife to toxic waste materials. Disposal ponds would be expected to destroy two acres of wildlife habitat. Impacts on wildlife would thus be high in all habitat types.

Thus, full site development, in addition to impacts from earlier stages, would result in the following impacts within the site:

(1) Severe habitat destruction and degradation and high disturbance to wildlife.

(2) Reduction in overall productivity and diversity of the site.

(3) Significant reduction in density of most species. In particular, full site development within critical habitat would have the following results:

(a) desert tortoise populations would probably be reduced to less than 10 per square mile;

(b) breeding populations of prairie falcons and golden eagles would be eliminated from the lease area, and would probably be significantly affected throughout their habitat;

(c) use of the area for nesting and foraging by most other raptors and mammalian predators would be severely reduced;

(d) Mojave ground squirrels would be reduced in density in the site and, like the prairie falcons and golden eagles, might be significantly impacted throughout their habitat; and

(e) populations of chukar and Gambel's quail would be reduced to low densities within the site, thus eliminating the recreational values of hunting these species.

All of these impacts would be long-term in nature; recovery of the vegetation and thus, of the habitat can be expected to require hundreds of years in this area.

3.4.3 Ecological Interrelationships

This stage would involve extensive land clearing for roads and drill sites and related production facilities. Impacts would be similar to those of the previous stage except that they would be of greater magnitude and more intensity. There would be a reduction in primary production and cover which would reduce the number of animals present. There would be more extensive elimination of habitat and animals with a greater possibility of long-range unanticipated impacts.

3.4.4 Human Values

Impacts to aesthetic values resulting from the field development stage would be similar to those of exploration drilling, but would be greater in magnitude and intensity, especially with regard to trail and road construction.

Generally, all types of surface disturbances will alter the form, line, color and texture of the existing environment and may be visible to an observer from 1/4 mile to 12 miles away, depending on the elevation of the viewer in relation to the object being viewed and its elevation as well. The physical presence of workers, drill rigs, earth-moving equipment, construction equipment, and service vehicles with the associated dust, noise, and night lighting from their operation would be very obvious in the existing desert landscape. A short-term impact resulting from this stage would be production testing, which would generate noise, steam, waste water and odors. Long-term impacts in the forms of surface disturbance, excavation, waste materials, pipelines, transmission lines, fences, roads, and the generating plant site with all associated structures would result from this stage.

Impacts associated with the development of drill sites would be essentially identical to those already discussed.

The surface disturbance associated with the creation of pipeline transmission routes would have the same general impacts as new dirt roads because the pipelines and transmission lines would be linear in form, little excavation would be involved, and there would be service roads associated with them.

The surface disturbance at the generating plant site would alter the form, line, color and texture of the existing desert landscape through the removal of vegetation and the compaction and displacement of surface materials over the large area required for such a facility. Visual range on flat lands would be in the vicinity of one mile and at least 12 miles when either the site or the viewer was at an elevated position. The visual impact of such a large surface disturbance would be obvious for an extremely long period of time.

The surface disturbance resulting from fencing would have the same impacts as new trails because vehicle access would be necessary to install the fence and the fence would be of linear form.

Scarification would alter the texture of the land itself in the areas where it occurs. The visual range (distance) would be the same as that associated with the surface disturbance of the impact which occupied the site prior to scarification. The period of visual impact would be reduced from that of the particular impact prior to scarification.

Pipeline support placement and transmission tower foundation placement would introduce new line and color in the existing landscape due to the linear routes, the necessary excavation and the introduction of the footings themselves. The visual range and time span would be the same for new dirt roads.

Building foundation construction would introduce new form, color and texture while altering existing form, color and texture in the existing landscape. Visual range and time span would be the same as for generating plant surface disturbance.

Evaporation pond and berm construction would also introduce new form, line, color and texture while altering existing form, color and texture in the existing desert landscape. The visual range of these forms would be at least 12 miles. The time span would exceed the life of the project by many years.

Excavation associated with rehabilitation activities on portions of the project which have been closed down would alter the form and color of the areas where it occurred. The visual range and time span would be the same as the visual range and time span of the surface disturbance caused by the impact that occupied the site prior to rehabilitation.

The generating plant, cooling towers and associated buildings would introduce new form, line, color, and texture to the existing desert landscape. Because of their scale, the visual range of these structures would be limited only by the capabilities of the human eye. The time span of visual impact of these physical structures would be until closedown occurs.

Pipelines and well heads would introduce new form, line, color, and texture into the desert landscape due to their linear alignment, consistent and repetitive tubelike form, and unnatural coloration and smoothness. The time span would be the same as for the generating plant and the visual range would be somewhat less.

Transmission poles, conductors and insulators would introduce new form, line, color, and texture into the desert landscape. The visual range varies with the relationship of the transmission towers to the landscape. It could be as little as two miles when closely backdropped and as much as nine miles when skylined. The time span of visual impact would be until closedown occurs.

Fencing would also introduce new form, line, and color into the existing desert landscape. The visual range of a linear fence would depend on the construction materials used and could be as much as a mile. The visual time span would be until closedown occurs.

The cumulative impacts of the field development stage can be considered to be high on Class II and III lands and moderate on Class IV lands.

This stage in geothermal development would potentially have the greatest impact to cultural resources in the area since it involves the greatest disturbance of the area's surface. Complete avoidance of destruction or alteration of cultural resources is unlikely. The discussions of impacts for the previous development stages apply here as well. Additionally, secondary visual impacts would increase as a result of disturbance or destruction of the environmental setting of some cultural resource districts, such as Bedrock Spring and Golden Valley.

Any type of excavation, earth movement or soil compaction, in and about paleontological sites, will reduce or destroy fossil values contained at the site. Caustic and acidic solutions could have an effect on fossil-bearing strata and materials. In addition, as access is improved increased vandalism of fossil sites could be an important factor in connection with this phase of development.

Heavy equipment, vibrators and explosives used near paleontological sites could damage any relatively large, vertebrate fossils.

The socioeconomic impacts from this stage are based on a period of five years from completion of exploration to completion of the electrical power plant. A total of 30 production wells could be drilled in this five-year period and the power plant could be constructed in the last two of the five years.

Potential employment during the field development stage is shown in Table 3-3. There could be a peak employment of 135 people near the end of the field development stage. Most of these people would come from outside the EAR area due to the specialized skills needed and union hiring practices.

TABLE 3-3

POTENTIAL FIELD DEVELOPMENT EMPLOYMENT - ONE 2560-ACRE LEASE

Component	Time Period	Employees
One drill rig	5 years	20
Power plant	2 years	100
Roads	5 years	5
Transmission lines	1 year	10

The additional services needed to serve this temporary influx of people would be provided by the communities in which they choose to live. Given the number of vacant housing units available, these people could be provided housing with little impact on the community. Some workers would probably choose to live in motels or camper vehicles.

The property tax revenues from this lease would be approximately $355,000 per year*. These revenues would accrue to the County of San Bernardino, and the local school and special districts. No revenues would accrue to the adjacent area of Kern County.

Some of the residences and buildings in the settlement of Red Mountain appear to be located on National Resource Lands proposed for lease. If these lands were leased, and the residential part of that lease developed, there would be impacts on the residents and people who own these buildings. Development within the residential community of Red Mountain might require removal of some of these buildings and residences.

Impacts on the residents of Red Mountain from noise and odors would be similar to those from the exploration stage except that the number of sources would be greater and the duration longer in the field development stage. Operation of well-drilling equipment in the community would make a portion of the area unusable for residential purposes for the duration of the drilling and testing activity. In addition, if noxious odors were released in the community, some of the area would be rendered unsuitable for habitation until the odor source was eliminated.

The equipment for drilling, construction, and field operation would constitute a safety hazard to people living nearby. This would be greatest for operations within the settlement of Red Mountain. Additional traffic, especially heavy equipment traffic, would increase the hazard to people on streets and roads. The amount of this increase is unknown.

* Geothermal development fair market value is $284,000 per mw: property tax rate is $10 per $100 assess value.

Since a relatively high proportion of the people living in this vicinity are over 65 years and have poverty-level incomes, it may be expected that these people would share a relatively high proportion of the impacts from development in and around the Red Mountain settlement.

3.4.5 Land Use

The impacts on mineral resources would be the same as those discussed for the exploratory drilling stage.

Development of the geothermal resource would impair all recreational activities in the immediate vicinity of the site. The overall effect on recreation in the area would depend upon the physical size of the development and the area it covers. Extensive development could curtail much of the existing recreation activities in their immediate areas. For example, some portions of motorcycle race routes might be removed from such uses by development. ORV use in general would similarly be affected. Camping would essentially be eliminated in the actual areas of development. Recreation activities which depend on other resources would be directly affected as the resource upon which they depend is affected. For example, removal of vegetation would foreclose botanic and wildlife sightseeing as well as hunting.

This stage would have a more traumatic effect upon livestock grazing than any of the others in that there would be more disruptions and more forage loss at this time than during any of the other stages. Vegetation enhancement along roads would not mitigate this and fences constructed along roads would hamper livestock movement.

Toxic gas would destroy forage plants but would not directly poison livestock. As before, recreational ORV might have a serious negative impact upon grazing.

This stage of the development will probably have the greatest detrimental effect upon the overall land use. Larger land areas will be required for development and once the area is committed to the development of the geothermal resource other uses would be either restricted or omitted. Impact to the present users would depend on where this development takes place. The increase in people and equipment in the area would increase the safety hazard to individuals already there, especially the racing element. Ranchers would be affected through the loss of vegetation. Hunters could suffer because of a possible drop in wildlife due to the loss of suitable habitat and the increased presence of people on a continuous basis.

The impacts to the military could be essentially the same as those of the previous stage of development except that at this time they would be of a higher magnitude and intensity.

3.5 PRODUCTION AND OPERATION STAGE

3.5.1 Non-living Components

No new impacts to geological resources would result from production and operation activities that would not have occurred during the previous stages of development. In fact, overall activity would be considerably reduced over that required during field development and construction stages.

Although land subsidence and induced seismic activity might occur during the previous stage, the potential for these phenomena would probably be greatest during this stage. Subsidence might not present a problem in the main rock masses of Red Mountain, Almond Mountain and the Lava Mountains but it is possible that any fluid extraction taking place near Cuddeback Lake playa would encounter subsidence problems.

In the Spangler Hills, the bedrock areas should not experience subsidence. However, any fluid extractions taking place in the alluvial areas adjacent to the Spangler Hills and in the Pinnacles area could encounter subsidence problems. Of special concern would be the tufa towers in the Pinnacles area.

Increased seismicity might be induced by fluid injection into confined systems or heavy production of fluids from confined systems. It is not expected, however that these micro-earthquakes would be significant.

The production and operation stage would require disposal of liquid waste from the power plants and producing wells. In the EAR area, this would have to be accomplished by reinjection into the producing zones. Although data is sparse, it is thought that producing geothermal zones in the Randsburg-Red Mountain area lie at depths of probably several thousand feet. The ground-water level throughout the EAR area occurs at depths of 200 feet to 300 feet, and fluids to be reinjected would not enter the ground-water zones unless failure occurred in the well casing near the ground-water elevation.

Ground-water quality could be affected if cooling ponds or retention basins are constructed without proper impermeable base-lining materials. Although this possibility is remote due to the deep water table in the area, if contamination of ground-water were to occur wells and users to the south and north could be affected (Figure 2-5).

Depending on the type of power plant designed for this geothermal area, various amounts of water would be required for cooling turbines or condensing geothermal fluids. A portion of this water would probably have to come from the ground-water sources within the EAR area. This could have a significant impact on the already scarce water resources for this area, and in particular on wildlife and users in the Red Mountain-Randsburg settlements. Any excessive withdrawal from this ground-water source could probably never be replenished.

The production and operation phase could effect both the temperature and humidity about the plant. The steam lines and plant would be operating above the ambient air temperature and this heat would be radiated off, causing a slightly higher temperature about these structures. Additionally the humidity in the area could be raised slightly. Cooling towers or ponds would be needed and these could give off several acre-feet of water a day and thus raise the humidity.

Most activities during this stage of development would have little effect on soils. However, drilling of replacement wells and attendant activities will lead to some further erosion. Also soil erosion would occur due to heavy use of roads. This would cause excessive gullies and ruts adjacent to the roadways. Erosion at the site development could cause excessive dust and affect the overall appearance.

The removal of vegetation for new well sites required to replace old wells would result in impacts to soils similar to those described in previous stages.

During the production and operation stage, new wells would be drilled to replace those which are no longer operable due to loss of the resource. Thus impacts on air quality would consist of the release of steam and noncondensible gases, but to a lesser extent than during the field development stage. Air resources would also be impacted by the release of steam and associated noncondensible gases from cooling towers.

Because overall activity during this stage would be considerably less than during the field development stage, noise sources would be reduced. Primarily, noise sources would be from plant operations, steam vents, and vehicles. Plant operation noise would be continuous, but steam venting and vehicle noise would be intermittent. Steam venting would be of high intensity and would tend to carry further.

3.5.2 Living Components

This stage could have important impacts upon the vegetation. Many of these impacts would have the longest duration, i.e., the life of the field. Other impacts, due to accidents or breakdowns, would have short duration. Magnitude and intensity would vary as to discrete operation. Timing would also vary; the timing of accidents and breakdowns, of course, is impossible to predict.

Maintenance operations would not impact vegetation unless geothermal steam was allowed to escape or vegetation was disturbed for new wells, roads, pipelines or by ORV activities. These impacts have already been discussed for the previous stages.

The disposal of water from geothermal wells has a large potential for adverse impacts upon vegetation depending on the methods of disposal. If all waste water was drained into closed basins, such as Cuddeback Lake or Searles Lake, via natural drainage systems, vegetation along the natural drainage between the discharge point and the playa could be damaged by the high boron content of the water. The volatile H_2S would vaporize from this water and damage vegetation for an undetermined distance downwind from the drainage. The amount of vegetation affected by the chemicals and the severity of injury would depend upon the distance from discharge point to playa, the intensity of the wind, and the concentrations of boron and H_2S. The two chemicals would cause an area of dead vegetation surrounded by another area of injured plants. Different plant species and possibly individual plants would have different tolerances. In addition, the boron in the water would collect in the soil along the drainage channel and sterilize it for an indeterminable amount of time.

The utilization of evaporation ponds would be almost as detrimental to the vegetation as discharging into natural drainages. Vegetation would have to be cleared in order to construct these ponds. The waste water would be restricted to a smaller area, but these areas would suffer a higher intensity impact. Magnitude, duration, and timing of impacts would be the same as for the previous disposal method. The H_2S would escape into the atmosphere in more concentrated amounts, and water could seep out of ponds if impermeable liners were not properly placed and/or maintained. If a leak should occur more vegetation would be damaged and more soil sterilized, with the magnitude dependent on the kind and amounts of toxic materials present. This would be especially true in areas with good drainage such as the Creosote Brush Scrub and the Transitional Shrubland.

If reinjection were found to be feasible, some small amount of steam would probably still escape into the atmosphere, thus affecting a small amount of nearby vegetation.

The disposal of materials such as trash and garbage generated by any human habitation could be accomplished either by removal off-site or by burial in dump locations in the area. If the latter occurs, pits would have to be excavated, probably by bulldozer. This, of course, would necessitate vegetation destruction.

Adverse impacts on wildlife during production and operation would result from waste disposal, water utilization, and human disturbance.

Waste disposal would be required for wastes from human habitation on the leases, sanitary facilities at the plant site, and excess geothermal fluids.

Wastes from human habitations and from sanitary facilities could require a certain amount of habitat for disposal facilities and dumps. This would have a moderate impact on all types except the Wash Type where, because of its small size, the impacts would be extremely high.

The major impact from waste disposal would be from excess geothermal fluids. Impacts from disposal of these fluids could range from highly positive to extremely negative, depending on the nature of the fluid, and on how it is handled. Toxic water would not only require using wildlife habitat for evaporation ponds, but such ponds could also be an attractive hazard to birds and other wildlife. On the other hand, clean water could be used to provide aquatic or riparian habitat which usually would support a relatively high density and diversity of wildlife in the desert.

A third possibility is that the excess fluid would be reinjected. This would still cause loss of some habitat for holding ponds and reinjection wells, but the other impacts would be minimal.

There is only one known permanent spring in the EAR area, Bedrock Spring. Development of wells that would affect this spring would have a high adverse impact on wildlife. Similarly if wells within the Alkali Sink Habitat Type lower the water table, they could change the nature of the vegetation and ultimately alter the productivity of the site.

Impacts on wildlife from general human disturbance at this stage would be similar to that from the field development stage. Human habitations and the associated activities of workers would prevent many species from using surrounding habitat. This disturbance would be extremely severe in the Wash, Creosote Rocky Slope and Transitional Shrub Habitat Types.

3.5.3 Ecological Interrelationships

This is a stage where presumably little new habitat would be destroyed. The major impacts would be associated with long-term human occupation and disturbance or with escape of toxic compounds into the environment during operations. Another major problem might be the introduction of exotic organisms. There are a number of vertebrate species which tend to follow human activity and construction and these include starlings, house sparrows, rats and mice. By creating habitat suitable for these species man might be creating competition for native species. Increasing the numbers of predator species such as coyotes by feeding them during times of stress might increase pressure on prey species at all times.

It is likely that weedy plant species would be introduced and would invade ground disturbed by construction or routine maintenance work. The large numbers of seeds produced at these sites can often permit weeds to invade neighboring natural areas to a greater degree than they otherwise could.

3.5.4 Human Values

Impacts to existing aesthetic values resulting from the production and operation stage include what would be the obvious physical presence of workers, trails, dirt and surfaced roads, pipelines, well heads, transmission lines, drill rigs and sites, earth moving equipment, service vehicles, fencing, and the generating plant and associated structures in the desert landscape for the life of the project. Accordingly, the dust, noise, odor, steam clouds, and waste materials associated with these impacts would be present. New and continuing impacts resulting from the production stage would be surface disturbance, excavation, production of waste materials, and the associated dust, noise, steam, odor and night lighting.

Impacts from surface disturbance would essentially be identical to those previously discussed for new trails, dirt and surfaced roads, drill sites, pipeline routes and scarification.

Impacts from excavation would be identical to those previously discussed for grading and ditching of roads, development of mud pits and the construction of pipeline supports and some rehabilitation activities.

Dust, noise, steam, odors, and night lighting would be present in the desert landscape throughout this stage and until closedown occurs.

The cumulative impacts of the production and operation stage can be considered high on Class II, III, and IV lands.

Impacts to cultural resources during this stage would be expected from drilling of new wells and development of waste disposal elements. Such impacts would be the same as discussed in previous stages.

The production and operation stage would have impacts on the paleontological sites in the area. These impacts would be the same as discussed in previous stages.

During the production and operation stage, 40 or more people could be employed. The power plant operation could employ 20 or more people full-time and the drilling of new wells to maintain the field could employ 20 people, although this activity would be intermittent.

Operation of a power plant in or adjacent to the settlement of Red Mountain would render some residences uninhabitable due to noise and odors. Some people would have to move and some existing structures might have to be removed to accomodate a power plant and associated pipe and transmission lines within the settlement. As in the development stage, a relatively large proportion of the impacts at Red Mountain would be shared by people over 65 years living on poverty-level incomes.

3.5.5 Land Use

Construction of the geothermal plant and facilities could have an impact on existing sand and gravel deposits.

The impact on existing mining claims and mineral properties and resources is unknown at this time. Under the Multiple Use Act (Public Law 585), the existence of geothermal leases over mining claims is permissible. However, discussions regarding surface rights and other concerns might have to be conducted between the mining claimants and mine owners and the involved geothermal companies.

Development of the geothermal resource and its attendant facilities would present physical barriers to vehicle travel. The presence of a generating plant would remove the sense of remote open space enjoyed by many ORV pleasure riders. Often ORV pleasure riding occurs in connection with one or more of the other recreation activities and this would be affected as those activities are affected.

Plant development with accompanying transmission lines, pipe lines, paved roads, noise, etc., would have a serious impact on any natural atmosphere in the surrounding area. Primitive values would be reduced or eliminated in the area where the presence of the generating plant would be noticeable.

The production and operation stage would have very little impact on grazing animals. There would be some disruption by vehicular traffic, but this would be minor. Livestock would soon get used to the noise created by wells and plant operations. Small amounts of forage may be killed by toxic gas.

The major land use impact would have already occurred during the field development stage. Areas would continue to be impacted, however, because of the continued drilling for new sources of geothermal energy in order to keep the power plant in full production and operation. During this time, as new wells were developed and added to production, other well sites could be closed down and rehabilitation projects begun on them. In this way the total number of acres affected would vary but remain relatively stable.

Impacts to military concerns could be similar to those previously discussed. However, overall magnitude and intensity would be less during this stage, mainly because of the decrease in numbers of people near the military reservations at any one time.

3.6 CLOSEDOWN STAGE

3.6.1 Non-Living Components

The major effect on the geologic resources from closedown activities would be subsurface in nature. Cement would be introduced into the holes to plug and seal them and the concrete and steel drill casing would remain in the ground after the site was vacated. A marker would remain above ground to provide identification.

No impacts would be expected to the area's water resources during this stage of development.

This stage should have no impact on the climate, except to alleviate impacts caused by geothermal development.

The overall impacts of the closedown stage on soils would be beneficial. Some wind and water erosion could occur, however, as a result of soil disturbance during dismantling of equipment. Closedown operations might also involve some destruction of vegetation resulting in temporary soil erosion until rehabilitation takes place.

Activities during this final stage would create intermittent noise for a relatively short duration. Sources of noise would include vehicular activities associated with the dismantling of the surface facilities.

3.6.2 Living Components

This stage should have the least amount of adverse impacts, since activities would be aimed at restoration and rehabilitation. In addition, all adverse impacts would have already taken place. A possibility does exist, however, of disturbing heretofore undamaged vegetation during dismantling operations.

Impacts on wildlife from the closedown stage should be minimal and for the most part short-term. No new construction would occur and disturbance from the removal of buildings, structures, etc., would probably not exceed that from production. With proper rehabilitation of landscape and vegetation, the impacts on wildlife could be quite positive. If, however, significant amounts of solid wastes and/or toxic substances were dumped or left behind at this time, adverse impacts would be high.

3.6.3 Ecological Interrelationships

The only major new impact at this stage should be the short-term disturbance associated with the removal of structures. There would also be wastes generated by demolition.

3.6.4 Human Values

Impacts to existing aesthetic values would result from the temporary physical presence of men and their construction and demolition equipment, earth moving, and the associated dust and noise that would be very obvious in the desert landscape. Lasting impacts would result from this stage in the forms of surface disturbance, excavation and waste materials.

Impacts from surface disturbance, excavation activities and waste materials would be similar to those previously discussed.

The additional cumulative impacts of the closedown stage can be considered high on Class II lands and low on Class III and IV lands.

By this stage most cultural or paleontological resources in the vicinity of previous development would have been destroyed or the impacts to the sites mitigated through scientific investigation as required by law. However, any further surface alterations of natural surfaces would result in the same impacts as discussed for the first stage.

Any paleontological impacts would already have occurred. Should new surface areas be disturbed during this stage, impacts similar to those already discussed would occur.

Socioeconomic impacts to the area would be minimal. Closedown of the field would provide no additional employment, and the people who had been employed during field operation would have to seek employment elsewhere.

3.6.5 Land Use

No new impacts to mining activities would be expected during this stage.

To the extent that the area can be restored to its natural state, scenic values would be restored. Recreation activities dependent upon natural resources would also be restored to the extent that these natural resources can be restored. ORV use would be allowed to return to its former status in the area.

This stage would create a considerable amount of disruption to grazing animals in that the dismantling equipment would probably be quite noisy.

Impacts to the military could be similar to those previously discussed, but would be high only during the period of time that facilities were being dismantled and removed. After this time, all impacts would be eliminated.

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Impacts to the wildlife would be similar to those previously discussed, but would be high only during the period of time that facilities were being dismantled and removed. After this time, all impacts would be eliminated.

4.0 MITIGATING MEASURES

4.1 GENERAL

There are various measures which can be implemented to mitigate potential environmental problems and impacts stemming from geothermal exploration and development activities. In general, these mitigation measures can be accomplished through enforcement of applicable Federal, State, and local laws and regulations, geothermal exploration and leasing regulations, geothermal operating regulations, Geothermal Resources Operational (GRO) orders, lease and land-use permit stipulations, and application of existing and developing and yet-to-be-developed technologies.

General activities conducted during the preliminary exploration stage would range from casual use to uses which may significantly affect the resources. Casual use includes surface exploration which generally does not result in significant disturbance and, as such, these activities are not regulated. Other activities which may result in a more significant impact would require the operator to submit a "Notice of Intent to Conduct Exploration Operations" prior to entry on the land. Subpart 3209 of 43 CFR Part 3200 provides for this measure. None of these exploration activities would be allowed prior to meeting the requirements of this Notice of Intent, and the operator would agree to conduct all applicable exploration operations pursuant to the prescribed terms and conditions.

Upon completion of the exploration activities, the operator would file a formal "Notice of Completion of Exploration Operations." Approval of this notice would be contingent upon satisfactory evidence for compliance with all stipulations set forth in the Notice of Intent. If subsequent corrective measures are identified, they must also be accomplished before the Notice of Completion is approved.

Any activities conducted during the exploration drilling stage and subsequent stages would require a lease by those wishing to conduct these operations. Section 3200.0-6(a) of the leasing regulations (43 CFR 3200) provides for an initial preleasing report on the resources of the proposed lease area and the potential impact of operations on the environment. This report would provide data for the evaluation of the potential effects of the leasing program on the total environment of the area in terms of exploration, development, and operational phases. Leases are granted on the basis of this data.

Subsequent to issuance of a geothermal lease, Part 270 of 30 CFR provides for operating regulations. These regulations apply generally to all geothermal leases to provide broad guidelines for the mitigation of various potential impacts.

Section 270.11 of these regulations provides for the issuance of detailed Geothermal Resources Operational (GRO) orders to implement the regulations. These GRO orders become part of the operating regulations and affect such activities as exploration; the drilling, completion, and spacing of wells; the plugging and abandonment of wells; and general environmental protection measures.

The basic requirement that lessees take all reasonable precautions to prevent all types of adverse environmental impacts is set forth in Section 270.30 of the operating regulations. The obligations and duties of lessees as related to specific impacts are set forth in Section 270.34, Plan of Operation; Section 270.40, Well Control; Section 270.41, Pollution; Section 270.42, Noise Abatement; Section 270.43, Land Subsidence and Seismic Activity; Section 270.44, Pits or Sumps; Section 270.45, Well Abandonment; Section 270.46, Accidents; Section 270.47, Workmanlike Operations. In addition, Section 270.76 requires the lessee to annually submit a report indicating compliance with the appropriate requirements and regulations.

The following mitigating measures include both those incorporated in existing GRO orders and those developed specifically for the EAR area. They constitute a commitment on the part of the Bureau of Land Management and the proposed action will not be implemented without the specified mitigating measures. Those mitigating measures included in the final version of the EAR will be specified as definite conditions of leasing.

4.2 NON-LIVING COMPONENTS

4.2.1 Topography and Geology

In order to maintain the unique geologic character of the Trona Pinnacles area, only casual use activities would be allowed within the Pinnacles themselves. In this manner, these geologic features would not be disturbed through clearing and drilling.

All other activities would be restricted to those areas peripheral to the Pinnacles. As outlined in GRO Order Number 4, Section 2, existing roadways would be used in each possible case. If drilling beneath the Pinnacles themselves is proposed, techniques such as slant drilling would be encouraged and, if feasible, stipulated

It is likely that, if subsidence of the ground surface over and around a geothermal reservoir were to occur, it would probably occur during the field development stage. Some tufa towers in the Pinnacles area would be most susceptible to subsidence problems in terms of surface disturbance and their nature would preclude field development in this area. If it was determined that surface subsidence were occurring beneath the Pinnacles, measures such as those in GRO Order Number 4, Section 8, would be immediately instigated to more fully investigate the hydrogeologic parameters affecting the magnitude, extent, and rate of subsidence. Once these parameters are understood, then remedial measures to minimize the subsidence whould be made a part of any further development operations. These measures might include artificial recharge and the utilization of yet-to-be-developed technologies.

Major concern is with the playas and alluvial plains. Here leasing and operating regulations pertinent to subsidence would be required, and may include reinjection. Stipulations contained in GRO Order Number 4, Section 8, require that careful records be maintained on monitoring seismicity of the field. If monitoring indicated a significant increase in seismicity, particularly in intensity of motion, remedial steps would be initiated. These remedial steps include limiting the rate of withdrawal or reinjection in the area of increased seismicity.

If reinjection was to be conducted in the same depth zone as extraction, and in sufficiently close proximity to the extracting wells, reinjected fluids could be used to maintain the formation fluid pressure in the geothermal aquifer system. Selection of locations of reinjection wells would be somewhat experimental; these locations would be based on the geology of the materials underlying the site as inferred from subsurface geologic data and on the results obtained from surface monitoring of land subsidence, seismic activities and monitoring of bottom hole pressures in wells. Reinjection of brines would also be into a zone having a salinity equal to or greater in concentration than that of the waste water.

The practical effect of regulations would be to require reinjection of geothermal wastes into subsurface reservoirs from which the water cannot escape to the surface environment.

4.2.2 Hydrology

Well drilling and completion practices that include measures to insure against subsurface corrosion by geothermal brines, such as cement filling around casing, would be stipulated. If a decision was made to abandon a test well, the cement filling must be to a sufficient depth to prevent movement of brines to overlying ground-water bodies.

All contingencies to provide for the prevention and control of well blowouts such as outlined in GRO Order Number 2 would be enforced.

During the abandonment and capping of wells, all pertinent operating regulations would be strictly enforced to insure an adequate seal against subsurface contamination. All of the above activities are included in GRO Orders Number 2 and 3.

4.2.3 Climatology

There are presently no practical measures available to mitigate the impacts on climate.

4.2.4 Soils

As outlined in GRO Order Number 4, Section 2, existing roads and trails would be used whenever possible.

Temporary trail construction would be held to a minimum and be for short-term use. Trail locations would be field-checked and rerouted when necessary to avoid easily eroded soils.

Whenever possible, upgrading and/or the use of existing roads would be stipulated, rather than allow the development of any proposed new roads. This would be particularly applicable for activities conducted during the preliminary exploration stage in terrain included in the Creosote Rocky Slope and Transitional Shrubland Habitat Types. If new roads elsewhere were needed, however, they would be adequately designed yet provide for the least amount of surface disturbance.

All proposed new roads would be equipped with erosion control devices, such as out-slopes for drainage on dirt roads and slopes, borrow pits, culverts, and culvert aprons on surfaced roads. No road or trail construction would block drainage systems. Culverts or other suitable crossings would be installed on drainages and the road drained or water barred as necessary to prevent erosion. Down spouts would be provided where culvert drains might cause fill cutting and accelerated erosion. The slope of cut banks and fill slopes would not be such that slope failure and sliding occur.

All proposed new roads planned for permanent or long-duration use would be adequately gravelled or paved to control erosion and all roads not deemed necessary for further use would be barricaded or blocked off.

During the preliminary exploration stage, portable metal mud pits for drilling mud would be used. During the other stages, excavated mud pits would be allowed only to the minimum necessary size. These pits, discussed in GRO Order Number 4, Sections 2 and 9(A)(4), whould be sealed with an impermeable liner, and when drilling completed, the mud pits would be purged of harmful chemicals, filled in and topsoil properly replaced.

At the drill sites themselves, all measures would be followed to prevent oil and gasoline spills and to minimize the escape of geothermal steam into the atmosphere. Harmful chemicals would be removed from all sumps and ponds and, upon abandonment, sumps and ponds would be filled and revegetated.

All rehabilitation measures, as discussed in GRO Order Number 4, Section 2 would be directed toward restoring the area to as near natural condition as possible. The topsoil on all disturbed areas, except where permanent facilities would be located, would be stockpiled for use in reclaiming sites, and areas would be scarified to break up compacted soil. Under no circumstances would the soil be turned over. The areas would then be revegetated by seeding and/or planting.

Power lines would be large enough to accomodate power from possible future plants as well as from the proposed plant. This would eliminate the construction of more lines in the future and the resultant surface soil disturbance.

4.2.5 Air Resources

As outlined in GRO Order Number 4, Section 9(A)(3), the volume and concentration of gaseous emissions would not exceed applicable air quality standards set by local, State, and Federal air pollution regulatory agencies (Section 2.1.7).

4.2.6 Noise

Objectionable noise from geothermal activity is regulated by GRO Order Number 4, Section 11. This regulation stipulates compliance with Federal occupational noise levels as specified in the Occupational Safety and Health Act (OSHA) of 1970. Noise standards for geothermal development as established by county ordinance would be adopted as appropriate by lease stipulation where these standards are more restrictive than Federal standards.

Several muffler designs have been successfully tested at existing geothermal fields and continued improvement of muffling equipment for both wells and well drilling rigs is expected. However, in order to protect the resources and values found in the critical noise sensitivity zones, only casual use activities would be allowed in these zones.

4.3 LIVING COMPONENTS

4.3.1 Vegetation and Wildlife

Sensitive Wildlife Species

The BLM has responsibility for protecting habitat for endangered species under the Endangered Species Act of 1973. It is also BLM policy to prevent species from becoming reduced to a level where they require listing on the Threatened Species List (BLM Washington Office Instruction Memorandum 75-42, 1975). The following mitigation measures would provide some protection for significant species within the EAR area:

(1) Allow only casual use within habitat identified as sensitive for the Mojave ground squirrel and desert tortoise;
(2) Allow only casual use within raptor nesting areas;
(3) Do not allow any power plant site development within raptor foraging areas; and
(4) Allow only casual use activities within the Wash habitat type.

General Mitigation Measures

All of the mitigation measures listed previously with respect to soils, noise, and air quality also serve as mitigation measures to vegetation and wildlife impacts. In addition, the following mitigation measures specifically apply to vegetation and wildlife:

Preliminary ORV exploration would be conducted when ephemeral annual plants are not actively growing, i.e., during summer, fall, or winter, or during dry springs.

All demolition would be carried out during late summer and fall if possible. This would minimize disturbance of reproduction by significant vertebrates such as raptors. The success of replanting efforts would be enhanced by the subsequent cool weather and rain. All wastes generated by demolition would be removed from the site and disposed of properly.

Unless it is unfeasible, reinjection of geothermal fluids would be stipulated as the means of disposing of this material. The other methods--evaporation ponds and dumping into natural drainages--would be disastrous due to the toxic materials (H_2S and boron) in the water and steam.

Wildlife access to the toxic water in mud pits would be discouraged with protective barriers, as partially outlined in GRO Order Number 4, Section 4.

The effect of water utilization on wildlife would be mitigated by avoiding any use of ground water that would reduce the water flow at Bedrock Spring, or would lower the water table in the Alkali Sink Habitat Type. In addition, disturbed artificial water devices ("guzzlers") would be placed in a suitable undisturbed location acceptable to BLM and California Department of Fish and

Game biologists if significant disruptive operations were taking place in the vicinity of these devices.

Destruction of vegetation and habitat by pipeline construction and access roads cannot be mitigated during the life of the lease. If restrictions to animal mobility may occur or if drainage patterns may be altered, then the pipelines would be constructed approximately one foot above the ground surface.

By using power pole designs and wire arrangements specified by the Raptor Research Foundation (1975), the danger of electrocution death to raptors would be minimized.

Adverse impacts on wildlife from recreational activities of workers would be largely mitigated by limiting activities on leased areas to those necessary for development of the geothermal resources. Recreational activities on lease areas by workers would be covered by the same regulations that apply to other recreational users.

If dump sites for wastes from human residences are proposed in the lease area, impacts would be completely mitigated in the lease area by requiring all workers to reside off the lease area.

As outlined in GRO Order Number 4, Section 2, all disturbed areas would be revegetated. In the EAR area, adapted native species* would be utilized.

*Vasek and others (1975a) report that Mojave Desert vegetation returns naturally very slowly. After 12 years, large amounts of cheesebush, a pioneer species, had returned on a pipeline right-of-way, but other species had not returned. They state that it might take centuries for Creosote Bush Scrub to return to normal.

Transplanting would be best, but seeding can be accomplished and would include the following species:

<u>Creosote Bush Scrub</u> - Cheesebush, brittlebush, hopsage, rubber rabbitbrush
<u>Transitional Shrubland</u> - California buckwheat, hopsage
<u>Shadscale Scrub</u> - fourwing saltbush, desert holly
<u>Alkali Sink</u> - allscale saltbush, fourwing saltbush, lenscale saltbush

All plantations would be irrigated until they are established.

Some efforts or experimentation would be made to establish the propagation of creosote bush*.

Activities regarding the closedown of operations are addressed in applicable Regulations and GRO Orders. All roads not necessary for other uses would be eliminated. All pipelines, powerlines and construction materials would be removed from the site and the area revegetated. All trash would be removed and rehabilitation conducted through seeding and/or planting whenever feasible in all disturbed areas.

4.4 ECOLOGICAL INTERRELATIONSHIPS

All of the mitigation measures listed previously with respect to living components serve as mitigation measures to impacts on ecological interrelationships.

*Not enough is known about the artificial establishment of this plant to permit a large-scale planting program. Experiments by the University of California at Davis, BLM, and the City of Los Angeles, Department of Water and Power, have failed. Experiments by the University of California at Riverside have succeeded, however. The plant was observed germinating naturally in great quantities along road-grader scrapings during freeway construction near Needles, California.

4.5 HUMAN VALUES

4.5.1 Aesthetics

Most of the mitigation measures which have previously been described for geology, soils, air quality, noise, and wildlife and vegetation would also mitigate impacts on aesthetics.

The following additional measures are recommended:

Dust control would meet the standards imposed by the Southern California Air Pollution Control District - Rule 51.1, Fugitive Dust, with the following amendment: no substance that permanently discolors the materials it is applied to would be used for the control of fugitive dust.

Where the creation of new trails is proposed, travel would be limited to necessary trips along the shortest routes under the following conditions: routes would be along the base of slopes whenever possible in order to minimize visibility by taking advantage of the existing line between distinct changes in slope, and by locating the road in the least obvious visual prominence zone. Also, as little vegetation as possible would be disturbed so as to retain the color and texture of an area and prevent erosion. Finally, travel would be at a conservative rate in order to minimize dust and maximize vehicle control in rough terrain.

If new dirt roads are proposed, they would be constructed only in such cases as are necessary to allow access to equipment that could not otherwise gain access to an area. They would be routed over previously disturbed surfaces where possible and along the base of slopes wherever possible to minimize the visual range. Surface disturbance would be limited to the roadway itself to minimize color and texture alterations.

The creation of straight stretches of road would be avoided in order to avoid introducing unnatural lines into the landscape. Curves that follow existing landforms are more in harmony with the natural landscape.

Gravel would be used only where it is necessary to improve the support characteristics of the existing surface. All gravel introduced would be of such a coloration so as to harmonize with the surrounding landscape, and new dirt roads would be posted in an attempt to discourage use by parties other than those engaged in the development of the geothermal field.

If new surfaced roads are proposed, they would be built only in such cases where gravel-improved dirt roads would not physically support the intended use either temporarily or over the life of the intended use. All surfaced roads would be of a type designed for low-speed use. They would be properly drained so as to minimize interference with the natural drainage patterns and the surface would be composed of materials which were of a color similar to the surrounding area. Surface disturbance would be limited to the width of the roadbed plus drainage correction. Routes would follow pre-established roads and areas of existing surface disturbance wherever possible under the conditions that routes be along the base of slopes wherever possible and avoid ridges, hilltops, and steep slopes. Straight stretches would be avoided wherever possible and new surfaced roads would be posted.

Excavation for the purpose of obtaining materials for use in construction or fill activities would not be permitted within the geothermal lease area unless a suitable source of fill from an existing barrow area is unavailable within an economically feasible distance. GRO Order Number 4, Section 2, provides for the least disturbance of the land surface. In the case of the creation of drill sites, surface disturbance would not exceed the area necessary for establishing the drill rig, mud pit, and parking and turn-around space for service vehicles.

Any drill cuttings and spent drill mud generated during the preliminary exploration stage that remain after the hole has been backfilled would be retained and disposed of at the nearest established dump site outside of the geothermal lease area, as would solid wastes generated throughout all stages of geothermal activity. Drill cuttings and spent drill mud generated throughout the exploration drilling, field development, and production and operation stages would be confined to the mud pits. The mud pit walls would be formed by excavated materials from the center of the proposed mud pit. Surface materials would be scraped and stored separately so that they could be replaced on the surface at whatever time the mud pit is rehabilitated.

Production testing would be limited to calm days. When testing is conducted, it would be as limited as possible with measures taken to insure that all liquid wastes were confined to the mud pit.

In the case of the creation of pipelines, surface disturbance would be limited to the pipeline and service road proper. Excavated materials would be placed along the pipeline in such a manner so as to assure their retention for the purpose of replacement in the approximate original positions at such time as removal and rehabilitation of the pipeline should occur. Such placements would be no higher than the top of the pipe. Pipelines would not be elevated more than one foot above ground and expansion loops should be constructed in a horizontal alignment. Field storage of materials and equipment would be at the plant site and not along the pipeline routes. All pipelines and associated structures would be painted with a non-reflective material so as to blend with the surrounding landscape.

Surface disturbance resulting from transmission system construction would be limited to the direct vicinity of each pole and the service road bed. Excavated materials would be retained at the base of the pole in such a manner so as to assure their retention for the purpose of replacement at such time as removal and rehabilitation should occur. Construction materials and equipment would likewise be field-stored in disturbed areas at the plant site and not along the transmission line route. Transmission poles would be dull-surfaced and the conductors would be of nonspecular material. Any switchyard equipment would be of the dull grey steel type or be painted with a non-reflective paint to match the surroundings.

Surface disturbance at the plant site would not exceed the area necessary for the generating plant, waste-water treatment facilities, field storage areas, and excavated material storage. Field storage of construction equipment and materials would be at the plant site proper in locations that would become evaporation ponds, and excavated materials storage areas. Excavated materials would be stored at the plant site and incorporated into fill needed for the construction of evaporation pond berms. That portion that cannot be used in fill operations at the plant site would be placed in such a manner that it occupies a minimum surface area and would not migrate through wind or water erosion. Surface materials at the plant site would be stored in such a manner so as to assure the replacement of surface materials to their approximate original positions at whatever time closedown occurs. Steps would also be taken to insure that placement of these materials does not change the existing drainage systems.

At such time that the outer boundaries of the geothermal development area were determined, fencing would be installed around the perimeter of the developed area to assure that geothermal activities were the only impact on the area at this time. The specific alignment would be chosen so as to cause minimal impact on vegetation such as routing it over previously disturbed areas wherever possible. The construction and service road for the fence would be on the inside so as not to provide a jumping-off point for ORV's.

If scarification occurs during rehabilitation activities, it would be performed in such a manner so as to break up the surface but not bring materials of contrasting color to the surface.

4.5.2 Archaeology and Paleontology

Legislative Requirements

The BLM recognizes its legal obligation to ensure that all Bureau projects and Bureau-assisted or licensed projects (1) give adequate consideration to cultural resources, and (2) do not inadvertently harm or destroy cultural resources.

The primary authority for the protection and mitigation of sites or areas which may be impacted are (1) the 1906 Antiquities Act, (2) the 1966 National Historic Preservation Act, (3) the 1969 National Environmental Policy Act, (4) Executive Order 11593, and (5) the 1974 Archaeological and Historic Preservation Act.

The National Historic Preservation Act established the National Register of Historic Places and the President's Advisory Council on Historic Preservation. Section 106 of this Act requires that Federal, Federally assisted, and Federally licensed undertakings affecting cultural resource properties included, or having the potential for being included, on the National Register be submitted to the Advisory Council for review and comment prior to the approval of any such action or any such undertaking by the Federal agency.

The National Environmental Policy Act mandates that part of the function of the Federal Government is "to preserve important historic, cultural and natural aspects of our national heritage."

The recent Advisory Council on Historic Preservation procedures (39 FR 18:2.3355-3370; 36 FR 8:800.4) state that, "As early as possible and in all cases prior to agency decision concerning an undertaking, the Agency Official shall identify properties located within the area of the undertaking's potential environmental impact that are included in or eligible for inclusion in the National Register." This process is in compliance with the requirement of Section 106 of the National Historic Preservation Act and Sections 1(3) and 2(b) of Executive Order 11593. The procedures to accomplish this are outlined in the Federal Register of February 10, 1976 (41 FR 18:2.3367).

The first step in this procedure is to identify properties on or nominated to the National Register. This is done by simply consulting the National Register list and the monthly supplements. The complete list of National Register properties and nominations is published in the Federal Register in its entirety every year on the first Thursday in February. The monthly supplements appear in the Federal Register on the first Tuesday of each month. No sites in the project area are listed on the National Register.

Section 2(a) of Executive Order 11593 states that Federal agencies shall "locate, inventory, and nominate to the Secretary of the Interior all sites, buildings, districts, and objects under their jurisdiction or control that appear to qualify for listing on the National Register of Historic Places." Executive order 11593 directs all Federal agencies to inventory their cultural resources, to submit to the National Register all qualified sites, and to establish procedures for cultural resource preservation in their plans and programs. If the State Historic Preservation Officer does not concur in the BLM's evaluation, procedures outlined in 36 CFR 800 will be followed.

Mitigating Measures

In the event that the cultural resource sensitivity areas rated as high (Figure 2-47), are not withdrawn from lease consideration, they must be subjected to further intensive surveys and mitigation in compliance with 36 CFR 800.

The measures discussed below are recommended to mitigate potential impacts accruing from geothermal development in areas of moderate and low cultural resource sensitivity and within areas of potential fossiliferous deposits. In areas where such development would proceed, a number of alternative mitigation measures are possible. Some of these are:

(1) Alternative to Avoid. Geothermal development can probably avoid all archaeological, paleontological or historic sites and their surroundings by slant drilling techniques (where the technique is feasible), or by simply shifting road or drill pad sites, etc., to areas away from sites, at a distance to be determined by the archaeologist.

(2) Alternative to Mitigate. In any situation where an adverse effect upon cultural or paleontological resources cannot be avoided, mitigation must be accomplished. Mitigation work falls into two categories: that which must be accomplished prior to granting approval for geothermal development; and that which must be done in situations where the lessee may uncover hidden cultural resources during developmental work. Stipulations to regulate these situations (to be included in the contract with the lessee) are listed as follows:

(a) Unless specifically relieved of this requirement by the lessor, the lessee shall engage a qualified professional, acceptable to the lessor, to conduct a thorough and complete intensive inventory of areas to be disturbed in advance of surface disturbing activities, for evidences of archaeological, historical, or other cultural values or paleontological values. Upon receipt of an acceptable report of the intensive inventory, the lessor shall prepare mitigation plans derived from the findings of the intensive inventory in consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation. The lessee, through a qualified professional, shall undertake salvage, avoidance, or other mitigation measures, in advance of any surface activities as required by the mitigation plans and the State Historic Preservation Officer and Advisory Council on Historic Preservation Agreements. The responsibility for, and cost of, such inventory and mitigation shall be that of the lessee.

(b) The lessee shall immediately bring to the attention of the lessor all antiquities or other values of cultural or scientific interest, including but not limited to historic and prehistoric sites, fossils, and artifacts, discovered as a result of operations under this lease, and shall leave such discoveries intact until told to proceed by the lessor. The lessor will evaluate the discoveries brought to his attention and will determine, in consultation with the State Historic Preservation Officer, what action will be taken with respect to such discoveries...Appropriate scientific investigations shall be undertaken prior to proceeding with any operations that might be destructive to the discovery. The responsibility for, and the cost of, investigations and salvage of such values discovered during operations will be that of the lessee.

(c) Any cultural or paleontological resource work, required by the above stipulations, shall be undertaken under the authority of a current Federal antiquities permit applicable to the area to be inventoried, investigated, or salvaged by qualified professional archaeologists or paleontologists who have an adequate research design for the region and who can insure a multi-disciplinary study and report.

(d) All personnel employed by the participants will receive information on the importance of paleontological, archaeological, and historical resources, and the purpose and necessity to protect these resources. Applicable State and Federal law will be stressed, and management personnel will be urged to provide strict sanctions in enforcement of these laws. Vehicles and equipment will be operated only in specified areas which have received prior clearance. Collecting artifacts and fossils or archaeological exploration will not be allowed. This measure applies to the pre-construction, construction cleanup, and maintenance operations as required by appropriate laws.

(e) Upon leasing, a paleontological inspection of the lease every five years would be implemented in those areas where the Bedrock Spring Formation crops out. Measures listed in (a) above would be followed.

Compliance with these requirements would eliminate or reduce loss and damage of archaeological, paleontological, and historic values resulting from the proposed action. These regulations are applicable to all areas of Federal authority.

Since the field development stage potentially would have the greatest impact on cultural resources, stringent mitigation measures, as outlined above, must be followed.

4.5.3 Socioeconomics

To mitigate impacts on the settlement of Red Mountain it would be necessary to prohibit production well drilling and the release of odors from wells, pipes, or containers, and other development activities in that settlement. Included in the settlement of Red Mountain are Sections 6 and 7 of T. 30 S., R. 41 E. This measure would prevent disturbance to residents of the settlement from such activities. The restraint on release of odors would prevent the formation of concentrations of noxious geothermal-production-caused odors in the settlement resulting from Federal leasing within it.

To the extent that these restrictions would limit geothermal development within Red Mountain, they would also prevent the associated safety hazards to the residents. This measure would also reduce the incentive for people to leave the settlement due to disturbance from development of the lease. The occurrence of damage to interesting older structures in the settlement would also be reduced.

4.6 LAND USE

4.6.1 Mining and Mineral Exploration

Most of the mitigation measures previously described also apply to land use. In addition, the following mitigation specifically applies: all lessees would negotiate with mining claimants and mine owners to resolve conflicts between geothermal development and other forms of mineral recovery. If the lessee is not able to sucessfully resolve conflicts with mining claimants and mine owners, the lessee would have to explore other options which may be available.

4.6.2 Recreation

In order to protect the natural atmosphere of these areas, development of the resource into a power plant would be planned so that the plant would be located as far as possible from the Trona Pinnacles Natural Area and the Lava Mountains primitive area. The plant and accompanying pipelines and associated facilities would be constructed and painted to blend as much as possible with the surrounding landscape.

The effects of development of the resource on recreational ORV use can best be mitigated by planning facility location so as to block as little access as possible. Provision for vehicle crossings would be made for established roads and trails whenever possible. Well heads and other areas of operation would be fenced to reduce the danger to ORV's, especially motorcyles. Although ORV access would be maintained, such access and use would be restricted from those areas where either the public health and safety or the lessee's operations or security thereof may be jeopardized by such use.

4.6.3 Grazing

All drilling and development activities would be conducted when the least number of grazing livestock are present. If this is not feasible, as little disturbance as possible to the livestock would be allowed through noise control measures and restraint of unnecessary vehicular movement.

4.6.4 Nature of Land Use and Long-Term Plans

Virtually all mitigaton measures previously described would be applicable to minimize the impacts on the nature of the existing land uses and provide for a timely return to long-term land use plans. Strict compliance with stipulations would be particularly enforced with respect to rehabilitation and closedown activities.

Various mitigation measures would serve to reduce impacts to military activities in the area. Coordination would be carried out between all interested parties for the purpose of inspection of all equipment proposed for use within a lease. All airborne operations would be conducted after coordination with personnel at NWC and George Air Force Base to insure maximum safety. As discussed in other portions of the EAR, all operating regulations which address air quality guidelines would be strictly enforced. In addition civilian personnel working in the lease area would be made aware of any potentially hazardous situations.

5.0 UNAVOIDABLE ADVERSE IMPACTS

Some unavoidable adverse environmental impacts would result from implementation of leasing activities in the EAR area. Potential impacts and mitigating measures associated with such activities have been discussed in preceding sections.

Geothermal regulations, lease provisions, and GRO Orders are designed to assure that geothermal resources can be developed and utilized in an environmentally acceptable manner. In those instances where this cannot be done, development and use would not be permitted. However, virtually any human use of lands and their resources may have some degree of adverse impact. Where benefits warrant acceptance of minor impacts, such uses may be appropriate provided the impacts have been adequately recognized, mitigated to the extent possible, and are not so serious as to preclude the proposed action. The following discussion summarizes the types of adverse impacts that may be unavoidable should the proposal be implemented.

5.1 PRELIMINARY EXPLORATION STAGE

5.1.1 Non-Living Components

Unavoidable adverse impacts to non-living components of the environment during the preliminary exploration stage would be expected to be limited to a certain amount of the topsoil at locations of roads and trails. This would have temporary impacts until cover was restored and soil was stabilized. Evidence of such roads and trails might remain for several years, which would be conducive to use by others, thereby preventing re-establishment of cover for an undetermined amount of time.

