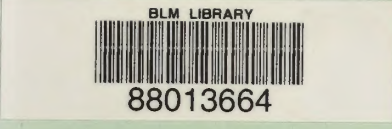


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FINAL

ENVIRONMENTAL ASSESSMENT  
OF

LEASING FOR  
GEOHERMAL EXPLORATION / DEVELOPMENT  
**GLAMIS/DUNES**  
IMPERIAL Co., Calif.



United States  
Department of the Interior  
Bureau of Land Management



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# United States Department of the Interior

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**Interested Parties:**

Enclosed is a copy of the final Environmental Assessment (EA) for proposed leasing of geothermal resources in the Glamis/Dunes area of Imperial County, California.

This EA analyzes the general impacts which would result from geothermal development in the study area. It has been determined that the proposed leasing action in Glamis/Dunes does not represent a major Federal action significantly affecting the quality of the human environment in the sense of Section 102(c) of NEPA. Therefore, no Environmental Statement (ES) will be prepared on this proposed action.

The impacts of subsequent plans of operation, prepared by the lessee, will be addressed in site specific Environmental Analyses (EAs). These will be prepared by United States Geological Survey (USGS).

If you have any questions concerning this document, please call Peter Ertman at (714)-787-1649, FTS 796-1649, or Joseph Edney at (714) 352-5842, FTS 894-2481.

Sincerely,

Gerald E. Hillier  
District Manager

Enclosure

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FINAL ENVIRONMENTAL ASSESSMENT

FOR THE

GLAMIS/DUNES

NON-COMPETITIVE AND COMPETITIVE

LEASING OF GEOTHERMAL RESOURCES

IN

IMPERIAL COUNTY, CA.

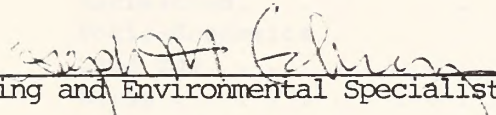
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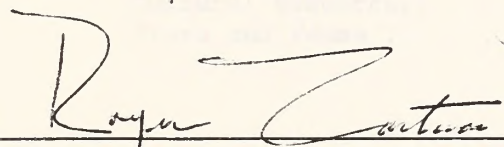
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CALIFORNIA DESERT DISTRICT

SEPTEMBER 1981

  
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CDD	Duane Winters	Air Quality, Climatology



## I. INTRODUCTION AND DESCRIPTION OF PROPOSED ACTION

### A. Introduction

#### Purpose and Need

This Environmental Assessment Record (EAR) is being prepared in response to applications received by the Bureau of Land Management (BLM) for leases on Federal lands. The purpose of this action is to lease lands for the development of their geothermal resources.

With present air quality limitations on coal, oil and gas-fired electrical generating plants, and the moratorium on nuclear powerplants in California, geothermal power is one of the few alternatives remaining that has the potential of meeting short-term electrical energy demands.

It is the policy of the Bureau of Land Management to provide Federal lands for the exploration, production, and utilization of their energy resources. This policy is the result of various Federal laws, including the Mineral Leasing Act of 1920, the Geothermal Steam Act of December 24, 1970, the Mining and Minerals Policy Act of 1970 and 1980, and the Federal Land Policy and Management Act of 1976.

It is the policy of this department to encourage the development of the mineral resources under its jurisdiction where mining is authorized. However, the public interest requires that...adequate measures be taken to avoid, minimize, or correct damage to the environment....(43 CFR 23.1, 1979).

The Federal Geothermal Leasing Program is authorized by the Geothermal Steam Act of 1970, and is implemented in accordance with the geothermal leasing and operating regulations contained in 43 CFR part 3200 and 30 CFR parts 270 and 271.

#### Issue Identification

The major issues associated with geothermal leasing in the Glamis/Dunes area are: (1) possible impact to wildlife, especially rare, endangered or sensitive species, (2) sensitive plant species - three State-listed Endangered, three candidate Federal Threatened species, (3) recreation (ORV) and visual impacts - due to the location of the Sand Hills Recreation Area within the study area, (4) cultural resources - trails and village sites, (5) water supply - agricultural priority consumption, (6) land uses - due to the County of Imperial's concerns for cooperative land-use planning within the geothermal development process, and (7) California Desert Plan designation of WSA within the study area, (8) Algodones Dunes Outstanding Natural Area - National Natural Landmark.

### Study Area

Forty-one (41) non-competitive lease applications and two Known Geothermal Resource Areas (KGRA) are located within the study area. The Glamis Dunes EA study area is bounded on the north by the third standard parallel-south SBM, on the west by the old alignment of the Coachella Canal, on the south by the All-American Canal and I-8 R.O.W., and on the east by a north line originating at the intersection of I-8 and the east boundary of Sec. 44, T 16 S, R 20 E; to the NE corner of Sec. 21, T 14 S, R 20 E; west to the NE corner of Sec. 19, T 14 S, R 20 E; north to the NE corner of Sec. 18, T 14 S, R 20 E; west to the NE corner of Sec. 14, T 14 S, R 19 E; north to the NE corner of Sec. 11, T 14 S, R 19 E; west to the NE corner of Sec. 9, T 14 S, R 19 E; north to the NE corner of Sec. 4, T 14 S, R 19 E; west to the SE corner of Sec. 33, T 13 S, R 19 E; north to the NE corner of Sec. 4, T 13 S, R 19 E. (See Map I-1).

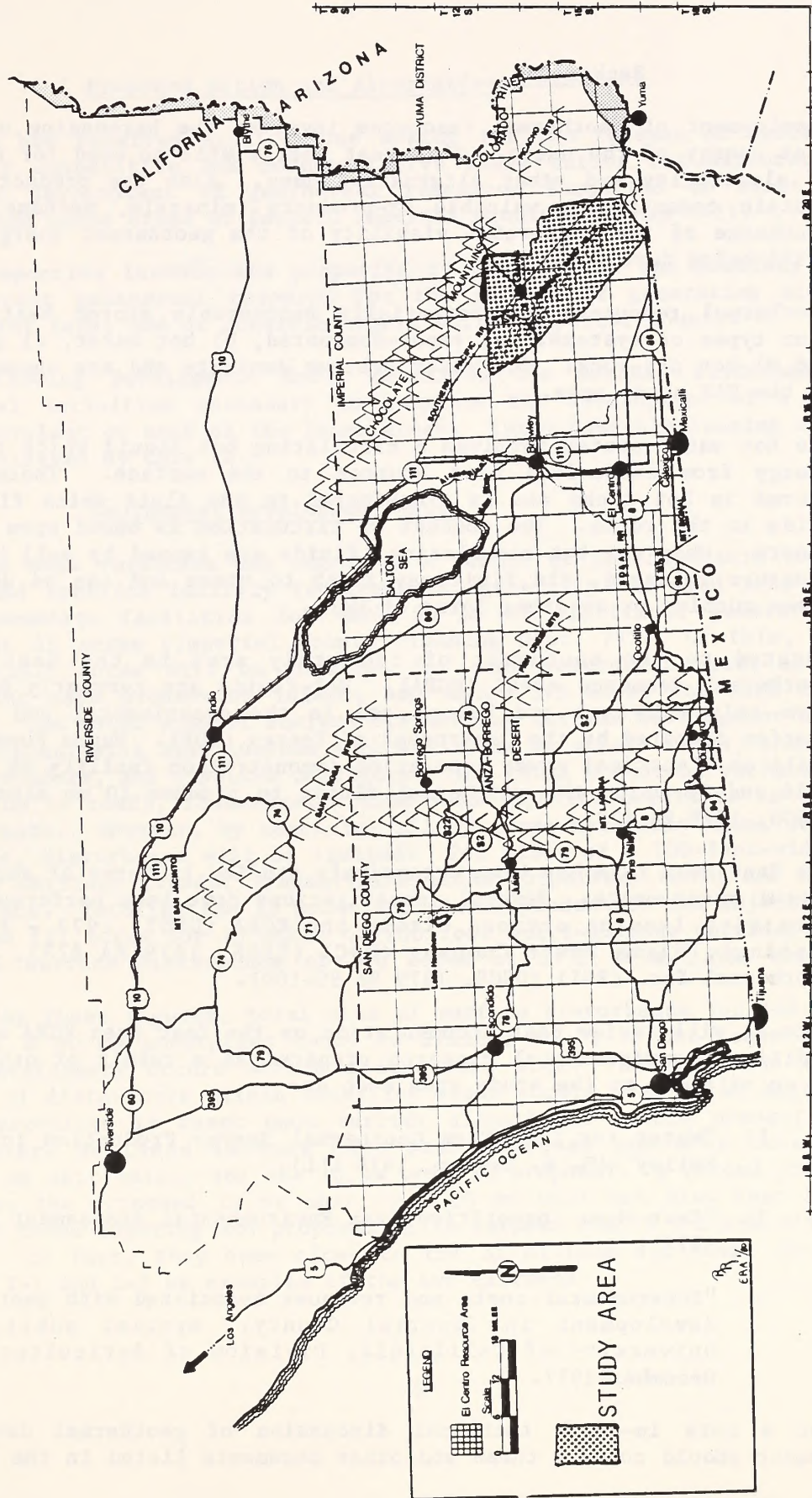
The study area is comprised of 194,517 acres of land, 160 acres of which are privately owned and 7,897 acres which are held by the State of California. The Bureau of Reclamation (BR) hold 104,329 acres in withdrawn status and the Bureau of Land Management (BLM) holds the remaining 82,131 acres in public land status. The BLM, through cooperative agreement with BR, manages all surface resources on the withdrawn lands.