In addition, temporary degradation of local air quality due to engine exhaust and fugitive dust from vehicle movement would occur.

A minor amount of noise would result from the drilling operations.

5.1.2 Living Components and Ecological Interrelationships

Preliminary exploration would cause light to moderate impacts by disturbing vegetation and wildlife and by degradation and destruction of habitat, resulting in a reduction in density of some species, particularly those such as the desert tortoise and Mojave ground squirrel that occupy the less rugged habitats in the EAR area.

Disturbance would be primarily a short-term impact; however, any habitat degradation even though light would be a long-term impact because of the relatively long period of time required for disturbed desert areas to return to their original state.

Prevention of all use of trails created during preliminary exploration by recreational ORV's would probably not be possible. However, the magnitude of secondary impacts on vegetation, wildlife and livestock forage cannot be determined at this time.

5.1.3 Human Values

Unavoidable adverse impacts on human values at this stage generally would include impacts to archaeologic and paleontologic resources and aesthetic values, but with proper mitigation measures these impacts may be extremely limited or eliminated.

Impacts on aesthetic values include: the temporary physical presence of workers, aircraft, truck-mounted drill rigs and other vehicles with associated dust and noise from their operation, and the visual impact of surface disturbance resulting from new trails and drill sites.

The potential magnitude of the remaining impacts associated with exploration drilling on an open-ended (nonsite-specific) project such as this would not be compatible with VRM objective class guidelines for Class II lands. Given a more site specific proposal and the opportunity to prescribe, in the field, a combination of conventional and unconventional methods of implementation, as further mitigating measures, it may be possible to conduct preliminary exploration activities in certain Class II lands within management guidelines. Providing the recommended mitigating measures are implemented, preliminary exploration would be compatible with management objectives for Class III and IV lands.

Any alteration of the earth's surface where paleontological or cultural resources are present results in degradation of site integrity or destruction of its scientific and educational value. It is possible that no paleontological or cultural resources would be disturbed during this phase but until exploration areas were precisely located, the adverse impacts would be difficult to judge. Certain damage to the resource base might be unavoidable. New roads in nearby areas would increase indirect effects and vulnerability due to increased access and use (vandalism, unmalicious destruction, relic collecting, ORV's, etc.). Further discussion is presented in Section 5.2.3.

5.1.4 Land Use

The preliminary exploration stage would have little direct effect on recreation. Recreational activities based upon natural resources, such as vegetation, would be affected as those resources were affected.

The increased numbers of non-military personnel near NWC and the Cuddeback Gunnery Range would represent an increase in the potential for a security compromise.

5.2 EXPLORATION DRILLING STAGE

5.2.1 Non-Living Components

While modern drilling techniques are capable of preventing accidents such as well blowouts, there is still the possibility they may occur due to human error, equipment failure, or other factors, such as seismic activity. Well blowouts could occur during any stage in which well drilling and operation take place and could result in uncontrolled venting of steam, associated gases, and mineralized water to the atmosphere and surface area, degrading air and soil, creating high noise levels, and exposing individuals to possible injury. Adverse impacts would continue until the blowout was controlled. The impact of the incident could range from minor to serious, depending upon location and duration of the blowout.

While the probability of extensive damage due to rupture of a well casing might be low, the possible consequences to domestic water supplies or subsurface contamination would be high and could constitute a hazard to human health and safety. Accidental spillage of geothermal fluids, drilling mud, or other contaminants at any stage of development could damage the surface environment.

Degradation of air quality would increase over the previous stage due to a greater number of vehicles and engines operating in the area and the resultant engine exhaust. In addition, release of geothermal gases during well drilling and testing would tend to degrade air quality. A slight increase in temperature and humidity in the microclimate would be unavoidable at this stage of development.

While compliance with lease stipulations and GRO orders would prevent serious adverse impacts, some minor impacts on soils from increased surface disturbance would result. The unavoidable impacts discussed in Section 5.1.1 above would be expected with some intensification in areas of heavy activity.

Noise would again occur but would be increased slightly in both intensity and duration.

5.2.2 Living Components and Ecological Interrelationships

Exploratory drilling would result in additional, unavoidable disturbance to vegetation and wildlife and additional degradation and destruction of habitat, due to increased surface disturbance and to release of geothermal steam. Together with impacts from the previous stage, this would result in further reduction in the overall productivity of the area and a reduction in the density of most plant and animal species. Density of predatory species in particular would be reduced because they occupy the top of the food chain, and are quite sensitive to changes in primary productivity. Thus, there would be marked but still relatively small reductions in biomass. This would be true for a number of years even if cleared areas were replanted.

5.2.3 Human Values

Impacts on visual resources would increase over those of the previous stage due to increased surface disturbance resulting from road grading, drainage work, drill site development, excavation of mud pits, and construction of new trails and dirt and surfaced roads. These impacts would be unavoidable and visible in the landscape.

The temporary physical presence of workers, drill rigs, earth moving equipment and service vehicles with the associated dust, noise, and night lighting from their operation would be evident during this stage.

The possible extent of remaining impacts resulting from this type of nonsite-specific proposal would not be compatible with VRM objectives for Class II lands. Given a more site-specific proposal and the opportunity to prescribe a combination of conventional and unconventional methods of implementation as further mitigating measures, it may be possible to conduct exploration drilling in certain Class II lands within management guidelines. Providing the recommended mitigating measures are implemented, exploration drilling would be compatible on Class III and IV lands.

The discussion of unavoidable impacts to cultural resources occurring during the first stage of development is applicable for this and succeeding stages. Certain impacts to paleontological and cultural resources would be probable. Direct impacts would be controlled to the maximum possible extent by mitigating measures, but these would not eliminate damage to the resource base. Limitations in existing technology for location, evaluation, recovery, and analysis of these resources would prevent total data preservation and would remove those resource sites affected by geothermal development from future research use when technology improves.

5.2.4 Land Use

The impacts of exploration drilling upon recreation values and grazing resources would be similar to, but of greater magnitude and intensity than, the previous stage, since the level of development activity would increase.

The increased numbers of non-military personnel near NWC and the Cuddeback Gunnery Range would represent an increase in the potential for a security compromise.

5.3 FIELD DEVELOPMENT STAGE

5.3.1 Non-Living Components

Unavoidable adverse impacts to non-living components of the environment would increase over levels of previous stages due to increased levels of activity. Additionally, the potential for well blowouts and casing ruptures would increase. Subsidence could begin to occur, in spite of prevention measures, and might affect the broad alluvium-filled valleys and playas. Reinjection, to reduce waste disposal problems and to avoid subsidence could cause increased seismic activity in the area, which, in turn, might increase the potential for a damaging earthquake.

5.3.2 Living Components and Ecological Interrelationships

Unavoidable impacts on living components of the environment would increase as the level of development increased. Full site development would result in the following impacts, in addition to those from earlier stages:

(1) Severe habitat destruction and degradation and high disturbance to wildlife; (2) Reduction in overall productivity and diversity of the site; (3) Significant reduction in density of most plant and animal species. In particular, full site development within critical habitat would have the following results: (a) desert tortoise populations would probably be reduced to less than 10 per square mile; (b) breeding populations of prairie falcons and golden eagles would be eliminated from the lease area, and would probably be significantly affected throughout their

habitat; (c) use of the area for nesting and foraging by most other raptors and mammalian predators would be severely reduced; (d) Mojave ground squirrels would be reduced in density in the site and, like the prairie falcon and golden eagle, might be significantly impacted throughout their habitat; and (e) populations of chukar and Gambel's quail would be reduced to low densities within the site, eliminating the recreational values of these species in that locale.

All of these impacts would be long-term in nature; recovery of the vegetation and thus of the habitat would require hundreds of years.

5.3.3 Human Values

This stage of development would have the greatest unavoidable impacts upon human values. The temporary physical presence of men, equipment and associated dust, noise and night lighting would be present throughout this stage. The long-term visual impacts of surface disturbance and construction of new trails and roads, drill sites, well heads, pipelines, transmission lines, generating plant, and all other attendant facilities could not be entirely mitigated and would be visible in the landscape.

The remaining impacts would not be compatible with VRM objective class guidelines for Class II lands, and it is felt that they could not be brought in line with Class II objectives even if given an opportunity for site specific mitigation. With a more site-specific proposal it may be possible, in the field, with a combination of additional conventional and unconventional mitigating measures to conduct field development in Class III lands within management guidelines.

Providing the recommended mitigating measures are implemented, field development activities would be compatible with management objectives for Class IV lands.

The greatest loss to the cultural and paleontological resource base would most likely occur during this stage, despite mitigation measures.

Development of the resources would contribute to population growth in the vicinity of the development area. New housing units might be needed to accommodate the labor force. To people who view the spread of residential land use as adverse, this would be an unavoidable adverse impact of the proposed action.

Additional public services would be required to service people who choose to locate new housing in Kern County. The cost of providing these services could exceed the increase in property taxes yielded from the new housing. None of the property tax from the geothermal development itself would be expected to benefit Kern County.

5.3.4 Land Use

One of the primary attractions of the EAR area is the wide-open spaces where one can travel unhindered by fences or other man-made obstructions. This wide-open space with few developments also gives rise to another attraction; a remoteness from civilization, a chance to be close to nature, or, in other words, primitive values. Development in any portion of this area would reduce the above-mentioned values in the vicinity of the development. Roads and powerlines would cut large areas into smaller parcels. A steam generating plant would give surrounding areas an appearance of "civilization". Impacts of development on these values cannot be mitigated.

Any losses in animal or plant populations, cultural resources, or any other resources caused by the development of the geothermal resource would be a loss to those persons whose recreation experience was based on that resource. These losses cannot be mitigated.

The primary adverse impact on ORV activities would be the loss of space occupied by development and the barriers to dirt roads and trails that would result from pipelines or paved roads. Paved roads represent a safety hazard to ORV's and, if used heavily enough, the road could be a barrier to motorcycle events. Loss of these areas for recreation use would exist for the life of the project and could not be mitigated during that time.

There would be the loss of a small but significant amount of livestock forage due to geothermal development. In addition, there would be disturbance of livestock in areas adjacent to the development site.

Existing land uses would be changed to geothermal development. This change would be in effect for the life of the project and could not be mitigated during that time.

The increased numbers of non-military personnel near NWC and the Cuddeback Gunnery Range would represent an increase in the potential for a security compromise. In addition, the introduction of relatively permanent facilities and structures would occur at the time the power block and related facilities are constructed.

5.4 PRODUCTION AND OPERATION STAGE

5.4.1 Non-Living Components

Unavoidable impacts on most non-living aspects of the environment during this stage would be the same as or similar to those discussed above for the field development stage. However, increased potential for subsidence and possibly seismicity would exist during production and operation as pressure was released and fluids were drawn from the reservoir.

Full-scale operation would produce noise from drilling operations, well-testing and steam line vents. Noise levels measured at The Geysers, California, for these operations showed drilling operations producing 55 dBA at 1,500 feet, muffled testing wells producing 65 dBA at 1,500 feet, and steam line vents producing 90 dBA at 250 feet. This stage would be the "noisiest" and even with environmental controls, lease stipulations, and regulations, these impacts could not be avoided.

5.4.2 Living Components and Ecological Interrelationships

The production and operation stage would not cause significant unmitigatable impacts on wildlife and vegetation beyond those already caused by the previous stages. All facilities would be constructed and most of the damage would have already occurred. Release of toxic gases, however, could cause further damage to vegetation.

This stage could last for a very long period of time and so would represent a chronic disturbance to remaining species. Many organisms might be unable to adjust to the change in the quality of the environment.

5.4.3 Human Values

Most impacts on human values would already have occurred during previous stages. The physical aspects of development, i.e., the presence of transmission lines and pipelines, generating plant, etc., would be evident for the life of the project, as would the odor of H_2S if scrubbers did not prove feasible.

The physical presence of workers, unsurfaced and surfaced roads, well heads, pipelines, transmission lines, service vehicles, fencing, the generating plant and associated structures at the plant site, including wastewater treatment facilities, would be evident for the life of the project. Noise, dust, odors, steam clouds, and night lighting would also be present for the life of the project.

The long-term visual impacts resulting from excavation and surface disturbance of various types cannot be entirely mitigated and therefore would be visible in the landscape.

The remaining impacts would not be compatible with the VRM objective guidelines for Class II lands and could not be brought in line with Class II objectives even with site-specific mitigation in this desert landscape. With a more site-specific proposal, it may be possible, in the field, through a combination of conventional and unconventional mitigating measures, to conduct production operations in certain Class III lands within management guidelines. Providing the recommended mitigating measures are implemented, production and operation of a geothermal plant and associated facilities would be compatible with management objectives for Class IV lands.

Subsequent new activity in new areas, such as drilling of new production wells, would most likely further erode the cultural and paleontological resource base unless some areas were avoided. Still, in some cases the surrounding environment would be degraded, thus having an impact on a site's aesthetic surrounding, which is necessary for interpretive enjoyment or for the understanding of man-land relationships.

5.4.4 Land Use

Existing land uses would already have been changed to that of geothermal development. During this stage, however, the impacts would be of a greater intensity and longer duration.

The increased numbers of non-military personnel near NWC and the Cuddeback Gunnery Range would represent an increase in the potential for a security compromise. Any impacts due to facility location would continue from the previous stage.

5.5 CLOSEDOWN STAGE

5.5.1 Non-Living Components

Subsurface changes could continue, resulting in subsidence and further alteration of the physical character of the land until an equilibrium was reached. The extent of this impact cannot be determined at this time.

During the removal of surface facilities, some unavoidable impacts on air quality and soils might occur due to a slight increase in surface disturbance over the production and operation stage, but these impacts should be minor and short-term. Air quality would also be temporarily affected to some extent by engine emissions from vehicles being operated during this stage.

5.5.2 Living Components and Ecological Interrelationships

The only unavoidable adverse impact on vegetation and wildlife associated with this stage would be the noise and disturbance resulting from demolition. However, most of this disturbance would be short-lived and the area should return to a semi-natural state.

5.5.3 Human Values

Generally, activities taking place during this stage of development would be concerned with returning the site to a condition as closely approximating the original natural state as possible. Any evidence of the operation left after closedown would be detrimental to the natural appearance of the area. Any resources which could not be restored would be a loss to those recreation activities dependent on them.

The temporary physical presence of workers, demolition equipment, earth moving equipment, trucks and miscellaneous service vehicles with the associated dust and noise from their operation would be obvious throughout this stage. The visual impacts of surface disturbance and excavation are of most importance due to the extensive area involved and their very long-term nature. These remaining impacts would not be compatible with the VRM objective class guidelines for Class II lands. Providing the recommended mitigating measures are implemented, closedown would be compatible on Class III and IV lands.

Further surface disturbance could have further adverse impacts on existing cultural or paleontological resources. Also, in some cases where a site's integrity might have been partially destroyed, complete destruction could ensue.

The closedown stage would contribute to the stagnation of, or decline in, the viability of businesses in the Searles Valley, Ridgecrest, or Red Mountain communities.

5.5.4 Land Use

The temporary increase in numbers of non-military personnel near NWC and the Cuddeback Gunnery Range would represent an increase in the potential for a security compromise. The above impacts would end upon completion of closedown activities.

6.0 SHORT-TERM USES VS. LONG-TERM PRODUCTIVITY

6.1 GENERAL

Geothermal resource development implies a change in land use from the present situation toward an industrial complex. The leasing of lands for geothermal resource development would involve the commitment of a portion of the geothermal heat, water, land, and other resources of the sites involved. Short-term use of the area would last up to 50 years depending on the extent of the resource.

The exploration and testing phases of geothermal leasing are designed to determine the nature and extent of geothermal resources. Generally, the active portion of this phase is of short duration, sometimes extending only over a period of days, months or, at most, a few years. It may be intensive and continuous for short periods or periodic over several years. Where such exploration proves unsuccessful, there would not be subsequent use of the lands for development and production of geothermal resources. Under such conditions, leases would terminate at the end of the 10-year primary term. However, in many instances such leases would be relinquished by the lessee at an earlier date to avoid additional lease payment costs. Exploration and lease provisions require that lands disturbed by unsuccessful exploration will have to be rehabilitated as nearly as possible to their original condition upon termination of these activities. Such rehabilitation would include measures such as grading, drainage, soil stabilization, revegetation, removal of all equipment and supplies, proper removal or disposal of all wastes, filling in of holding ponds, etc. In the desert biome, aesthetic and vegetative impacts may last over a period of years due to slow natural recovery factors.

Where exploration disclosed the existence of economically attractive geothermal resources, the development and production of such resources for electric power generation, and possibly water and mineral by-products, could be expected to occur. Timing of such development will depend upon electric power markets, power transmission systems, construction schedules, etc. Once production begins, the geothermal resource would be withdrawn at a rate greater than the natural replenishment rate. Over a period of years (perhaps 20 to 50 years, depending upon the nature of the resource province) production capacity would be depleted to the point where further operation would not be economically feasible. When the reservoir is no longer capable of sustaining the geothermal operation, the leases would terminate, the facilities would be dismantled, and the land would be rehabilitated. insofar as practicable, to its original condition. Most of the area involved in the operation would have become well stabilized except for the actual areas used for the generation facilities, roads, or other structures or facilities. Removal of improvements would result in some disturbance, particularly in well and steam pipeline areas, but such disturbance would be of a temporary nature and subject to appropriate rehabilitation. Unless the land areas occupied by production facilities were to be used for some subsequent and nonrelated purpose, they would be properly graded, drained, stabilized, and revegetated so that they would again become a part of the natural environment. Relatively large areas of level land would remain, such as the power generator site.

It should be recognized that geothermal heat is a wasting resource that otherwise would be dissipated over time from the surface of the earth to the atmosphere with little or no identifiable benefit. By contrast, development of this resource in an environmentally acceptable manner can provide substantial benefit by affording a relatively clean power generation energy source. While depletion of some of the heat within the geothermal reservoir would occur over the period of operation, no permanent adverse effect is anticipated. Over time, perhaps a hundred or more years, natural heat transfer within the earth might even return the heat content to nearly the same intensity as existed before utilization. At some time in the relatively distant future it might be possible for the area to again be used for similar productivity. Any use of by-product minerals probably would represent mineral recovery that otherwise would never have occurred. Such use would preclude the need to obtain a like amount of such materials from other sources. Where waste waters are reinjected, the associated mineral values would be returned to the earth.

The generation of power would probably be the principal use of the geothermal resources. However, there also is a good possibility that use of minerals or other by-products of water might be possible. In terms of total energy requirements, the contribution of the geothermal resource may be relatively small but it would be important on a local basis.

The geothermal resource may contribute to the production of chemicals from the brines and fresh water through desalination.

In many cases, the geothermal resource may not be of sufficient temperature to be useful for electric power production but will be useful for space heating or industrial processing.

Although explicit data are lacking, the geothermal fluids also may be of sufficient purity to be used directly for irrigation or other purposes after the fluid has been cooled. This could provide a source of fresh water during the period of power operation and it is possible that the wells could continue to be used even after power production has ended.

The extent and nature of committing the resources of this area to geothermal development and an assessment of their potential environmental impacts have been described in detail in the preceding sections.

6.2 NON-LIVING COMPONENTS

The majority of the impacts on the non-living components of the environment are expected to occur during the life of the project. Should subsidence and/or earth tremors occur, long-term damage to the environment may occur in the form of reduced storage capacity of the subsurface reservoir and damage to the Trona Pinnacles. Spills of toxic geothermal fluids may cause long-term sterility of the soil.

6.3 LIVING COMPONENTS

Plant communities and wildlife habitat destroyed by construction activities would take hundreds of years to return to their pre-construction state in terms of full productivity. The prairie falcons and Mojave ground squirrel are two species that could suffer loss of breeding populations in the area to the extent that they may never become reestablished.

6.4 ECOLOGICAL INTERRELATIONSHIPS

Short-term use of the area for geothermal development may lower the diversity of native species and allow the introduction of exotic species. This could result in a long-term change in the ecological interrelationships in the area.

Should the wells produce water that is usable for irrigation, ecological relationships could be disrupted in the present desert biome.

6.5 HUMAN VALUES AND LAND USE

The primary impacts on human values probably would occur during the short-term use of the area for geothermal development. Some of these impacts could have long-term consequences such as loss of aesthetic, archaeologic, historic, and paleontologic resources.

Even after rehabilitation of roads, well pads, and plant sites, it will take a very long time for the area to recover to the extent that these intrusions are no longer noticeable.

Roads constructed for geothermal development may have become habitual routes of travel for recreationists and other users of the area and it could be difficult to stop usage of certain routes.

loss of full productivity. The black-footed ferret and Richardson ground squirrel are two species that could suffer loss of breeding populations in the area to the extent that the range would become reestablished.

6.4 ECOLOGICAL INTERRELATIONSHIPS

Short-term use of the area for geothermal development may lower the diversity of native species and allow the introduction of exotic species. This could result in a long-term change in the ecological interrelationships in the area.

Should the waste product water (brine) be suitable for irrigation, ecological relationships could be changed in the present desert biome.

6.5 HUMAN VALUES AND LAND USE

The primary impacts on human values probably would occur during the short-term use of the area for geothermal development. Loss of open space to roads and transmission corridors such as loss of aesthetic enjoyment of historic and archaeological resources.

When all geothermal facilities are removed and the area reclaimed, it would take a long period of time for the area to return to the natural state and these conditions are no longer reversible.

Roads constructed for geothermal development may have become heritage routes of access for recreationists and other users of the area and it would be undesirable to lose the range of people routes.

7.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

7.1 NON-LIVING COMPONENTS

The principal commitment of resources would be the depletion of thermal energy and water from the geothermal reservoir. Both of these resources are renewable, however not within the life span of a specific project.

Compaction and land subsidence that may result from the removal of geothermal fluids could have irreparable consequences. An equivalent amount of water storage would be lost. If seismic activity should result from fluid withdrawal or reinjection, there could be considerable damage, depending upon the severity of such activity. The Trona Pinnacles could be damaged by such seismic activity.

Should spills of toxic geothermal fluids occur, the resulting soil sterility may be irreversible.

7.2 LIVING COMPONENTS

Plant communities and wildlife habitat destroyed by geothermal development will take hundreds of years to become re-established after closedown is completed. Thus, those species of wildlife eliminated from the area because of loss of habitat will not become reestablished for many years. Furthermore, species such as the Mojave ground squirrel and the prairie falcon, that are now present in low numbers or densities, may never become reestablished.

7.3 ECOLOGICAL INTERRELATIONSHIPS

Lowered diversity of native species and the introduction of exotics which could be caused by the geothermal development of the area could prevent the ecological relationships now present in the area from becoming reestablished for an indeterminable amount of time.

7.4 HUMAN VALUES AND LAND USE

The greatest potential for irretrievable loss of resources is to the cultural resources in the area. If historic, paleontologic, or archaeological values within the analysis area are disturbed or destroyed by the proposed action, they cannot be duplicated or restored to a condition that would provide the scientific information they possessed nor can the site be used for recreation in the form of outdoor education.

Losses of present wildlife or plant species will result in a loss of recreational opportunity for those who enjoy observing them or at least knowing that those species are present in the area.

Dedication of land surface to industrial uses generally would result in land areas being used for wells, associated surface facilities, a power plant, roads, and transmission lines. While not of a permanent nature, such uses would represent a commitment for a period of 25 to 50 years. This is a relatively long period in terms of human lifetimes and related alternative uses of these lands and their other resources. Aesthetic resources rank among those resources that may be significantly altered during and beyond the life of the project. This is especially true in terms of the effects of vegetation alteration and loss, surface displacement, construction scars and road cuts upon the visual integrity of the lease area. Estimates of the time required for these areas to return to their natural condition range from hundreds of years to infinity. Human energy, money, and construction materials are other resources irretrievably committed in the development of geothermal steam.

of the project. This is especially true in terms of the effects of vegetation alteration and loss, surface displacement, construction scars and road cuts upon the visual integrity of the lease area. Estimates of the time required for these areas to return to their natural condition range from decades of years to infinity. Human energy, money, and construction materials are other resources irretrievably committed in the development of oil shale lands.

8.0 ALTERNATIVES TO THE PROPOSED ACTION

Alternatives as they relate to this EAR have been identified.

8.1 NO LEASING

Under this alternative, no geothermal leases would be issued for Federal lands in the Randsburg KGRA and the adjacent and nearby areas. An equivalent amount of electrical energy would have to be obtained from alternative power sources; thus, impacts of electrical energy generation would occur elsewhere, rather than in the EAR area. Development of geothermal resources on private lands would then be even more intensive. Private land holdings within the EAR area, particularly to the south of the Randsburg KGRA, are already under lease and are being explored for geothermal resources. In areas where private lands are adjacent to Federal lands, the geothermal resources of the Federal lands could be depleted through intensive development in the private sectors. Although no direct environmental impacts would occur on Federal lands if leasing were not permitted, surface environmental impacts associated with exploration and development would still occur on leased, private lands. If full development is realized on the private sector, potential subsurface effects, such as subsidence, could occur with surface expression on public lands as a result of these operations. The more intensive development of the private land resources could result in less efficient overall use of geothermal resources in the area and could result in more severe environmental impacts as environmental requirements, restrictions, and controls may not be as intensive or adequate as they would be for operations on Federal lands.

Persons qualified to convert valid leases or permits under the Minerals Leasing Act of February 25, 1920, or to convert existing mining claims located on or prior to September 7, 1965, would not be permitted to convert such leases, permits, or claims to geothermal leases covering the same lands. This would result in denial of the so-called "grandfather rights" provided for in Section 4(a) of the Geothermal Steam Act.

As a result of no leasing, the potential use of geothermal fluids as a heat source to replace other forms of fuel for electrical energy or space heating would be foregone. Such use of geothermal resources could have environmental advantages as it would eliminate the environmental impacts associated with the total systems required to provide the alternative heating sources. A potentially significant source of State and local tax revenue would be lost.

8.2 LEASE ONLY LANDS CLASSIFIED AS "GRANDFATHER" LANDS

Under this alternative, only those persons entitled to "grandfather' conversion rights would obtain leases. In the Randsburg KGRA, Section 25 is being petitioned under this clause.

While this alternative could result in less power production from these areas, it still might provide a source of power for local demand. In most instances, there should not be a significant difference in impact throughout the "grandfather" areas since appropriate environmental protection provisions would be included in all lease stipulations and related GRO orders.

8.3 DEFER LEASING UNTIL NEW OR IMPROVED TECHNOLOGIES AND/OR SYSTEMS ARE AVAILABLE FOR GEOTHERMAL ENERGY PRODUCTION

Under this alternative, leasing might be delayed for five or ten years to allow additional time for the development of new technologies or systems for geothermal power production and for environmental protection. Such improvements could result in production systems that achieve both more efficient use of the resource and reduced environmental impacts, primarily with respect to the potential air and water quality factors.

There will be considerable lapse of time between leasing and actual power production. During this time development and production elsewhere probably will have progressed to the point where many of the new systems or controls have been developed and tested and could be applied to Federal leases at the time development is undertaken. While many of the environmental problems will differ due to the nature of the geothermal steam or liquids and the setting in which operations are to be conducted, some technology and systems designed for one area can be used in other areas.

This alternative might result in the need to construct generation facilities outside the area to meet regional power needs and to offset the additional electrical energy supply source that would have resulted from earlier development. The impacts would be in terms of time as energy demand growth will continue and such plants probably would have to be built sooner or later.

8.4 LEASE ONLY LANDS TO BE DEVELOPED JOINTLY WITH ADJACENT PRIVATE LANDS

This alternative primarily would apply to leasing within the Randsburg KGRA. Under this alternative, Federal lands would be leased as a part of appropriate area development of private and public lands to provide for development units conducive to efficient and economic development and production.

The potential environmental impacts as previously discussed for these areas could occur to the extent that public lands were involved. Since similar impacts probably would occur from private development in the same general area, the overall impacts involve acreage relationships. It is possible that inclusion of Federal lands in logical units actually could reduce potential impacts from private development in that environmental stipulations and controls applicable to the public lands also could impact on the adjacent private activity. Under this alternative, no development would take place in the Spangler Hills or South Searles Lake geothermal areas, nor in the northern half and adjacent area of the Randsburg KGRA.

8.5 LEASE LANDS OF LOWER ENVIRONMENTAL SENSITIVITY

Under this alternative geothermal leasing would not be allowed in areas which would be sensitive to environmental disturbance despite the implementation of the mitigation measures described in Chapter 4. Two options are available under this alternative:

(1) Lease only those lands of low environmental sensitivity.

(2) Lease only those lands of low and moderate environmental sensitivity.

Figures 8-1 through 8-14 illustrate for each resource those portions of the EAR area which would sustain either low, moderate or high impacts despite mitigation. These maps were prepared utilizing the sensitivity criteria as defined for each resource in Appendix G and represent overall mitigated impacts for all five stages of development.

It should be noted that sensitivity maps are not presented for ecological interrelationship or socioeconomic considerations. Sensitive areas illustrated on the vegetation and wildlife maps represent an analysis of ecological interrelationships. Also, all impacts with respect to socioeconomics would be low when mitigation measures are applied.

The maps illustrating sensitivities with respect to geological, noise and wildlife resources, Figures 8-1, 8-5, and 8-7, respectively, also indicate where only casual use activities would be allowed, as outlined in Chapter 4.

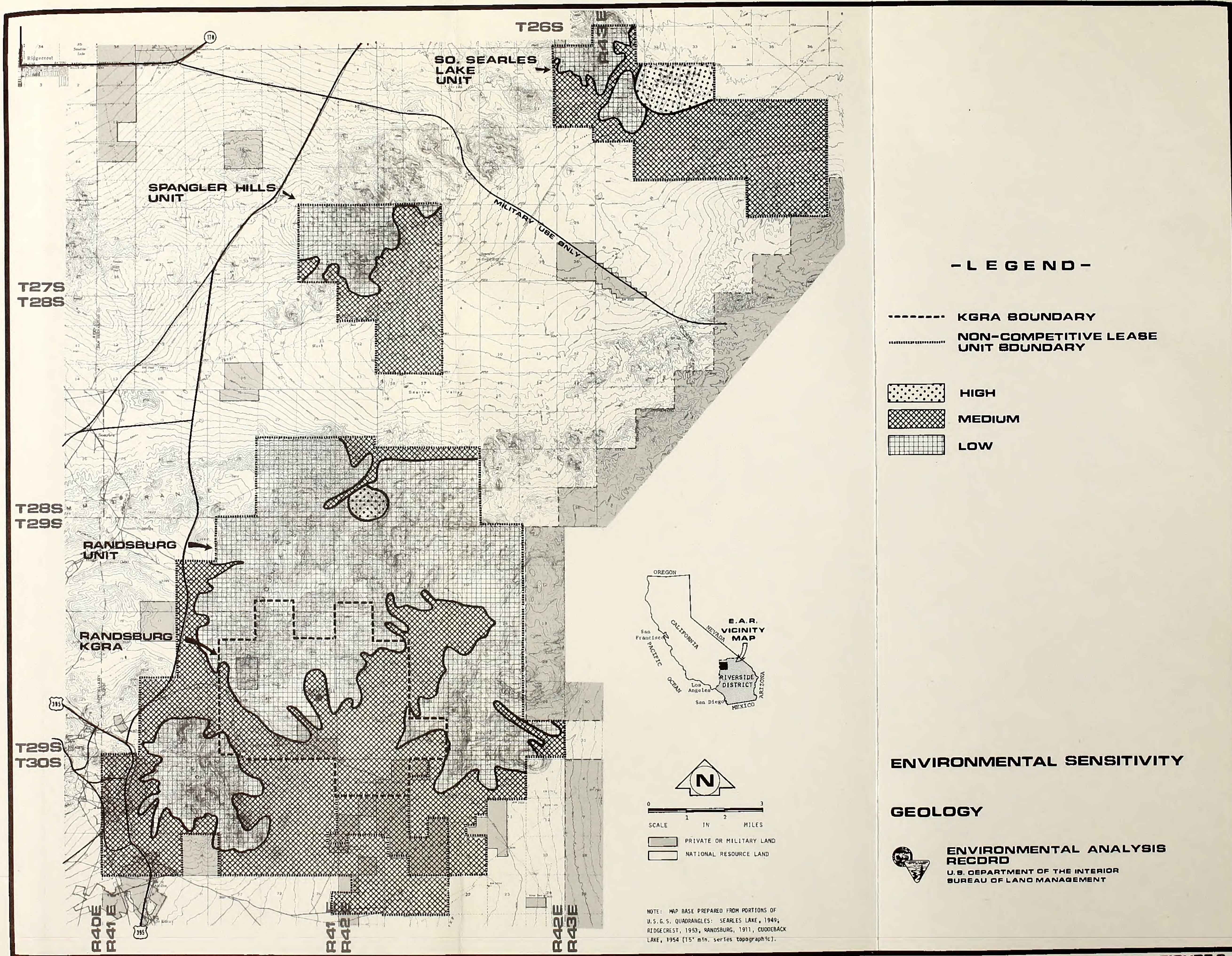
Figure 8-15 is a composite map, for all resources, of the low, moderate, and high sensitivity areas as well as casual use areas. The sensitivities shown reflect the highest sensitivity for any one area. For example, should an area be of high sensitivity for one resource but of low or moderate sensitivity for other resources, the area is illustrated as being of high sensitivity.

Figure 8-15 also illustrates the locations of the 37 non-competitive lease application boundaries.

Resource development under this alternative could be less efficient, with increased costs resulting from elimination of prime development areas. However, it is difficult to fully evaluate the entire impact of this alternative as there may be no direct relationship between the best geothermal reservoirs and surface values. Even though only portions of the area would be impacted by development, many of the potential impacts could directly or indirectly affect adjacent areas. Considerations primarily involve a matter of degree and intensity of impacts.

8.6 UTILIZE GEOTHERMAL RESOURCE FOR PURPOSES OTHER THAN ELECTRICAL ENERGY PRODUCTION

As indicated in Chapter 1 (Section 1.4.1), the geothermal system at Randsburg may not be adequate for the production of electricity. Little data exist on the nature or the extent of the resource, and further exploration and study under lease may support earlier conclusions. It is difficult to predict at this time if development of the resource for space heating or industrial or irrigation purposes is viable alternative uses. It is also difficult to consider at this time what impacts would result from such alternative uses.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RANDSBURG UNIT
RANDSBURG KGRA
T29S
T30S
R40E
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R41E
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R42E
R43E
- L E G E N D -
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
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LOW
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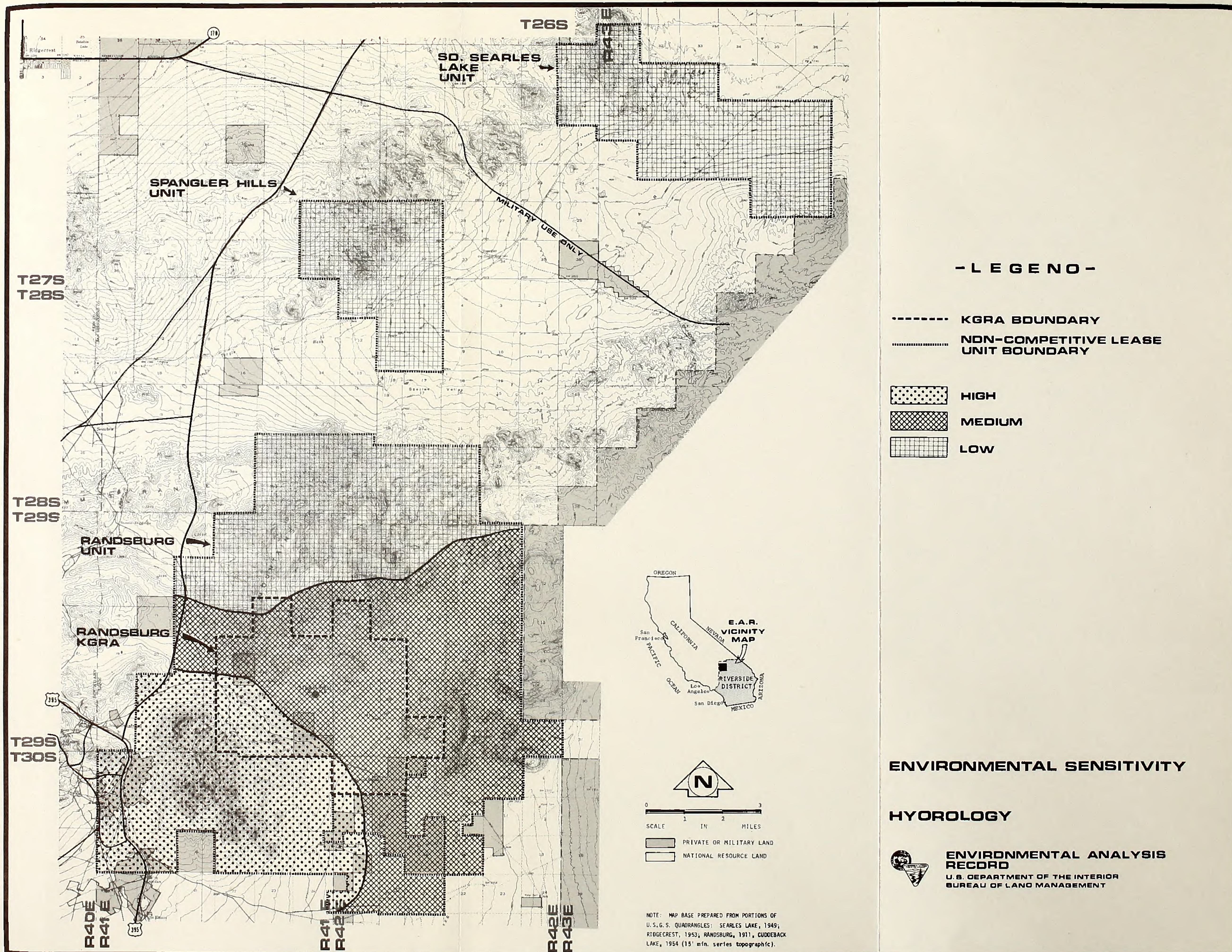
CALIFORNIA
NEVADA
E.A.R. VICINITY MAP
San Francisco
PACIFIC OCEAN
Los Angeles
San Diego
RIVERSIDE DISTRICT
ARIZONA
MEXICO
N
SCALE IN MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911; CUDDEBACK LAKE, 1954 (15' min. series topographic).
ENVIRONMENTAL SENSITIVITY
GEOLOGY
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-1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RANDSBURG KGRA
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R43E
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CALIFORNIA
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San Francisco
Los Angeles
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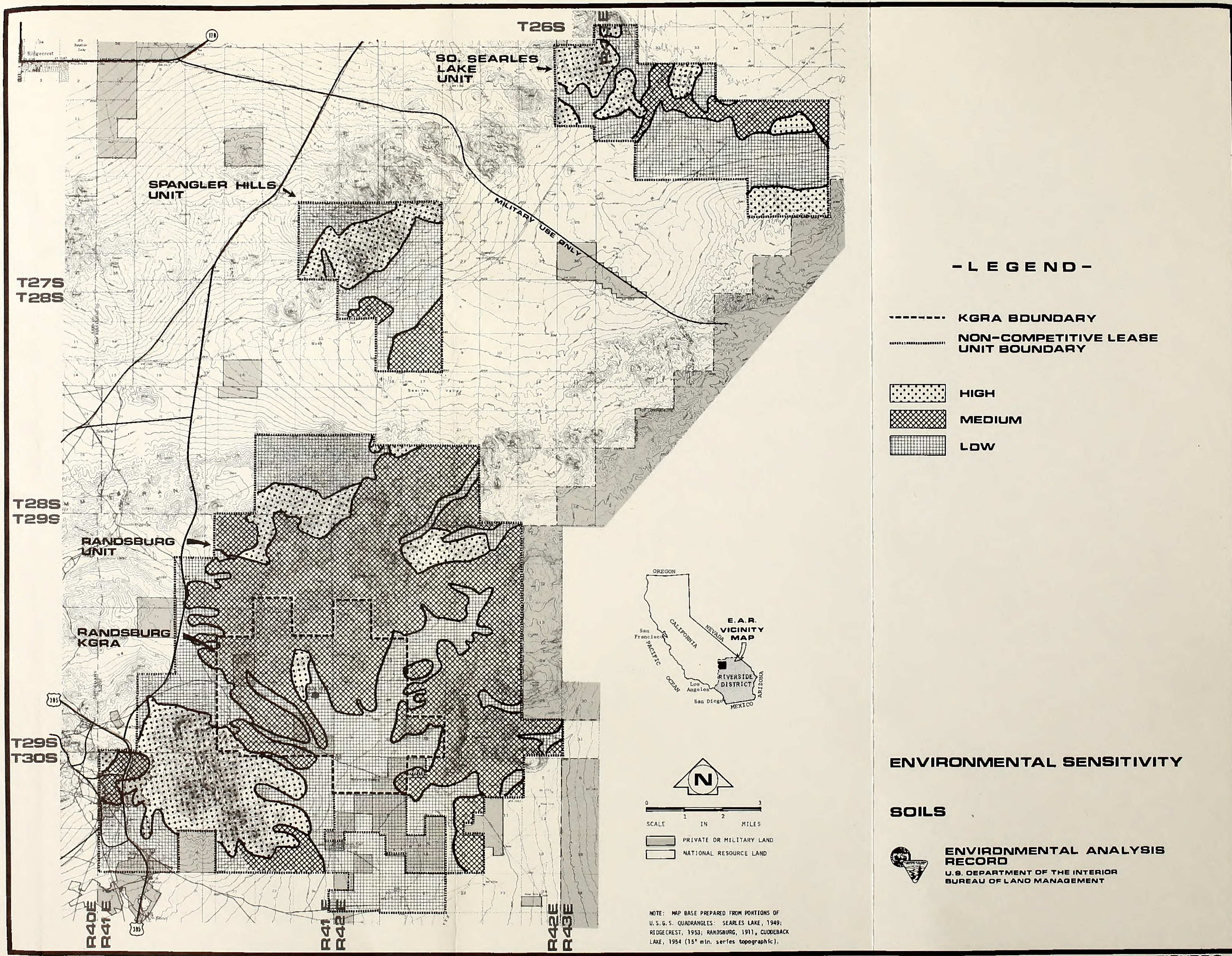
MEXICO
ARIZONA
RIVERSIDE DISTRICT
E.A.R. VICINITY MAP
N
SCALE IN MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
HIGH
MEDIUM
LOW
ENVIRONMENTAL SENSITIVITY
HYDROLOGY
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-2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RANDSBURG UNIT
RANDSBURG KGRA
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R42E
R43E
OREGON
CALIFORNIA
NEVADA
PACIFIC OCEAN
San Francisco
Los Angeles
San Diego
MEXICO
ARIZONA
RIVERSIDE DISTRICT
E.A.R. VICINITY MAP
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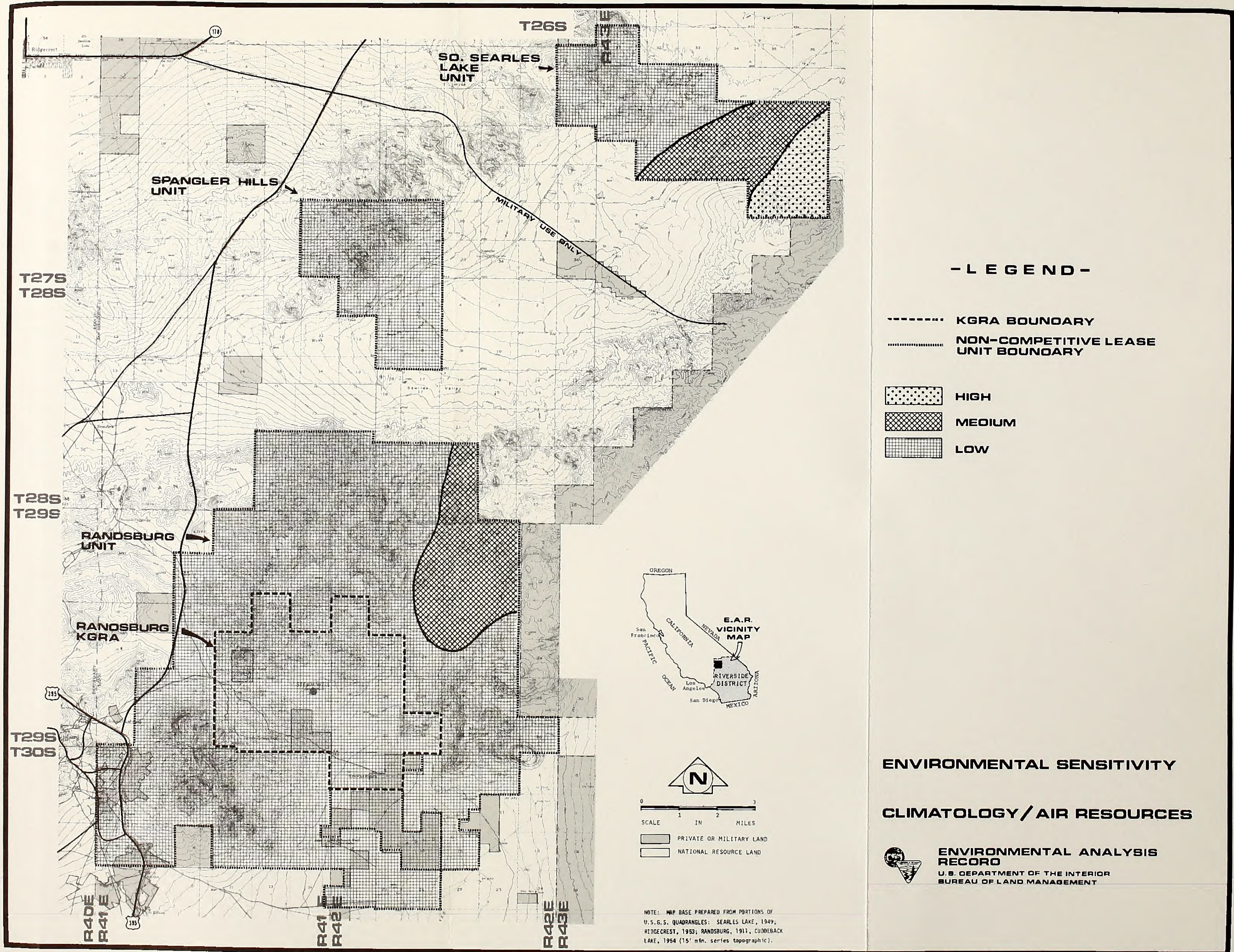
SCALE IN MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
HIGH
MEDIUM
LOW
ENVIRONMENTAL SENSITIVITY
SOILS
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-3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MEXICO
ARIZONA
RIVERSIDE DISTRICT
E.A.R. VICINITY MAP
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SCALE 0 1 2 3 IN MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
-LEGEND-
KGRA BOUNOARY
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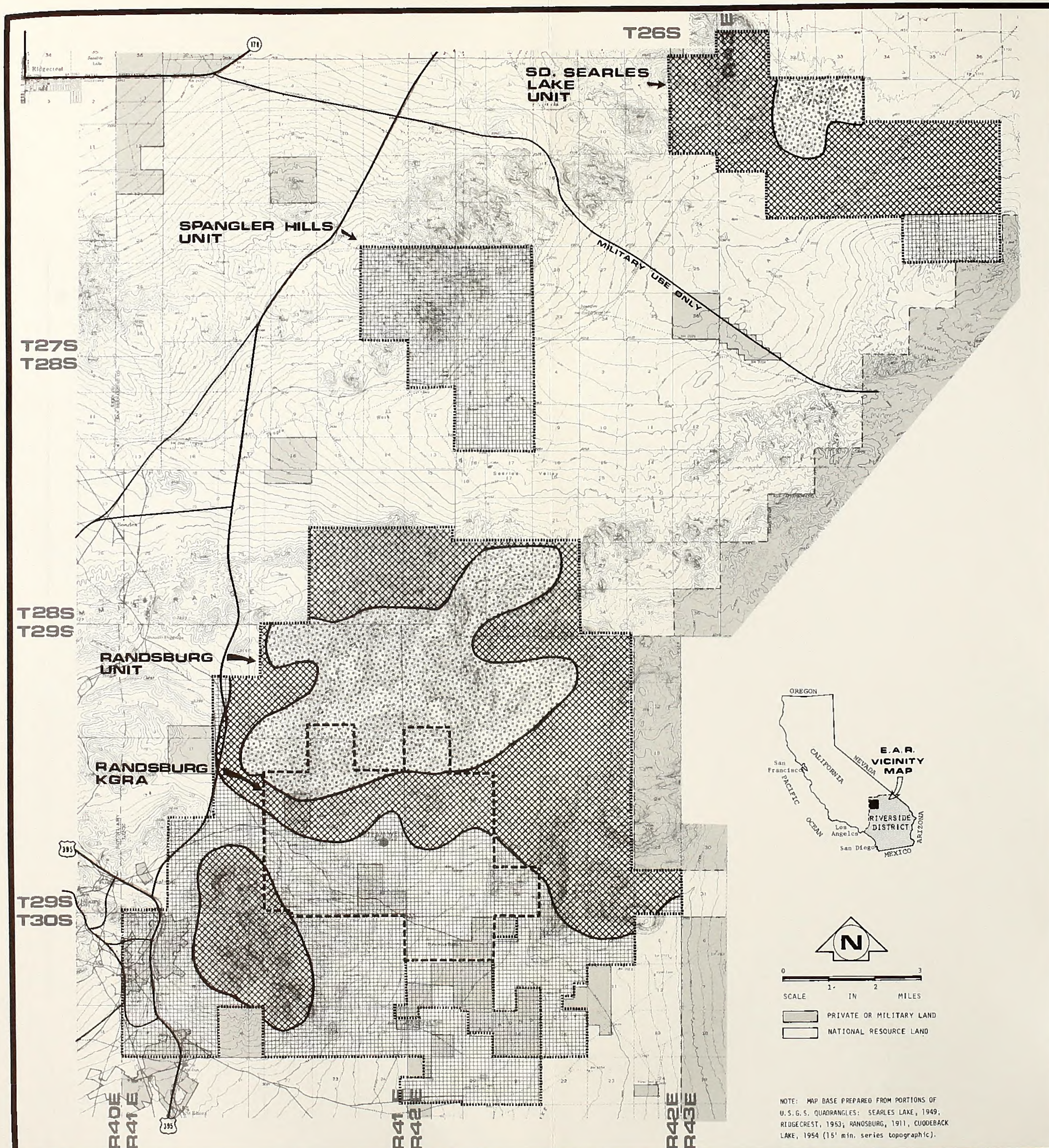
ENVIRONMENTAL SENSITIVITY
CLIMATOLOGY/AIR RESOURCES
ENVIRONMENTAL ANALYSIS RECORO
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-4