The larger study area has been established to assure that any future expansion of geothermal activities within the study area which might result from the initial exploration investigations will have been considered. The larger study area also enhances the accuracy of the environmental investigations and impact analysis presented in this assessment.

This EAR analyzes the impacts that occur as a result of the proposed leasing action. This document will present analysis of several alternative actions which BLM management could use as a means of mitigating major impacts resulting from the proposed action. This document is subject to public review and comment. BLM management will use this final document as the primary tool for making determinations in the following three areas:

- 1) The sensitivity of the study area environment to geothermal development intrusion; and
- 2) The need for further study through the more extensive requirements of an environmental statement (ES); or
- 3) If leasing should occur, the conditions under which leasing would be allowed.

Map I-1  
**REGIONAL LOCATION MAP**  
 GLAMIS/DUNES GEOTHERMAL ER STUDY AREA



## Background

Development of geothermal resources involves the harnessing of the natural heat energy of the earth. This heat energy will be used for the generation of electricity and other alternative uses. Also the production brine may contain commercially valuable by-products (minerals, methane, gas, etc.). Knowledge of the commercial viability of the geothermal energy resource is still being developed.

Geothermal resources are potentially recoverable stored heat occurring in four types of systems: a) vapor-dominated, b) hot water, c) geo-pressured, and d) hot dry-rock. Hot water systems dominate and are suspected to exist in the EAR study area.

The hot water system involves a circulating hot liquid which transmits heat energy from subsurface heat sources to the surface. Thermal energy is stored in hot rocks and is transferred to the fluid which fills pores and voids in the rocks. The concept of circulation is based upon thermodynamic theory. When the hot-circulating fluids are tapped by well bores, and the pressure released, the fluid may flash to steam and can be used to turn a steam turbine or do other forms of work.

Located to the southwest of the study area is the East Mesa "Known Geothermal Resource Area" (KGRA). Hot-fluids are currently being produced from this KGRA and are being used in the experimental and developmental station operated by the Department of Energy (DOE). Magma Power Company has built an electrical power generation demonstration facility on the East Mesa KGRA and is using the geothermal fluids to produce 10 mw electrical energy (USGS, 1978 EA #78).

The East Mesa KGRA has been extensively studied in terms of surface environmental assessments. Several investigations have been performed in association with leasing actions within the KGRA (USDI, 1973 - Final ES Geo. Leasing), Magma Power Company (MPC) (USGS, 1978 EA #78), and Republic Geothermal Inc. (RGI) (USGS, 1979 EA 99-100).

This EA will review past documentation on the East Mesa KGRA as well as the additional environmental research prepared as a result of other activities in an adjacent to the study area such as:

- 1) "Water for Long-Term Geothermal Energy Production in the Imperial Valley" (D. W. Layton, 1978 LLL).
- 2) "East Mesa Competitive Area Environmental Assessment Record" (BLM, 1977).
- 3) "Governmental costs and revenues associated with geothermal energy development in Imperial County," special publication 3241, University of California, Division of Agricultural Sciences, December 1977.

For a more in-depth technical discussion of geothermal development the reader should consult these and other documents listed in the bibliography.



### Proposed Action and Alternatives

The BLM has received applications asking for the release of public lands for both competitive and noncompetitive lease action for exploration and possible development of geothermal resources suspected to exist in the Glamis and Dunes areas of Eastern Imperial County (see Map I-2).

The prospective lessees are proposing to explore for and possibly develop an apparent geothermal resource for the purpose of generating electrical energy for local use or possible export out of Imperial County.

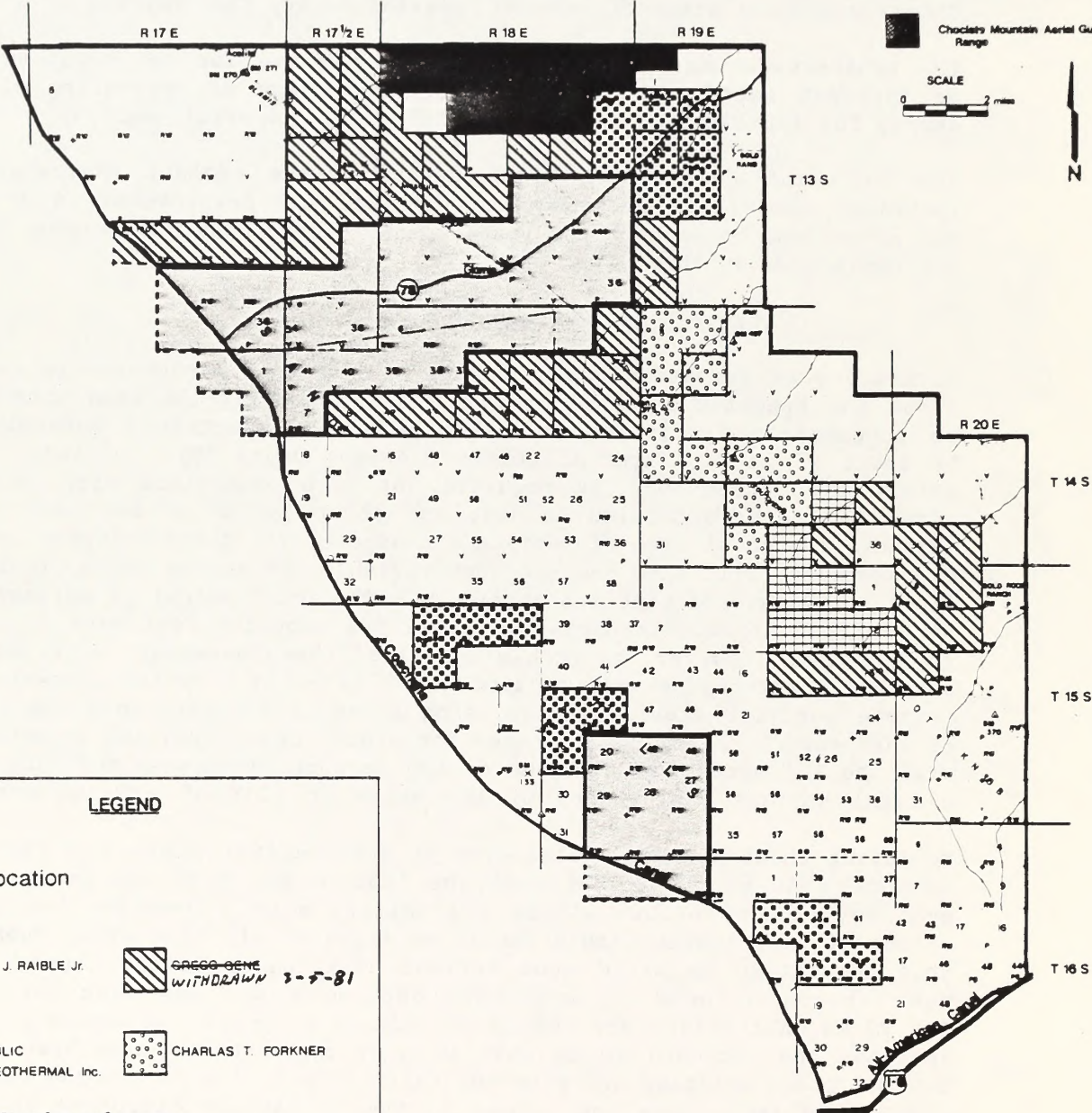
The following Development Model describes the surface disturbances and technical activities necessary to complete the development of a geothermal powerplant on each of the lease areas. Three possible leasing decisions are considered by this EA.

### Geothermal Development Model

Although some variation may occur as a result of landownership considerations and specific facility requirements, generally the land area required to accommodate facilities for each 50 mw of electrical generation will be about 25 acres (Imperial County Planning Dept. 79). Of this, approximately 16.5 acres will be required for each powerplant site, about five acres for each production island, and about 3.5 acres for each injection island. The total area of surface disturbance for the development of one 50 mw powerplant will also include such variables as access roads, transmission line corridors, and pipeline corridors. The total amount of surface disturbance due to roads, transmission line, and pipeline corridors is difficult to estimate. However, by combining all of these necessary uses, as much as possible, disturbance will be limited. Ten miles of a 100-foot-wide multi-purpose corridor (roads, transmission lines, pipeline) would use 121 acres of surface. Totaling the 25 acres for plant, production and injection sites with the 121 acres for 10 miles of 100 foot multi-purpose corridor presents a total surface disturbance of 146 acres or 5.7% of a 2,560 acre lease.