-LEGEND-

KGRA BOUNDARY

NON-COMPETITIVE LEASE UNIT BOUNDARY

CASUAL USE

MEDIUM

LOW

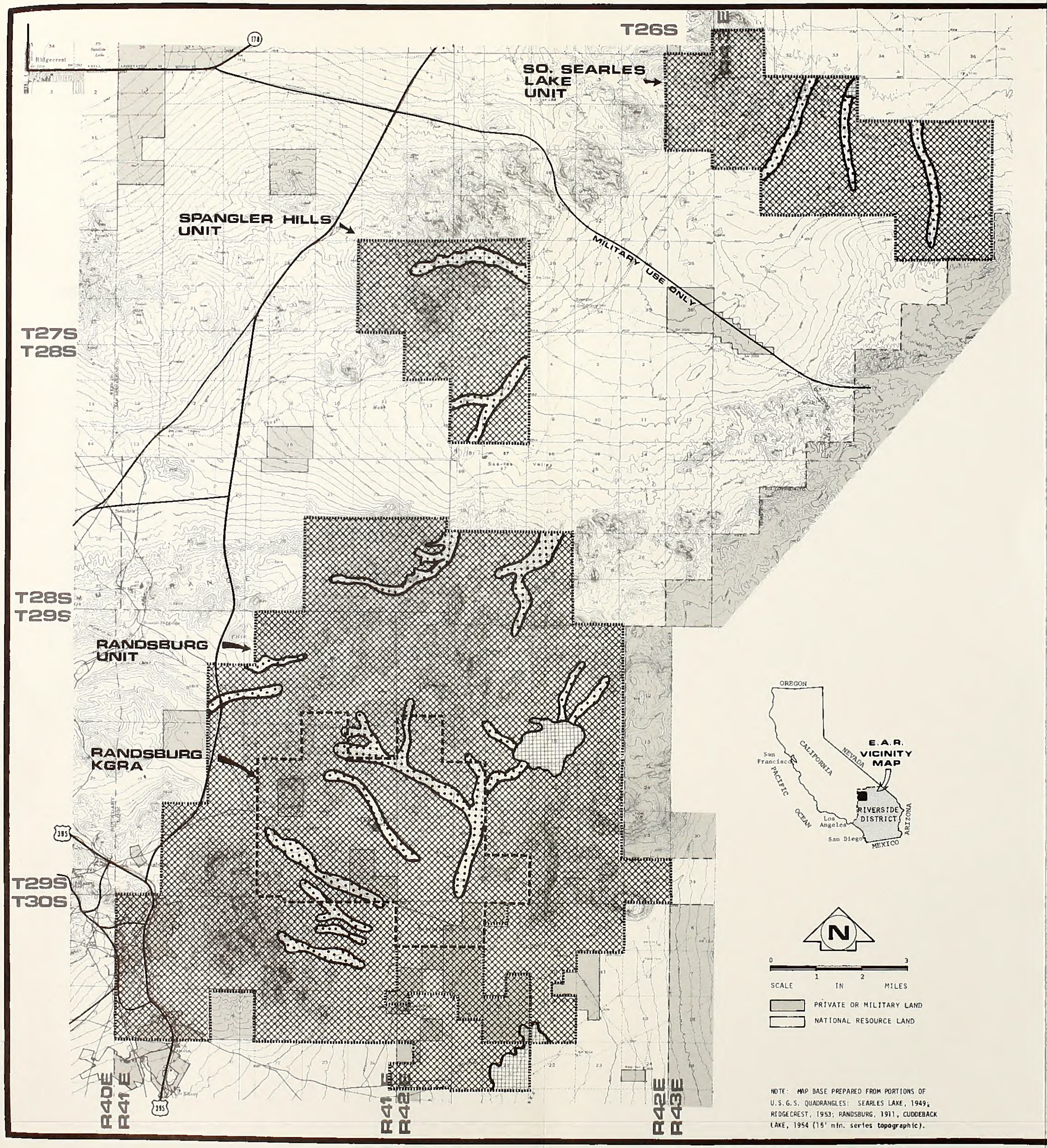
ENVIRONMENTAL SENSITIVITY

NOISE

ENVIRONMENTAL ANALYSIS RECORD

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-5



- L E G E N D -

- - - - - - - - KGRA BOUNDARY
.... NON-COMPETITIVE LEASE UNIT BOUNDARY

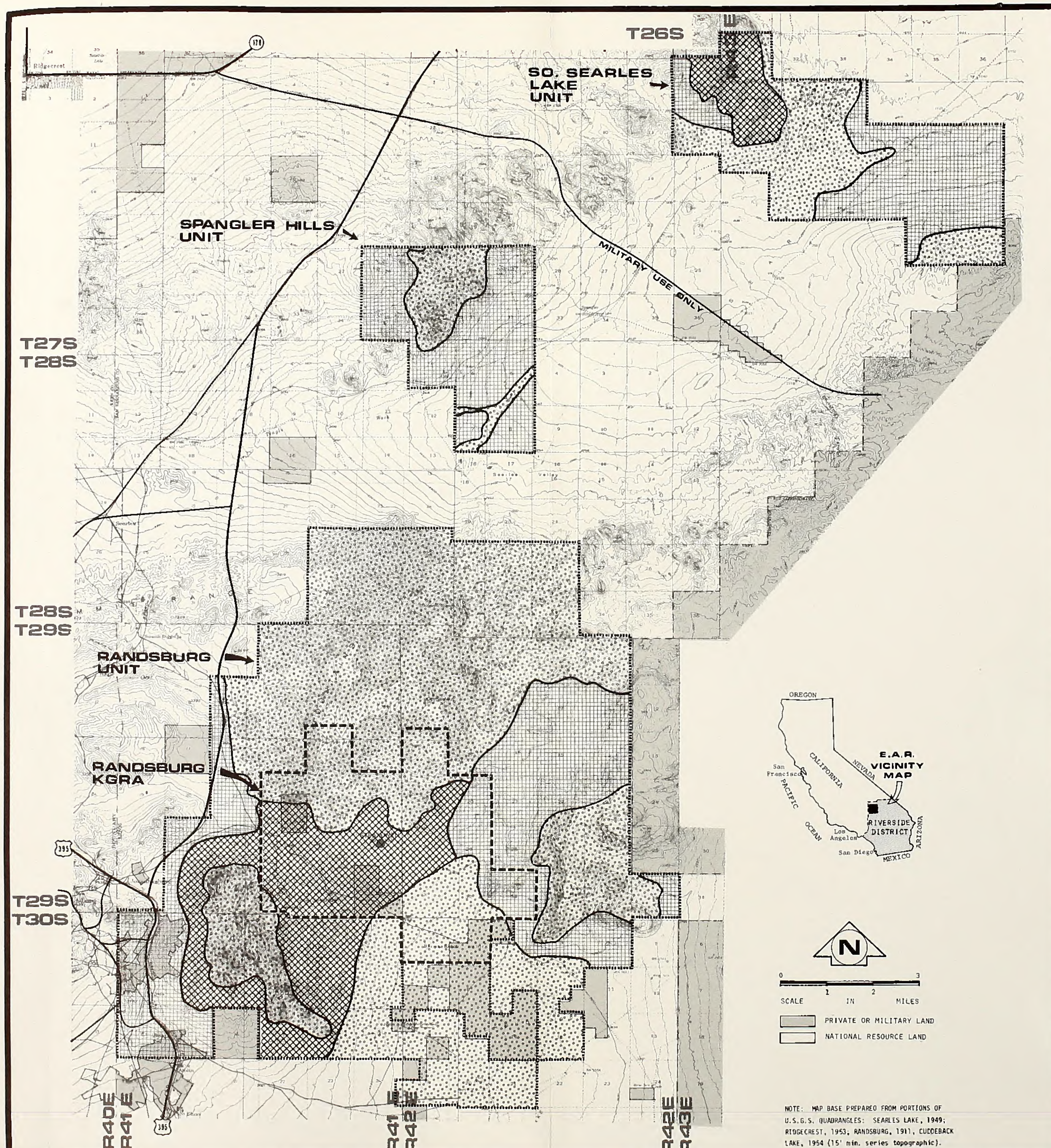
HIGH
MEDIUM
LOW

ENVIRONMENTAL SENSITIVITY

VEGETATION AND ECOLOGICAL INTERRELATIONSHIPS

ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-6



-LEGEND-

KGRA BOUNDARY

NON-COMPETITIVE LEASE UNIT BOUNDARY

CASUAL USE

MEDIUM

LOW

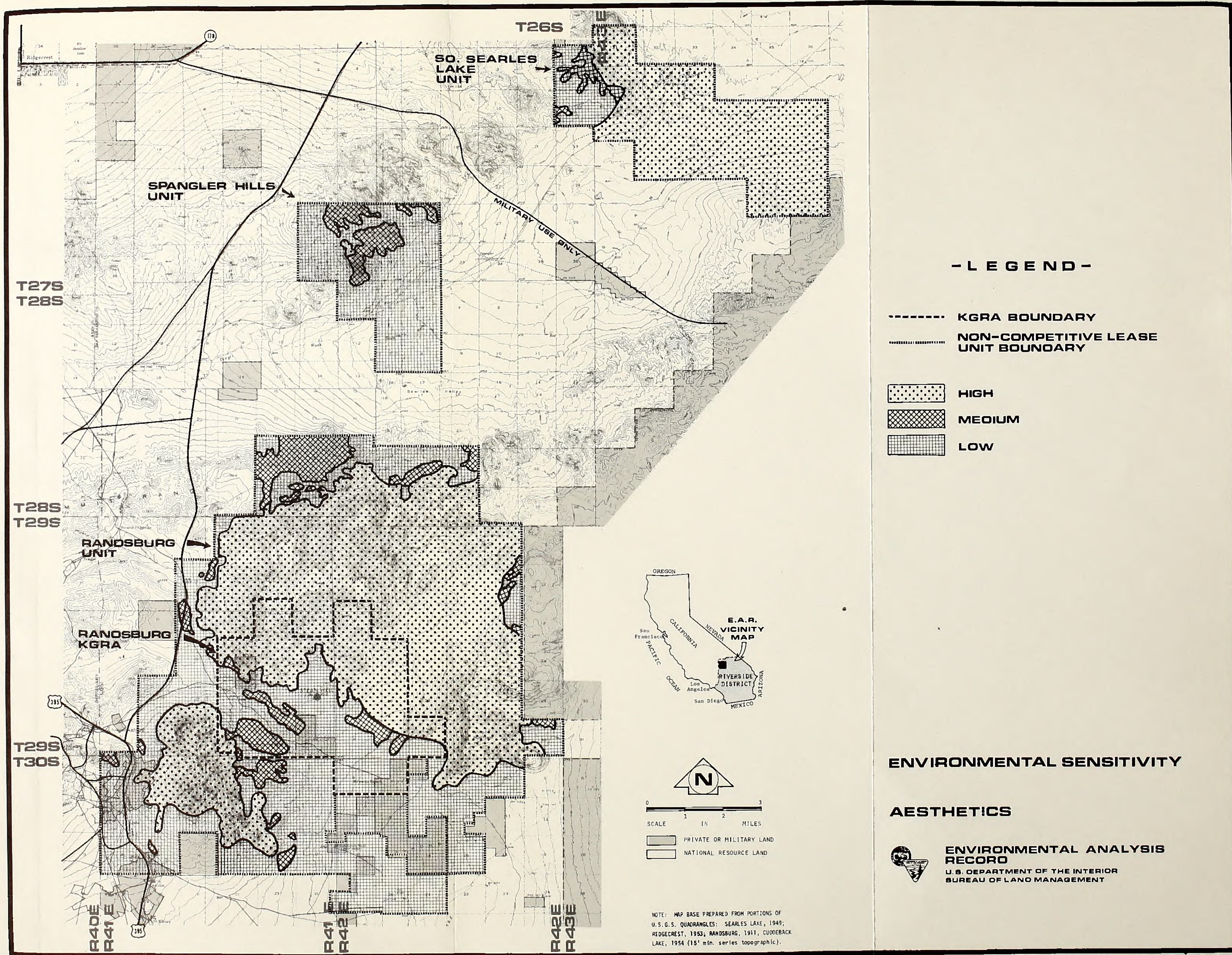
ENVIRONMENTAL SENSITIVITY

WILDLIFE

ENVIRONMENTAL ANALYSIS RECORD

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-7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-LEGEND-
KGRA BOUNDARY
NON-COMPETITIVE LEASE UNIT BOUNDARY
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E.A.R. VICINITY MAP
RIVERSIDE DISTRICT
SCALE IN MILES
PRIVATE OR MILITARY LAND
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
ENVIRONMENTAL SENSITIVITY
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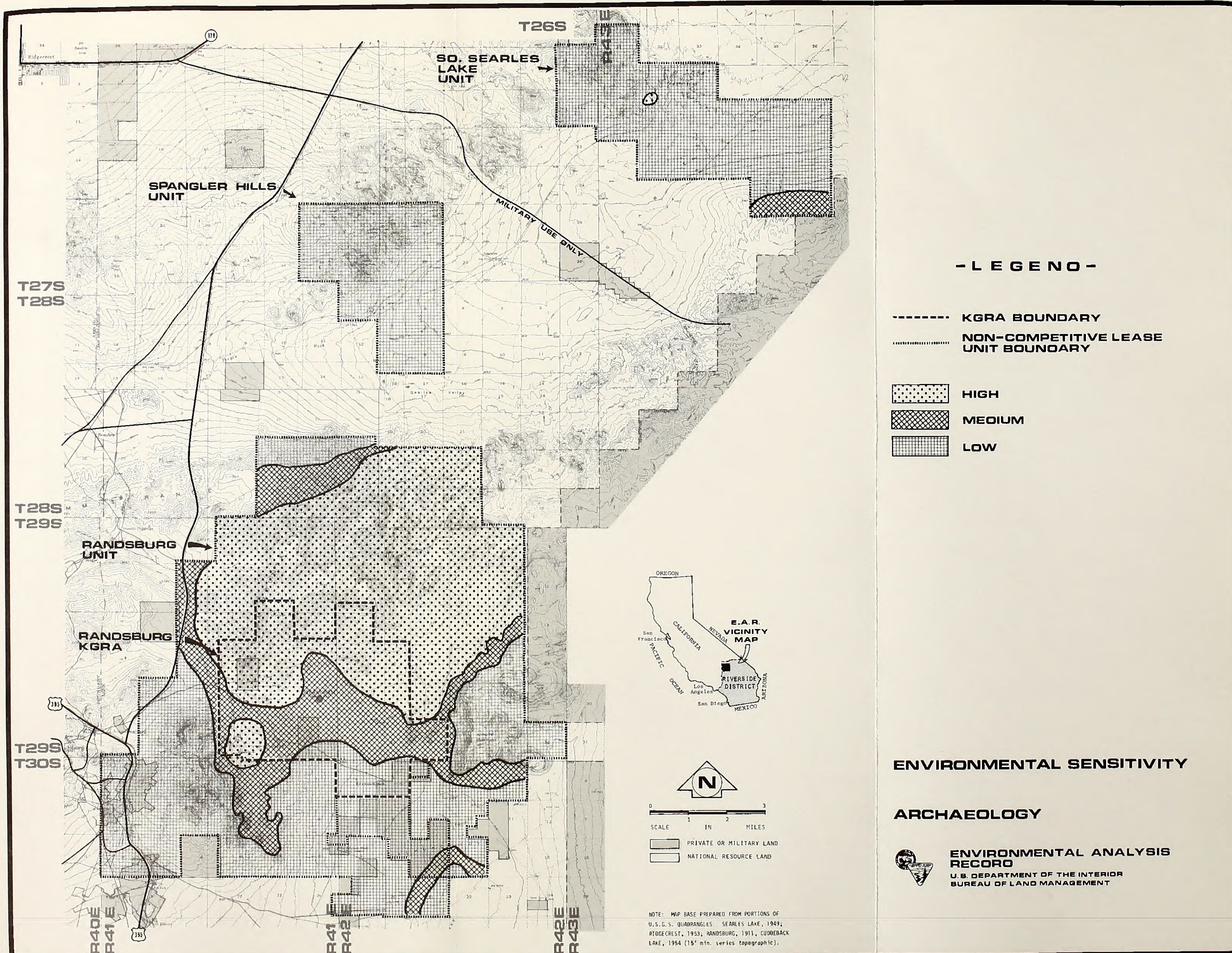
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
FIGURE 8-8



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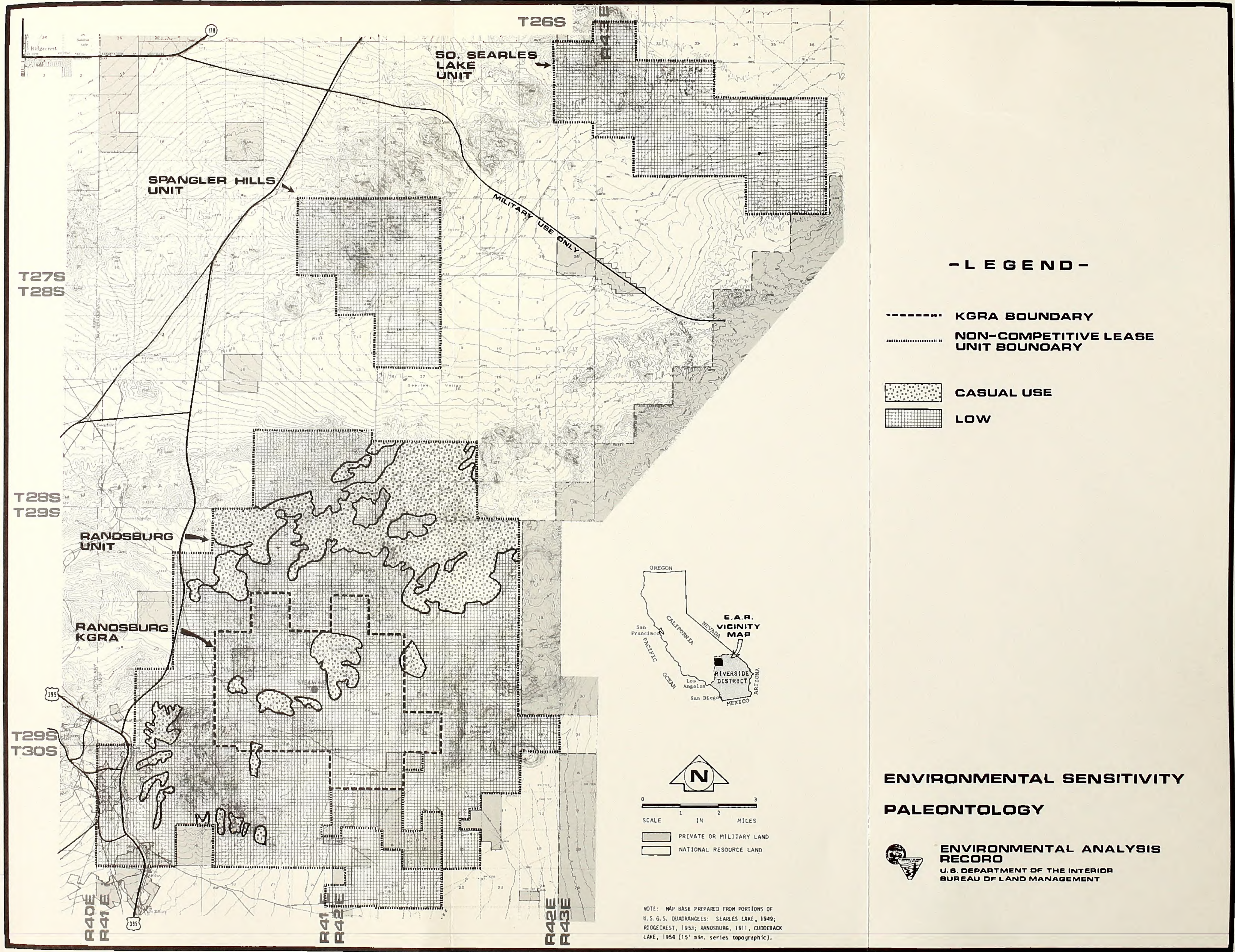
NATIONAL RESOURCE LAND
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANDSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
ENVIRONMENTAL SENSITIVITY
ARCHAEOLOGY
ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-9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KGRA BOUNDARY
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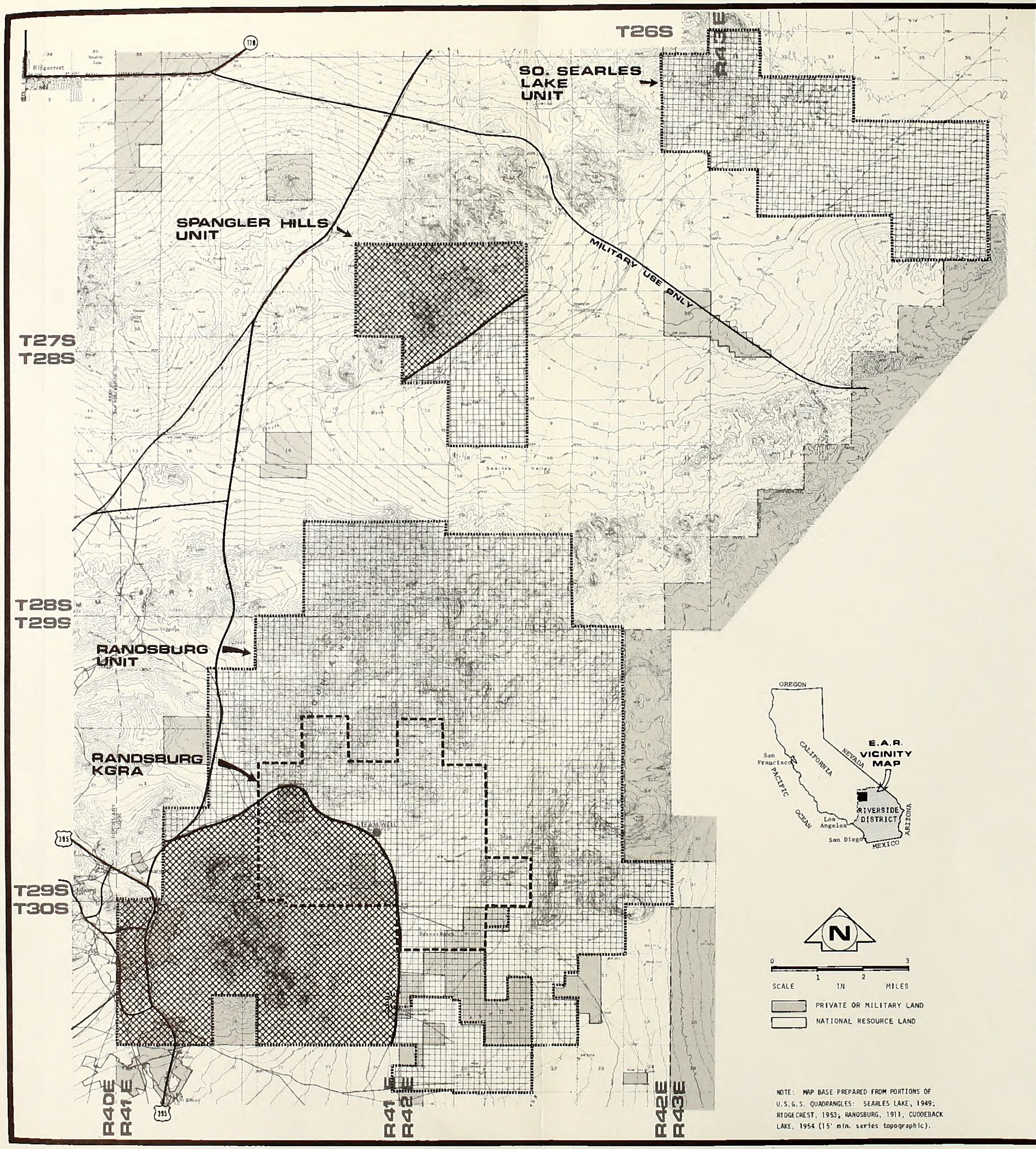
NOTE: MAP BASE PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES: SEARLES LAKE, 1949; RIDGECREST, 1953; RANOSBURG, 1911, CUDDEBACK LAKE, 1954 (15' min. series topographic).
ENVIRONMENTAL SENSITIVITY
PALEONTOLOGY
ENVIRONMENTAL ANALYSIS RECORO
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-10



- LEGEND -

KGRA BOUNDARY

NON-COMPETITIVE LEASE UNIT BOUNDARY

HIGH

MEDIUM

LOW

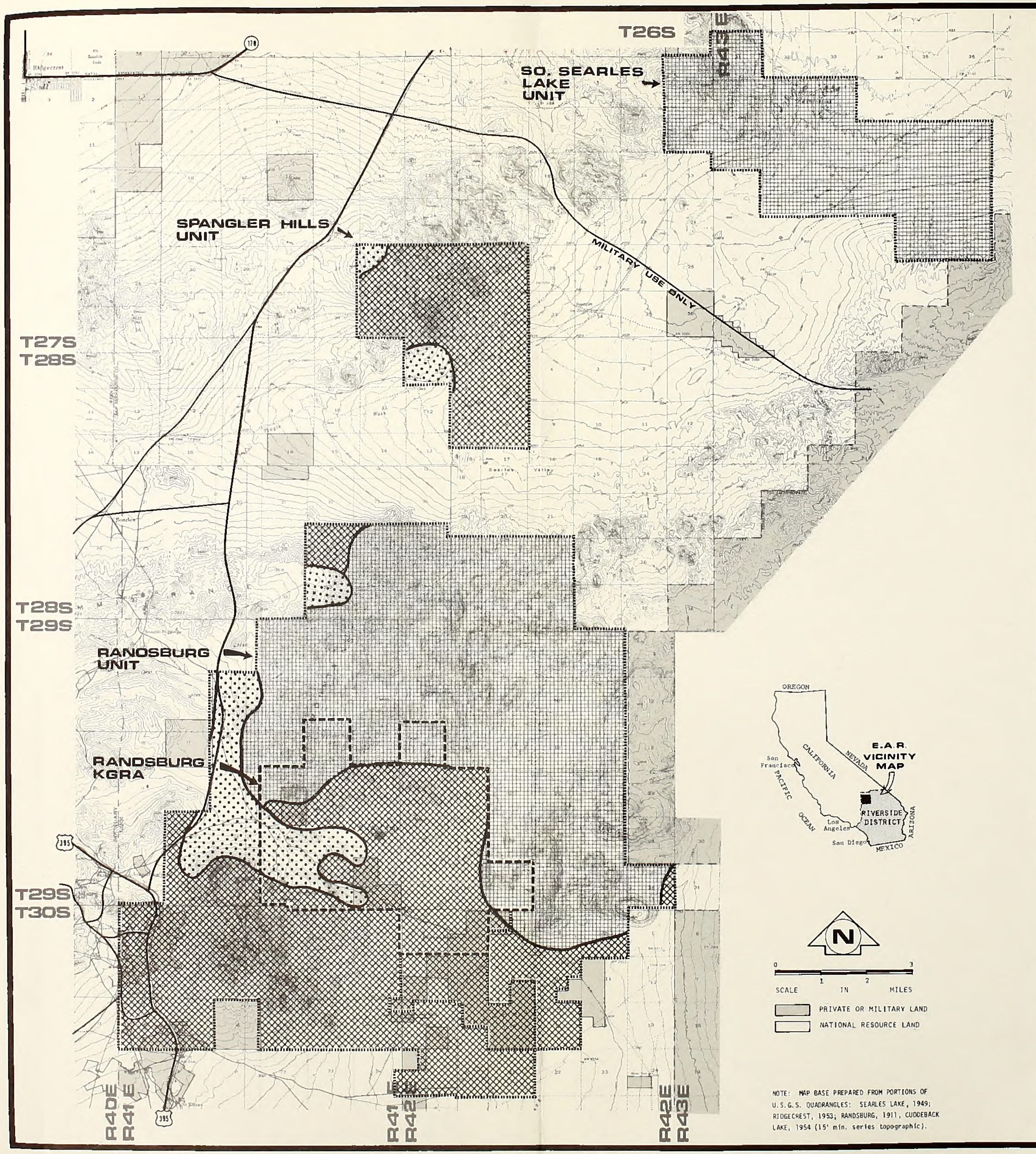
ENVIRONMENTAL SENSITIVITY

MINING AND MINERAL EXPLORATION

ENVIRONMENTAL ANALYSIS RECORD

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-11



-LEGEND-

- - - - - KGRA BOUNDARY
.... NON-COMPETITIVE LEASE UNIT BOUNDARY

HIGH

MEDIUM

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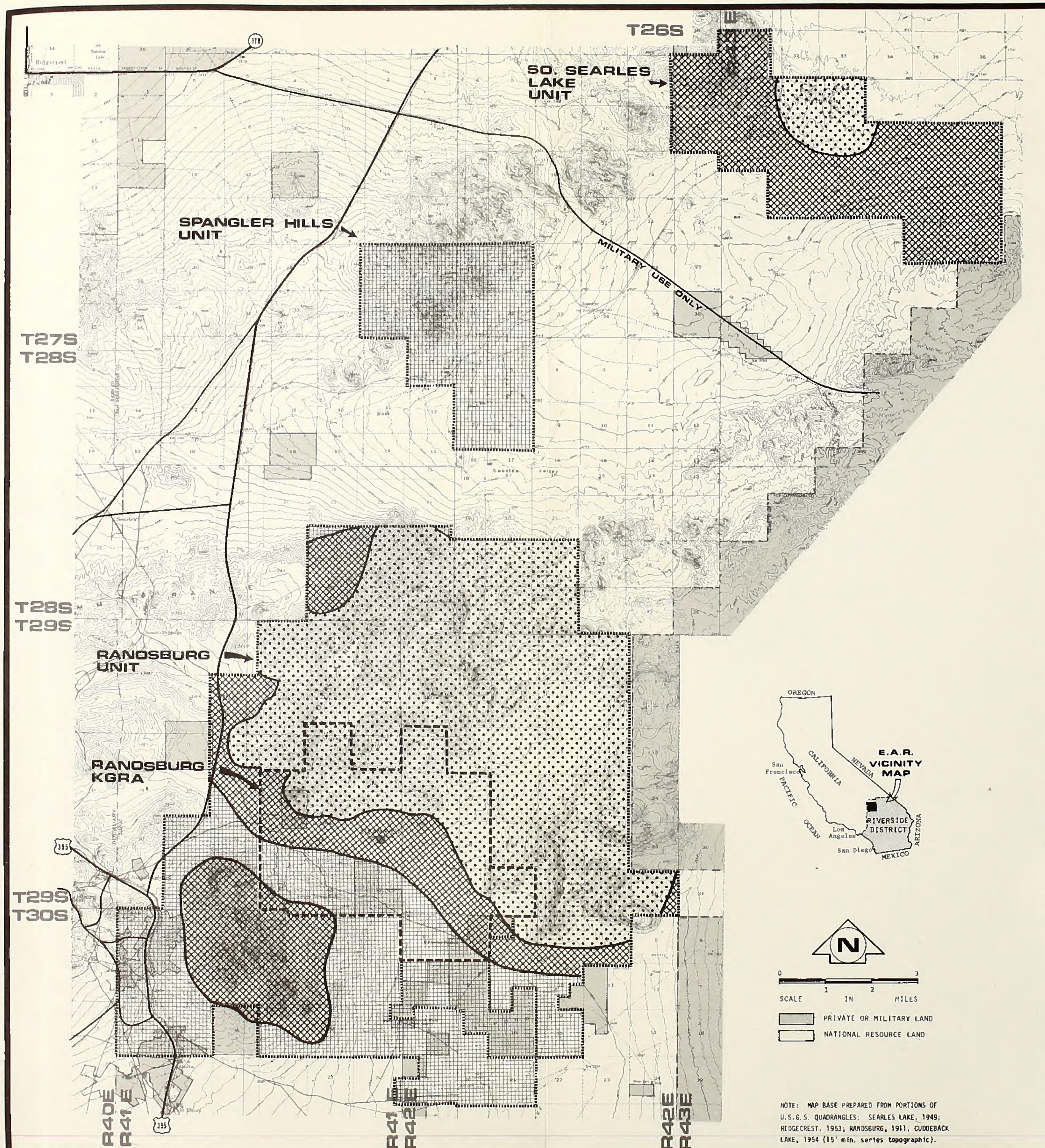
ENVIRONMENTAL SENSITIVITY

RECREATION-VEHICLE ORIENTED

ENVIRONMENTAL ANALYSIS RECORD
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-12



- L E G E N D -

- - - - - - - - KGRA BOUNDARY

.... NON-COMPETITIVE LEASE UNIT BOUNDARY

HIGH

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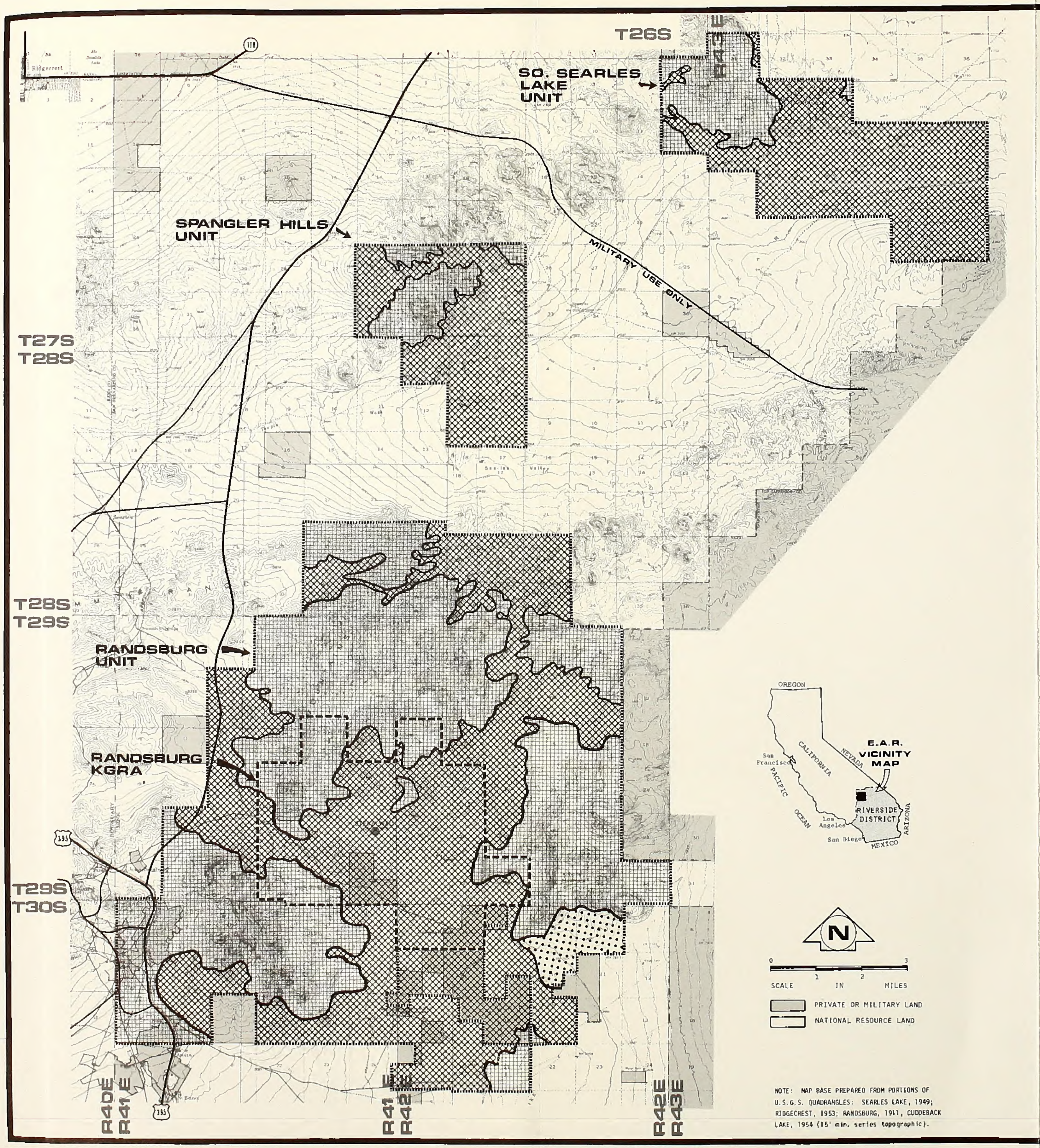
ENVIRONMENTAL SENSITIVITY

RECREATION-LAND AND ACTIVITY ORIENTED

ENVIRONMENTAL ANALYSIS RECORD

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-13



-LEGEND-

KGRA BOUNDARY

NON-COMPETITIVE LEASE UNIT BOUNDARY

HIGH

MEDIUM

LOW

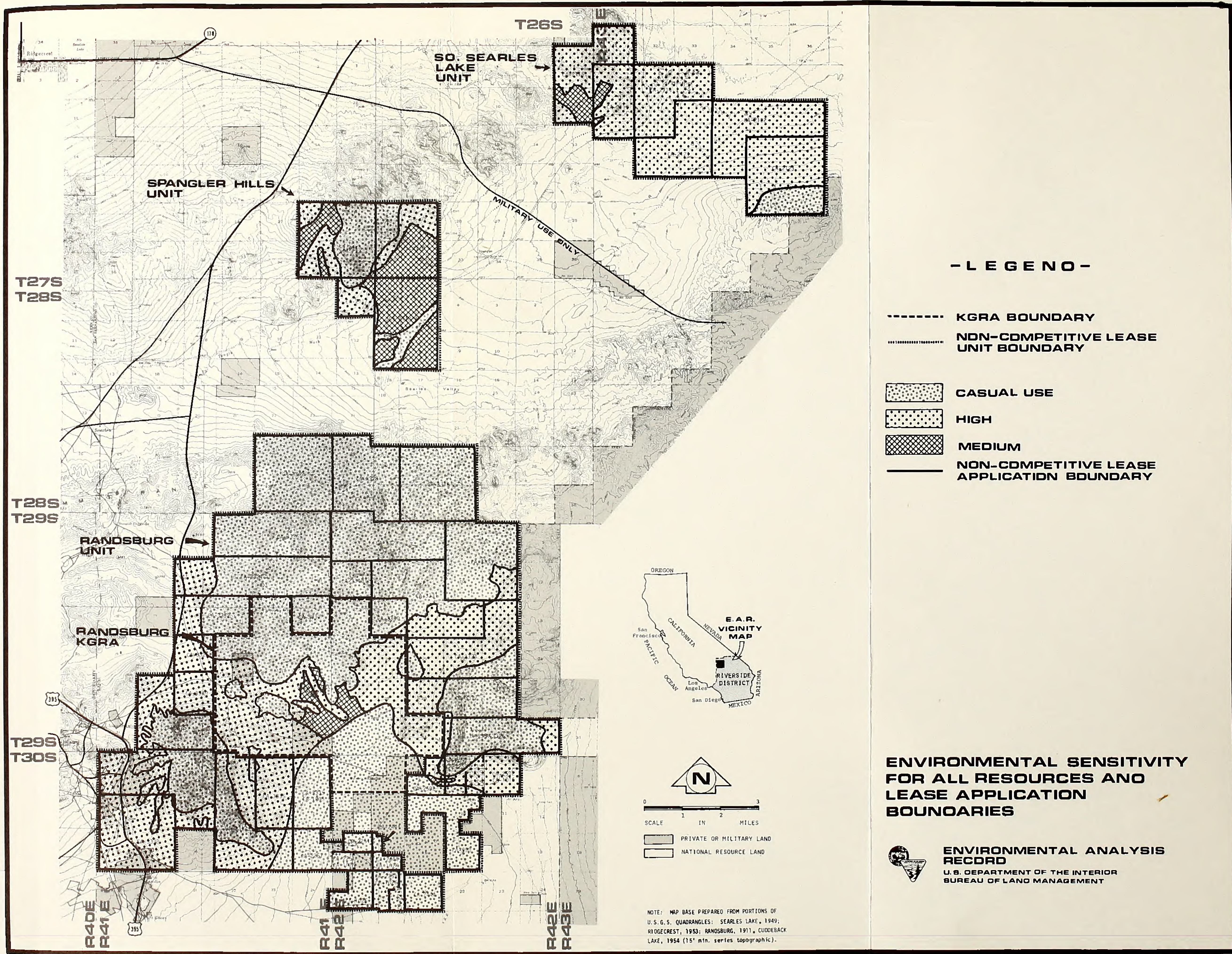
ENVIRONMENTAL SENSITIVITY

GRAZING

ENVIRONMENTAL ANALYSIS RECORD

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FIGURE 8-14



ENVIRONMENTAL SENSITIVITY FOR ALL RESOURCES AND LEASE APPLICATION BOUNDARIES

FIGURE 8-15

9.0 CONSULTATION AND COORDINATION

The following agencies were contacted during the preparation of the Draft Environmental Analysis Record.

UNITED STATES DEPARTMENT OF THE INTERIOR

Geological Survey
Office of the Area Geothermal Supervisor
Conservation Division
Menlo Park, California

Bureau of Land Management
Desert Planning Staff
Riverside, California

Bureau of Land Management
Susanville District Office
Susanville, California

Fish and Wildlife Service
Sacramento, California

UNITED STATES DEPARTMENT OF DEFENSE

Department of the Navy
R. G. Freeman III
Rear Admiral, U.S.N.
Commander
Naval Weapons Center
China Lake, California

STATE OF CALIFORNIA

Southern California Air Pollution Control District
San Bernardino Zone
San Bernardino, California

University of California - Riverside
Dr. Ray C. Thompson
Air Pollution Control Laboratory

Department of Fish and Game
Robert Vernoy
Victorville, California

Department of Fish and Game
Gary Stacey
Long Beach, California

Department of Fish and Game
G. W. Moor
Barstow, California

COUNTY OF SAN BERNARDINO

County Transportation Dept.
Ann Konn
Traffic Division

County Planning Dept.
Tony Grey
Design Engineering

County Museum
Dr. Gerald Smith, Director
Redlands, California

10.0 INTENSITY OF PUBLIC INTEREST

Prior to publication of the Draft EAR, the proposed action had been initially brought to the attention of the news media, Federal, State, and local government agencies, elected officials, BLM District Advisory Board members, conservation organizations, and interested members of the public by the BLM Riverside District's monthly Energy Report and a News Release.

The mailing list of the monthly Energy Report numbers about 300, and includes government agencies, organizations, and members of the public. About 600 copies of the News Release were mailed to news media in Kern, Riverside, San Bernardino, Los Angeles, and Orange Counties as well as interested organizations, elected officials and members of the public in January, 1976.

Moderate interest was expressed as a result of these notifications. Articles concerning the proposal appeared in local newspapers and telephone requests for further information were received in the Riverside District Information Office.

The Draft Management Framework Plan for National Resource Land in El Paso and Red Mountain Planning Units, (U.S. Dept. Interior, 1975d) mentioned the Randsburg geothermal development potential and, during the MFP's four month review period from November 17, 1975, to January 15, 1976, a few comments pertaining to exploration and development were received. No comments were voiced during the public information meetings held in Trona, Ridgecrest and Los Angeles, or during the open house held in California City during February, 1975.

The greatest interest in the proposed action had been shown by the several companies who had filed the 37 lease applications in the proposed lease area.

The Department of the Navy expressed interest in learning of the nature of the proposed geothermal exploration and development program in the area. They were concerned that the development would interfere with their military research and testing operations at the China Lake Naval Weapon Center, east of and adjacent to the EAR area.

The California State Lands Commission expressed an interest in the proposal and asked to be kept informed of all activities relating to the proposed action.

After completion of the draft document, a 30-day review period was established. To assure exposure of the proposed action and to solicit public comment, an extensive mailing list of over 750 government agencies, private organizations and interested individuals was utilized. All those on this list were informed of the availability of copies of the Draft EAR and were invited to attend a public information meeting. In addition, over 175 copies of the Draft EAR were mailed and the recipients were asked to comment and were invited to attend the public meeting. This meeting was held on the evening of May 17, 1976, in Johannesburg, California, and was attended by 15 individuals.

During the 30-day review period, several letters were received commenting on the Draft EAR. Following are copies of each of these letters and the staff's response to each of the comments.

Advisory Council
On Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

May 5, 1976

Mr. Delmar D. Vail
District Manager
Riverside District Office
Bureau of Land Management
1695 Spruce Street
Riverside, California 92507

Dear Mr. Vail:

This is in response to your request of April 30, 1976 for comments on the draft environmental analysis record (DEAR) for proposed geothermal leasing in the Randsburg-Spangler Hills-South Searles Lake areas of California. Pursuant to its responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969, the Advisory Council on Historic Preservation has determined that the DEAR appears adequate concerning compliance with Section 106 of the National Historic Preservation Act of 1966. With respect to compliance with the Executive Order 11593, "Protection and Enhancement of the Cultural Environment" issued May 13, 1971, it is noted that there are seven cultural properties within the area of the undertaking's potential impact which may be eligible for inclusion in the National Register of Historic Places. Therefore, pursuant to Section 2(b) of the Executive Order 11593 and Section 800.4(a)(2) of the "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800), which sets forth the steps for compliance with Section 2(b), the Council requests the Bureau of Land Management (BLM) to request in writing an opinion from the Secretary of the Interior with respect to the eligibility of these seven properties for inclusion in the National Register, and inform us of the findings. The BLM is reminded that should the Secretary of the Interior determine these properties are eligible for inclusion in the National Register, it should follow the remaining steps set forth in Section 800.4 to evaluate the effect and obtain the Council's comments as appropriate, prior to proceeding with the undertaking.

Should you have any questions or require any additional assistance, please contact Michael H. Bureman of the Advisory Council staff at P. O. Box 25085, Denver, Colorado 80225, telephone number (303) 234-4946.

Sincerely yours,

Michael H. Bureman

for Louis S. Wall
Assistant Director, Office
of Review and Compliance

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Louis S. Wall, Advisory Council on Historic Preservation, Washington, D.C.

- -

Comment: Page 1, Paragraph 1.

Response: BLM has requested in writing an opinion from the Secretary of the Interior (in consultation with the State Historic Preservation Officer) as to the eligibility of the seven properties identified for nomination to the National Register of Historic Places. The Council will be informed of the Secretary's decision. If the properties are determined to be eligible then the remaining steps set forth in 36 CFR 800.4 would be followed to evaluate the proposed action's effect on those properties.

Southern California
AIR POLLUTION CONTROL DISTRICT
SAN BERNARDINO ZONE
172 WEST THIRD STREET, SAN BERNARDINO, CALIFORNIA 92415 • (714) 383-1661

May 10, 1976

Mr. Delmar D. Vail, District Manager
Bureau of Land Management
U. S. Department of the Interior
Riverside District Office
1695 Spence Street
Riverside, CA 92507

Dear Mr. Vail:

Thank you for transmitting a copy of the Draft Environmental Analysis Record for proposed geothermal leasing in the Randsburg-Spangler Hills-South Searles Lake areas, dated April 30, 1976. Our comments are provided below:

I. General

On pages 3-22, 3-30 and 3-31, you note some possible detriment due to the release of hydrogen sulfide (H_2S) from the test drillings. One concern which you should address - either in this report, or in another one more germane to the specific area - is that of the Naval Weapons Center (NWC), China Lake, for releases of H_2S. We have recently been contacted by NWC personnel who are concerned that geothermal development in (or near) the Christmas Canyon area of the Randsburg Wash could impact some very sensitive equipment in that area, if it were exposed to either H_2S or sulfur dioxide (SO_2). The equipment and the project are classified. BLM personnel with the proper security classification should contact Mr. James R. Ouimette, Physicist, Environmental Engineering, Public Works at NWC. His telephone number is (714) 939-3639. Mr. Ouimette's superior is Captain Floyd Daniel, Jr., CEC, USN, who also may be contacted at Public Works, NWC, China Lake.

II. Specific

Page 2-37, Sect. 2.1.7.2: Add a modifier to first sentence stating that a new air monitoring station was opened at Trona in March, 1976. Page 2-37, third line from bottom, change 1975 to 1974.

Page 2-39: Change first sentence to read: "The following data are extracted from the Report of the Air Pollution Control District for San Bernardino County (1974)."

Table II-5: The California Standard for Sulfur Dioxide (24-hour average) was changed back in 1975 to 0.04 ppm (105 ug/m^3). Add a new horizontal entry for sulfates as follows:

Sulfates	24 hour	25 ug/m^3	-	-	-

Page 2-39: Please note, via an asterisk and footnote on the oxidants tabulation, that the oxidant readings for those days should be multiplied by 0.8 to make them consistent with the 1975-adopted method of oxidant instrument calibration.

You may wish to use the now-available 1975 tabulation, which is as follows:

VICTORVILLE, 1975

Month	Days/Hours (STATE)	Days/Hours (Federal)
January	0/0	0/0
February	1/2	2/9
March	4/20	8/45
April	1/1	3/11
May	1/1	10/33
June	9/40	11/82
July	16/47	27/121
August	9/26	21/74
September	6/10	11/28
October	0/0	3/3
November	0/0	0/0
December	0/0	1/1

FOR OXIDANT

Very truly yours,

DONALD M. THOMAS, APCO
San Bernardino Zone
Southern California APCD

DMT:CAO:mmm

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Donald M. Thomas, Southern California Air Pollution Control District, San Bernardino Zone, San Bernardino, California.

- -

Comment: Page 1, Paragraph 2.

Response: The text has been modified in appropriate sections to identify those impacts and mitigation measures that are applicable to the operations of both the China Lake Naval Weapons Center and George Air Force Base.

Comment: Page 1, Paragraph 3.

Response: Suggestion has been incorporated into the text.

Comment: Page 1, Paragraph 4.

Response: Text has been corrected.

Comment: Page 2, Paragraph 1.

Response: Suggested data has been incorporated into the table.

Comment: Page 2, Paragraphs 2, 3.

Response: Suggested 1975 tabulation has replaced the 1974 tabulation.

PHILLIPS 66

PHILLIPS PETROLEUM COMPANY
DEL MAR, CALIFORNIA 92014
BOX 752 714 755-0131

NATURAL RESOURCES GROUP
Energy Minerals Division
Geothermal Operations

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

May 17, 1976

B1-17-76GO

Mr. Delmar D. Vail
District Manager
Bureau of Land Management
Riverside District Office
1695 Spruce Street
Riverside, CA 92507

Dear Mr. Vail:

I have received and examined a copy of the Draft Environmental Analysis Record for proposed geothermal leasing in the Randsburg-Spangler Hills-South Searles Lake areas of California.

Overall, I would say that the document is informative, well written and illustrated and quite thorough. I do, however, have a few comments on certain segments which are not acceptable to us in their present form:

Page 2-208-line 2

The word "geothermal" should be changed to "hydrothermal" as the former word may imply some evidence of commercial potential to the non-geologist.

Page 2-210, bottom 3 lines

The statement is made with regard to the Lava Mountains. "Few, if any, roads penetrate the jagged volcanic mountains and pristine values find their best expression there." This statement is highly editorial in nature and has no place in a factual compilation.

Page 2-211, line 11

"The Lava Mountains are used for hiking and could also be used for back-packing". I have personally spent considerable time in the area doing geological reconnaissance, part of it on foot. I have observed no hikers or backpackers, which is not at all surprising, since there is no water available in the Lava Mountains. Certainly, any area could be used for backpacking, but as one who has had lots of experience in backpacking and climbing, there is little probability of such an area ever becoming popular among backpackers. This is especially true, in view of the large areas of mountain wilderness available for such activities a short distance north and south of the Randsburg KGRA where lack of water is not a problem (eg. the San Gorgonio and John Muir Wilderness areas and large sections of undeveloped national forest land).

Page 3-2, lines 14-16

The implication is that sampling of hand sized rock specimens for geologic mapping will adversely affect the environment. This is absolutely absurd!

Page 3-12, paragraph 4

The comment is made that during the preliminary stages of exploration, drill cuttings, mud and solid waste(?) will alter "the color, texture and form of the existing landscape". At such an early stage of exploration, only shallow (less than 500 feet), small (4 3/4 inch) diameter holes are drilled for temperature measurements. Most of the cuttings and mud are put back into the hole on completion and the remainder is raked to conform to the ground contour. The small volume of material left over blends in with surface materials very readily (as it would be expected to, since it normally consists of the same rock fragments and clay found on the surface). Evidence for this is found in the fact that such holes are often difficult to relocate even a few months later.

Page 3-13, paragraph 3 through 3-15, paragraph 2

The comment is made that during the preliminary stage of exploration, "any disturbance of the surface would alter or destroy whatever cultural resources are present", and further that "mapping, geophysical exploration, geochemical surveys, and drilling directly or indirectly alter the surface, either by the establishment of new roads by drill operations or through unauthorized collecting, increased accessibility (new roads) and increased worker/visitor use of the area. The major effect of these unregulated activities would be the partial or total destruction of existing archeological or historical sites in the areas of surface alteration".

This is, in our view, a very biased sequence of comments. In the first place, the BLM examines drill sites well in advance to insure that no archeologically or historically significant areas will be disturbed. Surveys, sample collecting and drilling operations can and do make use of existing roads only. We find the comment using the words "unregulated activities" particularly offensive, as it is quite apparent to us that our activities are exceedingly regulated.

In conclusion, I would like to point out that the probability of discovering a commercial geothermal resource at the Randsburg KGRA is very small. However, in the happy event that one is found, we are entirely prepared to do everything in our power to protect the environment. Moreover, it is impossible not to do so, since every aspect of exploration and development is overseen by the USGS once geothermal leases are issued. We would hope that no primitive area status would be assigned to any part of the Randsburg KGRA until such time as exploration has proved or disproved the existence of a commercial geothermal resource in the area. Certainly many people, including outdoorsmen and conservationists, would argue that the best use of such an area as the Lava Mountains, should it happen to be commercially exploitable, is to provide badly needed energy in California.

Sincerely,

Joe Beall
Geologist

JB:jm

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS, SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Joe Beall, Phillips Petroleum Company, Natural Resources Group, Del Mar, California.

Comment: Page 1, Paragraph 3.

Response: Suggestion has been incorporated into the text.

Comment: Page 1, Paragraph 4.

Response: Staff feels that a discussion of primitive or pristine values is a discussion of feelings or impressions that are invoked in people as a response to stimuli. This statement attempts to convey the values people place upon areas such as Dome, Almond and Klinker Mountains.

Comment: Page 1, Paragraph 5.

Response: In compiling data for this area's Unit Resource Analysis (U.S. Dept. Interior, 1975b), it was learned that the Lava Mountains have been utilized for hiking. Also, areas such as the San Gorgonio and John Muir Wilderness Areas have experienced overcrowding problems. As these problems are expected to increase in the future, it is the staff's feeling that areas such as the Lava Mountains may see increased popularlity and should be set aside for future use.

Comment: Page 2, Paragraph 2.

Response: Suggestion is accepted and the reference has been deleted from the text.

Comment: Page 2, Paragraph 3.

Response: Staff agrees in part and the text has been modified accordingly. Staff feels, however, that any surface disposal of drill cuttings within the lease area would be visible in that "fresh" soil and

Response Page 2, Paragraph 3 (Continued)

rock material would be spread over material that has undergone surface weathering. This would provide for a local contrast in colors of surface materials.

Comment: Page 2, Paragraph 4, 5.

Response: The implication of unregulated activities is in reference to increased visitor use, ORV activities, and unauthorized collection by workers and visitors. These activities are extremely difficult to regulate and can be as damaging as activities involved in actual drilling. If activities associated with the preliminary stage of exploration and any followup stages were unregulated with respect to cultural resources then damage to this data base could result. Only by reiterating possibilities can caution and prudence during operations be insured. Also, in a public document of this nature all possibilities of damage to the environment should be addressed, regardless of previous actions and regulations.

UNIVERSITY OF CALIFORNIA, RIVERSIDE

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO · SANTA BARBARA • SANTA CRUZ

DEPARTMENT OF EARTH SCIENCES
Geography — Geology — Geophysics

RIVERSIDE, CALIFORNIA 92502

May 13, 1976

Mr. Delmar D. Vail
District Manager
Bureau of Land Management
1695 Spruce St.
Riverside, CA 92507

Dear Mr. Vail:

I recently read the draft of the environmental analysis record of the proposed geothermal leasing of the Randsburg, Spangler Hills, and South Searles Lake areas. From my paleontological and geological viewpoint I think your staff has accomplished a broad treatment. I would, however, like to make some comments regarding salvage and conservation of paleontological resources, as well as to offer my services in future studies of this sort.

Specifically, I think that paleontological values should be mentioned on pp. 4-20, 4-21, and strongly recommend that the lessor not relieve the lessee of requirements specified in paragraphs a,b,c, and d.

I generally agree with the statement on p. 5-3, but note that the tone of the text concerns evaluating the degree of destruction of values after such destruction has happened. I reiterate, as on pp. 4-20, 4-21, that the best way to prevent almost all loss (except vandalism) is to provide systematic paleontological survey of an area before the developer moves into it. This is not necessarily a recommendation for a district-wide blanket survey, but rather a survey integrated with the developers schedule. Places in which the developer had no immediate interest could be surveyed, if required, at a later date. The same proposal applies to section 5.3.3. (p. 5-8).

Regarding long-term or short-term use (p. 6-5), the following, I think, applies mainly to paleontological remains. Paleontological resources differ importantly from archaeological resources in that the former occur in layered rocks, the latter usually, but not always, on the ground surface. Thus, in many cases archaeological materials may be completely salvaged initially. For paleontology, the fossils may occur at the surface, but also be preserved underground along the plane of the bedding. Surface collecting or even minor quarrying will not recover all of the specimens. Over the years, additional erosion by natural or man-made agencies will expose more specimens. Thus, for either long- or short-term use of an area, provision should be made for periodic, at least yearly, inspection for paleontological materials.

Mr. Delmar D. Vail
May 13, 1976
Page two

The faunal list (p. 2-186) is accurate, but it leaves the impression that fossils occur only at the localities found by Smith. In fact, these localities are found by a nearly random process, and significant paleontological material almost certainly is to be found in any of the area underlain by the Bedrock Spring formation. Any developments that occur on rocks of that formation should include prior inspection for fossils by qualified scientists.

Finally, I note that much of the Lava Mountains is now designated as a Primitive Area, with restrictions to any vehicle use, including scientists operating under the provisions of the Federal Antiquities Act. If the Lava Mountains are to remain a Primitive Area, leasing the area for geothermal exploration seems a dubious policy, at best.

If I can be of assistance on future evaluation studies please don't hesitate to call on me.

Sincerely,

Michael O. Woodburne

Michael O. Woodburne
Associate Professor of Geology

MOW/gal

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Michael O. Woodburne, Department of Geology, University of California, Riverside, Riverside, California.

- -

Comment: Page 1, Paragraph 2.

Response: The text has been modified to incorporate your suggestion.

Comment: Page 1, Paragraph 3.

Response: The text has been modified to incorporate your suggestion.

Comment: Page 1, Paragraph 4.

Response: Staff agrees with the intent of your suggestion; however, a compromise mitigation measure is presented. Staff feels that a five-year inspection interval would fit within legal requirements, economic considerations and existing erosional-depositional rates. Text has been modified to incorporate this measure.

Comment: Page 2, Paragraph 1.

Response: The text has been modified to incorporate your suggestion.

SIERRA CLUB

FOUNDED IN 1892

SAN DIEGO CHAPTER
HOUSE OF HOSPITALITY
1549 EL PRADO, BALBOA PARK
SAN DIEGO, CALIFORNIA 92101

May 17, 1976

Project Officer
Geothermal Leasing Program
Bureau of Land Management
1695 Spruce Street
Riverside, CA 92507

Dear Sir:

As geothermal co-ordinator for the Sierra Club's Southern California Regional Conservation Committee, I appreciate this opportunity to comment on your office's Draft Environmental Analysis Record for the Proposed Geothermal Leasing program in the Randsburg - Spangler Hills - South Searles Lake areas.

The draft EAR is generally quite comprehensive and thorough, and we wish to particularly commend the BLM for extending the analysis through all phases of the potential development program, including the generation of power and the closedown stage.

As you note, the Randsburg KGRA and associated areas represent a relatively low temperature resource with perhaps limited potential for electrical energy development. Nevertheless, in the event exploration and development are pursued, the Sierra Club would feel compelled to oppose these activities in the Trona Pinnacles and Lava Mountains areas. Your report correctly notes the special nature of these two areas, and we would hope BLM would discourage exploration within them. The same comments would hold true for significant cultural resource areas.

One point we would have liked to have seen discussed further is surface brine disposal. Even if reinjection is practiced, over a field life of, say, 50 years it appears that considerable surface disposal is apt to take place. The report does not mention the average salinity of the resource in this area, nor what might result in future years if surface disposal ponds are simply covered over. Could this point be covered in greater detail?

A final point might be that a better place-name map would be useful. The reproduced topo map used throughout has very small print and some locations (e.g., Golden Valley) are hard to locate.

We would appreciate it if you could place the name of the undersigned on your District office geothermal mailing list to receive future announcements and reports of this type.

Yours truly,

Philip R. Pryde

Philip R. Pryde
5377 Redding Road
San Diego, CA 92115

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Philip R. Pryde, San Diego Chapter, Sierra Club, San Diego, California.

Comment: Page 1, Paragraph 3.

Response: Staff feels that various mitigation measures designed to reduce potential impacts in the Pinnacles and Lava Mountain areas have been adequately discussed in Chapter 4.

Comment: Page 1, Paragraph 4.

Response: At the present time, no data is available with which to determine an average salinity. As the resource is explored, this data will gradually become available.

The text has been modified in appropriate sections to indicate that surface disposal ponds would not be simply covered. Any toxic chemicals would be removed from the pits before they are backfilled.

Comment: Page 1, Paragraph 5.

Response: The selection of maps appropriate for use as a base is extremely limited. Staff agrees that the map used is probably not ideal, but in view of available base map material, printing constraints, and the need to portray as much meaningful data as possible on one map, the topographic map base has been retained.

Comment: Page 1, Paragraph 6.

Response: Your name has been placed on the District's list to receive the Monthly Energy Report, which contains the information you are interested in.

Getty

Getty Oil Company | P.O. Box 5237, Bakersfield, California 93308 • Telephone: (805) 399-2961

California Exploration and Production Division

May 21, 1976

U. S. Department of the Interior
Bureau of Land Management
Riverside District Office
1695 Spruce Street
Riverside, California 92507

Attention: Mr. Delmar D. Vail, District Manager

Re: Your: 1122 (C-061.3)
Draft Environmental Analysis Record
Covering Proposed Geothermal Leasing
Randsburg Area, San Bernardino County,
California

Gentlemen:

Getty Oil Company has made a thorough review of the captioned Draft Environmental Analysis Record and find such report to be extremely complete and comprehensive.

We would like to record our objection to the possible total and exclusive withdrawal of the Lava Mountains Area as a primitive or pristine area from geothermal exploration and development. We believe that the presence of a geothermal resource in this area is likely and that the industry must have the opportunity to explore and develop same, even under the most stringent supervision and restriction.

The opportunity to review the Draft Environmental Analysis Record and to present these comments is appreciated.

Very truly yours,

GETTY OIL COMPANY

Dan W. Sparks
Landman

DWS:js

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Dan W. Sparks, Getty Oil Company,
Bakersfield, California.

- -

Comment: Page 1, Paragraph 2.

Response: Staff acknowledges your objection.

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WESTERN REGION
P. O. BOX 92007, WORLOWAY POSTAL CENTER
LOS ANGELES, CALIFORNIA 90009

May 18, 1976

Mr. Delmar D. Vail
Riverside District Manager
Bureau of Land Management
Riverside District Office
1695 Spruce Street
Riverside, California 92507

Dear Mr. Vail:

A review of your Draft Environmental Analysis Record for "Proposed Geothermal Leasing" has been completed by this headquarters.

Our findings indicate that this proposed project will not present any problem from an environmental viewpoint to any existing or presently planned FAA facilities.

Please be advised that this approval does not obviate the requirement to file a notice with the FAA where applicable and as stipulated under Part 77 of the Federal Aviation Regulations.

We appreciate the courtesy extended in bringing this matter to our attention.

Sincerely,

W. BRUCE CHAMBERS
Regional Planning Officer

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: W. Bruce Chambers, Department of Transportation, Federal Aviation Administration, Los Angeles, California.

- -

Comment: Page 1, Paragraph 3.

Response: Staff acknowledges your notice and, should development occur, the prospective lessee would comply with pertinent regulations.

Burmah

Burmah Oil and Gas Company

May 21, 1976

Bureau of Land Management
Riverside District Office
1695 Spruce
Riverside, California 90507

RE: Request for EAR Randsburg, Spangler Hills and South Searles Lake Areas

Gentlemen:

Kindly furnish the undersigned, at the address shown, three (3) complete copies of the Environmental Analysis Record for Proposed Leasing for Geothermal Resources in the subject areas. Any charges in connection with this request will be promptly paid upon receipt of invoice.

Your cooperation in this respect is greatly appreciated.

Very truly yours,

Emmet E. Wolter
Geothermal Consultant

EEW/sfz

2828 Junipero Avenue • P. O. Box 2828 • Long Beach, California 90801 • (213) 636-3301

one of The Burmah Group

18144 Valley Vista Blvd.
Tarzana, CA 91356

1791 (Randsburg)
N-2

Riverside District
Bureau of Land Management
U.S. Department of the Interior
Riverside, CA

Dear Sirs,

I am a part-time graduate student at U.S.C. working towards my Masters of PUblic Administration, and working as a planner in the L.A. area. I am trying to build up a small reference library to help me with my work and my school-related research In this regard, could you tell me the cost and availability of a copy of your Draft Environmental Analysis Record on the Proposed Geotherman Leasing ; Randsburg, Spangler Hills, and South Searles Lake Areas?

Thank you very much for your help and concern.

YOurs,

Victor Kamhi

DEPARTMENT OF THE NAVY
NAVAL WEAPONS CENTER
CHINA LAKE, CALIFORNIA 93555

IN REPLY REFER TO:

70309/TB:gtl
Serial 3398
26 May 1976

Mr. Delmar Vail, District Manager
Bureau of Land Management
U. S. Department of the Interior
P. O. Box 723
Riverside, California 92507

Dear Mr. Vail:

The Bureau of Land Management's recently released Environmental Analysis Record, "Proposed Geothermal Leasing in the Randsburg, Spangler Hills, and South Searles Lake Areas", has been reviewed at the Naval Weapons Center. This EAR does not reflect potential impacts of the Center's RDT&E operations on prospective lessees nor does it address potential impacts of geothermal exploration or development on NWC's activities pointed out in my letter to you dated 9 March 1976.

NWC's position is that these potential impacts must be considered in detail before a final decision is made on geothermal leasing of the region under consideration. Enclosed is a reiteration of the Center's specific concerns with respect to its operations being impacted by and impacting on potential lessees in this region. To provide a sound background for decision-making, it is suggested the BLM include these aspects of potential impacts of geothermal exploration or development in the Randsburg, Spangler Hills and South Searles Lake areas in its final environmental analysis.

Regulations issued by the Secretary of the Interior provide:

> Notwithstanding any other provision in these resolutions, geothermal leases shall not be issued for (1) Lands which the Secretary has identified or may identify as being necessary to the performance of his or any other Federal officer's authorized functions, and on which geothermal resource development would, in his judgement, interfere with such functions; or (2) Lands respecting which the Secretary has made or may make a finding that the issuance of geothermal leases would be contrary to the public interest.
>
> * * * * *
>
> Where leases are issued...for lands neighboring (lands withdrawn for any agency outside the Department of the Interior)... the lessees shall be required to perform such lease operations

and take such measures as are prescribed by the Secretary for the protection of the Federal interests therein. 43 CFR & 3201.1-2 (1973).

The Naval Weapons Center is interested in development of alternative energy and is currently involved in a research program exploring potential geothermal sources. The Center is chiefly concerned with its primary mission of research and development, test and evaluation for the protection of national security. As stated in the Center's letter of 9 March 1976, programs vulnerable to compromise by any breach of physical security are being conducted on the Mojave "B"/Randsburg Wash Test Range, using equipments that are environmentally sensitive. The BLM is urged to give full consideration to these factors in its final assessment of geothermal leasing in the areas under discussion.

I, or a member of my staff, will be happy to discuss these considerations further if you so desire. It is my sincere wish that this matter be resolved in a timely manner to the satisfaction of both the Bureau of Land Management and the Naval Weapons Center.

Sincerely,

R. G. FREEMAN, III

Copy to:
Mr. Ed Hastey, State Director
Bureau of Land Management
2800 Cottage Way, Room E2841
Sacramento, CA 95825
CDR George Krauther
NFEC (Code 03)
200 Stovall Street
Alexandria, VA 22332
Mr. Reid T. Stone
U. S. Geological Survey
Conservation Division
Office of the Area Geothermal Supervisor
Mail Stop 92
345 Middlefield Road
Menlo Park, CA 94025
CAPT V. Skrinak
Navy Energy and Natural Resources R&D Office
Building CP 6, Room 824
Washington, D. C. 20360
Dr. Peter Waterman
Office of Assistant Secretary of the Navy (R&D)
Pentagon, Room 4E741
Washington, D. C. 20350
Mr. I. I. Shull
CNM (MAT-035)
Crystal Plaza 5, Room 820
Washington, D. C. 20360

Naval Weapons Center
Position on
Proposed Geothermal Leasing
of
Randsburg, Spangler Hills
and South Searles Lake Areas

The introduction of geothermal exploration and exploitation will increase the number of non-DOD personnel operating in the area and also the amount of electronic equipment on the land directly outside Mojave "B"/Randsburg Wash Range Complex where RDT&E activities are frequently scheduled on a round-the-clock basis. Potential enemies of our country are known for their activity in electronic surveillance. NWC's concern is that there be no compromise of highly classified equipment operating at NWC to foreign agents posing under the guise of geological and geophysical surveys.

It is likely that some legitimate equipment used in geophysical surveying may cause electronic interference with critical testing at NWC; therefore, it is requested that the Naval Weapons Center, as the designated agent of the BLM and USGS, shall have rights of inspection of all equipment, including, but not limited to any electronic and mechanical devices prior to the introduction of such equipment into leased lands within twenty (20) miles of NWC lands; and further have the right to inspect at any time all equipment within twenty (20) miles of NWC lands. Operators of such equipment as described above shall be responsible for coordinating their activities through Commander, NWC, and be prepared to present such equipment at NWC for inspection a minimum of 10 working days prior to field use, if requested. All proprietary rights shall be respected and preserved to the owner/user.

For reasons of safety to both military and civilian aircraft and to protect NWC equipment against compromise as discussed above, all airborne operations including, but not limited to, electronic and photographic missions within 20 miles of the NWC border shall be coordinated with the Airspace Coordinator, NWC (via Commander, NWC). Further, because of the very low flight profiles sometimes flown in the areas under consideration for lease, the location of any operations requiring structures, either fixed or mobile, higher than thirty (30) feet shall be reported to and approval obtained from Commander, NWC, a minimum of five (5) working days prior to erection. These structures shall be lighted for night visibility and as a minimum, shall comply with FAA Lighting Standards (FAR 77). Refer to NWC letter of 9 March 1976, enclosures (1) and (2).

The probability of aircraft flying at low altitude and high speed in the area should be stressed to potential lease holders. These operations are often low-level flights with the aircraft engines in afterburners. The combination results in fairly intense sound fields with rapid onset, resulting in potential damage to sensitive geophysical devices and startled personnel working in the area.

The substantial increase in personnel in the area outside NWC is of particular concern along the NWC boundaries and in the area defined in the BLM draft EAR as the South Searles Lake Non-Competitive Lease Boundary. To date, it has been possible to monitor visitors to the area outside the NWC Mojave "B"/Randsburg Wash Complex western boundary. This would become extremely difficult with exploration/exploitation activities occurring in the adjacent area. For this reason, the following is requested:

a. Create a buffer zone of one section width along the NWC border restricting surface activities. This area could be leased and explored/exploited through slant drilling but not from the surface directly above. Since some NWC equipment is located close to the NWC boundary, this buffer zone would both ease security problems and provide additional needed space in which low-flying aircraft could maneuver to avoid drilling rigs and other obstacles. With respect to currently proposed leasing areas, this buffer would include the following:

T 26 S, R 44 E
Sections 20,29,32

T 27 S, R 44 E
Sections 5,8,7,18

T 27 S, R 43 E
Sections 13,24,23,26,27,34,33

T 28 S, R 43 E
Sections 4,9,8,17,18,19

T 28 S, R 42 E
Sections 24,25,26,35,34

T 29 S, R 42 E
Sections 2,11,14,23,26,35,36

T 29 S, R 43 E
Sections 31,32,33

(All Mount Diablo Base and Meridian)

These are marked on enclosure (1) of the NWC letter of 9 March 1976. In an independent action, a request to withdraw the eastern one-half (1/2) of T 28 S, R 43 E, Sec 9 is being pursued by NWC for security reasons.

b. Because of the intense NWC activity of a security sensitive nature in the immediate area of the South Searles Lake Non-Competitive Lease Zone, the Navy requests that this entire zone be withdrawn from leasing. This would include not only the sections previously under consideration by BLM for withdrawal under the Desert Management Plan, but also those sections and portions of sections bordering the NWC road; i.e., T28S, R43E, Sec 5 and 6, and T27S, R43E, Sec 30, 31, 32. In addition to the security reasons stated earlier, NWC is concerned that geothermal operations in that immediate area will result in pollutant levels, including dust, that will interfere with and degrade Navy equipment in the immediate area.

c. Exploitation of the South Searles Lake Non-Competitive Lease Zone would result in pressure on the Navy to allow use of the Navy-owned and maintained Randsburg Wash access road. Maintenance costs to keep this road operational for Navy use are high, as stated in the NWC letter of 9 March 1976. If public or commercial use of the road were permitted, these maintenance costs would increase substantially. The Navy will not assume the financial or legal liabilities that would attend permitting public or commercial use of the road. Further, explosives and classified equipment are often brought from the main portion of NWC to the Randsburg Wash area via this road. Extensive travel on this road and activity in the surrounding areas will increase the chance of compromise and vehicle accidents.

Emissions from the geothermal exploration/exploitation processes pose a very real concern in any of the lease areas. A particular worry is the Randsburg KGRA which is directly upwind of a major concentration of electronic/optical equipment. Although at a distance of over ten miles, the topography is such that the prevailing winds will carry the pollutants directly up a valley often subject to inversion conditions. Unless properly controlled, concentrations of various gases, particulates and aerosols will be transported to the test areas and corrode electronic relays and contacts, etch optic coatings, and possibly reduce visibility to an unacceptable level through fogs and dust clouds. Effects of this nature have already been experienced as a result of chemical processing operations at Trona; therefore, included in lease restrictions should be the condition that should Navy operations and/or equipment be adversly affected by emissions from geothermal operations on those leases, the lease operator shall cease operations until emission control devices and procedures sufficient to mitigate these problems have been implemented. In addition, federal, California and San Bernardino County ambient air emission standards and San Bernardino County performance standards will be strictly enforced and compliance monitored.

The electronic equipment used at NWC emits high intensity radiations of sufficient strength to initiate explosive devices that might be used in seismic experimentation and well perforation. Further, the emitted radiations will likely affect measurements and perhaps even burn out electronic devices used in explorations of the geothermal leases. The lease operators should be made aware of this potential problem so that adequate precautions can be taken. It is suggested that where NWC electronic emissions appear to be a problem, the operators schedule activities through Commander, NWC.

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS, SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: R. G. Freeman III, Department of the Navy, Naval Weapons Center, China Lake, California.

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Comment: Page 1, Paragraph 2.

Response: Staff appreciates your responsibility for base security and realizes that, should leasing occur, additional hardships may result from increased numbers of non-DOD personnel and equipment. Staff also feels that it carries the responsibility to insure that national resource lands are managed within the concept of multiple-use management. To this end and on the basis of the information provided in your response to the Draft EAR, the staff feels that to grant your request for status as designated inspection agent for a distance of 20 miles is to relinquish our land use management responsibility. Also, expenses for the mobilization and rental of drilling rigs are high. To require a prospective lessee to add ten or more days of expenses to his exploration schedule and arrange for movement of equipment to the NWC would, staff feels, unduly burden the lessee. None of this is to say that the BLM would not welcome any opportunity to coordinate with the lessee and the NWC for the inspection of any equipment that may be introduced onto the lease. Indeed, we consider this also to be a part of our management responsibilities.

Comment: Page 1, Paragraph 3.

Response: At the Plan of Operation approval stage, joint agreement between the USGS and BLM would control the location of all structures to be introduced onto the lease. The BLM is charged, in part, with the management of a lease and would require that the lessee inform NWC, at least five working days prior to its introduction onto the lease, of the location of any proposed structure over 30 feet high and the period of time it will be in operation.

Comment: Page 1, Paragraph 4.

Response: Staff acknowledges the potential for hazardous conditions and would inform prospective lessees.

Comment: Page 2, Paragraph a.

Response: At the present time, it does not appear as though an exclusive one-mile buffer zone would in fact ease security problems. This zone is presently open to a myriad of uses, including ORV activities, hunting, sightseeing, photography, grazing, rockhounding, etc. Therefore, staff does not feel it can grant your request for this one-mile buffer zone. However, on a case-by-case basis, we would consider site specific security requirements.

Comment: Page 2, Paragraph b.

Response: Staff acknowledges your request for withdrawal of the South Searles Lake unit from consideration for geothermal leasing.

Comment: Page 2, Paragraph c.

Response: During the preparation of the Draft EAR it was learned that those lease applications which included lands near the Randsburg Wash Access Road had been previously withdrawn. Therefore, staff does not feel the access road would now be used for any geothermal-related activities. A revised Figure 1-1 illustrates the extent of lands under existing lease applications.

Comment: Page 3, Paragraph 3.

Response: Quantitative data regarding types and amounts of possible emissions in the EAR area are not available at this time. Operational regulations which mandate adherence to local, state and Federal air pollution guidelines would be enforced, and the text has been modified to so indicate.

Comment: Page 3, Paragraph 4.

Response: Staff acknowledges potential dangers from high intensity radiations from NWC electronic equipment. All lease operators would be made aware of such dangers and, if need be, further coordination with the Commander, NWC, would be instigated.

In summary, pertinent portions of Chapters 2, 3, 4 and 5 have been modified to incorporate summaries of the various aspects of potential impacts to the NWC and their related mitigation measures.

MANTECH OF NEW JERSEY CORPORATION
WESTERN OPERATIONS
11722 SORRENTO VALLEY ROAD
SAN DIEGO, CALIFORNIA 92121 • TEL: (714) 453-6633

May 25, 1976

Bureau of Land Management
1695 Spruce Street
Riverside, California 92507

Gentlemen:

I am interested in reviewing a copy of the Environmental Impact Statement concerning proposed geothermal resource leases in the Randsburg - Spangler Hills - South Searles Lake areas. If copies are readily available I would appreciate one. If copies are not readily available, perhaps we could arrange to borrow one for a short while and reproduce those sections of interest. Thank you for your cooperation in this matter.

Sincerely,

Robert B. Marusich
Principal Engineer

ADDRESS ALL COMMUNICATIONS
TO THE COMMISSION
CALIFORNIA STATE BUILDING
SAN FRANCISCO, CALIFORNIA 94102
TELEPHONE: (415) 557-3237

Public Utilities Commission

STATE OF CALIFORNIA

May 24, 1976

FILE NO. 1799-2

Mr. Delmar D. Vail, District Manager
Bureau of Land Management
1695 Spruce Street
Riverside, California 92507

Dear Mr. Vail:

Your Draft Environmental Analysis Record (EAR) for proposed geothermal leasing in the Randsburg-Spangler Hills - South Searles Lake areas of California has been reviewed. Here are the staff comments.

Based upon your statements on pages 1-1 and 1-11, it would appear that the study areas may have the potential to produce 250 megawatts of electrical power. If electric generation is anticipated, then certification or authorization of electric generating plants by the California Public Utilities Commission (CPUC) and/or the State Energy Resources Conservation and Development Commission may be needed. The environmental documents would then have to satisfy rules adopted by various California agencies with jurisdiction over the project. These rules are prescribed by the California Environmental Quality Act (CEQA) and the Guidelines for Implementation of CEQA (Guidelines).

At this time, the CPUC's Rule 17.1 which was adopted to comply with CEQA and the Guidelines requires that the following items be included in an Environmental Impact Report (EIR):

1. The growth-inducing impact of project.
2. A specific discussion of plans for future development related to the project under consideration.
3. Besides the list of persons, the EIR should include the qualifications of the persons responsible for compiling the information and a discussion of the methods they used to produce the information.
4. Consideration should also be given to adding the CPUC to the list of public agencies which will have jurisdiction by law over the project if electric power is generated for public use.

It appears that disposal of waste geothermal fluids under production conditions may be a problem as stated on pages 1-19 to 1-21. A discussion of the impacts of potential alternative disposal methods, if contained in one place in the environmental document, might be helpful.

Very truly yours,

PUBLIC UTILITIES COMMISSION

By William R. Johnson

WILLIAM R. JOHNSON
Executive Director

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS, SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: William R. Johnson, Public Utilities Commission State of California, San Francisco, California.

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Comment: Page 1, Paragraph 2.

Response: The model developed in the EAR contemplates a total of 50 MW rather than 250 MW of electrical power. The text has been modified to clarify model assumptions.

Comment: Page 1, Paragraph 3.

Response: Should an EIR be required, the CPUC's Rule 17.1 would be complied with by the lessee and the necessary information provided.

Comment: Page 2, Paragraph 1.

Response: Discussions regarding impacts from each method of liquid waste disposal are provided in terms of the various stages of development. These discussions appear in Chapter 3.

STATE OF CALIFORNIA

EDMUND G. BROWN JR., Governor

STATE LANDS COMMISSION
EXECUTIVE OFFICE

1807 13TH STREET
SACRAMENTO, CALIFORNIA 95814

May 28, 1976

Mr. Delmar D. Vail
District Manager
Bureau of Land Management
Riverside District Office
1695 Spruce Street
Riverside, California 92507

Dear Mr. Vail:

The Division of State Lands has reviewed the Draft Environmental Analysis Record for Proposed Geothermal Leasing; Randsburg, Spangler Hills, and South Searles Area and wishes to make the following comments:

1. Generally, the document is well done. However, the discussions of air quality and climate rely heavily on distant test localities. We suggest that the Bureau collect data on the areas proposed for leasing prior to any action and incorporate this in either the final EAR or a supplement to this document.

2. The EAR relies too heavily on data from The Geysers K.G.R.A. for determining impacts. Since the suspected geothermal system is a moderate-temperature hot water one, The Geysers' dry steam system is probably not a reliable data source for determining impacts of the proposed leasing.

3. On page 1-15, second paragraph, the term "truck-mounted" connotes a much smaller drilling rig than those employed for five to ten thousand feet exploratory holes. The term "portable drilling rig" is more appropriate.

4. On page 1-17, paragraph 4: The phrase "each well may occupy approximately forty acres" should be changed to "well spacing may be on a forty acre pattern".

5. It would be useful if the data sources for Tables I-4 and I-5 were given.

6. On page 1-22 electrical transmission facilities are discussed. A useful addition would be a map showing existing transmission lines in this region.

7. On page 2-39, first paragraph: The author probably means that ozone is the most characteristic component of photochemical smog, not that the term ozone is sometimes synonymous with smog.

8. Page 3-46, first paragraph: We think it very unlikely that subsidence due to geothermal development could cause destruction of the pinnacles south of Searles' Lake, but appreciate the concern of the authors to investigate every possible contingency.

Thank you for the opportunity to comment.

Sincerely,

WILLIAM F. NORTHROP
Executive Officer

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS, SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: William F. Northrop, State Lands Commission, Executive Office, Sacramento, California.

Comment: Page 1, Number 1.

Response: Because no air quality or climatological data are available for areas within the EAR area, the nearest test localities were utilized. Pertinent data regarding air quality would be collected and measured as required in applicable GRO Orders. If agreeable to the parties concerned, these data can become available as development activities occur. In addition, submission of a Plan of Production must include environmental baseline data for a period of one year prior to submission.

Comment: Page 1, Number 2.

Response: The staff agrees that a direct comparison between The Geysers and the EAR area is not possible. At the present time, however, there are no operating power plants utilizing this type of resource. Thus, closely comparable data for comparision purposes is not available, and the staff excerpted data it thought applicable in terms of general information which would aid in identifying possible impacts.

Comment: Page 1, Number 3.

Response: Suggestion has been incorporated into the text.

Comment: Page 2, Number 4.

Response: Suggestion has been accepted and text modified accordingly.

Comment: Page 2, Number 5.

Response: Suggestion has been accepted and data sources identified.

Comment: Page 2, Number 6.

Response: Suggestion has been accepted and a map prepared.

Comment: Page 2, Number 7.

Response: Source material was checked and the statement in the text is essentially correct. The text has been modified to clarify the statement.

Comment: Page 2, Number 8.

Response: Staff has reconsidered and text has been modified accordingly.

Robert G. Bear
841 Cherry Avenue
Beaumont, California 92223

May 27, 1976

Riverside District Office
Bureau of Land Management
1695 Spruce St.
Riverside, CA 92507

Gentlemen:

Thank you for sending me a copy ofthe Draft Environmental Analysis Record for proposed geothermal leasingin the Randsburg, Spangler Hills-South Searles Lake areas. I wish to submit the following comments:

1. I commend maximum effort to tap geothermal sources of energy in the light of the declining reserves of the irreplaceable types of energy ~~from~~ which we have relied on principally in the past, chiefly the fossil fuels.

2. I commend your concern for measures to mitigate the inevitable environmental impacts during the various stages of geothermal power operations.

3. I would hope that the concerns of the military at China Lake would not be permitted to interfere with the overriding national need to develop additional new sourcesof energy.

Respectfully,

Robert G. Bear

Robert G. Bear

600A Nimitz
China Lake, Ca. 93555
May 25, 1976

U.S. Department of the Interior
Bureau of Land Management
Riverside District-California

Gentlemen:

I have been advised to contact you for the following public document:

ENVIRONMENTAL ANALYSIS RECORD
FOR
PROPOSED GEOTHERMAL LEASING
IN THE
RANDSBURG-SPANGLER HILLS-SOUTH SEARLES LAKE AREAS
CALIFORNIA

I, and my associates, would like four copies of this draft. It is our understanding that public inputs are required by June 3, 1976. We have had limited access to one copy, so we do have some understanding as to what it contains.

Your expeditious handling of this request will be greatly appreciated.

Sincerly,

Robert A. Wheeler

Robert A. Wheeler

DLW:raw

Sent copy 6/1/76 RB

Sierra Club Southern California Regional Conservation Committee
Desert Subcommittee

June 3, 1976

To: Riverside Destrict Manager
Bureau of Land Mangement

Fm: Lyle K. Gaston, Chairman

Re: Draft EAR for proposed geothermal leasing in Randsburg-Spangler Hills-S. Searles Lake, CA-960-6-HD-88

We would like to commend the Bureau for its excellent documentation of the resources in chapter 2. In general in chapter 3, the environmental impacts were covered adequately except in a few specific areas as discussed below.

We have two general questions: 1) Is the project viable? 2) Can the scope of the project be evaluated before the extent of the resource is known? The viability of the project is questioned both from Table I-1 and p 6-3. Water temperatures of 125°C (60 psi) is just not enough pressure to operate steam turbines. Compare this with geothermal brine in Imperial Valley at 260°C (700 psi) where there is sufficient energy to operate a turbine. Until the extent of the resource is known, the total project can not be specified.

The following are our specific questions and comments.

Water is one of our primary concerns with this project. Nowhere is the EAR is the amount of ground water (not geothermal brine) necessary for the cooling towers specified, however, on p 3-46, and p 4-10, pumping of ground water is acknowledged. The estimated use of 40-45 acre feet/MW-year is an extremely inefficient use of water in a water-deficient area. Use of fresh ground water in such an inefficient manner should not be permitted. The final EAR should address the water problem quantitatively. The inablility to answer such questions as this is why we raise general question no. 2.

It is proposed that the brine be reinjected but no specifics were given as to how much energy (electrically operated pumps) will be necessary to do this. How much of the gross output of the generating facility will be used for this? What then is the net usable power?

It would be very instructive in the final EAR to have two idealized scale maps showing one lease (2560 acres) with 25 well sites and another one with 60 well sites each showing the pipeline array, the service roads for the pipelines, and the other necessary facilities. This would show that pipelines and service roads woudd start 2/3 to 1/4 mile apart on the perimeter and converge to one central point. With pipelines 10 to 30 inches in diameter and 12 inches off the ground, this would effectively prohibit any other use on the entire lease area.

The statement about noise standards on p 4-8 should acknowledge OSHA and Cal OSHA standards. Depending on the velocity with which the geothermal brine comes out of the ground, and the specific location of the wells, noise could be a serious problem. Cerra Prieto can be heard for miles. Any leases should specify noise limits at the perimeter of the lease.

We share your concern over the qualitative and quantitative aspects of brine disposal. The boron problem may be more severe than docum nted if there is a surface blow-out of a well. Mist containing boron compounds could drift many miles downwind under some conditions. Surface run-off along existing washes could cause phytotoxicity just where plant production is the highest. Both of these problems as well as mitigating measures should be treated in the final EAR.

Since this project is long-term (30+ years) and involves essentially the total commitment of 142 square miles of land for a single, exclusive use, we ask that an environmental impact statement be prepared on this proposed project. We fubther request that the proposed project be limited at this time to exploratory drilling for the purpose of determining actual temperature gradients.

Thank you for giving us the opportunity to review this draft EAR. We appreciate your consideration.

Lyle K. Gaston

Lyle K. Gaston
Chairman, Desert Subcommittee

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Lyle K. Gaston, Desert Subcommittee,
Sierra Club.

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Comment: Page 1, Paragraph 2.

Response: Staff agrees that project viability could be more accurately determined if a more extensive data base was available. Also, the extent of the resource itself is admittedly an estimation based on scanty data. However, the staff feels that the assumptions included in the proposed action and project model are not so totally invalid as to prevent development of a workable evaluation of the scope of the project. For example, exploration and development activities can be sufficiently analyzed to provide information that would be helpful in deciding whether leases should be awarded. Also, once a lease is granted, operating regulations would be made applicable to all activities at their outset. These regulations would provide for monitoring and are flexible enough to permit sound environmental protection.

It should also be noted that certainty as to viability would probably not be apparent until and after exploration and development activities commence. These activities need to be regulated and proper regulation can only come after possible impacts from proposed activities have been identified. Therefore, in most cases, and in this one in particular, the scope of the project must be developed prior to extensive knowledge of the resource base.

Comment: Page 1, Paragraph 4.

Response: Staff acknowledges that quantitative data concerning the amount of ground water used for cooling is not presented in the EAR. Several parameters associated with the geothermal system in the area are not completely known at this time and valid estimates of the amounts of cooling water that may be utilized from one or all of the potential sources (steam condensate, waste fluids, etc.) are very difficult to develop.

Water use in any area that is water-deficient must be closely examined to determine efficiency of use. In the EAR area, any water use that would reduce flows or lower tables in sensitive wildlife

Response Page 1, Paragraph 4 (Continued)

habitat areas would be mitigated by avoiding any such use of that water. It may, in fact, be that a lack of water might prove to be a limiting factor in the development of geothermal resources in this area.

Comment: Page 1, Paragraph 5.

Response: Staff does not believe enough is known about the resource in the area to develop this specific data. For example, data is not available concerning either reservoir pressures, permeability-thickness products, or the depths at which injection wells would be developed. All of these play a part in well injectivity (Chasteen, 1974). Depending on whether the resulting pressure differentials develop toward or away from the producing formations, the wells would inject volumes of fluid via methods ranging from those without pumps to those requiring pumps. Staff does not feel that valid estimates of the amounts of electrical energy required for injection pumps are possible at this time.

Comment: Page 1, Paragraph 6.

Response: Staff does not agree that valid maps approximating the final arrangement of production facilities in this area can be developed now or that these facilities would effectively prohibit any other use of the entire lease area. Specific site development patterns are evolving ones and any successful future operations would vary substantially in response to the particular geologic, topographic, and technologic conditions prevalent at that time. It may be, for example, that subsurface conditions are such that nearly all producing wells would be concentrated in one or two compact well fields, in which case significantly less than the entire lease area might be utilized.

Comment: Page 2, Paragraph 2.

Response: Text has been corrected to indicate applicability of state and Federal noise regulations.

Comment: Page 2, Paragraph 3.

Response: While staff believes that the probability of well blowouts in the EAR area is considerably less than, say, that at The Geysers, it does recognize that the possibility exists. To this end all drilling and production activities will be performed under Federal regulations designed to prevent such instances and, in the event of occurrence, contain the harmful effects of the blowout. Contingency plans for proposed containment, and public health and safety and clean-up measures must be submitted with the lessee's Application to Drill.

Comment: Page 2, Paragraph 4.

Response: Staff does not agree that the proposed action would involve the total commitment of all lands under consideration. The model developed for this proposed action is assumed to include only one 50 MW power plant on one 2,560 acre lease.

High Desert Environmental Defense Fund
P. O. Box 193
Lucerne Valley, Calif. 92356

6/3/76

Bureau of Land Management
Riverside District Office

Re: Draft EAR on Proposed Geothermal Leasing (Randsburg, Spangler and South Searles)

The EAR's resource inventory seems to be quite extensive and adequate, indicating a direct benefit of the El Paso-Red Mt. MFP's URA. BLM's concern for area resources is commendable and we certainly hope ORV activity will soon receive such close review.

6-3

Since it is difficult to assess the impacts of development without knowledge of the extent of the geothermal resource and its potential uses, we suggest that BLM consider not issuing leases until an economic study can be made of the potential viability of this energy source. Resources should not be disturbed unless there is a definite potential for the efficient production of easily usable energy. If space heating is the most probable use of the steam, is it worth the capital expenditures and environmental costs. Where is the market for the heat or power?

The availability of land for leasing should be conditioned on the outcome of economic and resource determinations in the exploration process. BLM's own preliminary assessment and documentation of impacts indicate that an EIS might be needed. This EAR can be turned into an EIS with very little effort due to the excellent inventories. An EIS and its formal hearing process would offer a better forum to the public.

4-8

It should be determined if Federal OSHA requirements might restrict noise levels.

1-26

Water requirements for cooling future power plants could prove to be limiting constraints on future development and should be considered in detail before leases are granted. What percentage of total water requirements can be met from steam or other wastes?

4-13

BLM should offer its own mitigations for fugitive dust since the Southern California Air Pollution Control District may not be in a position to enforce its own regulations in remote areas.

4-9

Rapture habitat could be disturbed so significantly so as to reduce numbers.

General

Category 2 lands adjacent to the Pinacles should not be considered suitable for geothermal production. A large buffer is needed. The unique and sensitive resources of Golden Valley should not be inflicted with even minor impacts. Lands of least sensitivity should be the only areas tapped, and then only if economically viable. The Alternative Sections should be expanded. A determination should be made of the net gain in energy use and/or production resulting from geothermal development in this area.

Charles H. Bell

Charles H. Bell, HDEDF

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Charles H. Bell, High Desert Environmental Defense Fund, Lucerne Valley, California.

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Comment: Page 1, Paragraphs 2, 3.

Response: Staff acknowledges your concern for project viability.

Comment: Page 1, Paragraph 4.

Response: Text has been modified to indicate that either local or Federal noise pollution standards would be made a part of operating regulations.

Comment: Page 1, Paragraph 5.

Response: Staff does not feel that sufficient data concerning the resource base in the EAR area is available to permit development of a valid scheme for waste utilization for cooling purposes.

Comment: Page 1, Paragraph 6.

Response: Staff is not aware of conditions or circumstances which would indicate that the Southern California Air Pollution Control District would be in such a position.

Comment: Page 1, Paragraph 7.

Response: Staff is aware of this possibility and has discussed the problem in Chapter 3. The mitigation measures in Section 4.3.1 to: (1) allow only casual use within raptor nesting areas, and to (2) not allow any powerplant site development within raptor foraging areas, should provide adequate protection for these birds.

Comment: Page 1, Paragraph 6.

Response: Staff is not aware of conditions or circumstances which would indicate that the Southern California Air Pollution Control District would be in such a position.

Comment: Page 1, Paragraph 7.

Response: Staff is aware of this possibility and has discussed the problem in Chapter 3. The mitigation measures in Section 4.3.1 to: (1) allow only casual use within raptor nesting areas, and to (2) not allow any powerplant site development within raptor foraging areas, should provide adequate protection for these birds.

Comment: Page 2, Paragraph 1.

Response: Staff acknowledges your suggestion regarding Category 2 lands, a buffer zone, the resources within Golden Valley, and those lands of least environmental sensitivity. Chapter 8 (Alternatives to the Proposed Action) has been expanded to more fully examine and identify those lands and resources of least, moderate and highest environmental sensitivity. It is also the staff's opinion that existing data concerning the resource base is, at this time, insufficient for determining net gain in energy use and/or production in this area. As the resource is explored and probed, the data necessary for such a determination will gradually become available.

REVIEW OF A DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG-SPANGLER HILLS-SOUTH SEARLES AREA PREPARED BY THE BUREAU OF LAND MANAGEMENT APRIL 1976

By

Clyde Kuhn and Beth Jersey

INTRODUCTION

The above named Environmental Analysis Record (EAR) was prepared in anticipation of geothermal, or natural steam, energy exploration and development in a portion of South-eastern California. This review examines the EAR for content adequacy, particularly in regard to cultural resources potential, evalution, and safeguards for the recovery of scientific information.

3 JUNE 1976

I. ARCHAEOLOGICAL VALUES

In 1967 E.L. Davis wrote:

> "Thirty years ago, worn-looking stone artifacts were found on beach remnants /which/ ...appeared to mark fairly high water stands of a permanent, Late Pleistocene lake... /.../
>
> The discoverers /.../ immediately saw the importance of their find and secured the advice and cooperation of experts in geology, climatology, and lithic archaeology. /.../
>
> /These researchers.../ issued a statement which was bold enough to remain controversial even today: that the artifacts were coeval with the last high stand of a Pleistocene lake and were therefore the remains of one of the earliest cultures to be recognized in the New World (1967: 346-347)."

Dr. Davis has spent the last decade exploring such evidence of early human occupation and subsistence settlement in Southeastern California and today is an authority in the field. Her earliest summary remains one of the best statements on the subject:

> "Between 7,300 and 10,500 years ago, climatic cycles in the West were evidently moister than those of today. At sometime during this moister interval, Paleo-western peoples with many local variants of a basic way of life began using the resources of the lakes and marshes. These peoples were generalized collectors who hunted extensively and did not grind seeds (1967: 345)."

In most recent years, Davis has engaged in an intensive interdisciplinary study of the China Lake basin:

> "...The remnant valley of one of the Pleistocene Lakes in the Mojave Desert. During the Wisconsin and Holocene periods, the lake filled and dried many times. At present it is a flat waste of sand and gravel. /.../
>
> Tools and flakes are scattered over many miles in three kinds of situations: on old land forms which appear to be well preserved: in newer and deeply eroding areas; and around blowouts. /.../
>
> On the old benches around a 2180 foot level, tools cluster in non-random distributions on high

ground, suggesting limited transport. Bones are often lower down... [...]

The valley of previous China Lakes contain a scatter of bones of a Rancholabrean Zoo similar to that of the famous Tar Pits. [...] Stone tools of middle and late Paleo-Indian phases [...] lie scattered or clustered attimes on the same surfaces which support most of the bones. However, association of artifacts and animals is unclear and may remain so (1974: 3-6)."

More recent work by Davis in press confirms a definite association of tools and Late Pleistocene fauna (Personal communication, 1975).

The China Lake basin interconnects with that of Searles Lake, and in Holocene time pluvial spillage out of China Lake filled Searles Lake (Davis, 1974: 16). There can be no question but that the two areas share a common geomorphologic history as well as a common chronology of human land use through time.

Failure to consider the relevance of E.L. Davis' research to the Searles Lake Basin is the greatest single inadequacy of the cultural resources element contained in the EAR under review.

Quaternary lake deposits of Searles Lake are present in both the Spangler Hills and South Searles Lake non-competitive geothermal lease areas (California Division of Mines and Geology, 1962; Smith, 1964: 4-5), and terraces of Pleistocene Searles Lake are present on the southeastern border of the South Searles unit (Smith, 1964: Plate 1, figures 17, 18 & pg. 55). Although these terraces are attributed to the last high stand of the lake at about 50,000 years ago (Smith, 1964: 44), it can be assumed that later shorelines are represented at lower elevations in the basin, perhaps abutting older dissected pediments of Plio-Pleistocene age (Smith, 1964: 10).

"A very faint shoreline (?) is visible at two places on the north shore of Cuddeback Lake at an elevation of 2,660 feet, approximately 110 feet above the present playa level. This shoreline (?) is defined by the upper limit on the slope of a slight concentration of fine sand. Although there is no evidence of wave erosion or of lake-shore tufa, the occurrence of similar deposits at the same elevation on the two hills would be a highly unlikely coincidence unless they were formed by a lake [of Lake Pleistocene age]. A better defined shoreline, indicated by beach sands and sandbars, lies about 10 feet above the present playa surface (Smith, 1964: 55, see also pg. 10)."

The Cuddeback basin makes up the southern portion of the Randsburg KGRA and non-competitive lease area.

In short, there is no pacuity of evidence identifying remnant land forms of Late Pleistocene age which elsewhere are intimately associated with human artifacts of great antiquity (see also Hastie, 1971 for arguments suggesting even earlier human occupation of North America).

Margaret Weide in 1973 prepared an inventory prospectus for cultural resources located upon Eastern California Bureau of Land Management administered public lands. Some of the non-artifactual, environmental and physiographic elements Weide believed pertinent to gaining an understanding of prehistoric subsistence included: contemporary biogeography; soils classification; contemporary hydrology; wildlife habitat; lithologic resources; "relict features of past hydrologic and pedologic regimes; and evidence of botanical and faunal changes, introduced species (1973: 8, 10)."

In determining the priorities of such an inventory, Weide suggested that at least two current research considerations should be taken in account in the selection of areas for study (1973: 33). One of the priorities dictated by current research was:

> "...Continuing importance of the California Desert in research into earlier periods of man's occupance of the New World focusing interest on areas of the desert where relict features of Late Pleistocene environments are evident...(1973: 33)."

Lastly, Weide's prospectus enumerated a set of methodological guidelines by which inventory should proceed: Stratifying large regions on the basis of vegetation, hydrology and physiography, recommending sample sizes as well as suggesting a field search design (1973: 15-16).

The basic study unit established by Weide for field search was the <u>quadrat</u>, a .5 km square survey block to be examined on foot by a team of researchers.

> "Each quadrat should be covered by a series of parallel transects spaced about 20 m apart, depending on terrain, with the team chief maintaining line and distance by compass and pacing. Thus a crew of six can cover a quadrat in four sweeps, each member walking 2 km (1973: 25)."

The EAR under review states that:

"Weide (1973) has proposed a scheme to the BLM for inventorying their planning units within the California Desert for cultural resources. This scheme seems generally applicable to the study area being discussed here (pg. 2-152)."

However, the theoretical, methodological and presentational treatment of cultural resources in this environmental statement at best only superficially meets the standards of Weide's proposed methodology and appears to be additionally inadequate on a number of other essential points. A more complete discussion follows.

1. Theory

No single theoretical approach appears to be advocated by the researchers evaluating the cultural resources of the proposed geothermal leasing area. Nevertheless, it is apparent that a number of basic presuppositions present in the study have influenced the cultural resource evaluation and heavily biased its findings.

The experts engaged in preparing this EAR have classified or categorized cultural resources into eleven types (pg. 2-153). Ten of these types relate to prehistoric features and are assigned to an ideal set known as a "site type." Closely linked to the definition of site type is an abstract concept known as "settlement pattern" (Appendix D). Settlement patterns are models of human subsistence activity, the ecological aspect of human interaction with environment.

Although this approach has certain advantages in archaeological research, it is very dependent upon analogies drawn from ethnographically known subsistence systems and is particularly non-temporal in character. In short, subsistence pattern site typologies are poorly suited for the task of understanding changing subsistence or culture through time.

In apparent recognition of this limitation the EAR researchers have noted:

"In this analysis the settlement pattern is viewed synchronically since temporal placement of many of the sites in uncontrolled (pg. D-7)."

However, artifactual debris encountered during the cultural resource evaluation of this proposed geothermal leasing area were not only typed according to "...analogy to historic hunting and gathering groups in the desert west (pg.

D-7), but, on the basis of other explicitly stated but factually unsupported characteristics, "...a majority of the sites /and presumedly the period of greatest occupation/ appear to fall within the Late Archaic Period (pg. D-7)."

It is clear that the possibility of changes in human subsistence economy through time has not been adequately assessed in the EAR under review and that the theoretical framework utilized to interpret cultural resources lacks chronological depth. The settlement pattern model utilized by this environmental analysis is, in the words of one theorist, a

> "...Descriptive functional model/ / with only limited explanatory value. /It is a.../ model for describing and organizing survey data in order to provide insight into the manner in which prehistoric societies functioned. /It is .../ unlikely to lead the archaeologist to an understanding of how a particular distribution of sites came to be, how it changed, or why it changed (Plog, 1974: 78)."

2. Methodology

In evaluating the cultural resources present in the proposed leasing area it appears that a two phase sampling system was utilized. In a first stage planning unit cultural resources inventory, "...probabalistic sampling at the one percent level was conducted during Winter, 1975." A second inventory appears to have been conducted at some later time, when "...a decision was made to stratify the entire area incorporating all blocks of the 314 square miles in geologic/geomorphic strata (pg. D-4)." Again some uncertainty exists in what constituted the final sample area. "Sample quadrats" both within and without the proposed leasing area boundries apparently make up thirty-three surveyed areas (pg. D-6).

A total of 158 sites were inventoried both without and "...within the sample universe (pg. D-7)." However, not all of these sites were found within the leasing area boundries nor were they all subjected to the same probablistic sampling strategy (pg. D-7).

The size of the "sample Quadrat" utilized in this inventory appear to have been "square mile sections of the Cadastral grid (pg. D-2)."

> "...28 quads (cadastral sections or parts thereof) totaling 25.78 square miles were surveyed. Two additional quads (2 square miles) from the planning unit inventory are included within the study area

boundries and form part of the sample (pg. D-6)."

Search tactics appear at first to have approximated those suggested by Weide:

> "Three or four BLM archaeologists participated in the survey of each sample quadrat. Examination was accomplished by a series of systematic back and forth sweeps. Spacing varied with the number of individuals present. Eight - or in less than one-fourth of the quadrats, six - sweeps were made of each quadrat. Zigzagging sweeps and checks of unusual environmental features between sweep corridors allowed for greater accuracy in site determinations (pg. D-3)."

Upon closer examination, however, a major discrepancy appears between the ideal quadrat size of .5 km recommended by Weide and the one square mile "quadrat" utilized in the geothermal leasing survey. "Zigzagging sweeps" are not a part of Weide's carefully detailed methodology of close order pacing of six individuals spaced about 20 meters apart (Weide, 1973: 25) resulting in a very detailed surface examination.