Following these figures, total area of surface disturbance for the development of a 50 mw powerplant could be limited to 7% of the lease area when such development occurs within a sensitive area. However, the estimated extent of disturbance within sensitive areas should most often approach 3%; this percentage is based upon current disturbance levels present in East Mesa where wellhead islands have been proposed and some constructed. One 10 mw unit exists and one 10 mw unit is proposed. A second proposal to increase the proposed 10 mw unit to a 50 mw unit has also been approved. None of these existing and proposed units surpass the 7% surface disturbance limit. In fact, they come close to the 3% minimum discussed above. See Tables I-1 and I-2 as examples of the two extremes.

GLAMIS/DUNES GEOTHERMAL STUDY AREA



Map I-2

**LEGEND**

Lease Location







- |   |  |
|---|--|
|  FRED J. RAIBLE Jr.          |  GREGG GENE<br>WITHDRAWN 3-5-81           |
|  REPUBLIC<br>GEOTHERMAL Inc. |  CHARLAS T. FORKNER                       |
|  APPLICATIONS<br>WITHDRAWN   |  KNOWN GEOTHERMAL<br>RESOURCE AREA (KGRA) |

Table I-1. Approximate Maximum Surface Disturbance Expected From Development Of A 50 MW Power Plant On One 2,560-Acre Leasehold

Unit	Number of Acres Disturbed per Unit	Number Of Units	Acres Disturbed
Power Plant Complex	5	1	5
Well	2	15	30
Disposal Pond & Sump	4	10	40
Pipeline	1	25	25
Access Roads	2.4	30	72
Mainline Road	7.3	1	7.3
Transmission Line	4.8	1	4.8
Total			184.1 = 7.2%

Adapted from U.S. Department of the Interior, 1973, as presented in USDI, USF&WS, 1978.

Table I-2. Estimated Minimum Surface Disturbance Expected From Development Of A 50-MW Power Plant On One 2,560-Acre Leasehold Located Within Sensitive (Gray) Areas Identified For Glamis Dunes Geothermal Study Area\*

Unit	Number of Acres Disturbed per Unit	Number Of Units	Acres Disturbed
Power Plant Complex*	10	1	10
Well, Disposal Pond & Sump*	5	2	10
Pipeline**	1	12	12
Access Roads**	2.4	15	36
Mainline Road**	7.3	1	7.3
Transmission Line**	4.8	1	4.8
Total			80.1 = 3.1%

\* Wellhead islands, directional drilling techniques, and cooling towers shall be utilized.

\*\*Multi-use corridors.

The economic life of the proposed geothermal development cannot be accurately estimated due to a lack of data on the size, temperature, and type of resource available. However, for the purpose of this assessment, the 30 year economic life of generation equipment will be the assumed life of project. Impacts directly associated with geothermal development will be felt at least that long.

## 1. Preliminary Exploration

The technical requirements of this stage involve many activities ranging from airborne exploration, topographical and geological mapping, geophysical exploration, and geochemical surveys, to drilling shallow (500') seismic and temperature gradient holes. Most of these activities involve small crews of two or three people and common pick-up trucks for transportation of the crew, and both truck-mounted and hand-held equipment. The existing roads and trails system within the study area could accommodate these vehicles. In-depth discussions of preliminary exploration can be obtained from the El Centro BLM Area Office.

## 2. Exploration Drilling

This stage includes the drilling of geologic information holes, exploratory wells, and test flow operations. A basic requirement of this phase is the use of large drilling equipment that is capable of reaching depths of 10,000 feet or more. Access roads and drilling sites must meet specific load bearing needs to accommodate this equipment. Thus, the possibility of extensive land movement exists. Drilling equipment, technology and methods are similar to those used in oil and gas operations. Pad construction could require as much as three acres of surface disturbance per well site in addition to access road development (see EA #78).

## 3 & 4. Field Development/Production and Operation

These two phases are both dependent upon successful exploration drilling (phase #2). These phases are each handled under separate permit, however, they are often simultaneous operations. Field development includes all necessary activities to develop an identified resource. Exploration continues in this phase in an effort to find the geographic and geotechnic boundaries of the resource.

The production and operation phase consists of the construction, operation, and maintenance of the power production system, the drilling of replacement wells, waste disposal, water utilization, and production of commercial electrical power and its transmission. The powerplant, transmission lines, and well sites will all be constructed and connected by a series of access roads and brine pipelines. Repair, maintenance, monitoring and operation of field equipment will require periodic use of access roads by large scale equipment. It is in these two phases that the greatest surface impacts can occur.