Computations based on the conditions described in the EAR (pg. D-3) indicate that sweeps by a team of three to four surveyors covering an area of one "quadrat" would have necessitated a spacing of 170 to 160 feet between each individual, far too great a distance to maintain either adequate communication or surface coverage.

An objection may also be made to the fact that geologic-geomorphologic stratification of the study area into Quaternary, Tertiary and Pre-Tertiary units was far too gross given the detail with which local geologic history is known. "Quaternary deposits" alone lump Plio-Pleistocene volcanics, Pliocene sedimentary rocks, Pleistocene non-marine sediments, Lacustrine deposits as well as pediments, terraces and other remnant physiographic features (California Division of Mines and Geology, 1962; Smith, 1964). Such generalization clearly does not meet either the data needs deemed requisite or standard variables suggested by Weide for inventory purposes (Weide, 1973: 8, 11).

3. Presentation

It is apparent that a large scale archaeological survey was initiated as part of the preparation of the EAR under review. Presumedly, a large amount of data regarding the distribution and characteristics of cultural features was collected. However, this material is little more than briefly summarized in the EAR and no where is it indicated where further information may be obtained regarding this material. How were sites recorded? Have they been included in the state inventory system? What types of diagnostic projectile points or other lithic tools were present?

The EAR should not be substituted for a full descriptive report of the survey and its findings. Data as it is now presented does not meet the needs of other researchers for comparative or information purposes.

The 1973 inventory prospectus suggested by Weide notes that:

> "...Archaeological inventory requires non-archaeological data at two junctures, first in stratifying the inventory area prior to drawing the samples, and later, in the analysis of site locations (1973: 8)."

It is believed that the EAR now under review has failed first to properly stratify the proposed geothermal leasing area. This argument is presented above. It is also apparent that in analyzing the location and importance of prehistoric occupation sites and settlement the cultural resource evaluators have failed to recognize important temporal indicators of environmental and cultural changes present in their data .

Evidence of geobotanic change is suggested by:

(a) The presence of bedrock mortars (pg. D-17). Not enough data is given, however, to permit outside researchers to determine what kind of grinding activity is suggested by such features. Mortars are elsewhere in California associated with acorn seed processing.

(b) A discrepancy in the distribution of milling stations and vegetation community:

> "Milling stations occurred in every vegetation community but were dominant in Creosote Bush Scrub and Alkali Sink Communities, and the ecotone area in between. They were exclusive to the Cheesebush Intrusive. Interesting, this site type was not abundant in the Transitional Community where grasses and other seed-bearing plants were apparently diverse and plentiful (pg. 2-164)."

This anomaly is highly suggestive of biogeographic change in vegetation since that past time of most intense seed grass subsistence activity by prehistoric gatherers.

Reinforcingly enough, elsewhere in the EAR it is noted that:

> "The Transitional Shrubland is a heterogeneous area that cannot be placed in any Munzian community. It is possibly a broad ecotone between Creosote Bush Scrub and Joshua Tree Woodland, although the latter is absent in the EAR area.
>
> This community covers all of the higher mountains, beginning at the top of the pediments and continuing to the mountain summits. Elevations range from 2,800 feet to 5,200 feet, and only rarely does it reach down the more rocky pediments into the valleys. It encompasses approximately 20,240 acres.
>
> The Transitional Shrubland is more of a continuum than a distinct community (pp. 2-59 - 60)."

One interpretation which may be offered as an explanation for the existence of this "dominant" ecotone is climatic change. During the last altithermal period (or cycle) a shift upward in plant community zonation may have almost eliminated the local occurrence of Joshua Tree Woodland (individual "trees" are present, see Smith, 1964: 2). With a climatic change into a cooler regime the area once occupied by the woodland could not be re-established in the isolated hills and low mountains which characterize this region. Lacking a suitable "dominant" plant species, the ecotone continuum then expanded in coverage.

A point of questional relevance pertains to the "predictive utility" of statistical correlations with prehistoric site types and environmental features in the EAR. Such simplistic correlations as rockshelters with lithologic units possessing structural characteristics encouraging the existence of such features, milling stations with Pliocene/Pleistocene/Holocene landforms, and historic sites with ore bearing lithologic units hardly needs statistical treatment to indicate non-random linkages (pg. D-10).

Although certainly not a major point of inadequacy, the chronologic placement of Gypsum Cave points in the cultural sequence table (II-11, pg. 2-144) is at such extreme variance from their classical assignation (Harrington, 1933) and pluvial dating "...at around 9000 to 7000 BC (Willey, 1966:54)," that there is little doubt such an interpretation would be debated by many scholars.

As an aside, Figure II-31 is a classic example of how to prepare a map of absolutely no informational value.

II. OTHER POINTS OF INADEQUACY

1. Natural Environment

Although a considerable portion of the EAR is devoted to describing the kinds and ecological relationships existing between higher plants and animals, invertebrata, lichen and micro-organisms are neither described or placed within the largertrophic system of which they are a part. In addition, reptiles appear inadequately studied. In short, the natural environment has not been fully examined and consequently, the impact of geothermal development has not been fully assessed.

2. Impacts

The impacts and hazards of geothermal development appear to be understated.

For example:

> "The sudden release of subsurface pressure as may occur during an accidental well blow-out, may affect the surface expression of the geothermal field. The most immediate effect, however, could be the development of ground surface phenomena, such as cratering and peripheral cracking at the site of the developing vent. These manifestations would be most damaging to the delicate features found in the area of the Pinnacles (pg. 3-19)."

In one recent blowout near the California Geysers, however, such "ground surface phenomena" took the following form:

> "On the day following the blowout, an oblong crater with maximum dimension about 100 by 120 feet, had been blown out to a depth of about 20 to 25 feet. Strong peripheral cracking had developed, and slumping was taking place, stair-step fashion, around most of the perimeter. The maximum size of the affected area was approximately 120 by 180 feet. /.../
>
> This /standby/ well, like over 50 percent of the wells drilled at the Geysers, was sited on a Quaternary landslide. /.../
>
> In the effort to regain control of the blown-out well, a great bowl-shaped depression, involving removal of over 120,000 yards of material, was excavated around the well casing to a depth of approximately 82 feet. /.../..
>
> It is difficult, if not impossible, to predict

ahead of time which slide or potential slide will be the next to move. Remedial measures can often be taken which will help to stabilize an old slide--or to prevent a new one. However, these measures are often costly and, for some types of slides, ineffective. /...7

The total cost of controlling, analyzing, plugging, and abandoning /...7 this well is still not known, but is is expected to be at least as high as the cost of drilling a new well (Bacon, 1976: 13, 16 & 17)."

Admittedly, this blowout occurred in a far different climatic region than that characterizing the desert west and structural failure of an obsolete casing may have attributed to the well failure, but alluvial features like those present in this incident are similar to conditions in the proposed geothermal lease area. Control of The Geysers well blowout was accompished finally "...by pumping in large volumes of cold water and a cement plug was installed below 160 feet (Bacon, 1976:17)."

This incident recalls an accident incurred by an inexperienced drilling team in the 1950's:

"One of the first times the /prospectors...7 hit the steam vault, they failed to cap the well quickly enough and the pressure blew out the top of a hill (Kiefer, 1974: 84)."

3. Mitigation

Mitigating measures proposed for cultural resources would appear not to be adequate for the safeguard of scientific information.

The Eastern California deserts are characterized by an erosional process which results in Desert Pavement.

"Alluvial surfaces in arid regions have been subjected to reduction by wind and rain through millennia; and where the alluvium has contained pebbles and larger stones, these have been lowered to a common level. /...7 These pavements are, when unbroken, essentially imperishable and impenetrable by natural forces, but because of their nature are very readily imprinted or damaged by man and animals.

It follows from this description of desert-pavement formation that any artifact found upon such pavement postdates it, and that no assumption as to the age of artifacts relative to each other can be made from location only. Differences, however, in oxidation, patination, or sand-blasting between lithic specimens found side by side give valid relationships in time... [...]

The terraces of lakes and playas which have not been subjected to aggradation after the advent of Postpluvial man generally bear no depth of cultural remains and are in effect similar to desert pavement. [...]

...A fundamental rule governing field survey work in fragile-pattern areas may be stated: since all of the artifacts in a fragile-pattern area are visible upon an existing surface, it is mandatory to collect or record ALL material in a site. [...]

The only opportunity to survey properly a "fragile" site is that of the first visit to the site; all subsequent surveys are of necessity faulty, since the original pattern has been destroyed (Hayden, 1965: 273, 274 and 275; emphasis in original)."

The presence of desert pavement in the proposed geothermal leasing area is attested to by Carter (1964: 10), as well as photographs in Carter's report and the EAR (Figures II-35, II-40, II-43, II-48, II-49, see also Table II-3).

The highly sensitive character of fragile-pattern sites, lithic scatters and other such surface features would necessitate full mitigating measures even during the preliminary geothermal exploration stage; including collecting and recording, with very detailed and meticulous attention paid to artifact spatial provenience and what few ecofactual clues may be associated with the distribution of artifacts and lithic fragments. In practice, this means that at least one archaeologist would be required to accompany every team of geothermal prospectors in the field.

4. Scenic values

For an area of such high scenic quality (pp. 2-128 - 141), it is surprising that no consideration has been given to the irreversible and irretrievable impact a geothermal facility would have upon the visual values of the region. Presumedly, the hills are only to be looked at, not looked out from. The reviewers are acquainted with an analogous situation in the Middle East in which a petroleum refinery was constructed in a basin surrounded by a desert range set aside as a National Park (Kuhn, 1975). The mountain ridges provided a spectacular overlook of the Perespolian plain (Marv Dasht), desert landscapes, <u>and the petroleum refinery</u>. The degree of visual degradation was dramatic.

5. Paleogeography

Paleonotological values (pg. 2-186) do not appear to be adequately assessed. Scientific study of stratigraphic paleontology, paleogeography and paleogeomorphology would be threated by all phases of geothermal development.

The geologic history of the Lava Mountains is of particular interest to paleozoologists and paleogeomorphologists:

> "The Garlock and Blackwater faults are major Cenozoic structural elements in this part of California. [...] Late Cenozoic vertical displacements along neither have been consistent enough to restrict deposition of sediments to one side. Along segments of the Garlock fault, however, vertical displacements have been consistent enough over appreciable periods of time to form local depositional basins several thousand feet deep.
>
> The middle Pliocene sedimentary rocks that crop out in the Lava Mountains represent deposits formed in one of these basins. In late Pliocene and Pleistocene time, the sense of vertical displacement was reversed, and the area of deposition was uplifted. Volcanic rocks were then deposited on the deformed and eroded basin fill, and the region has been undergoing erosion ever since (Smith, 1964: 9)."

Dating and paleoenvironmental reconstruction of this chronology of basin inversion was accomplished by an evaluation of type fossils included in the sedimentary rock of Plio-Pleistocene age (Smith, 1964: 19, 21, & 23), suggesting future work by paleontologists investigating Quaternary evolution, temporal comparisons with contemporary depositional features (Smith, 1964: 9), as well as an unique opportunity for paleogeomorphologic study of aridland erosion cycles. Geothermal exploration would directly endanger important paleostratigraphic associations essential to such future study.

6. Demography

The impact of geothermal development on regional demography does not appear fully assessed.

Cultural resources (historic structures) of local communities are noted (pg. 2-188) but no assessment of impact incurred as a consequence of a "...temporary influx of people (pg. 3-42)" during field development is made. What provisions are there for the inventory and rehabilitation of such community resources --recycling housing for new residents rather than constructing new units or mobile home parks to accommodate geothermal workers?

III. RETROSPECT

> "The greatest potential for irretrievable loss of resources is to the Cultural Resources in the area (pg. 7-2)."

This review has found that the cultural resource potential of lands included in the Randsburg-Spangler Hills-South Searles Lake proposed geothermal lease region have not been fully assessed nor have adequate mitigation measures been proposed for the recovery of scientific information inherent to such resources in the Draft Environmental Analysis Record of April 1976 prepared by the Bureau of Land Management. Other significant ommissions and inadequacies characterize this EAR and have been critiqued above.

The chapters considering "Short-term Uses vs Long Term Productivity, Irreversible and Irretrievable Commitments of Resources," and "Alternatives to the Proposed Action" contain a great deal of speculation and opinion. Exploitation of "Dry Hot Rock" geothermal fields is a risky and highly uncertain process (United States Energy Research and Development Authority, 1975: 6-8; Keifer, 1974: 87-88). Electrical power output, if sufficient resources were tapped, would be extremely limited (pg. 1-22)."

It is the final conclusion of this review that geothermal prospecting and development in the Randsburg, Spangler Hills and South Searles Lake areas would be a short term physical development with no guarantee of long term yield resulting in the destruction of irreplacable and as yet inadequately assessed cultural resources.

REFERENCES CONSULTED

Bacon, C. Forrest
1976 "Blowout of a Geothermal Well," pp. 13-17; California Geology; Volume 29, Number I, January.

California Division of Mines and Geology
1962 Geological Map of California, Trona Sheet, Second Printing, 1968, Ferry Building, San Francisco, California.

Corwin, Ruthann; Patrick H. Heffernan; Robert A. Johnson; Michael Remy; James A. Roberts; D.B. Tyler, Editors.
1975 Environmental Impact Assessment, Freeman, Cooper and Company, San Francisco, California.

Davis, Emma Lou
1974 "Paleo-Indian Land Use Patterns at China Lake, California," pp. 1-16, Pacific Coast Archaeological Society Quarterly, Volume 10, Number 2; April.

1967 "Man and Water at Pleistocene Lake Mohave," pp. 345-353, American Antiquity, Volume 32, Number 3, Salt Lake City, Utah.

Harrington, Mark Raymond
1933 "Gypsum Cave, Nevada," Southwest Museum Papers Number Eight, Southwest Museum, Los Angeles, California, April.

Hastie, William L.
1971 "Antiguity of Man in California," San Luis Obispo Archaeological Society Occasional Paper Number 5, Cuesta College, California.

Hayden, Julian D.
1965 "Fragile-pattern Areas," pp. 272-276, American Antiquity, Volume 31, Number 2, Salt Lake City, Utah.

Keifer, Irene
1974 "Earth Boils Below While We Scratch The Surface For Fuel," pp. 82-99, Smithsonian, Volume 5, Number 8; November.

Kuhn, Clyde E.
1975 "Some Introductory Notes On Park Resources Potential In Southcentral Iran," Report on field studies, Parks Unit, Division of Parks and Wildlife, Department of Environmental Conservation, Teheran, Iran.

Plog, Fred T.
1974 "Settlement Patterns and Social History," pp. 68-91, In Frontiers of Anthropology, Murray J. Leaf, Editor, D. Van Nostrand Company, New York.

Smith, George I.
1964 "Geology and Volcanic Petrology of the Lava Mountains, San Bernardino, California," Geological Survey Professional Paper 457, United States Government Printing Office, Washington, D.C.

Thornbury, William D.
1969 Principles of Geomorphology, Second Edition, John Wiley and Sons, Inc., New York, N.Y.

United States Energy Research and Development Administration (Office of Public Affairs)
1975 "Geothermal Energy," 12 pp., EDM-526(4-75)AP, USERDA Technical Information Center, Oak Ridge, Tennessee.

Weide, Margaret L.
1973 "Archaeological Inventory of the California Desert: A Proposed Methodology," Prepared for the USDI-BLM Desert Planning Program by the Archaeological Research Unit, University of California, Riverside, California.

Willey, Gordan R.
1966 An Introduction to American Archaeology, Volume One: North and Middle America. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS, SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Clyde Kuhn and Beth Jersey

For the most part staff feels that the comments received from Mr. Kuhn and Ms. Jersey appear inapplicable to the proposed action. The following paragraphs are in response to each of the reviewer's comments.

Comment: Page 2, Section I, Paragraphs 4, 5.

Response: While the reviewers indicate that Searles Valley and China Lake share a common geomorphic history as well as a common chronology of human land use through time, this is not entirely the case. Generally speaking the geomorphic history is the same, with certain micro-environmental differences significant to the occupational history of each region. According to G.I. Smith of the U.S. Geological Survey (1976, pers. comm.), a recognized geologic authority on the area, overflow from China Lake into Searles Lake during the Pleistocene resulted in transportation of various salts. This action raised the salinity content of the water to the point where it was not capable of supporting large game or human populations. This would account for the absence of Paleo-Indian or early Archaic remains in the area, either as reported by other workers or as indicated in the systematic survey of portions of this region.

It should be noted that the possibility of early cultural expressions in the area were addressed in the Draft EAR (page 2-141). In addition, Smith indicates from first hand observations that the association of megafauna with cultural remains in the China Lake basin is tenuous.

Comment: Page 2, Bottom Quote; Page 3, Paragraphs 1, 2.

Response: In further discussion with Smith it was indicated that the evidence for higher shorelines north of Cuddeback Lake is very tenuous and would most likely indicate Wisconsin or earlier age. No definitive remains of man older than about 15,000 years have been established in North America. In addition, detailed field examination of portions of these possible terraces revealed no cultural remains.

Comment: Page 4, Paragraph 3 and Preceding Statements.

Response: The reviewers indicate that the theoretical, methodological and presentational treatment of cultural resources only superficially meets the standards of Weide's proposed methodology. Several comments are germane to this criticism. (1) Both BLM and the Archaeological Research Unit of the University of California at Riverside have refined and revised much of Weide's methodology through a procedure of field testing. New, and staff feels, more applicable procedures, of course necessitate a differing presentation of data. (2) Staff feels the theoretical approach, despite the reveiwers' claims, closely parallels Weide's, with modifications discussed in some detail in the Draft EAR appendix. This approach can be considered within the framework of ecological anthropology as outlined by many authors (cf. Judge, Ebert and Hitchcock 1976, page 2-83).

Comment: Page 4, Item 1 (Theory)

Response: Contrary to what the reviewers state, staff feels that a definite theoretical approach, as previously mentioned, is implicitly and explicity discussed and applied.

The entire discussion of settlement pattern, ethnographic analogy and culture change by the reviewers seems immaterial to the scope and intent of the EAR, which is an assessment of existing resources, potential impacts and proposed mitigation measures. However, as clarification to several points raised the following comments are offered: Since archaeologists must deal with inferences and probability statements based on cultural and environmental remains, and on information derived from comparable living and historic groups, the site typology defined is conducive to analyzing culture change, provided temporal controls are available. However, such controls often involve detailed site studies beyond the scope of this project. Nevertheless, every attempt was made during the survey to temporally place sites. Details are provided on site records available at the BLM in Riverside and the San Bernardino County Museum.

Staff does not concur that settlement patterns are models of human subsistence activity. Their study can provide interpretation of social interaction, economics, magico-religious activities, etc.

Even though a synchronic outlook for most of the sites is used (most appear to be late prehistoric as outlined in the EAR), valuable information is present on man-land relationships, and a framework for more explicit and refined studies has been provided. Once again, it must be emphasized that an understanding of how a particular distribution of sites came to be, how it changed, or why it changed is beyond the scope and intent of this document. The fact that there has been an attempt to address this problem, staff feels, Response Page 4, Item 1 (Theory) (Continued)

is within the framework of reasonable scientific inquiry and can be considered an important adjunct to the main problem of land management.

Comment: Pages 5 and 6, Item 2 (Methodology)

Response: A discussion of sampling strategy has been presented in the Draft EAR (D3-7) and staff feels it is of adequate clarity for a document of this type. Generally, if more detailed knowledge of specifics regarding sampling is necessary BLM archaeologists are available for contact or the information may become available in later professional papers. Sampling within a management framework sometimes must be sufficiently flexible to account for management decisions, changes in lease applications and other contingencies with which strictly research-oriented projects do not have to contend. As noted, this accounts for the discrepancy between sample quads and final lease unit boundaries. Copies of the archaeological sample universe boundaries are available upon request.

The reviewers are correct in noting that our sampling design differed from Weide's, although her research objectives were generally followed. As previously mentioned, considerable revision of Weide's proposal has been implemented by the archaeological community as a result of field testing her admittedly idealized scheme. In addition it has been necessary to temper her scheme because of limits of manpower, budget and time. As BLM archaeologists have noted in public presentations (Society for California Archaeology Meetings, San Diego, 1976) the scheme applied here seems best suited for situations such as this (see page D-2 of the Draft EAR).

The reviewers are partially correct in noting that the zig-zagging sweep method may not have provided 100% coverage of a given survey quadrad. However, communications were adequate since hand radios were used by each surveyor. Such survey strategy was designed to provide an evaluation of probabilistically selected clusters, recognition of National Register properties and definition of sensitive areas, not just an absolute coverage. In fact, page 2-170 of the draft states that some minor sites may have been missed during the survey.

Several points must be addressed regarding the reviewers' comments on sample stratification. While they are correct in noting that the geology and geomorphology can be further subdivided, staff feels they are incorrect in stating that such units are far too gross for analytical purposes. Field assessments of sub-divisions were made and were used in calculations and subsequent analyses (as discussed in the EAR). Use of these generalized sub-divisions proved informative and of predictive utility in the development of a model of prehistoric land use. As has been demonstrated by Judge, Ebert and Hitchcock (1975, page 89), strata should be constructed so that their averages are as different as possible and their internal variance as small as possible. The scheme used approaches this idealized construct. Such strata provide a testing mechanism only, subject to rejection or further development. Further sub-divisions at this juncture of the regional study do not seem warranted.

Comments on modifications of the Weide proposal have already been addressed.

Comment: Pages 6 and 7, Item 3 (Presentation)

Response: For purposes of the EAR, staff feels the material has been adequately summarized. It should be understood that further information is available at the agency undertaking the work, and at the San Bernardino County Museum. Sites were recorded on records designed for computer storage and retrieval, utilizing locational, geologic, geomorphic, hydrologic, vegetational and cultural variables in checklist form, with a key available to the archaeologists undertaking the survey. While not pertinent to the EAR, projectile point types recovered (rare) include the Cottonwood and Rose-Spring series.

Nowhere has staff stated or implied that the EAR will be substituted for a full descriptive report of the survey and its findings. However, consultation with a number of archaeologists in California indicates that the data, even as presented in the EAR, is informative and can be used for comparative purposes. Even some of the reviewers' alleged criticisms demonstrate data utility.

Staff feels reviewers' criticism concerning alleged failure to recognize cultural and temporal change is unfounded. Bedrock mortars and metates were both found in the tool kits of many California Indian tribes and each served a number of different functions. Until further work is undertaken in the EAR area any relationship of these features to environmental or cultural change cannot be assessed. Distribution of milling stations with vegetation communities does not necessarily indicate change in vegetation communities. Apparently useful seed and plant resources were widespread in the area. The rougher, rocky, steeper zones may not exhibit such sites because of the nature of the terrain, not because of climatic/vegetation change. Certainly some of the preferred plants, i.e., chia, were probably not abundant in this area in most years, which could explain this phenomena. Obviously, more work along this avenue is needed in the context of organized research. Staff feels that discussions of this nature do more to point out the utility of the report than demonstrate deficiencies.

Comment: Page 8, Paragraphs 1-4.

Response: No specific information exists concerning the paleophytosociology of the EAR area. Staff feels that it is beyond the scope of this document to speculate on these aspects; indeed, speculation without backup data would be untenable.

Staff points out that, contrary to the impression conveyed, Joshua trees are present in the EAR area and feels this data has been amply presented.

Staff would also like to point out that the concept of dominance cannot be applied to an ecotone.

While it is obvious that some of the statistical correlations can be intuitively derived, many others cannot. As pointed out by Judge, Ebert and Hitchcock (1975, page 84) "The major advantage of the employment of statistical method over intuition in the scientific testing process is that a quantitative knowledge of the risks of error can be derived from statistics. The level of the inductive deductive process at which inconsistencies are most likely to lead to error is the assumption stage; all assumptions must therefore be examined for validity".

Concerning the dating of Gypsum Cave points, staff does not feel the reviewers are aware of recent research into the problem. Hester (1973, page 41) notes that while early researchers considered these points to be of some antiquity, later researchers have obtained radiocarbon dates, some on the dart shafts, indicating an age more recent than previously thought. Thus, Hester found these points date from about 1800 B.C. to 450 B.C., not 9000 to 7000 B.C., as the reviewers contend.

Comment: Page 9, Section II, Item 1 (Natural Environment) - "... invertebrata, lichen and micro-organisms are neither described or placed within the larger trophic system of which they are a part."

Response: To staff's knowledge no environmental analysis has ever attempted to

Response Page 9, Section II, Item 1 (Continued)

completely describe either the flora that includes lower plants or the invertebrate fauna of an area. Such a description would be a monumental task that would require decades to complete. In the absence of any indication of rare or endangered lower plants or animals in the area, staff does not feel that such a description is warranted.

The section on ecological interrelationships is designed to serve as a brief introduction to the unique features of the ecosystem in question and not to provide descriptions of general ecological principles that are not pertinent to the proposed action. Also, the staff is not aware of any interrelationships between invertebrates and lower plants that are unique to the EAR area.

Comment: Page 9, Section II, Item 1, Continued - "In addition, reptiles appear inadequately studied."

Response: Although staff was not able to verify the present of every reptile on the hypothetical list, it does feel that the list is essentially correct. This list is based not only on its own inventory but on a more extensive inventory of the whole area conducted by the BLM's Desert Planning Staff.

Comment: Page 9, Section II, Item 1, Continued - "In short, the natural environment has not been fully examined and consequently, the impact of geothermal development has not been fully assessed."

Response: In the absence of specific information about animals or plants not considered or important ecological interrelationships or impacts not covered, staff does not find any basis for the above statement.

Comment: Page 9, Section II, Part 2.

Response: Both the incidence of blow-outs and the magnitude of the resulting surface phenomena in the EAR area are probably less than those for The Geysers field. The geological factors which contribute to the development of blow-outs at The Geysers include the location of over 90 wells on mapped landslides that are intimately associated with various groundwater phenomena. These phenomena include a high ground water table and springs and seeps near the wells which permit watering of the slopes (Bacon, 1976). None of these features particularly characterize the EAR area (Alfors and others, 1973).

Comment: Pages 10 and 11, Section II, Item 3 (Mitigation).

Response: There is no disagreement on staff's part that desert pavement exists in the study area or that surface cultural manifestations in all situations are fragile. Staff believes that implementation of the recommended mitigation measures would safeguard any such sites or provide for adequate recovery (see page 4-20-21 of the Draft EAR).

Comment: Page 11, Section II, Item 4 (Scenic Values)

Response: Text in Chapter 7 has been modified to reflect the first sentence of your comment. In response to the remainder the point is well taken. However, it is the staff's contention that when one considers the combination of rich coloration, outstanding landforms, and the uniquely unintruded character of much of the study area along with the varied impacts of visual intrusions in different Visual Prominence Zones, (see page 2-139, paragraphs 3-6 and Appendix C, page C-3 and C-4, Visual Prominence Zones) it is only fitting that the hills rank above the flats in aesthetic quality.

Comment: Page 12, Item 5 (Paleogeography)

Response: Staff concurs that geothermal exploration and all following stages of development, if unmitigated, could directly endanger important paleostratigraphic associations and paleontological values. However staff believes mitigation measures listed in the final EAR safeguard such values. It should be stressed that geologic and geophysical analysis performed in conjunction with development can be a beneficial impact by providing valuable data on stratigraphy, geologic processes and other information. Staff does not feel that this particular area provides any more of a unique opportunity for a "paleo-geomorphological" study of arid land erosion cycles than adjoining areas. In any case, emphasis in terrain studies today is oriented more on processes rather than historical overviews.

In personal communication with G.I. Smith, staff has learned that he will soon publish an extensive study of much of this area, which will undoubtedly update much of his previous work.

Comment: Page 12, Item 6 (Demography)

Response: Living facilities for workers during the field development stage (the period of greatest employment) are discussed on page 3-42 of the Draft EAR. Since these workers would be expected to live in existing residences, motels and trailers in the communities around the EAR area, staff feels little impact on cultural resources would result from increased residential use. The number of workers involved is not expected to justify the construction of new communities or mobile home parks.

Comment: Page 13, Section III, Paragraph 3.

Response: Staff feels that little agreement can be accorded the reviewers' comments.

Comment: Page 13, Paragraphs 4, 5.

Response: The analysis of an action which is not precisely defined, whose extent of development is approximated, and the exact nature of whose resource base cannot be determined without completion of various exploratory activities, must be based on speculation and assumption. Because facts cannot be determined beforehand, the staff feels that an informed opinion has been offered as to what may result.

ENVIRONMENTAL IMPROVEMENT AGENCY

County of San Bernardino

~~316 Mt. View~~ · San Bernardino CA 92415 · (714) 383-1718
1111 East Mill Street, Bldg. 1

ROBERT B. RIGNEY, Administrator
Environmental Improvement Agency

June 3, 1976

Bureau of Land Management
Riverside District Office
1695 Spruce Street
Riverside, CA 92507

RE: COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD - PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS AND SOUTH SEARLES LAKE AREAS:

The Environmental Analysis Division (EAD) has not had the time to thoroughly review the EAR, therefore our comments are general in nature. The report seems to contain adequate inventories of the resources that could be affected by geothermal development. The analysis of potential impacts suggests that an EIS should be written on the leasing program, especially if it would be helpful in conditioning your permits with specific mitigation measures, some of which are outlined in the EAR. Although the EAR contains nearly the full content of an EIS, a direct public and resource benefit would result from an EIS's more formal public hearing process under NEPA.

You are probably aware that the County is handling several individual <u>exploration</u> applications on a "site approval" basis. (Site Approval requires a zoning-related discretionary decision from the Planning Commission.) The Getty Oil Company exploration request has been approved with the condition that another "site approval" or similar County approval will be required before actual <u>development</u> occurs. Although the County has determined that previous exploration applications have not required EIRs under the California Environmental Quality Act, development per se might be found to be significant and therefore require an EIR.

We would prefer that a more precise determination of the commercially available geothermal resource be made so that BLM and the County could better relate impacts and mitigation measures to the most probable use of the steam or heat and its by-products. If the potential is no greater than that mentioned in the EAR, it seems as if a more thorough economic analysis of the energy resource is needed. Assuming that just exploration will not significantly alter or consume surface resources, it may be more advantageous to not issue leases until the extent of the resource and its potential uses can be determined.

The proposed leasing program will probably not conflict with the 1966 County General Plan Map. Leasing will have little bearing on the recently adopted Joint Utility Management Program (JUMP) until and unless steam is harnessed for electricity production. The County would require certain measures at the development stage, even on Federal lands. It is difficult to determine whether the project will conflict with the County's Open Space and Conservation, Noise, and Seismic Elements to the General Plan.

We are definitely concerned about the significant amounts of water required to cool future plants, especially if it cannot be extracted from the steam effluent. Fugitive dust is an important issue. (Refer to the recently adopted Southern California APCD Regulation 4 for the new version of the Fugitive Dust Ordinance; call 213-443-3931.) The establishment of service roads could require County maintenance depending upon determination of responsibilities. Again, we believe that an economic assessment of the viability of the geothermal potential should be made before significant amounts of surface resources are allowed to be disturbed.

In order to simplify our separate reviewing processes, we would appreciate close coordination and data sharing.

ENVIRONMENTAL IMPROVEMENT AGENCY
Robert B. Rigney, Administrator

Lewis J. Walker

Lewis J. Walker
Environmental Review Board Officer

CHB:LJW:mlm

cc: Robert Rigney, EIA Administrator
John Jaquess, Chief, Plan Implementation Division
Pat Nemeth, Chief, Advanced Planning

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Lewis J. Walker, Environmental Improvement Agency, County of San Bernardino, San Bernardino, California.

Comment: Page 1, Paragraph 1.

Response: Staff acknowledges your suggestion that an EIS be prepared.

Comment: Page 1, Paragraph 3.

Response: Staff agrees that a more precise determination of the commercial viability of the resource would be advantageous. However, this determination could probably not be made without data from extensive exploratory programs designed specifically for that purpose. Staff feels that the identified mitigation measures are sufficient to reduce impacts from what is assumed to be the more disruptive activity which the area would be subject to. Should a less disruptive activity prevail, the proposed mitigation measures would still be adequate as a working base to insure proper mitigation.

Comment: Page 2, Paragraph 3.

Response: Staff is aware of the scarcity of water in the EAR area and acknowledges that water may be a limiting factor in the development of the resource. However, all pertinent regulations and mitigation measures designed to safeguard water quality and quantity in the area would be enforced.

As indicated in the text, Southern California APCD standards to control fugitive dust would be enforced.

Staff agrees that project viability could be more accurately determined if a more extensive data base was available. Also, the extent of the resource itself is admittedly an estimation based on scanty data. However, the staff feels that the assumptions included in the proposed action and project model are not so totally invalid as to prevent development of a workable evaluation of the scope of the project. For example, exploration and development activities can be sufficiently analyzed to provide information that would be helpful

Response Page 2, Paragraph 3 (Continued)

in deciding whether leases should be awarded. Also, once a lease is granted, operating regulations would be made applicable to all activities at their outset. These regulations would provide for monitoring and are flexible enough to permit sound environmental protection.

It should also be noted that certainty as to viability would probably not be apparent until and after exploration and development activities commence. These activities need to be regulated and proper regulation can only come after possible impacts from proposed activities have been identified. Therefore, in most cases, and in this one in particular, the scope of the project must be developed prior to extensive knowledge of the resource base.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 35TH COMBAT SUPPORT GROUP (TAC)
GEORGE AIR FORCE BASE, CALIFORNIA 92392

JUN [illegible]

REPLY TO ATTN OF: DEEE (Lt McKinnis, 2245)

SUBJECT: Proposed Geothermal Leasing in the Randsburg-Spangler Hills-South Searles Lake Areas (Yr ltr 30 Apr 76)

TO: Bureau of Land Management
Riverside District Office
1695 Spruce Street
Riverside, CA 92507

1. The purpose of this letter is to comment on the Draft Environmental Analysis Record forwarded as an attachment to the referenced letter, and to express our concerns regarding the problems which may result from the pursuit of the proposed leasing project.

2. In general, the Draft EAR adequately reviews the subject proposal and thoroughly describes the possible impacts and benefits of that action. However, while the adverse environmental effects of such leasing appear to be relatively minor, the planned development at the site in question could have a potentially serious impact on our flying training operations at Cuddeback Gunnery Range. Cuddeback Range is substantially smaller than the normal size for that type of facility. As a result, flight patterns to and from the range frequently extend beyond its actual boundaries, and aircraft, of necessity, periodically overfly the Randsburg KGRA, which at its closest point is only 3 miles west of Cuddeback Range. Any development in the vicinity of Cuddeback could result in a serious hazard to civilian personnel working in the project area. Particularly if the KGRA is found to be a productive site and is fully developed (with the resultant increase in the number of personnel employed there) the admittedly remote possibility of accidental loss of ordnance from aircraft passing over the site could have unacceptable consequences.

3. Also of some concern are two aspects of the potential development which require further clarification in the EAR. Specifically, these are:

a. The use of aerial photography in the Preliminary Exploratory Stage. Communications capabilities, type of aircraft, altitudes, frequency of operations, times, etc. will be required to preclude interference with range patterns and minimize potential for mid-air collision.

b. Steam-venting to the atmosphere during the Field Development Stage. We need to know the expected extent of emission to assess possible degradation to flight visibility, particularly during the critical final approach to weapon delivery patterns. Also to what extent, if any, there would be corrosive, or otherwise hazardous elements in the effluent.

4. It should be emphasized that our primary reservations with respect to the proposed leasing of BLM land for commercial development focus on the potentially serious safety problems arising from the KGRA's proximity to Cuddeback Gunnery Range. Any measures that could be taken in an attempt to minimize or eliminate those hazards with careful planning would serve everyone's interest.

5. Although plans are being prepared to eventually replace Cuddeback Range with a development in Superior Valley (some 10 miles to the east), Cuddeback will be utilized for essential part of the flying training at GAFB for at least 2-3 years. Therefore, it is important that any activities that would seriously jeopardize the mission of that facility be prohibited, and that all requests for operations in the vicinity of the range be carefully weighed to determine their overall impact. As indicated above, some question exists about the advisability of allowing what might become a large-scale project to be developed in such close proximity to an active AF gunnery range, and it is requested that serious reconsideration be given to either prohibition or postponement of the proposed BLM leasing for geothermal development.

Atch
1. Location Map

OLIVER P. FISHER, JR., Colonel, USAF
Deputy Commander

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS, SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Oliver P. Fisher, Jr., Department of the Air Force, George Air Force Base, California

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Comment: Page 1, Number 2.

Response: Staff acknowledges the potential for hazardous conditions.

Comment: Page 1, Number 3a.

Response: Staff agrees. Should aerial photography operations be proposed, these operations would be coordinated between George Air Force Base and the lessee to the extent needed to minimize interference with range patterns and the potential for mid-air collision.

Comment: Page 1, Number 3b.

Response: At the present time, insufficient data regarding the resource in this area preclude a reliable, quantitative determination of types and amounts of gaseous emissions. General references are made to emissions that occur in other areas as a guide to what type of emissions may occur here. The text has been modified to indicate that measures to mitigate air pollutants would include adherence to existing local, state and Federal air pollution regulations.

Comment: Page 2, Number 4.

Response: Staff acknowledges your concern for potential safety problems.

Comment: Page 2, Number 5.

Response: Staff acknowledges your suggestion for consideration to prohibiting or postponing geothermal leasing in the EAR area.

STATE OF CALIFORNIA—RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF FISH AND GAME

1416 NINTH STREET

SACRAMENTO, CALIFORNIA 95814

(916) 445-3531

June 1, 1976

Mr. Delmar D. Vail
District Manager, Riverside District
U. S. Bureau of Land Management
1695 Spruce Street
Riverside, CA 92507

Dear Mr. Vail:

We have reviewed your Draft Environmental Analysis Record for proposed geothermal leasing of Federal lands within the Randsburg-Spangler Hills-South Searles Lake areas of northwestern San Bernardino County. We commend you and your staff for the overall exceptional technical quality of the document. The sections describing the existing environment and impacts on the environment were particularly well written and informative.

We would, however, like to make the following comments regarding its content:

1. Page 1-11, 1st paragraph - The basis for assessing the impacts of geothermal development in this area was determined to be one 50 MW electric generating plant on one 2,560-acre lease. We believe it important to note this figure may be higher and that larger plants covering more acres may be constructed. In addition, this basis appears to neglect the possibility that areas peripheral to the proposed leases may also be developed. An example of this is the Geysers where the limits of the field are currently unknown. Wildcat drilling in areas peripheral to the Geysers KGRA have located what appears to be a significant wet steam - hot water field. The result may be an expansion into areas far beyond those that were originally envisioned as suitable for geothermal development. The same thing could happen in this area.

2. Page 1-16, table 1-2; page 1-23, table 1-6 - These tables indicate the surface disturbance expected to result from specific geothermal development activities. Such an approach is a good start toward assessing impacts, but it fails to consider subsequent impacts which could be major. For example, instead of a total of 10% (2% during exploration and 8% during production) of the lease area being disturbed, possibly

25% to 50% or more may be adversely impacted by such things as increased ORV use, shifting of grazing allotments to other areas, cumulative impacts, etc. Additionally, the use of 2,560 acres as one baseline unit to support one 50 MW plant may or may not be accomplished in this KGRA. Although we believe it to be a good estimate, we caution that the baseline unit could in actuality be larger or smaller than this acreage.

3. Page 3-3, 2nd paragraph - The Lawrence Livermore Lab environmental baseline study is site specific for the Imperial Valley. Any conclusions that may be drawn from their data regarding effects of geothermal development will most likely be applicable only to the Imperial Valley since it has been significantly modified as a result of man's activities.

4. Page 3-11, section 3.2.3 - Because of previous disturbances by man, wildlife habitat in this area has decreased to the point that additional disturbances, such as geothermal development, may result in catastrophic losses of wildlife through changes in critical ecological interrelationships.

5. Page 4-5, section 4.2.2 - This section should include a monitoring program for assessing potential impacts of geothermal energy production on the underground water flow that supplies surface springs and seeps.

6. Page 4-9, 1st paragraph, item 2 - We recommend that any prolonged use within raptor nesting areas be prohibited. In addition, roads, trails, well sites and production plants should be prohibited within the nesting areas of significant raptors.

7. Page 4-11, 1st paragraph - As will be discussed in the following paragraph, we strongly believe that habitat losses associated with geothermal development, including construction of pipelines and access roads, during the life of the lease can and must be mitigated.

We believe the mitigation section of the EAR is inadequate in terms of NEPA requirements because it fails to propose adequate mitigation for loss of wildlife habitat resulting from geothermal exploration and development within the proposed leases. Although revegetation of all disturbed areas after abandonment of the geothermal fields, whenever that occurs, is to be accomplished, there are no measures proposed for compensating for the loss of wildlife habitat in the interim. This is of major concern to our Department because of the significant acreages (nearly 100,000 acres) of sensitive and fragile desert habitats as well as the long developmental timeframes that are involved.

For your consideration, we would like to indicate several mitigation measures which we think could serve towards compensating for the loss of wildlife habitat associated with geothermal exploration and development within the subject area:

1. Significantly reduce or eliminate grazing allotments, particularly for sheep grazing, within the entire lease area as well as adjacent areas. Such action could help these lands to recover to their original productivity and thereby increase their ability to support wildlife. Populations of desert tortoises and various rodents and their predators could benefit significantly from this action.

2. Although difficult, implement measures for more effective prevention of ORV use in sensitive desert habitats within the entire lease area as well as adjacent areas. This will be of major concern as more and more access roads are constructed during geothermal exploration and development activities.

3. Through land exchange or purchase, acquire and then dedicate adjacent private lands to the existing desert tortoise preserve located near California City. Such action would benefit the desert tortoise as well as other wildlife by protecting their habitat in perpetuity.

4. Development, by acquisition of private lands or dedication of existing Federal lands, for new desert tortoise preserves in areas adjacent to or within the proposed leases. Preserves should be of a manageable size and should be large enough to encompass the seasonal movements of a given population of desert tortoise. Emphasis should be placed on lands having critical or sensitive habitat areas. An example would be the private inholdings in Sections 4, 5, 7, 8, 9, 10, 16, 17 within T 26 S, R 42 E, located in the southwestern portion of the Randsburg lease area. Sensitive habitat areas for desert tortoise as well as Mohave ground squirrel are present in these areas.

5. Increase the wildlife carrying capacity of desert habitats within the lease area as well as adjacent areas. We fully realize that this action must be done while exercising extreme caution to insure that existing habitat values are not impacted. We believe this could be accomplished by using specific rehabilitation techniques that would remove or decrease the level of occurrence of exotic plant species while at the same time restore or increase the level of occurrence of native plant species.

6. In conjunction with geothermal exploratory drilling, provide water for wildlife. For example, if water of adequate quality is encountered while drilling an exploratory well, a suitable portion of it should be made permanently available for wildlife.

7. Prohibit diversion and/or domestic uses of water found in desert springs or seeps.

8. Prohibit human use within a specified distance of natural desert water sources such as springs or seeps.

9. Use of slant drilling as much as possible in order to minimize the number of well pads required per generating plant.

We realize that several of the above mitigative concepts represent a radical change from present practices regarding the Federal geothermal leasing program. Nevertheless, we strongly believe that mitigation for the loss of wildlife habitat should be addressed within the EAR. If this is not to be done, then we believe a full and complete EIS, which is mandated by NEPA to discuss mitigation for all adverse project impacts (including loss of habitat), should be prepared for this lease proposal.

Furthermore, mitigation for the loss of wildlife habitat should be implemented as an integral part of subject leasing program. Until this is done, we have no alternative but to oppose the leasing of Federal lands for geothermal development in the Randsburg area. We must take this position to insure that the fish and wildlife of this sensitive area, which belong to the public, are protected for the future generations to enjoy.

Finally, we wonder about the procedures under which review of this EAR by various State agencies was accomplished. Recently, Claire Dedrick, Secretary for the California Resources Agency, and Ed Hastey, State Director for the Bureau of Land Management, agreed to a modification in the Bureau's EAR process that would help resolve some of the State's concerns regarding environmental aspects of the geothermal leasing program. It was our understanding that part of this agreement involved the submission of EAR's for geothermal leasing directly to the State Clearinghouse. Was this procedure followed with this EAR? We pose this question because your agency asked our Department directly for comments.

Thank you for the opportunity to provide these comments.

Sincerely,

E C Fullerton

Director

cc: Ed Hastey, BLM, Sacramento
Bill Spaulding, FWS, Sacramento
Felix Smith, FWS, Sacramento
Jim Burns, Resources Agency

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: E. C. Fullerton, Department of Fish and Game, Sacramento, California.

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Comment: Page 1, Number 1.

Response: Staff agrees that future data may indicate increased potential. At the present time, however, data would suggest that at best the resource in this area is suitable only for space heating purposes (White and Williams, 1975). It should be noted, however, that the authors themselves acknowledge scanty data and urge caution in interpretation. In exercising that caution the staff believes a greater potential over that cited should be considered. Therefore, it is felt that one 50 MW power plant on one 2,560 acre lease is the most reasonable and valid model which can be considered at the present time.

If areas peripheral to the proposed lease areas are developed, as you suggest they may be, this development would have to be on a Federal lease, the award of which can only be granted after an EAR has been prepared. Also, should the development be proposed for private lands, it cannot be necessarily assumed that control by Federal agencies would be exercised in any case.

Comment: Page 1, Number 2.

Response: These tables are designed to indicate direct impacts rather than subsequent or indirect impacts; these impacts, however, are considered in detail in Chapter 3.

Comment: Page 2, Number 3.

Response: Staff agrees that the study results will be most applicable to the Imperial Valley and that a "blanket" application to other areas is not possible. The intent of the abovementioned paragraph is, however, that additional information regarding these types of impacts will be available. In other words, the data bank will be added to so as to increase the awareness of possible impacts that may or may not be applicable to other areas but should, none the less, be considered.

Comment: Page 2, Number 4.

Response: The statement rendered is not true as a blanket statement because much of the area, particularly the Lava Mountains, has received very little human use and is relatively undisturbed. Other areas have received heavy use and damage as indicated in the report. However, the staff is not aware of any areas in the EAR area in which controlled geothermal development would result in catastrophic losses of wildlife above and beyond what has been identified in the Draft EAR.

Comment: Page 2, Number 5.

Response: As indicated in the Draft EAR the only natural source of surface water available to wildlife is Bedrock Spring. Th problem of diverting wildlife water from the EAR area is adequately addressed in Section 4.3.1 under general mitigation measures: "The effect of water utilization on wildlife would be mitigated by avoiding any use of ground water that would reduce the water flow at Bedrock Spring..."

Comment: Page 2, Number 6.

Response: In Section 4.3.1 the following measures are listed: "(2) Allow only casual use within raptor nesting areas; (3) Do not allow any powerplant site development within raptor foraging area;"

"Casual Use" is defined in the Regulations on the Leasing of Geothermal Resources (Federal Register, Vol. 38, No. 245, 1975) as follows:

> "Casual use" means activities that involve practices which do not ordinarily lead to any appreciable disturbance or damage to lands, resources, and improvements. For example, activities which do not involve use of heavy equipment or explosives and which to not involve vehicle movement except over established roads and trails are "casual use".

Thus staff feels that it has provided adequate protection for the significant raptors in the EAR area.

Comment: Page 2, Number 7.

Response: The following paragraphs address habitat losses.

Comment: Page 3, Number 1.

Response: Staff believes that this measure is beyond the scope of this report. To accomplish this measure, additional EAR's and their pertinent alternatives and mitigation measures would be necessitated due to the "snowballing" effect on other resource impacts and mitigation measures.

Comment: Page 3, Number 2.

Response: Staff believes that ORV management is a long-term Bureau program and, in the context of this report feels that this measure is beyond the scope of consideration.

Comment: Page 3, Number 3.

Response: Staff believes that desert tortoise habitat is sufficiently addressed and managed in other documents and programs. As such, this measure is beyond the scope of this report.

Comment: Page 3, Number 4.

Response: As above, staff feels this measure is beyond the scope of this report.

Comment: Page 3, Number 5.

Response: Staff believes this specific mitigation measure has been adequately addressed in part 4.3.1 of the Draft EAR in that seeding of native species is proposed. Staff also feels that the very general nature of the comment does not readily lend itself to a workable measure in the context of the EAR area.

Comment: Page 3, Number 6.

Response: This is a possibility that has been considered as a mitigation measure. However, at this time it is not known whether water of

Response Page 3, Number 6 (Continued)

adequate quality is available. Therefore, this proposal must be considered at the Plan of Operation approval stage.

Comment: Page 3, Number 7.

Response: Staff feels this item is adequately addressed in Section 4.3.1 of the Draft EAR. Bedrock Spring is the only natural water source available for wildlife in the EAR area.

Comment: Page 4, Number 8.

Response: There is a mechanism for accomplishing this under Section 308.5 of the California Fish and Game Code which states that:

> For the preservation, protection and restoration of mountain sheep and other birds and mammals in arid regions of the state, the commission, in cooperation with the agency authorized to manage the land, may prohibit any activity, including but not limited to camping, in the vicinity of waterholes, springs, seeps, and other watering places which are on public lands. The department may enter into agreements with other state and federal agencies controlling public lands for the purpose of posting such areas.

Our procedure for such designation in this district requires that the Department of Fish and Game initiate the action by proposing springs for designation.

In the absence of designation, staff feels that additional disturbance from geothermal activity would be minimized by: (1) the mitigation measure which allows only casual use within the area of Bedrock Spring, and (2) site specific mitigating measures and stipulations imposed at the Plan of Operation approval stage.

Comment: Page 4, Number 9.

Response: Technological constraints may be such that slanted borings radiating from a central drill pad are not possible.

Comment: Page 4, Paragraph 5.

Response: A copy of this EAR was forwarded directly to the State Clearinghouse. Because of the short public review period, however, a copy was also directly mailed to each of the various departments to insure their reception of the EAR with as much response time as possible.

STATE OF CALIFORNIA—THE RESOURCES AGENCY EDMUND G. BROWN JR., Governor

DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY
DIVISION HEADQUARTERS
RESOURCES BUILDING, ROOM 1341
1416 NINTH STREET
SACRAMENTO, CA 95814

District Offices: LOS ANGELES
Junipero Serro Bldg., Rm. 1065
107 South Broodwoy
90012

SACRAMENTO
Resources Bldg., Rm. 118
1416 Ninth Street
95814

SAN FRANCISCO
Ferry Building
94111

SACRAMENTO DISTRICT OFFICE
(916) 445-5716

June 2, 1976

Mr. Delmar D. Vail, District Manager
U. S. Bureau of Land Management
Riverside District Office
1695 Spruce Street
Riverside, California 92507

Dear Mr. Vail:

The California Division of Mines and Geology has reviewed the Draft Environmental Analysis Record for Proposed Geothermal Leasing in the Randsburg-Spangler Hills-South Searles Lake areas and finds that it is an exceedingly complete and thorough treatment for the analysis of the subject areas. There is an error in Appendix E, p. E-1: Bulletin 116-2, "Crustal Strain and Fault Movement Investigation" is listed as a publication of the California Division of Mines and Geology; it is in fact a publication of the California Department of Water Resources and should be so listed.

With regard to monitoring for both seismicity and subsidence, the Division of Mines and Geology is keenly interested in the obtaining of background information in as-yet undeveloped geothermal areas for later comparison with data obtained as development progresses. Because the subject areas are in remote locations and are relatively undeveloped, they would afford an excellent testing ground for performing such a study. We would be interested in knowing of any plans in progress along this line.

We were particularly interested in the section on Mining and Mineral Exploration that begins on p. 2-199 and in the statement on p. 4-22 of the EAR that: "all lessees should negotiate with mining claimants and mine owners to resolve conflicts between geothermal development and other forms of mineral recovery". Consideration should be given to adding a section requiring a review by a technical advisor or advisory committee in instances where geothermal development might result in the loss of "other forms of mineral recovery", or where mining claimants and geothermal developers are not able to resolve their conflicts.

I hope these comments will prove useful to you in preparing the final version of the report. If we can be of further assistance, please let us know.

Sincerely yours,

C. Forrest Bacon

C. Forrest Bacon
Acting District Geologist

cfb/dc

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: C. Forrest Bacon, Division of Mines and Geology, Division Headquarters, Sacramento, California.

Comment: Page 1, Paragraph 1.

Response: Text has been corrected.

Comment: Page 1, Paragraph 3.

Response: No provisions are currently available to establish a technical advisor or advisory committee. Perhaps this could be considered by the BLM's District (multiple-use) Advisory Board. The text has been modified, however, to generally indicate that additional avenues of negotiation might have to be utilized.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Division of Ecological Services
2800 Cottage Way, Rm. E-2727
Sacramento, California 95825

June 1, 1976

Mr. Delmar D. Vail
District Manager
Bureau of Land Management
1695 Spruce Street
Riverside, California 92507

Re: Randsburg, Spangler Hills & South Searles Valley Draft Environmental Analysis Record CA-060-6-HD-88

Dear Mr. Vail:

We have reviewed the referenced draft Environmental Analysis Record. We find that the draft EAR is generally well written and that it adequately addresses the existing fish and wildlife resources, the project impacts upon those resources and the possible alternatives. We believe that a couple of areas should be clarified. They are:

Page 2-100, 3rd paragraph: "...whereas the falcon prefer to feed upon birds..." This statement would be correct if you were referring to peregrine falcon but according to your Appendix B the only falcons you list in the area are the American Kestrel (sparrow hawk) and the prairie falcon. The Kestrel prey base is generally composed of insects and/or small rodents. The prairie falcon's prey base is generally small rodents such as ground squirrels. They will take birds but only supplementary to taking small rodents.

Page 3-36, 1st paragraph, last sentence: "...noise would have a high but short-term impact....where most of the raptors nest" is not a conclusion that we can support. For example, owls are nocturnal feeders and to a high degree locate and capture their prey by use of very refined hearing equipment. Continuous noise would affect their feeding habits. Raptor nesting also would be affected with some species more affected than others. We believe that high noise levels would have a "long-term" impact rather than a short-term impact.

We look forward to being of service to your agency in reviewing the final draft.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Sincerely,

Felix E. Smith
Field Supervisor

cc: Reg. Dir., (ES) USFWS
Portland, Oregon

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Felix E. Smith, U.S. Department of the Interior, Fish and Wildlife Service, Sacramento, California.

- -

Comment: Page 1, Paragraph 2. "...whereas the falcon prefer to feed upon birds..." This statement would be correct if you were referring to peregrine falcon but according to your Appendix B the only falcons you list in the area are the American Kestrel (sparrow hawk) and the prairie falcon. The Kestrel prey base is generally composed of insects and/or small rodents.

Response: The statement was intended to apply to the prairie falcon and not to all falcons. It has been corrected and modified to read: "...whereas the prairie falcon will feed primarily on birds where appropriate prey species are found in good densities".

Comment: Page 1, Paragraph 2. - The prairie falcon's prey base is generally small rodents such as ground squirrels. They will take birds but only supplementary to taking small rodents.

Response: Whereas staff recognizes that the prairie falcon, like many predators, can be opportunistic in its food habits, we are not aware of any evidence to justify the above assertion about the prairie falcons of the Mojave Desert. There is only one common diurnal rodent in the EAR area, the antelope ground squirrel, and this species is relatively inactive from fall until mid-spring. The reptile species in the area are not active during winter either. Therefore, the falcon must be dependent for at least four to six months of the year on birds. In particular, our limited knowledge of the prairie falcon in the Mojave desert indicates that these birds rely heavily on the ground-feeding, flocking birds such as Gambel's quail and horned larks which the species is so well adapted to capturing.

Comment: Page 1, Paragraph 3.

Response: The statement refers to the field development stage which would be of limited duration in any given area. Thus, although a few individual animals might be affected, the habitat would not be impacted by noise for a long period of time.

United States Department of the Interior
NATIONAL PARK SERVICE
WESTERN REGION
450 GOLDEN GATE AVENUE, BOX 36063
SAN FRANCISCO, CALIFORNIA 94102

IN REPLY REFER TO:
L7619
(WR)REQ

June 2, 1976

Mr. Delmer Vail
District Manager
Bureau of Land Management
1695 Spruce Street
Riverside, California 92507

Dear Mr. Vail:

We have reviewed the draft Environmental Analysis Record for proposed geothermal leasing in the Randburg-Spangler Hills-South Searles Lake areas of California. The following comments are for your technical assistance only and do not represent formal review comments on a draft environmental statement.

COMMENTS ON THE ENVIRONMENTAL ANALYSIS RECORD

The proposed stipulations on pages 4-20 and 4-21 to regulate the identification of cultural resources and the avoidance or mitigation of the adverse effects of the project upon such resources will not fulfill the requirements of Title 36, CFR 800. All cultural resources identified by a thorough and complete intensive archeological survey should be evaluated for their National Register of Historic Places eligibility, according to the criteria set forth in Title 36, CFR 800.10.

While a proposed mitigation plan developed by a professional archeologist can be very useful and may be implemented, the appropriate course of action to take concerning cultural resources listed on, eligible for listing on, or in the process of nomination to the National Register, should be determined in consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

We agree that avoidance of the sites should be accomplished whenever possible. Mitigation measures, such as salvage excavations, should be undertaken only when avoidance and preservation are not possible.

A copy of comments received from the State Historic Preservation Officer regarding the project's impact upon properties either listed on or in the process of nomination to the National Register of Historic Places should be included in the draft environmental statement.

We hope these comments are helpful in developing the statement.

Sincerely yours,

Harold R. Jones

Harold R. Jones
Acting Associate Regional Director,
Resource Management and Planning

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS, SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Harold R. Jones, National Park Service
Western Region, San Francisco, California.

- -

Comment: Page 1, Paragraphs 2, 3.

Response: Text has been modified to indicate that 36 CFR 800 requirements would be met.

Comment: Page 2, Paragraph 2.

Response: Staff has solicited comments from the State Historic Preservation Officer regarding the proposed action's impact upon properties identified as eligible to the National Register of Historic Places.

STATE OF CALIFORNIA

EDMUND G. BROWN JR., Governor

AIR RESOURCES BOARD

1709 - 11th STREET
SACRAMENTO 95814

June 3, 1976

Mr. Delmar D. Vail
District Manager
U. S. Bureau of Land Management
1695 Spruce Street
Riverside, CA 92507

Dear Mr. Vail:

Subject: Geothermal Leasing, Randsburg, Spangler Hills, South Searles Lake

This is in reply to your letter of April 30, 1976 asking for comments on the Draft Environmental Analysis Record for proposed geothermal leasing on BLM lands.

Our review of the document reveals it does not deal with air pollution to be expected from geothermal development. This is a serious deficiency. Air pollution, particularly that caused by hydrogen sulfide (H_2S), is the major environmental problem that has delayed approval of geothermal power plants in California. Hydrogen sulfide is frequently associated with geothermal phenomena such as hot springs, geysers and fumaroles. Extraction of geothermal resources by man usually results in the release of large amounts of hydrogen sulfide, creating odor problems.

At the Geysers, in Northern California, development of the geothermal field has proceeded far ahead of technology to control hydrogen sulfide. Emissions of H_2S from the power plants have resulted in frequent complaints from residents downwind. Concentrations of H_2S nearby frequently exceed the California ambient air quality standard (.03 ppm, 1 hour). Construction of new geothermal power plants has been delayed pending assurance of effective mitigation measures. Current power plants require retrofit with H_2S abatement systems which reduce the expected life of the plants, and increase maintenance costs. Had the problem of H_2S been properly addressed before construction, the ultimate cost to the utilities might have been considerably lower.

We believe that air pollution is a problem which must be dealt with in geothermal development. One of the first assessments which should be made at any geothermal field is that of the air pollution potential of the resource. California's experience at The Geysers has shown that it is very expensive to go back after plants are built and attempt to control pollution. We believe that it is far less expensive to design plants from the beginning to be flexible enough to accomodate controls which may become necessary.

For these reasons, we believe it is imperative that your Environmental Analysis Record contain a discussion of air pollution, of methods to assess air pollution potential, and of mitigation available for air pollution from geothermal developments. Thank you for the opportunity to comment.

Sincerely,

Harmon Wong-Woo, Chief
Division of Implementation and Enforcement

cc: Tom Quinn
Eli Chernow
Mary Nichols
Bill Lewis
George Taylor
Bill Lockett

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS, SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Harmon Wong-Woo, Air Resources Board, Sacramento, California.

Comments: Page 1, Paragraph 2; Page 2, Paragraph 1.

Response: Specific, quantified data on air pollutants from either similar resource types or from the resource located in the EAR area is not readily available. Staff feels, however, that it has discussed possible air quality contamination to the extent that existing data permit. H_2S is discussed: Table 1-3 quantifies certain gases associated with various systems and Chapter 3 discusses possible air quality impacts.

Pertinent sections of the text in Chapter 4 have been modified to indicate the Federal regulations which would require measurement and, if needed, mitigation of pollution from certain noncondensible gases, including H_2S. In addition, Table 2-6 identifies the ambient air quality standards applicable in California and the EAR area.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Area Geothermal Supervisor's Office
Conservation Division, MS 92
345 Middlefield Road
Menlo Park, CA 94025

JUN - 7 1976

Memorandum

To: District Manager, Bureau of Land Management, Riverside, California

From: Area Geothermal Supervisor

Subject: Randsburg, Spangler Hills, South Searles Lake EAR

Thank you for the opportunity to review the subject EAR. The baseline data section of it is of excellent quality and could well serve as a model for many others.

The section on Mitigating Measures (Section 4) contains many worthwhile ideas. It was, however, very difficult to determine which of the ideas would be imposed as Special Stipulations and Conditions on the leases to be issued in this area. Many of the suggested mitigating measures are already in effect as part of the Geothermal Steam Act of 1970, Rules and Regulations (30 CFR 270), standard lease terms or Geothermal Resources Operational (GRO) Orders that apply to all geothermal leases. Other mitigating measures can be best addressed on a site-specific basis when a Plan of Operation is submitted during the post-lease stage. The lessee cannot start any surface disturbing activity until the Plan of Operation is approved jointly by the Area Geothermal Supervisor and the Surface Management Agency.

A careful examination of the provisions of the EAR also reveals a lack of adherence to the concepts of multiple use planning. Only approximately one square mile of the Randsburg KGRA remains available for geothermal exploration and development after the exclusion from leasing (except for casual use) of large areas of the KGRA because of scenic values, archeological values, and various wildlife and wildlife habitat values. Substantial areas of the non-competitive lease areas have also been excluded from leasing under the same terms with the result that, of the 142 square miles included in the EAR study area, less than 20 square

Page 3-21, Paragraph 2: The 40 feet X 60 feet site would be only for a geologic information hole. Exploratory hole sites would be on the order of 1 to 3 acres or up to 300 feet X 300 feet.

Page 3-23, Paragraph 3: Only one or perhaps 2 of these disposal ponds would be allowed before disposal by other methods would be required. No pond of this size has yet been built.

Page 3-34, Paragraph 5: The term "virtually destroy" is semantically negative. Even though 1-3 acres need be cleared for each well site, rehabilitation of the site can begin soon after completion of the well. In general, only the area immediately surrounding the well head will remain disturbed and then only for the life of the geothermal resource.

It is very difficult to divorce impacts from mitigating measures (as has been done in this EAR) and still be able to relate the recommended mitigating measure to the identified potential impacts. The section on mitigating measures seems to have been compiled by personnel of unrelated disciplines who lacked an understanding of the existing geothermal regulations and whose work was not well coordinated. Contradictory and repetitious mitigating measures that did not take into account existing regulations were the result. Those mitigating measures that are to be recommended as lease stipulations should be clearly identified.

Special lease stipulations are derived from the discussion of mitigating measures. Many of the mitigating measures outlined in the EAR have already been properly addressed by rules and regulations, GRO Orders, and lease terms. Only mitigating measures that are modifications to or are not covered by the above may become special lease stipulations. The appropriate sections of rules and regulations, GRO Orders, and lease terms should be cited while discussing the mitigating measures.

Our specific comments regarding your section on mitigating measures are of two types. One type suggests a change or addition to the stated mitigating measure. Where it is applicable, we have cited the appropriate section of GRO Orders. The other type of comment indicates that the particular mitigating measure referred to is one that should be considered only when such an action has been proposed by a lessee in a Plan of Operation. An Environmental Analysis (EA) will be prepared by this office for all actions proposed by a lessee on his lease that are not of a casual use nature. Mitigating measures identified during preparation of the EA that are not covered by existing legislation or regulations will be added as Recommended Conditions for Approval.

Page 4-2, Paragraph 3: The provisions of CFR 270 (Geothermal Resources Operations on Public, Acquired, and Withdrawn Lands) are not "incorporated into each lease in a way that is based on that leases's particular environmental considerations" but rather apply generally to all geothermal leases.

Page 4-3, Paragraph 3: The second sentence contains two possible lease stipulations. "Existing roadways be used in each possible case" is stipulated in GRO Order No. 4, Section 2. "Techniques such as slant drilling be encouraged..." should be considered at the Plan of Operation approval stage.

Page 4-3, Paragraph 3, Sentence 3. Should be considered at the Plan of Operation approval stage.

Page 4-3, Paragraph 4: Unsuitable and inapplicable as a stipulation.

Page 4-4, Paragraphs 1 and 2: Subsidence is covered under GRO No. 4, Section 8.

Page 4-5, Paragraph 3: Corrosion problems will be addressed in the review of the Application for Permit to Drill (APD). Partially covered by GRO Order No. 2.

Page 4-6, Paragraph 1: Not necessary on the lease form as it is covered by GRO Order No. 4, Section 2.

Page 4-6, Paragraph 4: Should be considered at the Plan of Operation approval stage.

Page 4-6, Paragraph 5: Should be considered at the Plan of Operation approval stage.

Page 4-6, Paragraph 6: Should be considered at the Plan of Operation approval stage.

Page 407, Paragraphs 1 and 2: Should be considered at the Plan of Operation approval stage. Partially covered in GRO Order No. 4, Sections 2 and 9(A)(4).

Page 4-7, Paragraph 3: Should be considered at the Plan of Operation approval stage. Covered in GRO Order No. 4, Section 2.

Page 4-7, Paragraph 4: Lessee should not be asked to police ORV use by fencing roads and may not restrict public access under the provisions of Section 3, GRO Order No. 4.

Page 4-7, Paragraph 5: Should be considered at the Plan of Operation approval stage.

Page 4-8, Paragraph 1: Covered in GRO Order No. 4, Section 9(A)(3).

Page 4-8, Paragraph 2: Noise Abatement is covered under GRO Order No. 4, Section 11. Please rewrite this paragraph to reflect the information contained in Section 11. The extent of the area of exclusion appears extensive. Could better be handled at the Plan of Operation approval stage.

miles of Federal land remain open to rational exploration and development. Geothermal resources should be considered in parallel with the other resources values, instead of treating it as a residual value.

Specific comments on the EAR are contained in the accompanying attachment. We would appreciate receiving a copy of the final EAR and your proposed lease stipulations.

Attachment

ATTACHMENT

Comments on Randsburg, Spangler Hills
and South Searles Lake EAR

Page 1-9: The place name Pauzhetsk is misspelled in the EAR.

Page 1-15, Paragraph 2: Suggest inclusion of discussion of size of a well site (1-3 acres including reserve pit). Reserve pit sizes range in size from 75 feet X 150 feet at the Geysers, CA to 150 feet X 300 feet at Roosevelt Hot Springs, Utah. The size is dependent on the depth of the hole and whether or not it is planned to test the reservoir directly into pit.

Page 1-16, Table I-2: Two disposal ponds would probably be a more realistic maximum number. For long term testing of more than one or two wells a disposal well (injection well) would likely be required by this office.

Page 1-17, Paragraph 4: Suggest the following last sentence "To avoid interference of one well with another and to insure maximum production and efficiency, wells are normally drilled with a spacing of one well per forty acres.

Page 1-17, Paragraph 5: Last sentence -- the fluids consist mostly of water that contains those elements and ions you listed.

Page 1-23, Table 1-6: Suggest that only 2 disposal ponds be indicated in the table.

Page 2-9, Paragraph 4: Suggest rewriting so that the faults that show vertical movement are clearly shown to be neither the Garlock fault nor the San Andreas fault.

Page 2-10, Paragraph 5 and Page 2-11, Paragraphs 1, 2 and 3: Suggest consolidating these paragraphs.

Page 2-21, Table II-2: Only 4 of the indicated wells are readily visible on Figure II-5.

Page 2-99, last sentence: Perhaps you could specify the food source for the chuckwalla and desert iguana.

Page 2-100, Paragraph 2: Is the grasshopper carnivorous or insectivorous?

Page 2-109, Paragraph 1: "Pediments of" should be deleted from the last sentence (improper usage). Also, where does the selenium come from?

Page 4-9, Paragraph 1: Adaptation of these blanket measures would result in only approximately one square mile of the Randsburg KGRA being available for geothermal exploration. Please incorporate the multiple-use concept of management.

Page 4-10, Paragraph 1: Why this statement? Page 4-9, Paragraph 1 would eliminate all work in these areas anyway.

Page 4-10, Paragraph 2: Damage resulting from explosion seismology exploration is minimal at any time of year. If seismological exploration would not be permitted in noise sensitive areas (see page 4-8, Paragraph 2) why limit it timewise in other areas.

Page 4-10, Paragraph 3: Should be considered at the Plan of Operation approval stage.

Page 4-10, Paragraph 4: Should be considered at the Plan of Operation approval stage. Partially covered in GRO Order No. 4, Section 4.

Page 4-10, Paragraph 5: Should be considered at the Plan of Operation approval stage.

Page 4-11, Paragraph 1: Should be considered at the Plan of Operation approval stage.

Page 4-11, Paragraph 2: Should be considered at the Plan of Operation approval stage.

Page 4-11, Paragraph 4: Should be considered at the Plan of Production approval stage.

Page 4-12, Paragraph 1: Should be considered at the Plan of Operation approval stage. Covered by GRO Order No. 4, Section 2.

Page 4-12, Paragraph 4: This proposed stipulation is adequately covered by applicable Regulations and GRO Orders.

Page 4-13, Paragraph 4: Should be considered at the Plan of Operation approval stage. Covered by GRO Order No. 4, Section 9(A)(3).

Page 4-13, Paragraph 5: Should be considered at the Plan of Operation approval stage.

Page 4-13, Paragraph 6: Virtually no disturbance occurs in the emplacement of these devices.

Page 4-14, Paragraph 1: Should be considered at the Plan of Operation approval stage.

Page 4-14, Paragraph 2: Should be considered at the Plan of Operation approval stage.

Page 4-14, Paragraph 4: Not acceptable unless lessee is allowed to obtain the material in the immediate vicinity.

Page 4-15, Paragraph 1: Should be considered at the Plan of Operation approval stage.

Page 4-15, Paragraph 2: Would impose a great financial burden on the lessee to import fill material.

Page 4-15, Paragraph 3: Covered by GRO Order No. 4, Section 2.

Page 4-15, Paragraph 4: Should be considered at the Plan of Operation approval stage.

Page 4-16, Paragraph 2: Should be considered at the Plan of Operation approval stage. The statement that pipelines should be as close as possible to the ground is in conflict with an earlier statement that pipelines should be one foot above the ground surface.

Page 4-16, Paragraphs 3 and 4: Should be considered at the Plan of Operation approval stage.

Page 4-17, Paragraph 2: Fencing the development area could seriously curtail the migration of animals if it would encompass all well sites and pipelines.

Page 4-17, Paragraph 3: Should be considered at the Plan of Operation approval stage.

Page 4-20, Paragraph (2)(a): This stipulation almost wholly restates section 18 of the standard lease terms. Also, inclusion of the word professional as well as qualified severely limits the manpower pool that might accomplish the task.

Page 4-21, Paragraph (c): Omit the word professional.

Page 4-23, Paragraph 2: Should be considered at the Plan of Operation approval stage.

Page 4-23, Paragraph 4: The theme of this paragraph runs counter to all other mitigating measures which discourage ORV use. Also, if the entire development area were to be fenced as suggested, why fence the well heads?

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS, SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Reid T. Stone, U. S. Geological Survey, Area Geothermal Supervisor's Office, Conservation Division, Menlo Park, California.

- -

Comment: Page 1, Paragraph 1.

Response: Spelling has been corrected in the text.

Comment: Page 1, Paragraph 2.

Response: Suggestion has been incorporated into the text.

Comment: Page 1, Paragraph 3.

Response: Suggestion has been incorporated into the text and disturbance acreages modified accordingly. The number of wells has been increased to six to reflect the suggested injection well.

Comment: Page 1, Paragraph 4.

Response: Suggestion has been incorporated into the text.

Comment: Page 1, Paragraph 5.

Response: Suggestion has been incorporated into the text.

Comment: Page 1, Paragraph 6.

Response: Suggestion has been incorporated into the text, and disturbance acreages modified accordingly.

Comment: Page 1, Paragraph 7.

Response: Suggestion has been incorporated into the text.

Comment: Page 1, Paragraph 8.

Response: Staff feels that three related, yet different, types of subject matter are presented in the above-mentioned paragraphs. Each type should receive individual attention with the rank of paragraph.

Comment: Page 1, Paragraph 9.

Response: Figure 2-5 has been corrected to show all wells listed in Table 2-2.

Comment: Page 1, Paragraph 10.

Response: The term herbivorous denotes plant eating. The desert iguana and chuckwalla eat flowers, fruits, buds and leaves of a variety of perennial and annual plant species.

Comment: Page 1, Paragraph 11.

Response: The grasshopper mouse (*Onychomys torridus*) is both carnivorous and insectivorous.

Comment: Page 1, Paragraph 12.

Response: The paragraph has been rewritten to incorporate your suggestion and clarify references to the presence of selenium. Staff is not certain of the existence of selenium; the area in question is devoid of vegetation except for selenium-tolerant plants, such as squaw cabbage (*Caulanthis crassicaulis*) and little trumpet (*Eriogonum tricopes*). On these bases it was speculated that the particular forb inclusion may owe its existence to a high amount of selenium in the soil. On the bases of previous experience, it is also speculated that the source of the selenium is local soil parent material.

Comment: Page 2, Paragraph 1.

Response: Text has been corrected.

Comment: Page 2, Paragraph 2.

Response: Text has been corrected and pertinent references modified accordingly.

Comment: Page 2, Paragraph 3.

Response: It is true that rehabilitation of most of the site can begin soon after completion of the well. However, recovery times in desert vegetation communities are extremely slow, requiring hundreds of years (see vegetation section). Therefore, full recovery of the well site would not occur for years after the geothermal resources are exhausted.

Comment: Page 2, Paragraph 7.

Response: Text has been corrected.

Comment: Page 3, Paragraph 1.

Response: The cited GRO Order reference has been incorporated into the text. Text has been modified to indicate that the mitigating measure would be considered when such an action is proposed by the lessee.

Comment: Page 3, Paragraph 2.

Response: In view of previous and following corrections, staff feels above-mentioned sentence is repetitious and it has been deleted from the text.

Comment: Page 3, Paragraph 3.

Response: Suggestion has been accepted and material deleted from the text.

Comment: Page 3, Paragraph 4.

Response: The cited GRO Order reference has been incorporated into the text.

Comment: Page 3, Paragraph 5.

Response: The cited GRO order reference has been incorporated into the text.

Comment: Page 3, Paragraph 6.

Response: The cited GRO Order reference has been incorporated into the text.

Comment: Page 3, Paragraph 7.

Response: Text has been modified to indicate that the mitigating measure would be considered when such an action is proposed by the lessee.

Comment: Page 3, Paragraph 8.

Response: Text has been modified to indicate that the mitigating measure would be considered when such an action is proposed by the lessee.

Comment: Page 3, Paragraph 9.

Response: Text has been modified to indicate that the mitigating measure would be considered when such an action is proposed by the lessee.

Comment: Page 3, Paragraph 10.

Response: Staff feels that the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage. The cited GRO Order reference has been incorporated into the text.

Comment: Page 3, Paragraph 11.

Response: Staff feels that the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage. The cited GRO Order reference has been incorporated into the text.

Comment: Page 3, Paragraph 12.

Response: The paragraph has been deleted from text.

Comment: Page 3, Paragraph 13.

Response: Staff feels that the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage.

Comment: Page 3, Paragraph 14.

Response: The cited GRO Order reference has been incorporated into the text.

Comment: Page 3, Paragraph 15.

Response: The paragraph has been rewritten to reflect the information in the cited GRO Order reference. Staff feels that wildlife and primitive values in the identified critical sensitivity zone are such that the proposed mitigation measure should be made known prior to the award of a lease and the Plan of Operation approval stage. In addition, the most effective attenuation measure for noise is distance (for every doubling of the distance from the source there is a corresponding decrease of 6dBA). This necessitates extensive areas of exclusion to protect high resource values.

Comment: Page 4, Paragraph 1.

Response: Staff feels that adoption of these measures would provide significant protection for the wildlife resources in the area and would limit the area available for certain geothermal activities. This is entirely in keeping with the multiple use concept.

Comment: Page 4, Paragraph 2.

Response: This paragraph has been removed from the text.

Comment: Page 4, Paragraph 3.

Response: Seismological exploration would be limited timewise to minimize disturbance to wildlife species in areas not considered highly sensitive to noise but which still have significant values that require protection.

Comment: Page 4, Paragraph 4.

Response: Staff feels that, unless it is unfeasible, the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage. Text is modified to reflect the above.

Comment: Page 4, Paragraph 5.

Response: Staff feels that the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage. The cited GRO Order reference has been incorporated into the text.

Comment: Page 4, Paragraph 6.

Response: Staff feels that the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage.

Comment: Page 4, Paragraph 7.

Response: Text has been modified to indicate that the mitigating measure would be considered when such an action may result from a proposal by the lessee.

Comment: Page 4, Paragraph 8.

Response: Staff feels that the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage.

Comment: Page 4, Paragraph 9.

Response: Text has been modified to indicate that the mitigating measure would be considered when such an action is proposed by the lessee.

Comment: Page 4, Paragraph 10.

Response: Staff feels that the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage. The cited GRO Order reference has been incorporated into the text.

Comment: Page 4, Paragraph 11.

Response: Comment has been incorporated into the text.

Comment: Page 4, Paragraph 12.

Response: Staff feels that the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage.

Comment: Page 4, Paragraph 13.

Response: The paragraph has been deleted from the text.

Comment: Page 4, Paragraph 14.

Response: The paragraph has been deleted from the text.

Comment: Page 4, Paragraph 15.

Response: Text has been modified to indicate that the mitigating measure would be considered when such an action is proposed by the lessee.

Comment: Page 4, Paragraph 16.

Response: Text has been modified to indicate that the mitigating measure would be considered when such an action is proposed by the lessee.

Comment: Page 5, Paragraph 1.

Response: Staff has modified the text to indicate that material of complimentary rather than matching coloration may be utilized. Staff feels that this response, in conjunction with that for the comment on Page 5, Paragraph 3, would serve to reduce the potential financial burden.

Comment: Page 5, Paragraph 2.

Response: Text has been modified to indicate that the mitigating measure would be considered when such an action is proposed by the lessee.

Comment: Page 5, Paragraph 3.

Response: Text has been modified to incorporate the suggestion.

Comment: Page 5, Paragraph 4.

Response: The cited GRO Order reference has been incorpoarted into the text.

Comment: Page 5, Paragraph 5.

Response: Staff feels that the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage.

Comment: Page 5, Paragraph 6.

Response: Staff feels that the proposed mitigation measures are particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage.

The conflict on height of pipelines above ground surface has been resolved and the text corrected to so indicate.

Comment: Page 5, Paragraph 7.

Response: Staff feels that the proposed mitigation measures are particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage.

Comment: Page 5, Paragraph 8.

Response: Staff is not aware of any animals in the EAR area whose migration pattern would be curtailed by fencing.

Comment: Page 5, Paragraph 9.

Response: Text has been modified to indicate that the mitigating measure would be considered when such an action is considered by the lessee.

Comment: Page 5, Paragraphs 10, 11.

Response: It is the staff's interpretation that Section 18 of the standard lease terms would not provide for compliance with present antiquities legislation. Also, the staff does not feel that inclusion of the word professional as well as qualified severely limits the manpower pool that might accomplish the task. This measure merely insures that professional standards are maintained and that the work is accomplished in a professional manner. For the most part all professionals are qualified but not all those who profess to be qualified are necessarily so. To judge qualifications, rigid standards have been established but are only now in the implementation stage. At the present time, professionals working through a recognized institution or agency leave much less margin for error, and such contracting agencies and institutions are numerous in California.

Comment: Page 5, Paragraph 12.

Response: Staff feels that the proposed mitigation measure is particularly applicable to this area and as such should be made known prior to the award of a lease and the Plan of Operation approval stage.

Comment: Page 5, Paragraph 13.

Response: Mitigation measures as they pertain to ORV use are designed to neither encourage or discourage this use, but rather to maintain levels as indicated in the area's Management Framework Plan (U.S. Dept. Interior, 1976).

Text has been modified to reflect provisions outlined in GRO Order Number 4, Section 3.

Southern California
AIR POLLUTION CONTROL DISTRICT
DISTRICT HEADQUARTERS
9420 TELSTAR AVENUE. EL MONTE. CALIFORNIA 91731 • (213) 443-3931

June 7, 1976
File No. A60518

Mr. Delmar D. Vail
Manager, Riverside District
Bureau of Land Management
1695 Spruce Street
Riverside, California 92507

Dear Mr. Vail:

We have reviewed the Draft Environmental Analysis Record for Proposed Geothermal Leasing in the Randsberg - Spangler Hills - South Searles Lake areas and are pleased to offer these comments on the air quality aspects of the project.

Although the draft EAR qualitatively describes, in a highly general way, the potential air pollution sources and effects of geothermal exploration and development in the three areas it fails to provide any quantitative estimates of air pollutant emissions from project development and operation on which to base on evaluation of impacts on the air environment.

If, as stated on page 1-11, a 50 megawatt electric generating plant on a 2560 acre lease is used as the model for development intensity in this EAR it follows that emission data from existing geothermal plants of like size could be used as a starting point for estimating emissions from the plant under consideration. Adjustments then could be made for assumed differences between the model and actual plants.

Estimates of pollutant emissions should include those from all anticipated sources during the exploration, development and operational phases of the project. For example, the emissions from construction and drilling equipment, vehicles and all other fuel burning equipment used in the various phases should be calculated and listed in the EAR. Admittedly, certain assumptions will have to be made as to types and quantities of gases and particulates released to the atmosphere from the geothermal fluids, however, such data are available from existing projects and could be used as a basis for making reasonable assumptions for this project.

In Section 4.2.5, Mitigating Measures, it is recommended that the sentence, "All available technology should be encouraged to maintain air quality to standards set by - - - ", be changed by substituting the word, "required" for "encouraged".

In summary we feel that this draft EAR, because of its lack of specificity and quantitative data on air pollutant emissions, is inadequate as a document for evaluating the potential impacts on air quality from the proposed geothermal power plant.

If you have any questions regarding these comments please call me at 213-443-3931, Ext.238 or Thomas Mullins at 213-443-3931, Ext.241.

Very truly yours,

J. A. Stuart
Chief Air Pollution Control Officer

Alan K. Stazer

Alan K. Stazer
Senior Air Pollution Analyst
Head, Impact Analysis Section

AKS:jc

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD
FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS,
SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Alan K. Stazer, Southern California Air Pollution Control District, District Headquarters, El Monte, California.

Comment: Page 1, Paragraph 3.

Response: At the present time there are no operating geothermal power plants of the type included in the EAR model, either in terms of generating capacity or type of resource utilized. The Geysers in California is a producing field; however, a vapor-dominated system exists there. The system associated with the EAR area is considered to be a hot water system. On these bases, the staff does not feel that a more than generalized discussion of emissions is valid at this time or that realistic quantitive estimates of emissions are possible. It should be noted, also, that applicable regulations and GRO orders will be enforced during all phases of project development and operation.

Comment: Page 2, Paragraph 1.

Response: A geothermal EAR includes an assumed model of development which may be somewhat generalized. Staff does not feel that valid or realistic estimates of vehicle and construction equipment pollutant emissions are possible at this time. For example, attempts to estimate the number of construction and/or service vehicles associated with, say, power plant construction over a period of time that is itself a gross estimation would lead to the calculation of data that would be extremely speculative and widely open to disagreement. In addition, there is no way of determining at what time in the future development activities may take place. It is possible, for example, that development activities would not occur for up to a few years, in which case future fuel combustion technology may be significantly different from that of existing technology.

Comment: Page 2, Paragraph 2.

Response: Text has been modified to reflect the recommendation.

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P. O. BOX 2711
LOS ANGELES, CALIFORNIA 90053

SPLED-E

4 June 1976

Mr. Delmar D. Vail
District Manager
Riverside District Office
Bureau of Land Management
1695 Spruce Street
Riverside, California 92507

Dear Mr. Vail:

This is in response to a letter from your office dated 30 April 1976, file number 1122 (C-061.3), which requested review and comment on the draft environmental analysis record for the Proposed Geothermal Leasing in the Randsburg-Spangler Hills-South Searles Lake Areas of California.

The proposed plan does not conflict with existing or authorized plans of the Corps of Engineers. We have no comments concerning the environmental report for this proposed action.

Thank you for the opportunity to review and comment on this draft report.

Sincerely yours,

GARTH A. FUQUAY
Chief, Engineering Division

STATE OF CALIFORNIA—RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
LAHONTAN REGION

2092 LAKE TAHOE BOULEVARD
P.O. BOX 14367
SOUTH LAKE TAHOE, CALIFORNIA 95702
(916) 544-3481

June 8, 1976

Mr. Delmar D. Vail, District Manager
Bureau of Land Management
Riverside District Office
1695 Spruce Street
Riverside, CA 92507

Dear Mr. Vail:

RE: ENVIRONMENTAL ANALYSIS RECORD (EAR) - PROPOSED GEOTHERMAL LEASING FOR RANDSBURG, SPANGLE, HILLS, AND SOUTH SEARLES LAKE AREAS

We have reviewed the above-mentioned EAR. The California Regional Water Quality Control Board, Lahontan Region, is the State agency responsible for the control of waste discharges in the Mojave area. To enable the Regional Board to carry out its responsibilities, the law makes it mandatory that any person discharging or proposing to discharge waste within any region file with the Regional Board of that region a report of waste discharge. The law provides that the Regionl Board, after a public meeting, shall prescribe requirements as to the nature of the existing or proposed discharge with relation to the conditions to be maintained in the disposal area.

On May 8, 1975, the Lahontan Regional Board adopted the Water Quality Control Plan for the South Lahontan Basin of which the proposed project areas outlined in this EAR are a part. The Plan establishes beneficial uses for the waters of the hydrologic units encompassing the proposed project areas. Please refer to the Plan for a description of these beneficial uses. Waste discharge requirements prescribed by the Regional Board for discharges in these hydrologic units will reflect its concern for the protection of these beneficial uses.

Potential adverse impacts to water quality resulting from this type of operation include those resulting from reinjection of wastewater, percolation of toxic drilling muds and other wastewater, and the discharge of waste to surface waters as a result of construction activities. The mitigation measures outlined in this EAR to protect water quality are too general in nature to enable this agency to determine if water quality will be protected. The Regional Board will require a report of waste discharge be filed for each of these proposed projects, and the Regional Board will require that they contain all plans and specifications to be taken to protect water quality. This will enable the Regional Board to more fully evaluate the potential impacts of these projects on water quality. Although the report of waste discharge must contain specific mitigation measures, we believe the EAR also should provide more detail as to the toxic nature of drilling muds and its disposal, as well as contingencies to control geothermal waters in the event of a blowout during drilling.

Any activity in the vicinity of surface waters will be carefully scrutinized in view of its limited quantity in this area. In any event, the Regional Board, by adoption of waste discharge requirements, will not allow waste discharges to occur which could degrade surface or ground water quality.

If you have any questions concerning this matter, please contact William E. Davis or William D. Winchester of our South Lake Tahoe office at (916) 544-3481.

Very truly yours,

for ROY C. HAMPSON
EXECUTIVE OFFICER

cc: Division of Planning and Research

RESPONSE TO COMMENTS ON DRAFT ENVIRONMENTAL ANALYSIS RECORD FOR PROPOSED GEOTHERMAL LEASING IN THE RANDSBURG, SPANGLER HILLS, SOUTH SEARLES LAKE AREAS, CALIFORNIA

Comments from: Roy C. Hampson, California Regional Water Quality Control Board - Lahontan Region, South Lake Tahoe, California.

- -

Comment: Page 1, Paragraghs 2, 3.

Response: Where appropriate, staff has modified the text to indicate those operating regulations (GRO Orders) which would be enforced to insure environmentally acceptable methods of drilling, completing, plugging and abandoning well borings. These regulations address, among others, methods of reinjection, casing, and waste discharge. An approved Plan of Operation would be required before any of these activities are allowed to occur.

The text in Chapter 3 has been modified to incorporate a discussion of drilling fluid toxicity and plans for well blowout prevention and control.

Chapter 4 has been modified to indicate which Federal regulations are applicable to insure adequate treatment of any toxic materials found in drilling fluids prior to backfilling of the mud pit.

COUNTY OF ORANGE

ENVIRONMENTAL MANAGEMENT AGENCY
811 NORTH BROADWAY
SANTA ANA, CALIFORNIA

TELEPHONE: 834-5678
AREA CODE 714

MAILING ADDRESS:
P.O. BOX 4048
SANTA ANA, CALIFORNIA 92702

H. G. OSBORNE
DIRECTOR

June 9, 1976

FILE 215

District Manager
Bureau of Land Management
Riverside District
1695 Spruce Street
Riverside, California 92507

Thank you for including the County of Orange on your mailing list for the "Draft Environmental Analysis Record, Proposed Geothermal Leasing, Randsburg, Spangler Hills and South Searles Lake Areas", dated April 1976.

The document has been reviewed with interest, however, in our opinion, the anticipated impacts will not have a significant impact on the County or its operation.

Even though the County does not appear to be directly impacted by the project, we would appreciate receiving a copy of your final document for our files.

Thank you for your courtesy and cooperation.

Very truly yours,

H. G. Osborne
Director

JEB:bl

cc: ESD Project File
Reading File

11.0 PARTICIPATING STAFF

The following personnel participated in the preparation of this Environmental Analysis Record:

BUREAU OF LAND MANAGEMENT

RIVERSIDE DISTRICT OFFICE

John W. Bosworth	-	Natural Resource Specialist
Arlene F. Brooks	-	Cartographer
David G. Cone	-	Natural Resource Specialist
Allen Y. Cooperrider	-	Wildlife Biologist
Mark A. Dimmitt	-	Zoologist
William L. Duncanson	-	Landscape Architect
Donald H. Heinze	-	Range Conservationist
John L. Heywood	-	Recreation Specialist
Donn K. Hicks	-	Wildlife Biologist
Elizabeth A. Johns	-	Clerk Typist
Boma Johnson	-	Archaeologist
Wayne H. King	-	Desert Ranger
Lewis W. Kirkman	-	Desert Ranger
Randall P. Legler, Jr.	-	Ranger/Wildlife Biologist
Terry R. Loyer	-	Outdoor Recreation Planner
John T. Mezes	-	Realty Specialist
Karen H. Miller	-	Public Information Specialist
Leroy M. Mohorich	-	Geologist
David E. Reeder	-	Ranger/Wildlife Biologist
Andrew J. Regis	-	Mining Engineer
Eric W. Ritter	-	Archaeologist
Stanton D. Rolf	-	Ranger/Archaeologist
Andrew C. Sanders	-	Wildlife Biologist
J. Craig Taggart	-	Landscape Architect

BAKERSFIELD DISTRICT OFFICE

Helen F. Clough	-	Archaeologist
Joanne K. MacGregor Hanifan	-	Ranger/Archaeologist

CALIFORNIA STATE OFFICE

Dale E. Bays	-	Economist
Susan Grobman	-	Technical Writer/Editor
Douglas Kleinsmith	-	Natural Resource Specialist
William H. Olsen	-	Archaeologist

CALIFORNIA STATE OFFICE (Con't)

Garth Portillo	-	Archaeologist
Clara Stapp	-	Cartographer

U. S. GEOLOGICAL SURVEY

Jack Crowley	-	Office of Area Geologist
Larry P. Bauer	-	Office of Area Geothermal Supervisor
G. I. Smith	-	Geologic Division, Western Region

APPENDIX A

APPENDIX A-1

SPECIES LIST
ALL PHASES OF THE CREOSOTE BUSH SCRUB COMMUNITY

Botanical Binomial	Common Name(s)	% Presence
	SHRUBS	
Larrea tridentata	creosote bush	100
Ambrosia dumosa	bursage, burrobush	99
Hymenoclea salsola	cheesebush	77
Grayia spinosa	(spiny) hopsage	74
Lycium andersonii	boxthorn, Anderson thornbush	62
Haplopappus cooperi	goldenbush, Cooper goldenbush	54
Tetradymia stenolepis	Mojave horsebush	47
Acamptopappus Sphaerocephalus	goldenhead	40
Eurotia lanata	winterfat, whitesage	36
Ephedra nevandensis	Mormon tea, Nevada joint fir	34
Salazaria mexicana	bladder-sage, paper bag sage	34
Cassia armata	desert senna, desert cassia	26
Eriogonum fasiculatum	California buckwheat	29
Stephanomeria pauciflora	desert milk-aster, desert straw	19
Dalea fremontii	indigo bush, Fremont dalea	18
Lycium cooperi	boxthorn, peachthorn	16
Atriplex polycarpa	saltbush, allscale, cattle spinach	14
Acamptopappus shockleyi	goldenhead	13
Atriplex hymenoclea	desert holly	12
Lepidium fremontii	desert-alyssum	12
Chrysothamnus teretifolius	rock rabbitbrush, teret leaf rabbit brush	9
Atriplex confertifolia	shadscale	9
Peucephyllum schottii	pigmy-cedar, desert fir	6
Ephedra viridus	Mormon tea, mountain joint fir	5
Yucca brevifolia	joshua tree	3
Isomeris arborea	bladderpod	3
Encelia virginensis	brittlebush	2
Atriplex canescens	four wing, saltbush, wingscale	2
Chrysothamnus nauseosus	rubber rabbitbrush	2
Prunus fascicutata	desert almond	1
Haplopappus linearifolius	goldenbush, linear leaf goldenbush	1
Coleogyne ramosissima	blackbrush	1
	GRASSES	
Stipa speciosa	desert needlegrass	46
Bromus rubens	red brome	36
Scismus arabicus	Arabian grass, hair grass	24
Oryzopsis hymenoides	Indian ricegrass, sand bunchgrass	20
Bromus tectorum	cheatgrass, broncograss	15
Poa scabrella	Malpais bluegrass, pine bluegrass	14
Bouteloua barbata	sixweeks grama	5

Botanical Binomial	Common Name(s)	% Presence
	GRASSES (Continued)	
Sitanion hystrix	squirreltail grass	4
Poa annua	annual bluegrass	2
Avena fatua	wild oats	1
	CACTI	
Opuntia echinocarpa	silver cholla, thorny-fruited cactus	28
O. basilaris	beavertail cactus	9
Echinocactus polycephalus	niggerheads, cottontop	9
	FORBS	
Amsinkia tessulata	fiddleneck, checker fiddleneck	75
Mirabilis bigelovii	white wishbone, wishbone bush, four o'clock	60
Erodium cicutarium	filaree, afilaria	53
Eriogonum inflatum	desert trumpet	48
Machaeranthera tortifolia	desert aster	45
Eriogonum deflexum	skeltonweed	30
Oxytheca perfoliata	saucer plant, punctured bract	24
Chaenactis fremontii	pincushion flower, Fremont pincushion	24
Eriogonum pusillum	buckwheat, yellow turban	21
Cryptantha micrantha	(purple rooted) forget-me-not	18
Oenothera detoides	desert-primrose, devil's lantern, lion in a cage	16
Phacelia sp.	phacelia, wild-heliotrope	15
Eriogonum sp.	buckwheat	12
Salvia columbariae	chia	10
Chorizanthe rigida	rigid spiny herb	10
Eriogonum nidularium	bird's foot buckwheat, whisk broom	8
E. tricopes	little trumpet	7
Caulanthus inflatus	desert candle, squaw cabbage	7
Camissonia boothii	bottle cleaner, woody bottle washer	6
C. claviformus	brown eyed primrose	6
Lepidium flavum	peppergrass, yellow peppergrass	5
Mentzelia albicaulis	(small flowered) blazing star	5
Euphorbia polycarpa	(small seeded) sand-mat	5
Eschscholzia glyptosperma	desert golden poppy	5
Salsola iberica	Russian thistle	4
Cusuta denticulata	(toothed) dodder	4
Plantago insularis	plantain, desert indianwheat	4
Langloisia matthewsii	desert calico	4
Mentzelia sp.	blazing star	3
Sphaeralcea ambigua	desert globemallow, apricot mallow	3
Geraea canescens	desert sunflower	3

APPENDIX A-1 (Cont.)

Botanical Binomial	Common Name(s)	% Presence
	FORBS (Continued)	
Gilia sp.	gilia	3
Delphinium parishii	larkspur, Parish larkspur	2
Astragalus sp.	loco weed, milk vetch	2
Eschscholtzia minutiflora	little golden poppy	2
Mentzelia nitens	blazing star, Venus blazing star	2
Stillinga linearifolia	stillinga	1
Sisymbrium sp.	tansey mustard	1
Lupinus sp.	lupine	1
Penstemon thurberi	Thurber penstemon	1
Malvastrum rotundiflora	desert five spot, lantern flower, Chinese lantern	1
Chorizanthe brevicornu	chorizanthe, brittle spine-flower	1
Salvia carduacea	thistle sage	1

APPENDIX A-2

SPECIES LIST
TRANSITIONAL SHRUBLAND COMMUNITY

Botanical Binomial	Common Name(s)	% Presence
	SHRUBS	
Larrea tridentata	creosote bush	96
Hymenoclea salsola	cheesebush	92
Ambrosia dumosa	bursage, burrobush	87
Lycium andersonii	boxthorn, Anderson boxthorn	83
Grayia spinosa	(spiny) hopsage	79
Tetradymia stenolepis	Mojave horsebrush	63
Eurotia lanata	winterfat, white sage	63
Haplopappus cooperi	goldenbush, Coopers goldenbush	54
Ephedra nevadensis	Mormon tea, Nevada joint fir	46
Atriplex polycarpa	saltbush, allscale, cattle spinach	46
Eriogonum fasiculatum	California buckwheat	46
Stephanomeria pauciflora	desert milk-aster	42
Salazaria mexicana	bladdersage, paper bag bush	38
Acamptopappus sphaerocephalus	goldenhead	33
Peucephyllum schottii	pigmy cedar, desert fir	25
Lycium cooperi	boxthorn, peachthorn	25
Atriplex confertifolia	shadscale	17
Dalea fremontii	indigo bush, fremont dalea	17
Lepidium fremontii	desert alyssum	17
Yucca brevifolia	joshua tree	13
Chrysothamnus teretifolius	rock rabbit brush, teret leafed rabbitbrush	13
Ephedra viridus	Mormon tea, mountain joint fir	13
Isomeris arborea	bladderpod	8
Cassia armata	desert senna, desert cassia	8
Brickellia desertorum	desert brickellia	4
Atriplex spinescens	spiny saltbush	4
A. canescens	fourwing saltbush	4
Chrysothamnus nauseosus	rubber rabbitbrush	4
Artemesia spinescens	bud sagebrush	4
Encelia virginensis	brittlebush	4
	CACTI	
Opuntia echinocarpa	silver cholla, thorny fruited cactus	29
O. basilaris	beavertail cactus	8
	GRASSES	
Stipa speciosa	desert needlegrass	63
Poa scabrella	Malpais bluegrass	46
Bromus rubens	red brome	42
B. tectorum	cheatgrass; bronco grass	33

APPENDIX A-2 (Cont.)

Botanical Binomial	Common Name(s)	% Presence
	GRASSES (Continued)	
Schismus arabicus	Arabian grass	21
Oryzopsis hymenoides	Indian ricegrass, sand bunchgrass	17
Sitanion hystrix	squirreltail grass	8
Bouteloua barbata	sixweeks grama	8
Poa annua	annual bluegrass	4
	FORBS	
Amsinkia tessulata	fiddleneck, checker fiddleneck	79
Mirabilis bigelovii	white wishbone, wishbone bush, four o'clock	63
Machaeranthera tortifolia	desert aster	54
Eriogonum inflatum	desert trumpet	54
Erodium cicutarium	filaree, afilaria	38
Eriogonum deflexum	skeletonweed	38
Eriogonum pusillum	buckwheat, yellow turban	25
Camissonia claviformus	browneyed primrose	21
Oenothera deltoides	desert primrose, devil's lantern, lion in a cage	16
Cryptantha micrantha	forget-me-not	16
Chaenactis fremontii	pincushion, Fremont's pincushion	16
Phacelia sp.	phacelia, wild heliotrope	13
Oxytheca perfoliata	saucer plant, punctured bract	13
Mentzelia albicaulus	(small flowered) blazing star	8
Salsola iberica	Russian thistle	8
Eriophyllum sp.	eriophyllum	8
Dyssodia sp.	dyssodia	4
Astragalus sp.	locoweed, milk vetch	4
Caulanthus inflatus	squaw cabbage, desert candle	4
Eremocarpus setigerus	dove weed	4
Eschscholtzia glyptosperma	desert golden poppy	4

APPENDIX A-3

SPECIES LIST
SHADSCALE SCRUB COMMUNITY

Botanical Binomial	Common Name(s)	% Presence
	SHRUBS	
Atriplex hymenoclea	desert holly	100
A. confertifolia	shadscale	84
Ambrosia dumosa	bursage, burro bush	80
Suaeda torreyana	inkweed, Torrey sea-blight, iodine weed	68
Atriplex polycarpa	saltbush, allscale, cattle spinach	52
Lepidium fremontii	desert-alyssum	52
Larrea tridentata	creosote bush	52
Hymenoclea salsola	cheesebush	28
Dalea fremontii	indigo bush, Fremont dalea	16
Atriplex parryi	Parry saltbush	12
Petalonyx thurberi	(Thurber's) sandpaper plant	12
Acamptopappus schaerocephalus	goldenhead	8
Ephedra nevadensis	Mormon tea, Nevada joint fir	8
Cassia armata	desert senna, desert cassia	8
Amphipappus fremontii	eytelia	4
Atriplex canescens	fourwing saltbush, wingscale	4
Lysium andersonii	boxthorn, Anderson's boxthorn	4
Chrysothamnus nauseosus	rubber rabbitbrush	4
Isomeris arborea	bladder pod	4
	GRASSES	
Orhyzopsis hymenoides	Indian ricegrass, sand bunchgrass	8
Shismus arabicus	Arabian grass	4
	CACTI	
Opuntia echinocarpa	silver cholla, thorny fruited cactus	28
O. basilaris	beavertail cactus	8
	FORBS	
Chorizanthe rigida	rigid spiny herb	36
Geraea canescens	desert sunflower	36
Amsinkia tessulata	fiddleneck, checker fiddleneck	28
Eschsolzia glyptosperma	desert golden poppy	24
E. minutiflora	little golden poppy	20
Oenothera deltoides	desert primrose, devils lantern	20
Camissonia boothii	bottle cleaner, woody bottle washer	20
Lepidium flavum	peppergrass, yellow peppergrass	20
Oenothera sp.	evening primrose	16
Langloisia matthewsii	desert calico	16

APPENDIX A-3 (Cont.)