## 5. Closedown

Closedown and site abandonment will occur when it is determined that the resource is depleted or sooner depending on economics, technology, environmental concerns, or the Secretary of the Interior Administration of the lease terms. The economic life span of the resource has not yet been determined, but for the purpose of this EAR, 30 years is assumed. This is

simply the amortization period of a steam plant. This phase will include the removal of all facilities, abandonment of all wells, and the rehabilitation of the impacted surface. Well abandonment and pad rehabilitation will also take place during phases 3 and 4. Total reclamation to the satisfaction of the government is required prior to bond release.

#### Alternative Action #1/Proposed Action

Alternative one, if chosen, would provide for the leasing of all public lands applied for with all stipulations of the standard lease form (3200-21 May 1974-Geothermal Resources Lease) and the mitigation measures described in the GRO orders (Geothermal Resources Operational Orders-1976-Orders 1-7 USGS Conservation Division-Menlo Park) being applied.

This alternative will provide for surface access to all portions of the study area. The environmental impacts of such access would be controlled through the application of GRO Order No. 4 and those standard environmental protection stipulations developed as mitigation measures in the subsequent environmental reviews of required plans of operation, thus providing industry the maximum flexibility in surface management of surface resource impacts associated with geothermal resource development.

#### Alternative Action #2/Leasing of all Geothermal Resources with Restricted Surface Access

This alternative would provide for the development of geothermal resources that may exist in the study area but limit access and facility location in order to forewarn potential lessees of BLM's intent to minimize surface impacts to valuable resources. A site selection procedure modeled after the concepts of Ian McHarg (Chairman, Department of Landscape, Architecture and Regional Planning, University of Pennsylvania) was used in conjunction with map overlay techniques to specifically locate various surface resources. Each of these locations was then evaluated as to its sensitivity to disturbance and given a sensitivity rating.

A sensitivity rating of one represents resource locations which are considered to be highly sensitive to disturbance with no viable means of mitigation.

A sensitivity rating of two represents resource locations considered to be sensitive to disturbance and, if surface disturbances are allowed, extensive mitigation must be used to protect the impacted resource.

A sensitivity rating of three represents locations considered to be neither highly sensitive nor sensitive to disturbances associated with geothermal development.

Action two suggests that the values of all resources are equal: thus, development of geothermal resources should proceed in a manner which fits the interrelationships between the natural elements. With this principle in mind the research team has developed land use controls which restricts surface access and occupancy of portions of the proposed leases.

The research presented in this document demonstrates that the study area possesses several resources of high value to the public (cultural, flora, fauna, recreation, geothermal, etc.). Under Action 1 the entire lease area becomes subject to surface disturbance which may adversely affect some of the identified high value resources. Action 2 offers additional steps of mitigation which could be taken to protect the resources and forewarn the lessee that those resources of high value will be protected from surface disturbance.

Each resource specialist used the sensitivity rating system presented to develop a map overlay for each resource. The overlay maps were superimposed and a composite map developed (Map IV-1). Through staff discussions and resource evaluation this cumulative resource map was adjusted so the boundaries represent the closest 1/16 section (approx. 40 acres). The resultant product (Map IV-2) represents the composite sensitivity rating translated to areas requiring various degrees and types of mitigation which specifically address the resource(s) present. There are four categories of mitigation proposed:

Type I - Represents an area where a single resource is shown as sensitive.

Type II - Represents an area where two resources are shown as sensitive.