Botanical Binomial	Common Name(s)	% Presence
	FORBS (Continued)	
Oligomeris linifolia	oligomeris	16
Eriogonum cicutarium	filaree, afilaria	16
Dicoria canescens	bugseed, dicoria, desert dicoria	12
Mentzelia nitens	blazing star, Venus blazing star	12
M. species	blazing star	12
Plantago insularus	plantain, desert plantain	12
Malvastrum rotundifolium	desert five spot, desert lantern	12
Chaenactis fremontii	pincushion flower, Fremont pincushion	12
Cryptantha micrantha	(purple rooted) forget-me-not	12
Eriogonum deflexum	skeletonweed	8
E. inflatum	desert trumpet	8
E. pusillum	buckwheat, yellow turban	8
Camissonia claviformus	brown eyed primrose	8
Psathyrotes annua	fan leaf	8
Erigeron sp.	fleabune	8
Atriplex phyllostegia	arrow scale	8
Salsola iberica	Russian thistle	8
Eriogonum nidularium	bird's foot buckwheat	4
Astragulus sp.	loco weed, milkvetch	4
Abronia villosa	desert sandverbena	4
Mirabilis bigelovii	white wishbone, wishbone bush, four o'clock	4

APPENDIX A-4

SPECIES LIST
ALKALI SINK COMMUNITY

Botanical Binomial	Common Name(s)	% Presence
	SHRUBS	
Atriplex polycarpa	saltbush, allscale, cattle spinach	82
Acamptopappus sphaerocephalus	goldenhead	59
Atriplex confertifolia	shadscale	47
Lycium andersonii	boxthorn, Anderson boxthorn	41
Ambrosia dumosa	bursage, burrobush	41
Eurotia lanata	winterfat, white sage	24
Hymenoclea salsola	cheesebush	24
Lycium cooperi	boxthorn	18
Lepidium fremontii	desert alyssum	18
Artemesia spinescens	bud sagebrush	12
Tetradymia glabrata	littleleaf horsebrush	12
Grayia spinosa	(spiny) hopesage	12
Haplopappus cooperi	goldenbush, Cooper goldenbush	12
Tetradymia stenolepis	Mojave horsebrush	6
Peucephyllum schottii	pigmy cedar	6
Chrysothamnus naseosus	rubber rabbitbrush	6
C. teretifolius	rock rabbitbrush, teret leaf rabbitbrush	6
	GRASSES	
Oryzopsis hymenoides	Indian ricegrass, sand bunchgrass	47
Schismus arabicus	Arabian grass	41
Stipa speciosa	desert needlegrass	6
Bromus tectorum	cheatgrass, bronco grass	6
	FORBS AND CACTI	
Erodium cicutarium	filaree, afilaria	41
Salsola iberica	Russian thistle	41
Amsinkia tessulata	fiddleneck, checker fiddleneck	18
Eriogonum sp.	buckwheat	18
Opuntia echinocarpa	silver cholla, thorny fruited cactus	18
Phacelia sp.	phacelia, wild heliotrope	18
Astragalus sp.	locoweed, milk vetch	12
Oenothera sp.	evening primrose	12
Eriogonum niduarium	bird's nest buckwheat	6
Stanleya pinnata	prince's plume	6

APPENDIX B

APPENDIX B - SIGNIFICANT ANIMAL SPECIES BY HABITAT TYPES

A=abundant
C=common
U=uncommon
P=present but relative
abundance undetermined

O-observed
H=hypothetical

COMMON NAME AND SCIENTIFIC NAME	ALKALI SINK	CREOSOTE-FANS AND FLATS	CREOSOTE-ROCKY SLOPES	TRANSITIONAL SHRUBLAND	WASHES	SHADSCALE SHRUB	SEC. INTERIOR'S ENDANGERED LIST	SEC. INTERIOR'S THREATENED LIST	CALIFORNIA DEPT. OF FISH AND GAME ENDANGERED	CALIFORNIA DEPT. OF FISH AND GAME - RARE	CALIFORNIA DEPT. OF FISH AND GAME FULLY PROTECTED	PARTIALLY PROTECTED SPECIES	BLUE LIST OF DIMINISHING BIRDS	COMMENTS
AMPHIBIANS														
None														
REPTILES														
Desert Tortoise (_Gopherus_ _agassizi_)	U-O	U-O	U-O		U-H	U-O					X			
Banded Gecko (_Coleonyx_ _variegatus_)	U-O	C-O	C-O	C-O	C-O	U-H						X		
Desert Iguana (_Dipsosaurus_ _dorsalis_)	U-O	C-O			C-H	U-O						X		
Chuckwalla (_Sauromalus_ _obesus_)			C-O	C-H								X		
Zebra-tailed Lizard (_Callisaurus_														
draconoides)	C-H	A-O	U-O	U-H	C-H	A-O								
Collared Lizard (_crotaphytus_ _collaris_)		U-O	U-O	U-H	U-H							X		
Leopard Lizard (_Crotaphytus_ _wislizenii_)	U-H	U-O	U-O	U-H	U-H							X		
Spiny Lizard (_Sceloporus_ _magister_)	U-H	U-O	C-O	C-H	U-H									
Side-potched Lizard (_Uta_ _stansburiana_)	C-O	A-O	A-O	C-O	A-O	A-O								
Brush Lizard (_Urosaurus_ _graciosus_)		C-H	U-H		C-H									
Desert Horned Lizard (_Phrynosoma_														
platyrhinos)	U-H	C-O	U-O		U-H	U-O						X		

APPENDIX B (Cont.)

COMMON NAME AND SCIENTIFIC NAME	ALKALI SINK	CREOSOTE-FANS AND FLATS	CREOSOTE-ROCKY SLOPES	TRANSITIONAL SHRUBLAND	WASHES	SHADSCALE SHRUB	SEC. INTERIOR'S ENDANGERED LIST	SEC. INTERIOR'S THREATENED LIST	CALIFORNIA DEPT. OF FISH AND GAME ENDANGERED	CALIFORNIA DEPT. OF FISH AND GAME - RARE	CALIFORNIA DEPT. OF FISH AND GAME FULLY PROTECTED	PARTIALLY PROTECTED SPECIES	BLUE LIST OF DIMINISHING BIRDS	COMMENTS
REPTILES (Continued)														
Desert Night Lizard (Xantusia														
vigilis)		U-O	C-O	C-H	U-H									
Whiptail (Cnemidophorus tigris)	U-O	C-O	C-O	U-H	C-O	U-O								
Western Blind Snake (Leptotyphlops														
humilis)	P-H	P-H	P-H	P-H	P-H									
Rosy Boa (Lichanura trivirgata)			U-O	U-O	U-O							X		
Red Racer (Masticophis flagellum)	U-H	C-O	C-H	C-H	C-H	U-H								
Patchnosed Snake (Salvadora														
hexalepis)	U-H	U-O	U-H	U-H	U-H	U-H								
Glossy Snake (Arizona elegans)	U-H	C-O	U-O	U-H	C-H	U-H								
Gopher Snake (Pituophis melanoleucus)	U-H	U-O	U-H	U-H	U-H	U-O								
California Kingsnake (Lampropeltis														
getulus)	U-H	U-O	U-H	U-H	U-H	U-O						X		
Long-nosed Snake (Rhinocheilus														
lecontei)	U-H	U-O	U-H	U-H	U-H	U-H								

APPENDIX B (Cont.)

COMMON NAME AND SCIENTIFIC NAME	ALKALI SINK	CREOSOTE-FANS AND FLATS	CREOSOTE-ROCKY SLOPES	TRANSITIONAL SHRUBLAND	WASHES	SHADSCALE SHRUB	SEC. INTERIOR'S ENDANGERED LIST	SEC. INTERIOR'S THREATENED LIST	CALIFORNIA DEPT. OF FISH AND GAME ENDANGERED	CALIFORNIA DEPT. OF FISH AND GAME - RARE	CALIFORNIA DEPT. OF FISH AND GAME FULLY PROTECTED	PARTIALLY PROTECTED SPECIES	BLUE LIST OF DIMINISHING BIRDS	COMMENTS
REPTILES (Continued)														
Leaf-nosed Snake (<u>Phyllorhynchus</u>														
<u>decurtatus</u>)	U-H	C-H	U-H	U-H	C-H	U-H								
Shovel-nosed Snake (<u>Chionactis</u>														
<u>occipitalis</u>	U-H	C-O			U-H	U-H								
Black-headed Snake (<u>Tantilla</u>														
<u>planiceps</u>)		U-H	U-H	U-H	U-H									
Lyre Snake (<u>Trimorphodon</u> <u>biscutatus</u>)		U-H	U-H	U-H	U-H									
Night Snake (<u>Hypsiglena</u> <u>torquata</u>)		U-H	U-O	U-H	U-H									
Speckled Rattlesnake (<u>Crotalus</u>														
<u>mitchelli</u>)			U-H	U-H	U-H									
Desert Sidewinder (<u>Crotalus</u> <u>cerastes</u>)	C-H	C-O			C-H	C-O								
Mojave Rattlesnake (<u>Crotalus</u>														
<u>scutulatus</u>)	U-H	U-O	U-H	U-H	U-H	U-H								
BIRDS														
Turkey Vulture (<u>Cathartes</u> <u>aura</u>)	P-H	P-H	P-H	P-H	P-H	P-O								

COMMON NAME AND SCIENTIFIC NAME	ALKALI SINK	CREOSOTE-FANS AND FLATS	CREOSOTE-ROCKY SLOPES	TRANSITIONAL SHRUBLAND	WASHES	SHADSCALE SHRUB	SEC. INTERIOR'S ENDANGERED LIST	SEC. INTERIOR'S THREATENED LIST	CALIFORNIA DEPT. OF FISH AND GAME ENDANGERED	CALIFORNIA DEPT. OF FISH AND GAME - RARE	CALIFORNIA DEPT. OF FISH AND GAME FULLY PROTECTED	PARTIALLY PROTECTED SPECIES	BLUE LIST OF DIMINISHING BIRDS	COMMENTS
BIRDS (Continued)														
Cooper's Hawk (<u>Accipiter</u> <u>cooperi</u>)	P-H	P-H	P-H	P-H	P-H	P-H							X	
Red-tailed Hawk (<u>Buteo</u> <u>jamaicensis</u>)	P-H	C-0	P-0	P-H	P-H	P-H								
Golden Eagle (<u>Aquila</u> <u>chrysaetos</u>)	P-0	P-0	P-H	P-0	P-H	P-0					X			
Marsh Harrier (<u>Circus</u> <u>cyaneus</u>)	P-H	P-0	P-0	P-H	P-H	P-0							X	
Prairie Falcon (<u>Falco</u> <u>mexicanus</u>)	P-H	P-0	P-0	P-0	P-H	P-0							X	
American Kestrel (<u>Falco</u> <u>sparverius</u>)	P-H	P-0	P-H	P-H	P-H	P-0							X	
Gambel's Quail (<u>Lophortyx</u> <u>gambelii</u>)		U-0	C-0	C-0	U-H	U-H						X		
Chukar (<u>Alectoris</u> <u>chukar</u>)		U-0	C-0	C-0	P-H	P-H						X		
Killdeer (<u>Charadrius</u> <u>vociferus</u>)	U-H	U-H				U-H								
Mountain Plover (<u>Eupoda</u> <u>montana</u>)	U-0	U-0												
Rock Dove (<u>Columba</u> <u>livia</u>)		P-0												Around Human Dwellings.
Mourning Dove (<u>Zenaida</u> <u>macroura</u>)	C-H	U-H	U-H	U-H	U-H	U-0						X		
Roadrunner (<u>Geococcyx</u> <u>californianus</u>)	U-H	U-0	U-H	U-H	U-H									
Barn Owl (<u>Tyto</u> <u>alba</u>)	P-H	P-H	P-H	P-H	P-H								X	
Burrowing Owl (<u>Speotyto</u> <u>cunicularia</u>)	U-0	U-0			P-H	U-H								

APPENDIX B (Cont.)

COMMON NAME AND SCIENTIFIC NAME	ALKALI SINK	CREOSOTE-FANS AND FLATS	CREOSOTE-ROCKY SLOPES	TRANSITIONAL SHRUBLAND	WASHES	SHADSCALE SHRUB	SEC. INTERIOR'S ENDANGERED LIST	SEC. INTERIOR'S THREATENED LIST	CALIFORNIA DEPT. OF FISH AND GAME ENDANGERED	CALIFORNIA DEPT. OF FISH AND GAME - RARE	CALIFORNIA DEPT. OF FISH AND GAME FULLY PROTECTED	PARTIALLY PROTECTED SPECIES	BLUE LIST OF DIMINISHING BIRDS	COMMENTS
BIRDS (Continued)														
Common Poorwill (<u>Phalaenoptilus</u>														
<u>nuttalli</u>)	U-H	U-H	U-H	U-H	U-H	U-H								
Lesser Nighthawk (<u>Chordeiles</u>														
<u>acutipennis</u>)	U-H	U-H	U-H	U-H	U-H	U-H								
White-throated Swift (<u>Aeronautes</u>														
<u>saxatalis</u>)	U-H	P-H	U-H	U-H	P-H									
Anna's Hummingbird (<u>Calypte anna</u>)	P-H	P-H												
Costa's Hummingbird (<u>Calypte costae</u>)	P-H	P-H	U-H											
Common Flicker (<u>Colaptes auratus</u>)	U-H	U-0				U-H								
Western Kingbird (<u>Tyrannus verticalus</u>)	P-H	U-H			P-H									
Say's Phoebe (<u>Sayornis saya</u>)	C-H	C-0	U-H	U-H										
Horned Lark (<u>Eremophila alpestris</u>)	A-0	A-0	P-0	P-0										
Raven (<u>Corvus corax</u>)	C-0	C-0	C-0	C-0	C-0	C-0								
Verdin (<u>Auriparus flaviceps</u>)		U-0			U-0									
Bewick's Wren (<u>Thryomanes bewickii</u>)					U-0								X	

COMMON NAME AND SCIENTIFIC NAME	ALKALI SINK	CREOSOTE-FANS AND FLATS	CREOSOTE-ROCKY SLOPES	TRANSITIONAL SHRUBLAND	WASHES	SHADSCALE SHRUB	SEC. INTERIOR'S ENDANGERED LIST	SEC. INTERIOR'S THREATENED LIST	CALIFORNIA DEPT. OF FISH AND GAME ENDANGERED	CALIFORNIA DEPT. OF FISH AND GAME - RARE	CALIFORNIA DEPT. OF FISH AND GAME FULLY PROTECTED	PARTIALLY PROTECTED SPECIES	BLUE LIST OF DIMINISHING BIRDS	COMMENTS
BIRDS (Continued)														
Cactus Wren (Campylorhynchus														
brunneicapillus)		U-H			U-H									
Rock Wren (Salpinctes obsoletus)		U-O	C-O	P-H	C-H									
LeConte's Thrasher (Toxostoma														
lecontei)	U-O	U-O	U-O	U-O	U-O									
Ruby-crowned Kinglet (Regulus														
calendula)					U-H									
Loggerhead Shrike (Lanius														
ludovicianus)	C-H	C-O	C-O	P-H	C-O	C-H								
Starling (Sturnus vulgaris)		C-O												Around Human Dwellings
House Sparrow (Passer domesticus)		C-O												Around Human Dwellings
House Finch (Carpodacus mexicanus)	C-H	C-H	C-H	C-H	C-H	C-H								
Lesser Goldfinch (Spinus psaltria)	P-H	P-H	P-H	P-H	P-H									
Black-throated Sparrow (Amphispiza														
bilineata)	A-H	C-O	C-H	C-H	U-H	A-O								

APPENDIX B (Cont.)

COMMON NAME AND SCIENTIFIC NAME	ALKALI SINK	CREOSOTE-FANS AND FLATS	CREOSOTE-ROCKY SLOPES	TRANSITIONAL SHRUBLAND	WASHES	SHADSCALE SHRUB	SEC. INTERIOR'S ENDANGERED LIST	SEC. INTERIOR'S THREATENED LIST	CALIFORNIA DEPT. OF FISH AND GAME ENDANGERED	CALIFORNIA DEPT. OF FISH AND GAME - RARE	CALIFORNIA DEPT. OF FISH AND GAME FULLY PROTECTED	PARTIALLY PROTECTED SPECIES	BLUE LIST OF DIMINISHING BIRDS	COMMENTS
BIRDS (Continued)														
Sage Sparrow (Amphispiza belli)	C-O	C-O	C-H		C-O	A-O								
White-crowned Sparrow (Zonotrichia leucophrys)	C-H	C-H	C-H	C-H	C-H	C-H								
MAMMALS														
Black-tailed Jackrabbit (Lepus californicus)	C-O	C-O	C-H			C-O						X		
Cottontail (Sylvilagus audubonii)	C-H	C-H				U-H						X		
Antelope Ground Squirrel (Ammospermophilus leucurus)	C-O	C-O	C-O	C-O	C-O	C-O								
Mojave Ground Squirrel (Citellus mohavensis)	U-O	U-O			U-O	U-O				X				
Round-tailed Ground Squirrel (Spermophilus tereticaudus)	U-H	U-H												
Botta Pocket Gopher (Thomomys bottae)	C-O	C-O			C-O	C-O								

APPENDIX B (Cont.)

COMMON NAME AND SCIENTIFIC NAME	ALKALI SINK	CREOSOTE-FANS AND FLATS	CREOSOTE-ROCKY SLOPES	TRANSITIONAL SHRUBLAND	WASHES	SHADSCALE SHRUB	SEC. INTERIOR'S ENDANGERED LIST	SEC. INTERIOR'S THREATENED LIST	CALIFORNIA DEPT. OF FISH AND GAME ENDANGERED	CALIFORNIA DEPT. OF FISH AND GAME - RARE	CALIFORNIA DEPT. OF FISH AND GAME FULLY PROTECTED	PARTIALLY PROTECTED SPECIES	BLUE LIST OF DIMINISHING BIRDS	COMMENTS
MAMMALS (Continued)														
Little Pocket Mouse (<u>Perognathus</u>														
<u>longimembris</u>)	A-O	C-O	U-H			C-O								
Long-tailed Pocket Mouse (<u>Perognathus</u>														
<u>formosus</u>)	U-H	C-O	C-O	C-H	C-O	U-O								
Desert Pocket Mouse (<u>Perognathus</u>														
<u>penicillatus</u>)	P-H	P-H	P-H											
San Joaquin Pocket Mouse (<u>Perognathus</u>														
<u>inornatus</u>)	U-O													
Panamint Kangaroo Rat (<u>Dipodomys</u>														
<u>panamintinus</u>)		C-O	C-O	C-O	C-O									
Merriam's Kangaroo Rat (<u>Dipodomys</u>														
<u>merriami</u>)	C-O	C-O			C-O	C-O								
Desert Kanagroo Rat (<u>Dipodomys</u>														
<u>deserti</u>)	U-O					U-O								

COMMON NAME AND SCIENTIFIC NAME	ALKALI SINK	CREOSOTE-FANS AND FLATS	CREOSOTE-ROCKY SLOPES	TRANSITIONAL SHRUBLAND	WASHES	SHADSCALE SHRUB	SEC. INTERIOR'S ENDANGERED LIST	SEC. INTERIOR'S THREATENED LIST	CALIFORNIA DEPT. OF FISH AND GAME ENDANGERED	CALIFORNIA DEPT. OF FISH AND GAME - RARE	CALIFORNIA DEPT. OF FISH AND GAME FULLY PROTECTED	PARTIALLY PROTECTED SPECIES	BLUE LIST OF DIMINISHING BIRDS	COMMENTS
MAMMALS (Continued)														
Great Basin Kangaroo Rat (Dipodomys														
microps)	P-O					P-O								
Desert Wood Rat (Neotoma lepida)	U-H	U-O	C-O	C-O	C-O	U-O								
Grasshopper Mouse (Onychomys torridus)	C-O	U-O	U-O	U-O	U-O	U-O								
Canyon Mouse (Peromyscus crinitus)			C-O	C-O	C-O	P-O								
White-footed Mouse (Peromyscus														
eremicus)		P-H	P-H											
Deer Mouse (Peromyscus maniculatus)	U-O	C-O	C-O	C-O	C-O	C-O								
Harvest Mouse (Reithrodontomys														
megalotis)	P-H	P-O	P-O	P-H	P-H	P-H								
Coyote (Canis latrans)	C-O	C-O	C-O	C-O	C-O	C-O								
Kit Fox (Vulpes macrotis)	U-H	U-H	U-H	U-H	U-H	U-H					X			
Ringtail (Bassariscus astutus)		U-H	U-H	U-H	U-H						X			
Badger (Taxidea taxus)	U-H	U-H	U-H			U-H						X		
Spotted Skunk (Spilogale putorius)		U-H	U-H	U-H	U-H	U-H								

APPENDIX B (Cont.)

COMMON NAME AND SCIENTIFIC NAME	ALKALI SINK	CREOSOTE-FANS AND FLATS	CREOSOTE-ROCKY SLOPES	TRANSITIONAL SHRUBLAND	WASHES	SHADSCALE SHRUB	SEC. INTERIOR'S ENDANGERED LIST	SEC. INTERIOR'S THREATENED LIST	CALIFORNIA DEPT. OF FISH AND GAME ENDANGERED	CALIFORNIA DEPT. OF FISH AND GAME - RARE	CALIFORNIA DEPT. OF FISH AND GAME FULLY PROTECTED	PARTIALLY PROTECTED SPECIES	BLUE LIST OF DIMINISHING BIRDS	COMMENTS
MAMMALS (Continued)														
Bobcat (Lynx rufus)	U-H	U-H	U-H	U-H	U-H	U-H						X		
Gray Fox (Urocyon cinereoargenteus)		P-H	P-H	P-H	P-H									
California Myotis (Myotis														
californicus)	P-H	P-H	P-H	P-H	P-H	P-H								
Western Pipistrelle (Pipistrellus														
hesperus)	C-H	C-H	C-H	C-H	C-H	C-H								
Big Brown Bat (Eptesicus fuscus)	P-H	P-H	P-H	P-H	P-H	P-H								
Hoary Bat (Lasiurus cinereus)	P-H	P-H	P-H	P-H	P-H	P-H								
Desert Pallid Bat (Antrozous pallidus)	P-H	P-H	P-H	P-H	P-H	P-H								
Free-tailed Bat (Tadarida														
brasiliensis)	P-H	P-H	P-H	P-H	P-H	P-H								

APPENDIX C

APPENDIX C

CONCEPTS AND STUDY METHODOLOGY FOR AESTHETIC EVALUATION

Scenic Quality

The Bureau of Land Management's standard R.I.S. (Recreation Information System) methodology for rating scenic quality was used for this portion of the aesthetic evaluation (Table C-1).

Four landscape features (landform, water, vegetation, and man-introduced features-intrusions) are evaluated. In addition the overall aspects of color and uniqueness are evaluated. The uniqueness factor provides an opportunity to give added importance to one or all of the scenic factors. The condition of each individual factor determines its numerical score, and the sum of the individual scores determines the scenery class as indicated at the bottom of the chart. The individual numerical score for the condition of each factor as presented on the chart is not fixed but is meant to be a guide at particular identifiable points along a continuum of possible natural occurring conditions. The condition of visual intrusions in the landscape being rated, for example, might fall between the conditions described in the second and third columns and would accordingly be numerically rated.

It is important to note that this rating is made within the context of a predetermined identifiable reference: the southern California desert, within a radius of 10 miles to 15 miles. This is a total reference area of approximately 600 square miles.

TABLE C-1

SCENIC QUALITY RATING

KEY FACTORS	RATING CRITERIA AND SCORE		
LAND FORM (1)	Vertical or near vertical cliffs, spires, highly eroded formations, massive rock outcrops, severe surface variation. 4	Steep Canyon walls, mesas, interesting erosional patterns, variety in size and shape of land forms. 2	Rolling hills, foothills, flat valley bottoms. 1
COLOR (2)	Rich color combinations, variety or vivid contrasts in the color of soil, rocks, vegetation or water. 4	Some variety in colors and contrast of the soil, rocks & vegetation, but not dominant. 2	Subtle color variations, little contrast, generally muted tones. Nothing really eye-catching. 1
WATER (3)	Still, chance for reflections or cascading white water, a dominant factor in the landscape. 4	Moving and in view or still but not dominant. 2	Absent, or present but seldom seen. 1
VEGETATION (4)	A harmonious variation in form, texture, pattern and type. 4	Some variation in pattern and texture, but only one or two major types. 2	Little or no variation, contrast lacking. 1
UNIQUENESS (5)	One of a kind or very rare within region. 6	Unusual but similar to others within the region. 2	Interesting in its setting, but fairly common within the region. 1
INTRUSIONS (6)	Free from aesthetically undesirable or discordant sights and influences. 2	Scenic quality is somewhat depreciated by inharmonious intrusions but not so extensive that the scenic qualities are entirely negated. 1	Intrusions are so extensive that scenic qualities are for the most part nullified. -4

1-9 = C; 10-14 = B; 15-24 = A (Most Scenic)

Explanation of Rating Criteria

(1) Land Form or topography becomes more interesting as it becomes steeper and more massive.

Explanation of Rating Criteria (Cont.)

(2) Color. Consider the overall color of the basic components of the landscape (i.e., soil, rocks, vegetation, etc.) as they appear during the high use season. Key factors to consider in rating "color" are variety, contrast, and harmony.
(3) Water is that ingredient which adds movement or serenity to a scene. The degree to which water dominates the scene is the primary consideration in selecting the rating score.

(4) Vegetation. Give primary consideration to the variety of patterns, forms, and textures created by the vegetation.

(5) Uniqueness. This factor provides an opportunity to give added importance to one or all of the scenic features that appear to be relatively unique within any one physiographic region. There may also be cases where a separate evaluation of each of the key factors does not give a true picture of the overall scenic quality of an area. Often it is a number of not-so-spectacular elements in the proper combination that produces the most pleasing scenery -- the uniqueness factor can be used to recognize this type of area and give it the added emphasis it needs.

(6) Intrusions. Considers the impact of man-made improvement on the aesthetic quality. These intrusions can have a positive or negative aesthetic impact. Rate accordingly.

Visual Prominence Zones

High Visual Prominence - The high visual prominence zone is comprised of those types of topography where a visual intrusion would be highly visible. The most obvious situation occurs when a man-made object is silhouetted against the sky. Thus, all ridges, hill tops, mountain tops, plateau edges, and their immediate vicinity have been placed in the high sensitivity zone. The remainder of this zone is comprised of slopes greater than 50 percent. When a man-made object is placed on steep slopes, it almost invariably is highly visible due to the high visibility of surface disturbance and excavation scars which accompany construction on steep slopes.

Low Visual Prominence - This zone is made up of lands with slopes between 50 percent and six percent plus lands of less than six percent slope under the following conditions:

a. Areas less than one square mile that are bordered on at least 180° of their perimeter by lands of six percent or greater slope. Under these conditions a visual intrusion will be either screened from view or backdropped when viewed from comparable elevations.

b. Areas within 1/2 mile of lands in the high visual prominence zone.

In these lands visual intrusions would be of low visual prominence because when viewed from below the intrusion would be immediately backdropped by lands of greater elevation. In the case of superior viewer position, the intrusion would be located at the break in topography at the toe of a slope, a much less obvious position than a location in the flats would provide. Moreover, observation is shielded entirely from many angles by surrounding lands of superior elevation. The most critical viewer position in this zone is that of a view along the length of the toe of a slope. It is only in this case that skylining is possible.

Moderate Visual Prominence - The moderate visual prominence zone is comprised of those areas where a visual intrusion would be moderately visible in most situations. The landforms found in this group are the flat lands with slopes of less than six percent that are not in low visual prominence zones. In the project area these lands are comprised mainly of very large washes and wide valley bottoms whose major visual component is uniformity. In such an area any alteration of this uniform nature would be visible but not to the degree of immediate visibility that would occur in the high visual prominence zone. Occasional skylining occurs in these areas, usually as a function of distance. Visual impacts tend to become more pronounced as one increases the elevation of one's viewpoint in relation to the area being viewed.

Visual Sensitivity

Five criteria were identified as being key determinants of visual sensitivity for this study. These include: (1) highway and road-use volume; (2) recreation-use volume (trails, water bodies, facilities, etc.); (3) general social attitudes toward notable intrinsic resources (potential primitive, natural and cultural areas); (4) community land uses, relationship, attitudes, etc., considering all private uses of the land; and (5) relationships and plans of other governmental agencies.

The first criterion is a measure of the number of people seeing the area or the exposure it gets to one particular user type. The greater the exposure the greater the sensitivity. The second factor is an indication of the exposure the land gets from other types of users. The label here is recreation use volume because recreationists constitute the greatest off-road user group in the desert. Again, the greater the number of viewers, the greater the sensitivity. The third criterion is an indication of the attitudes and expectations the viewing public has toward the land's notable intrinsic resources such as scenic quality and cultural significance. The greater the degree of "naturalness" and harmony or cultural or historical significance an area exhibits, the greater concern the general public is likely to have for the use of that area and greater its sensitivity to change.

The fourth and fifth considerations concern the sensitivity of existing land uses, future planned uses and attitudes toward private lands. These concerns are considered separately by the user public in one instance and by the specific managing governmental agency in a second instance.

As indicated by Table C-2, a range of three possible conditions exists for each criterion. The most sensitive condition of each is found in the left column and the least sensitive in the right column. Because the factors are not necessarily of equal importance in determining visual sensitivity they were initially ranked in relative importance. If a criterion is not present in a particular area, it is left entirely out of consideration.

The condition of each criterion is then mapped. Based on the sensitivity level of each criterion present and the criterion weight, the area being rated receives a total score which determines its visual sensitivity.

Visual Resource Management Classes

Once the results of the inventory of the existing environment, have been compiled and mapped, the Visual Resource Management Classes are determined by overlaying the visual prominence, visual sensitivity, and scenic quality maps and from these combined maps, delineating all areas representing different combinations of conditions for these three factors. The values for each of these factors are located on a three-way matrix (Table C-3) which, at the point of intersection, for any combination of conditions indicates the visual resource management objective class for that area on the map (Figure 2-31). This procedure is repeated until all the areas on the composite map have been assigned their respective visual resource management classes. All

TABLE C-2

VISUAL SENSITIVITY SYSTEM

SENSITIVITY CRITERIA	CRITERIA CONDITION		
1.Highway and road use volume (3)*	+200 vehicles per day ADT** year round or seasonal.	20 to 200 vehicles per day ADT or seasonal.	Less than 20 vehicles per day ADT or seasonal.
2.Recreation Use Volume (trails, water bodies, facilities, etc.) (4)	20,000 or more visits/ year.	2,000 to 20,000 visits/year.	Less than 2,000 visits/ year.
3.General social attitudes toward notable intrinsic resources (potential primitive natural and cultural areas) (5)	An area of much concern.	An area of moderate concern.	An area of little concern.
4.Community land uses, relationships, attitudes, etc. Consider all private uses of land: grazing, mining, utility companies, etc. (1)	Scenic quality is very important.	Scenic quality is moderately important.	Scenic quality is not very important.
5.Relationships of other gov't agencies - Military, NPS, Fish and Game, Co. Gov't, etc. (2)	Scenic quality is very important.	Scenic quality is moderately important.	Scenic quality is not very important.

* The numbers in parentheses indicate the relative rank of that criterion.

** Average Daily Travel.

adjoining areas of the same class are now combined and an overall visual resource management objective map results. The visual resource management classes are used as a basis for determining the allowable impacts.

Below are listed the VRM classes as described in BLM Manual 6310.18 (U. S. Dept. Interior, 1975c). They are to be used as tentative minimum management objectives. Each visual quality objective class describes a different degree of modification allowed in the basic elements (line, form, color and texture) of the landscape. The primary character of the landscape will be retained

TABLE C-3

VISUAL RESOURCE INVENTORY AND EVALUATION

MATRIX FOR

DETERMINING VISUAL RESOURCE MANAGEMENT CLASS

		2/ VISUAL SENSITIVITY LEVEL								
		HIGH			MEDIUM			LOW		
SPECIAL AREAS		I	I	I	I	I	I	I	I	I
1/ SCENERY CLASS	A	II	II	II	II	II	II	II	II	II
	B	II	III	IV	III	III	IV	III	IV	IV
	C	III	IV	IV	IV	IV	IV	IV	IV	IV
		H	M	L	H	M	L	H	M	L
		3/ VISUAL PROMINENCE ZONES								

1/ SCENERY QUALITY INVENTORY — A,B,C,

2/ VISUAL SENSITIVITY LEVEL — High, Medium, Low

3/ VISUAL PROMINENCE ZONES — High, Medium, Low

NOTE: Class I applies only to classified special areas, e.g., Wilderness, Primitive, Natural Areas, etc. This quality standard is established through legislation or policy (No Class I lands occur in the EAR area).

Class V applies to areas identified in the scenery quality inventory where the quality class has been reduced because of unacceptable intrusions (This class does not occur in the EAR area).

regardless of the degree of modification.

A. Class I. This class provides primarily for natural ecological changes only. It is applied to primitive areas, some natural areas, and other similar situations where management activities are to be restricted.

B. Class II. Changes in any of the basic elements (form, line, color or texture) caused by a management activity should not be evident in the characteristic landscape.

C. Class III. Changes in the basic elements, (form, line, color, texture) caused by a management activity may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.

D. Class IV. Changes may subordinate the original composition and character but will reflect some basic elements of the character type.

E. Class V. Change is needed. This class applies to areas where the natural character has been disturbed to a point where rehabilitation is needed to bring it back into character with the surrounding countryside. This class would apply to areas identified in the scenery evaluation where the quality class has been reduced because of unacceptable intrusions. It should be considered an interim short term classification until one of the other objectives can be reached through rehabilitation or enhancement. The desired visual quality objective should be identified.

regardless of the degree of modification.

A. Class I. This class provides primarily for natural ecological changes only. It is applied to primitive areas, some natural areas, and other similar situations where management activities are to be restricted.

B. Class II. Changes in any of the basic elements (form, line, color or texture) caused by a management activity should not be evident in the characteristic landscape.

C. Class III. Changes in the basic elements, (form, line, color, texture) caused by a management activity may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.

D. Class IV. Changes may subordinate the original composition and character but will reflect the basic elements of the character type.

E. Class V. Change is needed. This class applies to areas where the natural character has been disturbed to a point where rehabilitation is needed to bring it back into character with the surrounding countryside. This class would apply to areas identified in the scenery evaluation where the quality class has been reduced because of unacceptable intrusions. It should be considered an interim class classification until one of the other objectives can be reached through rehabilitation or enhancement. The desired visual quality objective should be identified.

APPENDIX D

APPENDIX D-1

ARCHAEOLOGICAL SAMPLING MECHANICS AND GENERAL METHODOLOGY

Sampling Mechanics

In order to evaluate archaeological and historical remains within a large region, cultural resource specialists have found that a program of probabilistic sampling provides representative and reliable data within the bounds of restricted time, personnel and monetary resources. Such a program serves two ends: (1) it provides data essential to judging the cultural resource sensitivity of zones within the proposed area of impact and (2) it is compatible with scientific inquiry and insures adherence to a rigorous inductive-deductive method necessary to generate information on prehistoric social systems and environmental relationships.

Weide (1973) has proposed a scheme to the BLM for inventorying their planning units within the California Desert for cultural resources. This scheme seems generally applicable to the study area being discussed here.

The objectives of the inventory outlined by Weide (1973:5) include (1) discovery and recognition of prehistoric and ethnographic use; (2) determination of environmental variables that form the most accurate predictors of archaeological locations; (3) assessment of the value of environmental variables to predict archaeological resources; (4) development of projection of expected density and distribution of archaeological resources; (5) delineation of archaeological sensitivity areas; and (6) delineation of areas with a high probability of lower archaeological sensitivity.

The sampling design for the study area generally follows Weide (1973:6) in assuming that (1) exploitation of economic resources was a significant determinant of the land use pattern of the aboriginal inhabitants, (2) economic-subsistence systems were dynamic and closely related to current and past plant communities, geomorphology and hydrology, and (3) that relations between these variables and archaeological locales are of sufficient strength that predictions of site densities and locations can be generated for management purposes.

The problem-orientation of the survey is two-fold. First, it provides an information base for management decisions concerning cultural resources. Proper management includes primarily the preservation and protection of cultural resources and secondarily the development of interpretive programs. Second, such survey provides a minimal base wherein we can begin approximating site types and densities, settlement patterns and changes in cultural systems through time. Such work can lead to the formulation of a number of regional research hypotheses and models on which to build.

The proposed area of study (Figure 1-1), which includes Red Mountain, the Lava Mountains, Spangler Hills and portions of the Cuddeback basin and Searles Valley, is included within the larger Red Mountain planning unit of the Bureau of Land Management. This planning unit encompasses 700,000 acres. As part of the cultural resource inventory for this planning unit a first stage probabilistic sampling at the one percent level was conducted during winter, 1975. Clusters or areas for survey were selected by simple random sample from equal third sampling frames of the larger planning unit. Such clusters correspond to square mile sections of the cadastral grid.

In essence by dividing the planning unit into sub-units and then into quadrats, a systematic random cluster sampling was imposed. Advantages of systematic sampling have been detailed by Judge and others (1974:87). These include (1) comparative ease of delineating the sample in the field, and (2) assurance of samples widely dispersed over the research area.

Archaeologists are becoming increasingly aware that a multi-stage approach to sampling is mandatory for solving regional problems (cf. Judge and others 1975:121). Work on the geothermal area in effect provided a second stage to the sampling design, at least for nearly 12 percent (117 square miles) of the original planning unit. Several quadrats near and within the geothermal study area had been surveyed during the Red Mountain Unit Resource Analysis and several others were surveyed during the initial stages of the geothermal project which later were found to fall outside the study area boundaries (Figure 1-1). In addition, in a few cases where private lands encompassed more than one-half the survey quadrat, they were eliminated from consideration and another quad in the sample surveyed.

Three or four BLM archaeologists participated in the survey of each sample quadrat. Examination was accomplished by a series of systematic back and forth sweeps. Spacing varied with the number of individuals present. Eight - or in less than one-fourth of the quadrats, six - sweeps were made of each quadrat. Zigzagging sweeps and checks of unusual environmental features between sweep corridors allowed for greater accuracy in site determinations.

The sample universe was divided into a series of blocks totalling 117 square miles within a larger block bounded by Cuddeback Lake - Atolia on the south, Trona Pinnacles - Ridgecrest on the north, Red Mountain - Johannesburg on the west and the Naval Reservation on the east. The smaller inclusive blocks include one major block of 91.75 square miles and four lesser blocks of 15, 4.5, 4.25 and 1.5 square miles.

Because of various management, environmental and economic concerns attention was focused on the block areas rather than one solid block. Boundaries of the study area correspond strictly to those locations under or originally considered under lease application for potential geothermal developments and do not relate to natural environmental boundaries.

Certain modifications from the first stage sampling were necessary to accommodate management decisions, analysis and interpretation of the previous information and formulation of a regionally oriented research design. In view of the assumption that sampling results will be enhanced by stratification (i.e. environmental criteria) a decision was made to stratify the entire area incorporating all blocks of the 314 square miles into geologic/geomorphic strata.

The central hypothesis of this survey is that geomorphic features and related geologic units (Quaternary deposits, Tertiary volcanic zones and Pre-Tertiary intrusive igneous and metamorphic bedrock zones) represent important factors in the location of both habitation and activity areas, and certain landscape variables were clearly significant to the living pattern. While geologic/geomorphic units were instrumental in determining where members of communities and task forces pursued a living, they are by no means exclusive agents and the interrelationship of the total environment (socio-cultural included) must be considered in a dynamic sense.

McGinnies (1968:392) notes that in association with the landforms, a product of past and present climates, there is an array of soils and microenvironments that support characteristic vegetation communities. Also in association are various forms of animal life. In the sampling design vegetation communities and soils were not considered primary correlates of settlement pattern because (1) ethnographic data does not suggest significant variation in adaptation by vegetation zone as occur in the area, (2) significant shifts in vegetation zones and types may have occurred since aboriginal occupation, and (3) soil types are closely related to terrain and geology. Geologic units (with associated hydrology and landforms) were less likely to have fluctuated significantly since the inception of human occupation in the area.

The three geologic units were mapped for the area (Figure 2-3) as the stratifying variables. Then each section falling within individual geologic units was numbered consecutively for that unit. If more than one geologic unit fell within any one section then the unit with greatest representation was counted. Because of National Register procedures and in an attempt to acquire a representative sample within economic constraints approximately a 25 percent sample was selected by table of random numbers for each generalized unit. In a few cases where irregular sections or halves or quarters of sections fall within the boundaries they were surveyed as is (Figure 1-1). In at least one case a portion of a section was eliminated because of private ownership. This resulted in a few irregular survey quads. All statistical averages were considered in terms of square miles.

The investigative strategy provided for a relatively unbiased sample with moderately uniform coverage of all areas within the sampling universe.

As part of the study area inventory 28 quads (cadastral sections or parts thereof) totaling 25.78 square miles were surveyed. Two additional quads (2 square miles) from the planning unit inventory are included within the study area boundaries and form part of the sample.

Three additional planning unit inventory quads (three square miles) are within the larger block area close to the study area.

After the archaeological sampling design was initiated certain modifications of the proposed geothermal development area boundaries followed. Thus, 26 units or quads fall within the final boundaries, four adjoin the boundaries and three more, as discussed above, are in the vicinity (Figure 1-1).

Of the 30 surveyed quads, 16 fall within the Quaternary stratum, eight are in the Tertiary volcanics stratum and four within the Pre-Tertiary bedrock stratum. Using a generalized geologic map as a guide (Figure 2-3), of the 27.78 square miles surveyed, 16.52 square miles (59 percent) are within Quarternary deposits, 6.92 square miles (25 percent) are in Tertiary volcanic bedrock zones and 4.34 square miles (16 percent) are in Pre-Tertiary bedrock areas. Transferring this information to vegetation zones, 17.71 square miles (64 percent) are within the Creosote Bush Scrub Community, 5.99 square miles (21 percent) are within a Transitional community that includes elements of the Creosote Bush, Shadscale Scrub and Joshua Tree Woodland communities; 3.38 square miles are within the Alkali Sink community and 0.71 square miles (3 percent) are within a Cheesebush Inclusion zone.

Sample Results

For analytical purposes the archaeological sites have been broken down into 10 types: (1) villages or base camps, (2) probable temporary camps, (3) utilized shelters or caves, (4) milling stations, (5) quarries, (6) petroglyph sites, (7) hunting blinds, (8) isolated artifacts, (9) flake-detritus scatter, and (10) trails or alignments. Historic sites have been lumped into a single category. Appendix D-2 contains a definition of a site and each site type.

For purposes of testing, it is proposed that each site type corresponds to one or more sets of prehistoric activities ranging from one day to intermittent use over many years.

In this analysis the settlement pattern is viewed synchronically since temporal placement of many of the sites is uncontrolled. Based on the few time-markers found, midden composition, placement of certain sites still visible in areas of active deposition, and the general trend of late prehistoric development in the Mohave Desert, a majority of the sites appear to fall within the Late Archaic period (Late Prehistoric or Marana).

A total of 158 sites has been recorded within the sample universe (Figure 1-1) of which 138 were inventoried in units within the probabilistic sample. The systematic inventory resulted in an average of 4.97 sites per square mile. Subtracting historic sties, this figure is 4.75. Furthermore, if both milling stations and historic sites are not included, the figure is 2.70. These figures, of course, vary from location to location ranging from none to 15 per square mile. In one half-mile section surveyed 11 sites (mostly milling stations) were found. Number of sites per unit area, type of sites, diversity of cultural materials (and for management considerations, integrity, uniqueness, and scientific or educational value) are considered in defining sensitive - significant areas or districts, as discussed previously.

Table 2-13 is a compilation of site type sums, average number per square mile surveyed, percentage of total sites in sample units and percentage of prehistoric sites in sample units.

Three main village complexes are known in the area, (Figs. 2-34, 35) although one contains three closely juxtaposed midden locations probably representing a single village complex. However, these three locations were given separate site designations.

For every village (using three for computation) there are 10-15 "temporary" occupation camps (Figures 2-36, 37) or "temporary" occupied shelters/caves (Figures 2-38, 39) and about 20 or more milling stations. This figure is slightly variable since some of the small shelters exhibit only slight evidence of occupation and could be storage shelters. Also, one major village is known which occurs outside the sampling units but which must be estimated in the figures because of its importance to the settlement pattern. Furthermore, both villages and many temporary occupation sites contain milling implements (Figure 2-37). About seven flake scatters (probable small lithic workshops) are found for every village or main base camp. The remaining site types are relatively rare in the sample area. However, the number of these specialized sites fits the expected pattern based on previous inventories in the Mojave Desert. All apparently functioned directly or indirectly in subsistence pursuits: hunting blinds for ambushing mountain sheep and deer (Figure 2-40), quarries for procuring raw material for tools, (Figure 2-41) trails for aid in travel, communication and/or trade, and rock art sites (Figures 2-42, 43) for spiritual support, i.e., sympathetic magic of the hunt.

Other rare site variants are masked in these type categories. For instance, storage shelters are lumped into the Shelter/Cave type; thermal fractured rock scatters (ovens, roasting areas?) within the temporary occupation camp types, (Figure 2-36) and alignments within temporary occupation camp or trail categories (Figure 2-44). The site types could be broken down further according to size and individual elements, but until more adequate evaluation means are initiated, i.e., testing, these categories are used in developing an explanatory model of prehistoric adaptation. Appendix D-3 details the cultural constituents of each site recorded in the area. Historic sites are so few in number that they were lumped. A further discussion of historic land use is presented in other sections.

A prerequisite to predicting site locations, and developing a model of prehistoric land use is a correlation of sites to environmental characteristics (Appendix D-4).

Prehistoric site types within the sample were correlated with geomorphic features, hydrologic and geologic units and vegetation communities. All sites within the study area were correlated with soil associations. The interdependence of these variables has been discussed earlier.

Chi-square was applied to each set of variables (excluding soils) by site to determine if non-randomness was present and what were the apparent contributors. Raw frequencies of different types of sites occurring in different vegetation communities and geologic units were altered before being subjected to chi-square. Observed cell frequencies were computed as if each vegetation community (plus the ecotone) and each geologic unit were equally represented in the probability sample. We know that the larger the chi-square statistic, the stronger is the relatedness in the sample. In essence we have attempted to see whether or not our empirical frequencies differ significantly from those expected. The computing formula

$$x^2 = \frac{Fo^2}{Fe} - N$$

was used where Fo and Fe refer respectively to the observed and expected frequencies for each cell in a simple matrix of site type versus variable. The general null hypothesis utilized is that no difference occurs between site type and environmental variable.

In analyzing geologic unit versus site type, the chi-square value (141.95) exceeds the alpha value (39.99 at .005) for 20 degrees of freedom. A non-random correlation is indicated. The matrix cells contributing most to this correlation are shelter/caves with Tertiary volcanic units, Quaternary deposits with milling sites and historic sites with Pre-Tertiary bedrock areas. Less significant correlations are temporary camps with Tertiary bedrock units and Quaternary deposits and flake scatters with Quaternary deposits.

A contingency table of hydrology by site type indicates the chi-square value of 46.46 exceeds the alpha value (37.15 at .005) for 18 degrees of freedom. A non-random correlation is indicated. A matrix cell contributing most to this correlation is milling station sites with intermittent or ephemeral drainage channels, usually small arroyos. Other cells possible significant include temporary camps and flake scatters with intermittent or ephemeral drainage; petroglyph sites with springs and isolated finds with the Cuddeback Lake-playa. Input to this matrix may obscure certain relationships. For instance, while villages were often associated with nearby arroyos, springs were always close at hand but at greater distances than drainages. Most likely fresh water was available and utilized from the springs, not the channels which were dry most of the year.

Correlation of landform and site type resulted in a chi-square value of 299.75, exceeding the alpha value at .005 for 110 degrees of freedom. Two high correlations and five lesser correlations may be significant. Some of these associations reflect the results of the geologic unit - site type correlations, since many of the variables are dependent. For instance, there is a significant non-random association of milling stations with alluvial fans (Quaternary deposits). There is a high correlation of shelter/caves with canyons. Other matrix cells contributing to the correlation include villages with drainage terraces, quarries with ridges, petroglyphs with hills, isolated finds with playa-basins (playa-lake hydrology units); and historic sites with barrancas, i.e. where outcrops and mineral deposits might be associated.

Vegetation communities and site types were also compared. The chi-square value (150.0) exceeds the alpha value (66.77 at .005) for 40 degrees of freedom. A non-random correlation is once again indicated. The matrix cells contributing most to this correlation are milling stations with the Cheesebush Intrusion and the present day Creosote Bush Scrub - Alkali Sink ecotone. Cells which may be contributing to this non-random correlation include temporary camps and flake scatters with the Ecotone situation, isolated finds with the Alkali Sink Community, and petroglyphs with the Transition Community.

Taking the total sample of sites recorded in the study area, 69 occur in badlands, rough broken lands and rock lands association soils. All site types are represented. However, not unexpectedly, 19 of 21 shelter/cave sites, one of two quarries and all petroglyph hunting blind and trail/alignment sites occur in this soil association.

Another 46 sites were found in Arizo-Daggett association soils, including 26 milling stations, six flake scatters and nine temporary camps. This soil association corresponds with Quarternary depositional units.

Associations and Predictions

Bearing in mind the chi-square results, a visual examination of the matrices was conducted to see if other correlations, both positive and negative, were apparent. Thus, based on a generalized breakdown of certain environmental classes a number of possible correlations are hypothesized and predictions of activity zones within the study area, i.e., an approximation of settlement patterns, can be approached.

While we might cite the sample size as being inadequate to provide meaningful data in some cases, certain patterns appear evident. In terms of environmental correlates each site type will be discussed in turn.

Villages are found in Creosote Bush or Transitional vegetation communities on Tertiary bedrock units or Quaternary deposits within hilly country on terraces or ridges. Villages were not found in mountainous terraces (over 4,000 feet) on alluvial fans or around playas. All villages occur in close proximity to springs.

Temporary occupation camps occur principally in Alkali Sink and Creosote Bush Scrub communities, and in fewer numbers in transitional and ecotonal situations. They were found most frequently in areas of Quaternary deposition; less often in Tertiary bedrock zones and not at all in pre-Tertiary bedrock areas. In terms of landform these sites are found on ridges and hills, adjoining playas, on fans and terraces, but not in the mountains or in adjoining canyon/barrancas.

Shelter/caves were located only in Creosote Bush Scrub or Transitional vegetation communities in association with Tertiary bedrock units expressed in hills and canyons dissected by ephemeral or intermittent channels. It is possible that springs or seeps now relict were found closeby.

Milling stations occurred in every vegetation community but were dominant in Creosote Bush Scrub and Alkali Sink communities, and the ecotone area in-between. They were exclusive to the Cheesebush Intrusive. Interestingly, this site type was not abundant in the Transitional community where grasses and other seed-bearing plants were apparently diverse and plentiful. However, in terms of a small survey sample in this community, a higher number of temporary campsites and one village were found with many milling tools present at each. Also, much of this vegetation community is in steep or rough terrain. We must also consider the possibility that population levels were such that there was no need for women gatherers to venture into rough terrain when adequate resources were at hand on the fans and around the playas.

Quarries are apparently rare in the area, found only in the Creosote Bush Scrub community, in one case in Pre-Tertiary bedrock; in another in Tertiary bedrock. Each site is on a ridge or ridge-saddle within hills quite distant from any permanent water source. More quarries may be present in the central Lava Mountains not surveyed.

Petroglyphs are usually associated with villages in Creosote Bush Scrub or Transition communities. All are in areas of Tertiary bedrock on the side of hills or ridges near springs.

Hunting blind sites follow the same pattern as petroglyph sites except they occur both in hills and mountains, generally on talus slopes and away from fresh water sources like springs.

Most isolated finds occurred in association with the Cuddeback playa near clumps of Atriplex sp. The geologic unit is Quaternary in age, and either lacustrine or alluvial in origin.

Flake scatters occur almost exclusively in the Creosote Bush Scrub community on Quaternary fans, ridges and hills. But in almost every landform situation analyzed they are near intermittent or ephemeral drainages or near a playa.

Historic sites, associated with mining or the railroad, most likely were fortuitously associated with Creosote Bush Scrub or Transitional communities. Pre-Tertiary bedrock masses (with gold-bearing quartz veins) or Quaternary fans (to be crossed by the railroad or other roads and trails) were more important. Springs were developed into wells for water supplies or a high water table tapped for wells.

The single aboriginal trail/alignment cross-cuts Creosote Bush Scrub covered Quaternary alluvial fan deposits and heads northeast through Golden Valley. Undoubtedly trails occurred throughout the region but have been mostly obscured or destroyed by erosional and depositional events.

APPENDIX D-2

ARCHAEOLOGICAL SITE TYPE DEFINITIONS

A site, for purposes of this report, is any location exhibiting evidence of human activity over 50 years old. Each site is separated by a distance of greater than 100m and/or a distinct geomorphic feature such as a drainage element, ridge or bedrock mass. Types of sites used here are explained below.

01 Village - This site type results from long-term or seasonal occupation and activity by a number of families (probably a band-like group). Base camp can be used synonymously. Villages are identified archaeologically in the area by midden deposits containing primary and secondary tools (that is tools used in the manufacture of other tools), ceremonial items or ornaments, and other artifacts, and ecofactual remains. These sites are characterized by extensive (over 25 m diameter) scatter of abundant debris such as potsherds, fire-blackened and/or cracked cobbles, whole and broken tools, core-detritus, charred bone and seeds, milling tools, and, in cases, alignments, rock art and possibly burials/cremations.

02 Temporary Camps - This site type is inferred to be the result of short-term occupation-activity (one day to one month) by a few people (from an individual to several families). These sites can be identified archaeologically by occurrences of such constituents as milling tools and thermal fractured rock, sometimes with flaked stone tools and tool manufacturing debris, rock rings and alignments and in rare cases ecofactual material. Several occurrences of thermal fractured cobble scatters have been lumped

into this category. There seems to be a clear dichotomy between this site type and a village based on diversity and abundance of cultural features and artifacts and the absence of midden development. However, it must be pointed out that midden development in desert areas is more a product of time and environment. Older sites would be leached of many midden elements and years of sheetwash and deflation may have removed smaller particles and cultural debris leaving behind the larger elements.

03 Utilized Shelter/Cave - These sites represent probable temporary occupation locations containing similar cultural debris as described for the previous site type and in many cases they probably served the same function. The archaeologist is provided with the added benefit of preserved materials, such as basketry and ecofacts, resulting from natural protection afforded by the shelter. Since such sites were not tested, it is possible some shelters were used for storage. Since these sites are distinct geologically from the previous category it is hypothesized that a conscious selection between open site and rockshelter was made. This may reflect temporal/cultural differences in the occupational history or perhaps seasonal differences in activity.

04 Milling Stations - This site type is a manifestation of food processing, most likely plant foods such as hard seeds. Almost exclusively metates/manos were the milling tools found, rarely bedrock mortars. Metates usually occur as slabs or blocks. Sometimes a large boulder or outcrop was used, exhibiting a slick or rub on the horizontal surface.

05 Quarry - A quarry site is a location where lithic material has been extracted from a larger supply (usually cryptocrystalline), such as a seam,

vein or outcrop, or cobble-boulder concentration for the purpose of tool manufacture. Such sites are characterized by an abundance of flakes, shatter, cores, occasional hammerstones, preforms, blanks or rejects. In several cases associated activities such as milling, camping, and tool use were noted and these situations have been designated as temporary occupation camps even though the main activity focus may have been on raw material procurement.

06 Petroglyphs - Rock art is commonly divided into petroglyph and pictograph sites. Only the former is present within the study area. Petroglyphs represent pecked or incised figures or designs on boulders, rock outcrops or shelter walls. In some cases they might be associated with milling tools. All these sites in the study area are less than two km from a village.

07 Hunting Blind - This site type is usually located in hilly or mountainous terrain and is characterized by (a) small circular depressions formed in talus slopes by removal of boulders from the center and piling them around the depression in a wall-like manner or (b) small circular enclosures formed in outcrop areas by piling boulders into walls while using outcrop projections as natural walls.

08 Isolated Find - The occurrence of isolated artifacts other than milling tools were recorded for this region. Usually these sites are represented by a flaked stone tool such as a knife, scraper or projectile point.

09 Flake Scatter - Sites like this are characterized by scattered flakes and occasionally cores and flaked stone tools. Such locations appear to represent lithic workshops, in some cases perhaps butchering stations.

10 Historic Sites - These locations of post-contact Euro-American activity are generally related to mining or the local railroads or roads. Such sites are over 50 years in age, or had their inception more than 50 years ago. Isolated mining shafts or diggings such as pocketed the Spangler Hills were not recorded.

11 Trails/Alignments - Trails are rare in the area. These features are locations were the desert pavement has been disturbed and packed creating a narrow depression. Such trails run in a linear fashion. In one case a linear arrangement of boulders adjoined a trail segment. In other cases alignments occur at temporary campsites or villages and are lumped in those categories (see Appendix D-3).

APPENDIX D-3

Archaeological and Historic Resources
(Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-14	X		X										X	X	X		X					X
RM-19	X		X										X		X		X					
RM-20							X															
RM-21							X															
RM-22							X															
RM-23	X				X										X							
RM-24					X										X							
RM-35			X												X		X					
RM-55			X												X		X					
RM-56			X														X					
RM-68	X		X												X		X					
RM-69			X				X						X		X			X				X

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-70	X			X									X		X		X	X				
RM-71	X			X									X		X		X	X				
RM-72										X			X	X								
RM-73				X									X	X	X		X	X				
RM-74										X			X									
RM-78					X										X							
RM-79						X							X	X								
RM-80										X			X									
RM-81					X										X							
RM-82										X			X	?								
RM-83										X			X									
RM-84					X										X							

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-85			X										X	X				X				
RM-86			X										X	X	X							
RM-87												X						X			X	
RM-88											X							X				
RM-89					X								X		X							
RM-90										X			X									
RM-91										X			X	?								
RM-92					X										X							
RM-93					X										X							
RM-94									X					X								
RM-95					X										X							
RM-96										X			X									

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-97					X										X							
RM-98			X										X		X							
RM-99					X										X		?					
RM-100					X										X							
RM-101					X										X							
RM-102					X										X							
RM-103					X										?							
RM-104					X										X							
RM-105											X											
RM-106											X											
RM-107			X												?			X				
RM-108								X										X				

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-109					X										X							
RM-110											X											
RM-111									X					X								
RM-112									X					X								
RM-113						X							X	X								
RM-114											X											
RM-115	X										X											
RM-116											X											
RM-117					X										X							
RM-118					X								X		X							
RM-119					X										X							
RM-120					X										X							

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources (Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-121					X										X							
RM-122					X										X							
RM-123					X										X							
RM-124			X														X					
RM-125					X										X							
RM-126					X										X							
RM-127					X										X							
RM-128					X										X							
RM-129			X														X	X				
RM-130			X												X		X					
RM-131					X										X		X					
RM-132			X												X		X					

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-133			X										X		X							
RM-134					X										X							
RM-135					X								X		X							
RM-136		X											X		X	X						X
RM-137		X											X		X			X				X
RM-138		X		X									X		X			X		X		
RM-139					X										X							
RM-140	X			X									X		X			?				
RM-141	X			X									X		X							
RM-142	X			X																		
RM-143	X			X									X				X					
RM-144				X																		

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

		SITE TYPES											CONSTITUENTS									
SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-145				X																X		
RM-146				X											X		X			X		
RM-147				X																		
RM-148				X																?		
RM-149			X												X		X					
RM-150					X										X							
RM-151					X										X							
RM-152					X										X							
RM-153					X										X							
RM-154					X										X							
RM-155					X										X							
RM-156			X					X					X	X	X							

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

		SITE TYPES											CONSTITUENTS									
SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-157							X															
RM-158			X												X		X					
RM-159							X															
RM-160			X												X			X				
RM-161		X											X	X	X		X	X		X		X
RM-162			X										X	X	X			X				
RM-163					X										X							
RM-164					X										X							
RM-165					X										X							
RM-166					X										X							
RM-167					X										X							
RM-168					X										X							

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-169				X									X									
RM-170				X											X							
RM-171										X			X	X		X						
RM-172										X			X	X								
RM-173										X			X	X								
RM-174					X								X		X							
RM-175										X			X									
RM-176										X			X	?								
RM-177										X			X	X								
RM-178										X			X									
RM-179				X											X							
RM-180				X									X		X							

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-181										X			X									
RM-182	X				X										X							
RM-183										X			X	X								
RM-184			X										X	?	X			X				
RM-185					X										X							
RM-186					X										X							
RM-187					X								X		X							
RM-188					X										X							
RM-189			X										X	X	X			X				
RM-190			X										X	X	X			X				
RM-191			X										X	X				X				
RM-192										X			X									

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-193					X										X							
RM-194										X			X									
RM-195										X			X									
RM-196			X												X		X					
RM-197					X										X							
RM-198	X		X										X	X				X				
RM-199								X										X				
RM-200					X										X							
RM-201					X										X							
RM-202					X										X							
RM-203			X														X					
RM-204	X			X																X		

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	SITE TYPES: VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CONSTITUENTS: CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
RM-205	X			X													X					
RM-206	X			X													X					
RM-207					X										X							
RM-208				X																		
RM-209										X			X									
RM-210								X										X				
RM-211					X										X							
RM-212					X										X							
RM-213					X										X							
RM-214	X				X										X							
RM-215				X																		
SBCM-346	X	X					+						X	X	X	X	?		X	?		X

APPENDIX D-3 (Cont.)

Archaeological and Historic Resources
(Cultural Characteristics)

		SITE TYPES											CONSTITUENTS									
SITE NUMBER	SITES OUTSIDE SAMPLE UNITS	VILLAGE (1)	TEMPORARY CAMP (2)	SHELTER/CAVE (3)	MILLING STATION (4)	QUARRY (5)	PETROGLYPH (6)	HUNTING BLIND (7)	ISOLATED FIND (8)	FLAKE SCATTER (9)	HISTORIC (10)	TRAIL (11)	CORE-DETRITUS	FLAKED STONE TOOLS	MILLING TOOLS	PROJECTILE POINTS	FIRE-AFFECTED ROCK	ROCK RINGS/ ALIGNMENTS	CERAMICS	FAUNAL-FLORA REMAINS	TRAILS	OBSIDIAN
SBCM-348	X			X										X		X						
SBCM-349	X			X										X								

APPENDIX D-4

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
RM-14	02					X								X					X		X				X
RM-19	02					X								X					X		X				X
RM-20	06		X												X		X				X				
RM-21	06		X												X		X				X				
RM-22	06		X											X	X		X				X				
RM-23	04		X											X	X		X				X				X
RM-24	04					X								X					X		X				
RM-35	02							X						X					X		X				
RM-55	02			X										X					X		X				
RM-56	08					X								X					X		X				
RM-68	02											X		X		X			X	X					X
RM-69	02				X									X			X				X				
RM-70	03		X											X			X				X				X

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
RM-71	03		X		X									X			X				X				X
RM-72	09				X			X				X		X					X			X			
RM-73	03		X											X			X				X				
RM-74	09					X		X						X					X		X				
RM-78	04					X		X						X					X		X				
RM-79	05				X									X					X		X				
RM-80	09				X									X					X		X				
RM-81	04				X									X					X		X				
RM-82	09				X									X					X		X				
RM-83	09				X									X					X		X				
RM-84	04					X		X						X					X		X				
RM-85	02					X								X					X		X				
RM-86	02					X		X						X					X		X				

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
RM-87	11					X		X						X					X		X				
RM-88	10				X									X					X		X				
RM-89	04			X							X			X					X		X				
RM-90	09				X									X					X		X				
RM-91	09					X								X					X		X				
RM-92	04					X		X						X					X		X				
RM-93	04					X		X						X					X		X				
RM-94	08											X		X		X			X		X				
RM-95	04					X		X						X					X		X				
RM-96	09											X		X					X					X	
RM-97	04					X								X					X					X	
RM-98	02					X								X					X		X				
RM-99	04					X								X					X		X				

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
RM-100	04					X								X					X		X				
RM-101	04					X		X						X					X		X				
RM-102	04					X		X						X					X		X				
RM-103	04					X						X		X					X		X				
RM-104	04					X								X					X		X				
RM-105	10							X						X				X			X				
RM-106	10					X		X						X				X			X				
RM-107	02		X	X	X				X					X			X					X			
RM-108	07					X		X						X			X				X				
RM-109	04					X		X						X					X			X			
RM-110	10					X								X					X		X				
RM-111	08											X				X			X	X					
RM-112	08											X				X			X	X					

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
SITE NUMBER	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
RM-113	05		X		X				X					X				X			X				
RM-114	10		X								X			X				X			X				
RM-115	10		X								X			X				X			X				X
RM-116	10			X										X					X		X				
RM-117	04					X						X		X					X					X	
RM-118	04					X		X				X		X					X					X	
RM-119	04					X		X				X		X					X		X				
RM-120	04					X						X		X					X		X				
RM-121	04					X						X		X					X		X				
RM-122	04					X								X					X		X				
RM-123	04					X		X				X		X					X		X				
RM-124	02					X		X						X					X		X				
RM-125	04					X		X						X					X		X				

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	SITE TYPE	LANDFORM: MOUNTAIN	LANDFORM: HILL	LANDFORM: TERRACE	LANDFORM: RIDGE	LANDFORM: ALLUVIAL FAN-BAJADA	LANDFORM: CANYON	LANDFORM: ARROYO	LANDFORM: SADDLE	LANDFORM: BADLANDS	LANDFORM: BARRANCA	LANDFORM: PLAYA-BASIN	LANDFORM: GULLY	HYDROLOGY: INTERM.-EPHEMERAL DRAINAGE	HYDROLOGY: SPRING-WELL	HYDROLOGY: PLAYA-LAKE	GEOLOGY: EXTRUSIVE IGNEOUS (T)*	GEOLOGY: INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	GEOLOGY: QUATERNARY DEPOSITS (Q)*	VEGETATION: ALKALI SINK	VEGETATION: CREOSOTE	VEGETATION: TRANSITION	VEGETATION: CHEESEBUSH	VEGETATION: ECOTONE	STRATEGY: SITES OUTSIDE SAMPLE UNITS
RM-126	04					X								X					X		X				
RM-127	04					X								X					X		X				
RM-128	04				X	X								X					X		X				
RM-129	02					X								X					X		X				
RM-130	02					X							X	X					X		X				
RM-131	04					X								X					X	X					
RM-132	02					X						X		X					X					X	
RM-133	02				X				X	X				X	X		X				X				
RM-134	04		X		X					X				X	X				X		X				
RM-135	04			X	X			X						X	X				X				X		
RM-136	01			X				X						X	X				X		X				
RM-137	01			X				X						X	X				X		X				
RM-138	01			X				X						X	X		X				X				

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
RM-139	04			X				X						X	X				X				X		
RM-140	03		X		X		X							X			X				X				X
RM-141	03		X				X							X			X				X				X
RM-142	03		X				X							X			X				X				X
RM-143	03		X				X							X	X		X				X				X
RM-144	03		X				X							X	X		X				X				
RM-145	03		X				X							X	X		X				X				
RM-146	03		X				X							X	X		X				X				
RM-147	03		X				X							X	X		X				X				
RM-148	03		X				X							X	X		X				X				
RM-149	02			X				X						X					X		X				
RM-150	04					X								X					X		X				
RM-151	04					X							X	X					X		X				

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
RM-152	04					X							X	X					X		X				
RM-153	04					X							X	X					X		X				
RM-154	04				X	X								X					X		X				
RM-155	04		X											X	X		X				X				
RM-156	02		X		X									X	X		X					X			
RM-157	06		X		X									X	X		X					X			
RM-158	02		X		X									X	X				X			X			
RM-159	06		X		X									X	X		X					X			
RM-160	02		X		X									X	X		X					X			
RM-161	01		X		X			X						X	X		X					X			
RM-162	02		X		X									X	X				X		X				
RM-163	04							X						X	X				X			X			
RM-164	04		X		X									X	X		X				X				

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
RM-165	04		X					X						X	X				X			X			
RM-166	04					X						X		X					X		X				
RM-167	04											X		X					X	X					
RM-168	04											X		X					X	X					
RM-169	03		X		X		X							X			X					X			
RM-170	03		X							X				X			X				X				
RM-171	09		X	X						X				X					X		X				
RM-172	09		X		X				X	X				X					X		X				
RM-173	09		X		X					X				X					X		X				
RM-174	04		X			X	X			X				X					X				X		
RM-175	09		X				X	X						X					X		X				
RM-176	09		X	X				X						X					X		X				
RM-177	09		X				X							X			X				X				

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM: SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	HYDROLOGY: INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	GEOLOGY: EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	VEGETATION: ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	STRATEGY: SITES OUTSIDE SAMPLE UNITS
RM-178	09		X		X									X			X				X				
RM-179	03		X				X							X			X				X				
RM-180	03		X		X		X	X						X			X				X				
RM-181	09		X		X					X				X			X				X				
RM-182	04				X	X								X		X	X			X					X
RM-183	09					X								X		X			X	X					
RM-184	02					X						X	X	X		X			X	X					
RM-185	04				X	X								X		X			X		X				
RM-186	04				X	X							X	X		X			X					X	
RM-187	04											X		X		X			X	X					
RM-188	04											X	X	X		X			X	X					
RM-189	02											X		X		X			X	X					
RM-190	02					X						X	X	X		X			X	X					

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
RM-191	02				X									X		X			X		X				
RM-192	09				X	X								X		X			X		X				
RM-193	04											X	X	X		X			X	X					
RM-194	09							X						X		X			X		X				
RM-195	09					X		X						X		X			X		X				
RM-196	02					X							X	X					X		X				
RM-197	04					X								X					X		X				
RM-198	02					X								X					X		X				X
RM-199	07		X		X									X			X				X				
RM-200	04				X									X			X				X				
RM-201	04					X		X						X					X		X				
RM-202	04					X								X					X		X				
RM-203	02					X								X					X		X				

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
RM-204	03						X							X			X				X				X
RM-205	03						X							X			X				X				X
RM-206	03						X							X			X				X				X
RM-207	04	X												X			X					X			
RM-208	03	X					X							X			X					X			
RM-209	09	X												X			X					X			
RM-210	07	X			X									X			X					X			
RM-211	04		X		X									X	X		X				X				
RM-212	04		X		X									X	X		X					X			
RM-213	04		X		X									X	X		X				X				
RM-214	04					X								X					X	X					X
RM-215	03		X				X							X			X				X				
SBCM-346	01		?			?									X		X				X				X

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-4 (Cont.)

(Environmental Characteristics of Sites)

SITE NUMBER	LANDFORM													HYDROLOGY			GEOLOGY			VEGETATION					STRATEGY
	SITE TYPE	MOUNTAIN	HILL	TERRACE	RIDGE	ALLUVIAL FAN-BAJADA	CANYON	ARROYO	SADDLE	BADLANDS	BARRANCA	PLAYA-BASIN	GULLY	INTERM.-EPHEMERAL DRAINAGE	SPRING-WELL	PLAYA-LAKE	EXTRUSIVE IGNEOUS (T)*	INTRUSIVE IGNEOUS (P)* AND METAMORPHICS	QUATERNARY DEPOSITS (Q)*	ALKALI SINK	CREOSOTE	TRANSITION	CHEESEBUSH	ECOTONE	SITES OUTSIDE SAMPLE UNITS
SBCM-348	02					X		X						X					X	X					X
SBCM-349	02					X		X						X					X	X					X

*T = Tertiary Volcanics
P = Pre-Tertiary Intrusives, Metamorphics
Q = Quaternary Deposits

APPENDIX D-5

ARCHAEOLOGICAL MODEL

Based on the available archaeological data it is possible to begin building a model on regional settlement patterns and demography and infer subsistence/economic pursuits. At this stage in the analysis we are hindered by a lack of systematic analysis of the cultural constituents of representative site types so that we must address ourselves more to generalities than specifics.

Villages or base camps were located around the periphery of the Lava Mountains and Red Mountain at the hill-fan interface where springs were present. Such sites are rare in the area indicating population density was not large, most likely no more than three local groups or bands and more likely only one or two. Such groups probably averaged around 25 persons based on analogy to historic hunting and gathering groups in the desert West (cf. Martin, 1973) and latter discussion. The two main village complexes located during the survey are seven miles apart, separated by moderately rough terrain. While there might be contemporaneous base camps between, there is still the leeway of considerable territory for exploration including a variety of micro-environments. Among South African Bushmen, Lee (1969:57) found that a six-mile radius from main base camps (with waterholes) included all the area within a day's walk. This might suggest alternate use of main villages or else irregular territories.

The pattern of exploration was apparently widely dispersed coinciding with plant and animal resources. Game hunted, based on examination of faunal remains in sites and petroglyph portrayals, included rodents, rabbits, deer, mountain sheep, possibly antelope, and tortoise, with deer and sheep hunted in highland areas, rabbits, rodents, tortoises and antelope more frequently pursued in lower areas. Plant foods apparently utilized and abundant today (or inferred to have been abundant) include the following grasses: Poa scabrella, Malpais bluegrass; Stipa speciosa, desert needlegrass; and Oryzopsis perfoliata, Indian ricegrass. Poa sp. and Stipa sp. appear to have been more dominant in the Lava Mountain and Red Mountain area in the current Transitional Community, less so in Teagle Wash-Searles Valley and the Spangler Hills. Oryzopsis sp., while predominant today in the Alkali Sink Community, was probably abundant in other areas of the Lava Mountains and Red Mountain, and infrequent in Teagle Wash-Searles Valley and the Spangler Hills. A probable important food plant found in abundance in the Golden Valley area is chia (Salvia columbariae). The association of this plant with a dense and diverse record of archaeological activity, including both milling and temporary occupation sites, seems more than coincidental. Fresh water, other than small ephemeral playas, seems to have been a limiting factor to village-base camp setups. Other important plant foods in the area, judging by today's distribution (see vegetation section), may have included Atriplex confertifolia (Shadscale or saltbush) seeds, Lycium cooperi (boxthorn) berries (principally in the Alkali Sink Community around Cuddeback playa), Eriogonum inflatum (buckwheat or desert trumpet) seeds, Eriogonum fasiculatum (California buckwheat) seeds and Yucca brevifolia (Joshua tree) buds in the Transition Community as well as a number of these and other shrubs in the Cheesebush Intrusion. The seeds, shrubs and berries from these plants were available during the spring and summer which is the indicated ethnographic time of occupation in this area.

Temporary campsites and lithic workshops appear to represent short term (1-2 day) forays for hunting and/or gathering away from the principal base camps. The richer location around the villages may have been exploited first with subsistence activities centered more frequently later in the season at more outlying areas as observed by Lee (1969) among the Bushmen hunter and gatherers of South Africa. If late spring or summer showers brought small water stands in channels, or tinajas, or heavy winter rainfall created stands of water in playa situations, then temporary occupation at these locations may have occurred. Ethnographic information coupled with archaeological data suggests no fall or winter occupation is evident in the area.

Older occupation (i.e. pre-Cottonwood-Rose Spring point correlates) is evident in some petroglyph sites and in archaeological features (i.e., rock rings, alignment and tool patination) within Golden Valley. However, at both locations a continuity in occupation into later time periods seems evident. No evidence of early occupation around the Cuddeback Playa was evident, although erosion and deposition has been ongoing.

Other resource procurement activities, such as quarrying, were predicated by the geology. Cryptocrystalline outcrops in the Golden Valley and Lava Mountains and a small quarry in the Spangler Hills apparently coincided, except in the latter case, with important plant and animal resources.

Petroglyphs, generally found near villages and springs, also coincide with probable big game hunting areas and in one case were associated with a hunting blind. In other cases they are near small canyons/barrancas or along present trails where game could be driven to ambush. That these petroglyphs in part represent sympathetic magic of the hunt (cf. Heizer and Baumhoff, 1962; Ritter, 1970; Grant and others, 1968) is probable.

Little prehistoric occupation or activity is evident in the Spangler Hills, Teagle Wash-Searles Valley locations. The principal reason appears to be (1) lack of permanent water, (2) lower vegetation density and less diversity of plants with some of the possibly more important plants (i.e. rice grass) rare and; (3) fewer big game animals, tortoises and cottontails. Rainfall was apparently lower here than other areas considered. Transitory use of the area is apparent. No indication of Paleo-Indian activity, as has been found near China Lake, was found or has been reported for this basin.

Martin (1973:1450) found that in western Arizona (inhabited by Pai groups), an area similar environmentally in many respects to the study area, plant resources, such as seed bearing plants, were seasonally complementary rather than competitive and stable in geographic distribution making extensive searching unnecessary. As a result, lone women could best exploit these resources. Such may have been the case in this study area. Perhaps this is supported by the many single metates found scattered in the area. Thus, there would not be much economic advantage in grouping gatherers (women) together. "On the other hand, the limitations imposed by pregnancies, child rearing, and the requirement that wild products be processed for consumption should have led to some cooperation between women. It would appear that a group of two and at most three active, mature women would have been the minimal functional and, therefore, optimal unit" (Martin 1973:1450). On the other hand, Martin (1973:1451-52) found that through cooperative hunting efforts by male members greater yield was obtained. This held true for deer, sheep, antelope and rabbits as apparently occurred in the Red Mountain-Lava Mountain area judging from today's wildlife, faunal remains noted in sites and petroglyph portrayals. Thus, Martin (op. cit) found:

> ...a group of about four cooperating mature, active hunters would (1) allow the use of the most efficient technique for hunting deer, (2) enable the consumption group to send out two pairs or even four separate hunters when game was scattered or hard to find, (3) result in the more efficient consumption of kills, and (4) put less pressure on the local resources than would larger groups, thereby keeping returns on labor relatively higher. These same mature hunters, in conjunction with their immature and aged dependents, could also mount fairly effective rabbit drives.

The best archaeological evidence of male hunting activities to support this cooperative hunting proposition include hunting blinds, assumed to involve an individual or individuals to drive the game and one or more hunters waiting in ambush.

In following Martin at this juncture in the regional study we must rely more on supposition than fact to infer that groups in the study area were similar to Pai hunter-gatherer groups. Such groups consisted of four mature men, their wives and immature children, their successor males and the latters' spouses and children, and other attached personnel (the aged, orphans, widows, and immature children) (Martin 1973:1464). However, based on the ethnography of the general area and the archaeological record, this demographic pattern seems most consistent.

Historic patterns have been discussed previously. These sites clearly do not correspond with the prehistoric pattern with minor exceptions. For instance, the Spangler Hills were an important mining district with many associated sites such as mines, buildings, roads, wells and other features. The Teagle Wash-Searles Valley area is transected by a historic railroad with associated camps. Other areas of mining and well development are present in the Red Mountain-Atolia area. The 20-Mule Team road also transects a portion of the area.

The study area received little attention by archaeologists or historians until the BLM initiated intense management studies as a response to user-group concerns. Before that time the area was considered to be low in cultural resources with the exception of several petroglyph sites and a village location. Now it is obvious that major sections of the area contain diverse and abundant archaeological resources; that this area was given more than transitory interest by prehistoric inhabitants. For example, in comparing the results from this study with that from the Red Mountain URA and the adjoining El Paso URA, only 1.8 sites per square mile were found in the former and 2.26 in the latter compared to 4.97 for this study area. Close comparisons are evident between this study area and the El Paso Mountains, an area also high in resource value.

A further study of the history of this region would be worthwhile and productive, and there are indications of important historic developments in the area.

APPENDIX E

APPENDIX E
References Cited

Alfors, J. T., Burnett, J. L., and Gay, T. E., Jr., 1973, Urban geology master plan for California: Calif. Div. Mines and Geol. Bull. 198, 112 p.

Allen, C. R., Amand, P. St., Richter, D. F., and Nordquist, J. M., 1965, Relationship between seismicity and geologic structure in the southern California region: Seis. Soc. Amer. Bull., vol. 55, no. 4, p. 753-797.

American Association for the Advancement of Science, 1974, Off-road vehicle use: Science, vol. 184, p. 500-501.

Audubon Society, 1974, The Blue List for 1974: Amer. Birds, vol. 28, no. 6, p. 971-974.

Bacon, C. F., 1974, Blowout of a geothermal well: California Geology, Calif. Div. Mines and Geol., vol. 29, no. 1, p. 13.

Beatley, J. C., 1974, Thenological events and their environmental triggers in Mojave Desert ecosystems: Ecology, vol. 55, p. 856-863.

Berry, K. H., and Wessman, E., (in press), A study of the distribution and habitats of the Mojave ground squirrel (Spermophilusmohavensis): Bu. Land Management, Riverside, Calif.

Byrne, S., 1973, The effect of off-road vehicle use in the Mojave Desert on small mammal populations: Unidentified paper, p. 64-73.

California Department of Fish and Game, 1973, State of California fish and game code: Calif. Dept. Fish and Game, Sacramento, Calif., 339 p.

_____, 1974, At the crossroads: Calif. Dept. Fish and Game, Sacramento, Calif., 112 p.

California Division of Mines and Geology, 1972, Seismic safety information 72-3: Map of earthquake epicenters 1934-1971, Calif. Div. Mines and Geology, Sacramento, Calif.

California Regional Water Quality Control Board, 1975, Water quality control plan report - South Lahontan Basin (6B): State Water Resources Control Board, Dept. of Water Resources, Sacramento, Calif.

Chasteen, A. J., 1974, Geothermal steam condensate reinjection: Proceedings, conference on Research for the Development of Geothermal Energy Resources, Calif. Inst. Technology, Pasadena, Calif., p. 340-343.

Clark, M. M., 1973, Map showing recently active breaks along the Garlock and associated faults, California: U.S. Geol. Survey Misc. Geol. Inv. Map I-741, scale 1:24,000.

Davidson, E., and Fox, H., 1974, Effects of off-road motorcycle activity on Mojave Desert vegetation and soil: Madrona, vol. 22, no. 8, p. 381-390.

Dibblee, T. W., Jr., 1967, Areal geology of the western Mojave Desert, California: U.S. Geol. Survey Prof. Paper 522, 153 p.

Ellis, A. J., 1975, Geothermal systems and power development: American Scientist, vol. 63, p. 510-521.

Farmham, D. L., Miller, P. H., and Vercey, I. C., 1959, The weather at NOTS, 1946-1958: U.S. Naval Ordnance Test Station, Navord Report 6527, China Lake, Calif., 48 p.

Federal Water Pollution Control Administration, 1968, Water quality criteria: FWPCA, 234 p.

Fenneman, N. M., 1931, Physiography of the western United States: McGraw Hill, New York, 534 p.

Garfunkel, F., 1974, Model for the Late Cenozoic tectonic history of the Mojave Desert, California, and for its relation to adjacent regions: Geol. Soc. Amer. Bull., vol. 85, no. 12, p. 1931-1944.

Garrett, R. L., and Mitchell, D. J., 1973, A study of prairie falcon populations in California: Calif. Dept. Fish and Game Admin. Rept. 73-2, 15 p.

Garrett, R. L., 1976, Humboldt State University, Arcata, Calif., pers. comm.

Grant, C., Baird, J. W., and Pringle, J. K., 1968, Rock drawings of the Coso Range: Maturango Museum Pub. 4, China Lake, Calif.

Grinnell, J., and Miller, A. H., 1944, Distribution of the birds of California: Pac. Coast Avifauna, no. 27, Cooper Ornith. Soc., 608 p.

Ground Water and Wells, 1972: Johnson Div., Universal Oil Prods. Co., St. Paul, Minn., 55165, 400 p.

Hall, M. C. and Barker, J. P., 1975, Background to prehistory of the El Paso/ Red Mountain desert region: Archeological Research Unit, Univ. of Calif., Riverside, Calif.

Harrison, R. T., 1974, Off-road vehicle noise effects on operators and bystanders: Soc. of Automotive Engineers, Inc., 12 p.

Heizer, R. F., and Baumhoff, M. A., 1962, Prehistoric rock art of Nevada and eastern California: Univ. Calif. Press, Berkeley.

Hester, T. R., 1973, Chronological ordering of Great Basin prehistory: Contributions of the Univ. of Calif. Archaeological Research Facility, Berkeley, no. 17, 199 p.

Hildebrand, J. L., 1970, Noise pollution: an introduction to the problem and an outline for future legal research: Columbia Law Review, vol. 70, p 652.

Hulin, C. D., 1925, Geology and ore deposits of the Randsburg Quadrangle, California: Calif. Mining Bur. Bull. 95, 152 p.

Johnson, H. G., Vasek, F. C., and Yonkers, T., 1975, Productivity, diversity, and stability relationships in Mojave Desert roadside vegetation: Bull. Torrey Botanical Club, vol. 102, no. 3, p. 106-115.

Judge, W. J., Ebert, J. I., and Hitchcock, R. K., 1975, Sampling in regional archaeology survey in Sampling in Archaeology, J. W. Mueller, ed.: Univ. Ariz. Press, p. 82-124.

Kats, Gerrett, 1975, University of California, Riverside, Calif., pers. comm.

Kroeber, A. L., 1925, Handbook of the Indians of California: Bu. of American Ethnology, Bull. 78, Smithsonian Institution, Washington, D.C.

Kuhn, M. W., 1974, Environmental effects of off-the-road vehicles on the Kelso Dunes, California: Calif. Council Geographic Education, Bakersfield, Calif., May 5, 1974, 12 p.

Land, B., 1974, The toxicity of drilling fluid components to aquatic biological systems, a literature review: Fisheries and Marine Service, Technical Report no. 487, Environment Canada, p. J1-J33.

Lee, R. B., 1969, !Kung Bushman subsistence: An input-output analysis in Environment and Cultural Behavior, A. P. Voyda, ed.: Am. Museum Sourcebooks in Anthropology, Natural History Press, New York, p. 47-800.

Lindal, B., 1970, The use of natural steam in a distomite plant: U.N. Symposium on the Development and Utilization of Geothermal Resources, Pisa, Italy.

Luckenbach, R. A., 1975, What the ORVs are doing to the desert, California: Fremontia, Jan. 1975, p. 3-11.

Mabey, D. R., 1960 Gravity survey of the Western Mojave Desert: U.S. Geol. Surv. Prof. Paper 316-D., 72 p.

Martin, J. F., 1973, On the estimation of the sizes of local groups in a hunting-gathering environment: Amer. Anthropologist, vol. 75, p. 1448-69.

McGennies, W. G., 1968, Appraisal of research on vegetation of desert environments in Deserts of the World, McGennies, Goldman, and Payloe, eds.: Univ. Ariz. Press, p. 331-569.

McNitt, J. R., 1963, Exploration and development of geothermal power in California: Calif. Div. Mines and Geol., Spec. Rept. 75, p. 45.

Moor, G. W., 1975, Calif. Dept. Fish and Game, Barstow, Calif., pers. comm.

Moyle, W. R., Jr., 1969, Water wells and springs in Panamint, Searles, and Knob Valleys, San Bernardino and Inyo Counties, California: Calif. Dept. Water Res. Bull. no. 91-17, 110 p.

_____, 1971, Water wells in the Harper, Superior, and Cuddeback Valley areas, San Bernardino County, California: Calif. Dept. Water Res. Bull. no. 91-19, 99 p.

_____, 1974, Temperature and chemical data for selected wells and springs in southeastern California: U.S. Geol. Survey Water Res. Inves. 33-73, 12 p.

Munz, P. A., and Keck, D. D., 1959, A California flora: Univ. Calif. Press, Berkeley and Los Angeles, 1681 p.

Nakamura, H., Sumi, K., Katagiri, K., and Iwata, I., 1970, The geological environment of Matsukawa Geothermal Area, Japan: U.N. Symposium on the Dev. and Utilization of Geothermal Resources, Pisa, Italy.

Namowitz, S. N., and Stone, D. B., 1960, Earth science, the world we live in: Van Nostrand Co., Canada, 614 p.

Odum, E. P., 1971, Fundamentals of ecology: W. B. Saunders Co., Phila., 574 p.

Ouimette, J. R., Environmental Engineering Office, Naval Weapon Center, China Lake, Calif. pers. comm.

Petersen, H. P., and Gross, E. E., 1972, Handbook of noise measurement: General Radio Co., Concord, Mass.

Procunier, R., 1976, Div. Air and Hazardous Materials, Environmental Protection Agency, San Francisco, Calif., pers. comm.

Raptor Research Foundation, 1975, Suggested practices for raptor protection on powerlines: Raptor Research Foundation, Inc., Dept. Zoology, Brigham Young Univ., Provo, Utah, 84601, 3 p. and exhibits.

Ritter, D. W., 1970, Sympathetic magic of the hunt as suggested by petroglyphs and pictographs of the western United States: Centro Camuno di studi preistorici, 25044, Capo di ponte (Breicia), Italia.

Robinette, G. O., 1972, Plants, People, and environmental quality: U.S. Dept. Int., Washington, D.C.

Ryall, A., Slemmons, D. B., and Gedney, L. D., 1966, Seismicity, tectonism, and surface faulting in the western United States during historic time: Seis. Soc. Amer. Bull., vol. 56, no. 5, p. 1105-35.

San Bernardino County, Environmental Improvement Agency, 1974: 1974 Annual Report, Air Pollution Control District: San Bernardino County, Env. Improve. Agency Rept., 53 p.

Scholl, D. W., Pleistocene algal pinnacles at Searles Lake, California: Jour. Sed. Petrology, vol. 30, no. 3, p. 414-431.

Shaw, D. R., 1975, The toxicity of drilling fluids, their testing and disposal: Environmental Aspects of Chemical Use in Well-Drilling Operations, Environmental Protection Agency, 560/1-75-004, Office of Toxic Substances, Washington, D.C., p. 463-472.

Smith, G., 1974, San Bernardino County Museum, Redlands, Calif., pers. comm.

Smith, G. I., 1960, Time of last displacement on the middle part of the Garlock fault, California: U.S. Geol. Survey Prof. Paper 400-B, p. B280.

_____, 1962, Large lateral displacement on Garlock fault, California, as measured from offset dike swarm: Amer. Assoc. Petroleum Geologists Bull., vol. 46, no. 1, p. 85-104.

_____, 1964, Geology and volcanic petrology of the Lava Mountains, San Bernardino County, California: U.S. Geol. Survey Prof. Paper 457, p. 97.

_____, 1976, U.S. Geological Survey, Menlo Park, Calif., pers. comm.

Southern California Edison Co., 1973, Lucerne Valley Generating Station Environmental Impact Statement: SCE, Appendix C.

Starry, R. M., 1974, Gold Gamble: Maturango Museum, Pub. 7, Indian Wells Valley, China Lake, Calif., 168 p.

Stebbins, R. C., 1974a, Off-road vehicles and the fragile desert: Amer. Biol. Teacher, vol. 36, no. 5, pt. 2, p. 294-304.

_____, 1974b, Off-road vehicles and the fragile desert: Amer. Biol. Teacher, vol. 36, no. 4, p. 203-208, 220.

Strahler, A. N., 1960, Physical geography: John Wiley & Sons, Inc., New York, 534 p.

Thelander, C. G., 1974, Nesting territory utilization by golden eagles (Aguila chrysaetos) in California during 1974: Calif. Dept. Fish and Game, Admin. Rept. 74-7, 19 p.

Thompson, R. C., 1976, Air Pollution Control Laboratory, University of California, Riverside, Calif., pers. comm.

Thornbury, W. D., 1965, Regional geomorphology of the United States: John Wiley and Sons, Inc., New York, 609 p.

U.S. Bureau of the Census, 1970a, U.S. Census of Population: Number of Inhabitants, Final Report PC(1)-A6 California.

_____, 1970b, Census of Population and Housing: Census Tract Reports, Bakersfield and San Bernardino - Riverside - Ontario SMAA'S.

_____, 1970c, Census of population: General Population Characteristics PC(1)-C6 California.

U.S. Dept. Interior, 1973, Final environmental statement for the geothermal leasing program, vols. 1 and 2.

_____, 1974a, Desert Vehicle Program: Bu. Land Management, Calif. Desert Plan Staff, Sacramento, Calif.

_____, 1974b, Environmental Impact Statement, Proposed Barstow-Las Vegas Motorcycle Race: California State Office, Bu. Land Management, Sacramento, Calif.

_____, 1975a, Environmental Analysis Record, Surprise and Warner Valleys: Bu. Land Management, Susanville, Calif., and Lakeview, Or. Dists.

_____, 1975b, Unit Resource Analysis for National Resource Lands in El Paso and Red Mountain Planning Units: Bu. Land Management, Calif. Desert Plan Staff, Sacramento, Calif.

_____, 1975c, Bureau of Land Management Manual, Visual Resource Inventory and Evaluation (6300, 6310), Washington, D.C.

_____, 1975d, Draft Management Framework Plan for National Resource Lands in El Paso and Red Mountain Planning Units: Bu. Land Management, Calif. Desert Plan Staff, Sacramento, Calif., 25 p.

_____, 1975e, Bureau of Land Management: Social-economic profile of the California Desert study area, Report No. 2 - Employment, 11 p.

_____, 1976, Management Framework Plan for National Resource Lands in the Red Mountain Planning Unit: Bu. Land Management, Riverside District Office, Riverside, Calif.

U.S. Environmental Protection Agency, 1971, Effects of noise on wildlife and other animals, Tech. Rept. NTID300.5, 77 p.

_____, 1972, Report to the President and Congress on noise: U.S. Government Printing Office, Washington, D.C.

University of California, 1975, Plan for the long-term assessment of environment quality in Imperial Valley, California, in relationship to the development of geothermal resources, Part II, Air Quality, Draft #2, September 16, 1975: Div. of Biomedical and Env. Research, Lawrence Livermore Lab., Univ. Calif., Livermore, Calif., typewritten, 24 p. and addenda.

Vasek, F. C., Johnson, H. B., Eslinger, D. H., 1975a, Effects of pipeline construction on Creosote Bush Scrub vegetation of the Mojave Desert: Madrono, vol. 23, no. 1, p. 1-64.

Vasek, F. C., Johnson, H. B., and Brum, G. D., 1975b, Effects of power transmission lines on vegetation of the Mojave Desert: Madrono, vol. 23, no. 3, p. 114-130.

Vernoy, R., 1975, Calif. Dept. Fish and Game, Barstow, Calif., pers. comm.

Weide, L., 1973, Archaeological inventory of the California Desert: a proposed methodology, U.S. Dept. Int., Bu. Land Management Report, Riverside, Calif., 40 p.

White, D. E., Muffler, L. J. P., and Truesdell, A. H., 1971, Vapor-dominated hydrothermal systems compared with hot-water systems: Bull. Econ. Geol., vol. 66, no. 1, p. 75-07.

White, D. F., and Williams, D. L., eds, 1975, Assessment of geothermal resources of the United States - 1975: U.S. Geol. Survey Circ. 726, 155 p.

REFERENCES CITED (cont'd)

_____, 1979a, Bureau of Land Management [illegible] of the California Desert Study Area, Figure [illegible], p. 6.

_____, 1979, Management Framework Plan for Northern Resource Areas on the [illegible] Mountain Planning Units: U.S. Land Management, Riverside District Office, Riverside, Calif.

U.S. Environmental Protection Agency, 1971, Effects of noise on wildlife and other animals: Tech. Rep. NTID300.5, 74 p.

_____, 1976, Quality criteria for water: U.S. Government Printing Office, Washington, D.C.

University of California, Davis, 1977, [illegible] ment quality in selected deserts, California, in Investigations in the development of geothermal resources, Part II, [illegible], Draft 45, September 1977, 30 p., in Riverside [illegible] Coachella Valley [illegible], 73 p. and appendix.

Vinson, T. S., [illegible], 1973, Effects of [illegible] conditions on [illegible] of the [illegible]: [illegible], p. 1-64.

Vizet, [illegible], 1976, [illegible] of the [illegible], p. 415-449.

[illegible], 1970, [illegible].

White, [illegible], 1973, Archaeological inventory of the California Desert: [illegible], U.S. Dept. Int., BLM, Land [illegible], Riverside, [illegible] p.

White, D. E., Muffler, L. J. P., and Truesdell, A. H., 1971, Vapor-dominated hydrothermal systems compared with hot-water systems: Econ. Geol., v. 66, no. 1, p. 75-97.

White, D. E., [illegible], 1978, [illegible] of [illegible]: [illegible] Survey [illegible], 163 p.

APPENDIX F

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GLOSSARY OF TERMS

ADAPTATION - (ecological) adjustment of an ethnic system to the conditions of its environment.

ALLUVIUM - a general term for all detrital deposits resulting from the operations of modern rivers.

ANTHROPOMORPH - human figures represented in prehistoric rock art.

ANTICLINE - a configuration of folded rocks in which the rocks dip in two directions away from a crest.

AQUIFER - a stratum or zone beneath the earth capable of producing water, as from a well.

AUTECOLOGY - the ecology pertaining to a single organism.

AXIAL PLANE - an imaginary plane through a rock fold that includes the axis (place of sharpest folding) and divides the fold as symmetrically as possible.

BEDROCK - any solid rock exposed at the earth's surface or overlain by loose, unconsolidated material.

BIOMASS - the mass of all living components in an ecosystem.

BRECCIA - a rock made up of coarse fragments; may be sedimentary or formed by crushing or grinding along faults.

CAIRNS - concentrations of cobbles and/or boulders which served as markers for trails, burials, territories and the like.

CARNIVOROUS - refers to animals that eat primarily meat.

CARRION - dead animals or parts of animals utilized for food.

COMMON - short for common allotment; a grazing allotment where two or more livestock operators graze their livestock more or less together.

COMPONENT - an ethnically delimited part of a site.

CONGLOMERATE - rounded, waterworn fragments of rock or pebbles cemented together by another mineral substance.

CONTINUUM - an area that is not a distinct plant community; instead, it is an area which has a flora which is gradually but continuously changing in composition.

CORE - the residual cobble or slab from which flakes or chunks were derived for further refinement into flaked stone tools.

CRYPTO-CRYSTALLINE - rock where the mineral grains are not observable, including such categories as chert, agate, chalcedony, obsidion and quartzite.

CULTURE CHANGE - modification of a cultural system, or the development of a new system.

DECIBEL - a unit for measuring the volume of a sound.

DETRITAL - produced by the disintegration and weathering of pre-existing rocks.

DETRITUS - flakes and shatter derived from tool manufacture; usually of crypto-crystalline or fine-grained rock.

DIURNAL - refers to animals whose primary activity times are during the day.

DRAWDOWN - the difference in feet between the water level before and after a pump test.

ECOFACTS - prehistoric human refuse such as plant remains and bone from animals; usually found at occupation sites or shelters.

ECOLOGY - a branch of biology dealing with the relations between living organisms and their environment.

ECOTONE - the transition zone between two plant communities, as that between forest and prairie.

EDAPHIC - pertaining to soil conditions that influence plant growth.

EPHEMERAL - seasonal; occurring only in certain seasons.

ETHNOGRAPHY - study of the nature of contemporary ethnic groups.

EYRIES - regularly used nest sites of raptors.

FAULT - a surface of rock rupture along which there has been differential movement.

FAULT PLANE - a fault surface.

FELDSPARS - a group of abundant rock forming minerals.

FLAKED STONE TOOLS - tools such as knives, scrapers, and projectile points manufactured from fine-grained or glassy-like rock by purposive removal of fragments or flakes into the desired form.

FORB - a broad-leafed, herbaceous plant.

GEODETIC - pertains to investigations of any scientific questions connected with the shape and dimensions of the earth.

HERBIVOROUS - refers to animals that eat primarily vegetable matter.

HIATUS - a break or interruption.

HYDROTHERMAL - an adjective applied to heated magmatic solutions rich in water and to the rocks, ore deposits, alteration products and springs produced by them.

INSECTIVOROUS - refers to animals that eat primarily insects.

LAGOMORPH - the order of mammals to which rabbits, hares and pikas belong.

LAPILLI - material ejected during volcanic explosions.

LEFT-LATERAL - fault movement in which the wall opposite the observer has moved relatively to the left.

LITHIC SCATTER - dispersed tools and manufacturing debris of fine-grained or glassy-like stone; such material was systematically fractured into tools with resulting refuse.

LITHOLOGY - the physical character of a rock, generally as determined either megascopically or with the aid of a low-power magnifier.

MANO - a milling tool usually in the form of an oval cobble, sometimes shaped by pecking; used to pulverize seeds and other items on a rock slab or metate.

MESIC - refers to moderate water conditions or plants which prefer moderate water conditions.

METATE - a milling stone, usually in the form of a flat slab, upon which seeds or other materials were placed for pulverizing with a mano or handstone.

MIDDEN - a deposit composed of cultural remains; charcoal, ash, bone and general trash formed over a period of years by prehistoric human occupation.

MILLING TOOLS - stone tools such as boulder slabs and cobbles used together to grind seeds and other plant foods; this category includes manos, metates, grinding slicks and handstones.

NICHE - position or function of a given organism in a community of plants or animals.

PEDIMENT - the gently sloping erosion surface carved in bedrock and generally covered with water-deposited gravels; generally occurs between mountain fronts and basin bottoms.

PERCOLATION - movement of water under hydrostatic pressure through the voids of rock or soil.

PERENNIALLY - lasting throughout the entire year.

PHOTOSYNTHESIS - process whereby plants convert radiant energy from the sun to chemical energy.

PLAYA - the flat-floored center of an undrained desert basin.

PLUTONIC - pertains to igneous rock that is formed beneath the earth's surface by consolidation from magma.

PROPHYLITE - an altered greenstone-like rock consisting of minerals such as calcite, chlorite, quartz, pyrite and iron ore and resulting from hydrothermal alteration.

SCARIFY - to loosen (the soil) with a type of cultivator; to break up (a road surface).

SETTLEMENT PATTERN - the overall name for both activity and residential patterns.

SILIFICATION - the introduction of or replacement by silica.

SITE - any place in which cultural remains have accumulated.

SOIL SERIES - a group of soils that formed from a particular kind of parent material.

SPECIFIC CAPACITY - the yield of a well divided by drawdown; a measure of the physical condition of a well and the aquifer(s) which it penetrates; a well with a large specific capacity is capable of a greater yield than a well with a small specific capacity.

SPECIFIC GRAVITY - the ratio of the mass of a body to the mass of an equal volume of water at a specified temperature.

STRATA - plural of stratum.

STRATIGRAPHY - that branch of geology that deals with the formation, composition, sequence, and correlation of the stratified rocks as parts of the earth's crust.

STRATUM - a section of a formation that consists throughout of approximately the same kind of rock material.

SYNECOLOGY - the ecology of groups of living organisms.

TECTONIC - of, pertaining to, or designating the rock structure and external forms resulting from the deformation of the earth's crust.

THERMAL FRACTURED ROCK - cobbles and pebbles that are carbon stained, cracked or fractured from heating in cooking fires and other burning activities.

TRANSPIRATION - the evaporative loss of water from plants.

TUFF - a rock composed of compacted volcanic fragments.

XERIC - refers to dry conditions or plants that prefer dry conditions.

YIELD - the yield of a well, in gallons per minute, for the drawdown indicated.

ZOOMORPH - figures of animals present in rock art panels.

APPENDIX G

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SENSITIVITY CRITERIA FOR RESOURCES

GEOLOGY

High - Areas which would probably be affected by seismic activity and/or ground water removal.

Moderate - Areas which may be affected by ground water removal.

Low - Areas which are not expected to be affected by either seismic activity or ground water removal.

HYDROLOGY

High - Areas where the injection of brine waters would be expected to affect domestic and livestock water supplies.

Moderate - Areas where the injection of brine waters could affect domestic and livestock water supplies.

Low - Areas where the injection of brine waters would generally not affect ground water.

CLIMATOLOGY/AIR RESOURCES

High - Areas from which the release of gaseous emissions would travel to the NWC in such concentrations as to damage sensitive equipment.

Low - Areas from which the release of gaseous emissions would not damage sensitive equipment at the NWC.

SOILS

High - Areas which are severely susceptible to erosion (wind and/or water).

Moderate - Areas which are moderately susceptible to erosion.

SOILS (Con't)

Low -	Areas which are slightly susceptible to erosion.

NOISE

High -	Areas which contain the highest primitive values and raptor eyries.
Moderate -	Areas which contain outstanding aesthetic qualities or raptor eyries.
Low -	Areas which do not contain outstanding aesthetic qualities or raptor eyries.

VEGETATION

High -	Areas which contain the highest percentage of vegetative cover, highest density of plant cover, and the greatest variety of species.
Moderate -	Areas which have only moderate amounts of vegetative cover, density and variety of species.
Low -	Areas which are either devoid or nearly devoid of vegetation.

WILDLIFE

High -	Areas which contain high quality wildlife habitat which is sensitive to disturbance and cannot be mitigated.
Moderate -	Areas with either (1) high quality habitat that is not particularly sensitive or on which the impacts can be partially mitigated, or (2) high quality habitat that is already impacted but which will be further impacted.
Low -	Areas which contain low quality wildlife habitat.

AESTHETICS

High -	Areas of Class II lands; residual impacts would exceed established VRM guidelines and the high quality aesthetic values found on these lands would be negated.
Moderate -	Areas of Class III lands; residual impacts would exceed established VRM guidelines and the aesthetic values found here would be severely impaired. (It may be possible through a combination of conventional and unconventional mitigating measures to bring the impacts of a site specific proposal in line with Class III management guidelines).
Low -	Areas of Class IV lands; residual impacts will meet management guidelines for these lands.

ARCHAEOLOGY

High -	Areas whose element value totals 100 or more (see Section 2.4.2.6).
Moderate -	Areas whose element value ranges between 30 and 99.
Low -	Areas whose element value totals less than 30.

PALEONTOLOGY

High -	Outcrops of the Bedrock Spring Formation.
Low -	Outcrops of all other formations.

MINING AND MINERAL EXPLORATION

High -	Areas presently undergoing intense activity.
Moderate -	Areas of past or present activity of a minor nature; small mining operations or exploratory shafts.
Low -	Areas of very little activity beyond claim staking.

RECREATION - VEHICLE ORIENTED

High -	Areas where development could eliminate or extremely limit vehicle oriented activities.
Moderate -	Areas where development could limit availability of routes of vehicle oriented activities.
Low -	Areas where development could cause minor change in vehicle routes or have no effect.

RECREATION - LAND AND ACTIVITY ORIENTED

High -	Areas where development could, either by its physical presence or its presence nearby, prevent the use of the area or limit its availability for use.
Moderate -	Areas where development could, by its physical presence, limit the enjoyment of the values or activities in the area.
Low -	Areas where development is expected to have either a small impact or no impact on enjoyment of the values or activities in the area.

GRAZING

High -	Areas which, in addition to possessing quality grazing conditions, are strategically located for gathering activities and include gathering facilities (water, corrals, etc.).
Moderate -	Areas which are good for grazing only during favorable years and are not particularly convenient for or equipped for gathering operations.
Low -	Areas which have little or no value for livestock grazing due to unfavorable topography.

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