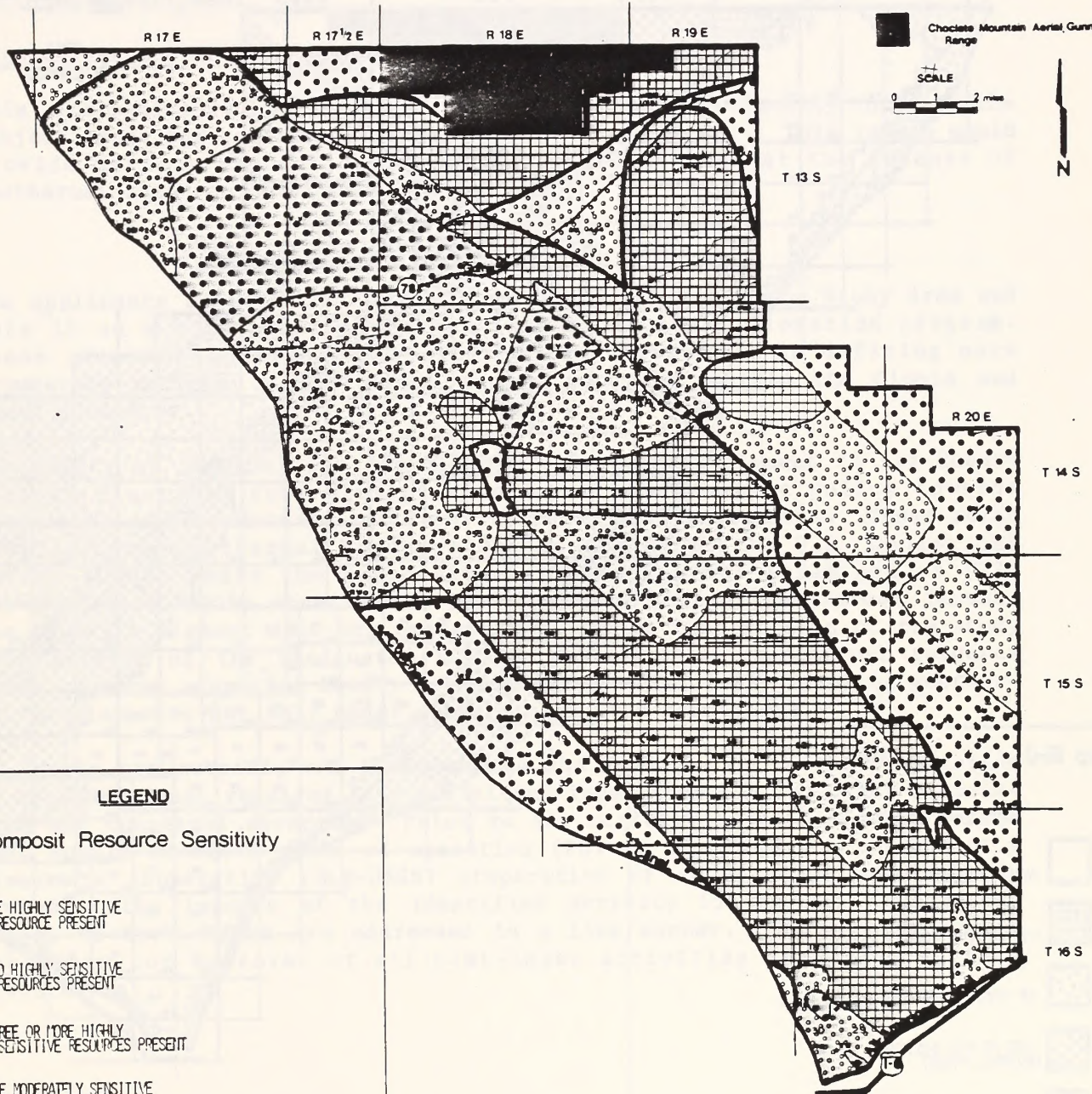
Type III - Represents an area where three or more resources are shown as sensitive.

Type IV - Represents an area where surface occupancy should not be permitted, because existing surface resources are of a highly sensitive nature; thus, they should not be disturbed.

Those areas shown as highly sensitive should not be considered for surface occupancy leasing. Access to subsurface geothermal resources should only be from adjacent lands. If the highly sensitive area is of such size that access to geothermal resources is not possible from adjacent areas, then that area not accessible should not be considered for leasing.

Those areas which are designated as sensitive should be considered for surface occupancy only when there is a demonstrated need for access which will directly benefit the economic development of the geothermal resource. The sensitive areas should not be leased with provisions for surface occupancy described; however, the lessee will be able to petition the BLM for surface occupancy rights for specific site development at the same time the lessee submits plans of operations to the USGS. It should be the responsibility of the lessee to provide USGS and BLM the necessary information demonstrating the need for surface access. To demonstrate such a need the lessee should provide data that shows a viable geothermal resource does exist and that access to that resource can only be obtained through occupancy of the surface location in question. Through the ensuing environmental studies (USGS EAs) prepared for the plans of operation, the BLM will study the requests for surface occupancy and apply appropriate mitigation to those requests which are approved.







GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



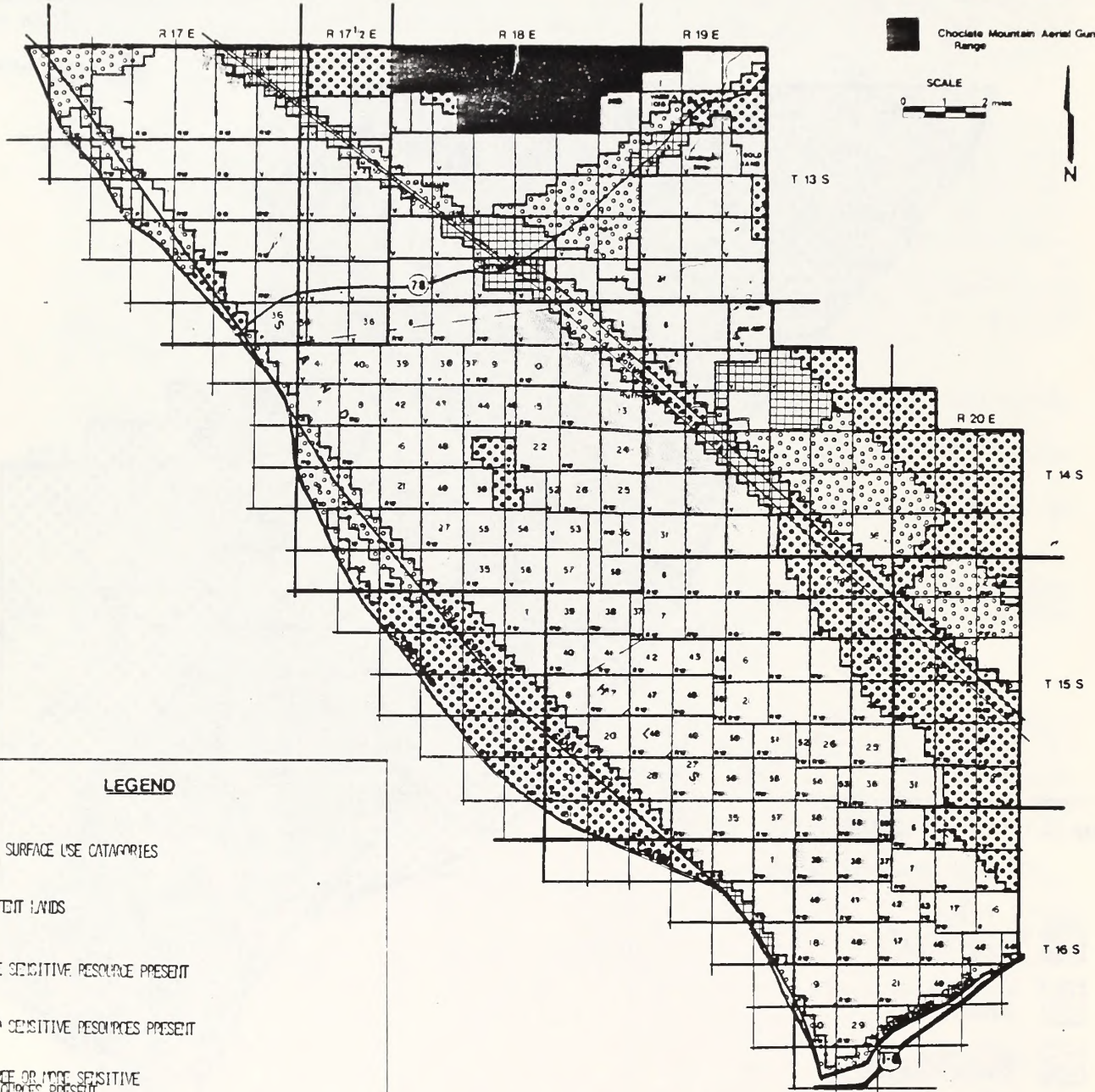
Map IV-1

**LEGEND**

Composit Resource Sensitivity

-  ONE HIGHLY SENSITIVE RESOURCE PRESENT
-  TWO HIGHLY SENSITIVE RESOURCES PRESENT
-  THREE OR MORE HIGHLY SENSITIVE RESOURCES PRESENT
-  ONE MODERATELY SENSITIVE RESOURCE PRESENT
-  TWO MODERATELY SENSITIVE RESOURCES PRESENT
-  THREE OR MORE MODERATELY SENSITIVE RESOURCES PRESENT






GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



Map IV-2

LEGEND

SURFACE USE CATEGORIES

-  PATENT LANDS
-  LOW SENSITIVE RESOURCES PRESENT
-  MEDIUM SENSITIVE RESOURCES PRESENT
-  HIGH OR MORE SENSITIVE RESOURCES PRESENT
-  HIGHLY SENSITIVE RESOURCES PRESENT  
NO SURFACE OCCUPANCY



It is recognized that exploration drilling is necessary to identify the viability of the geothermal resource present. However, the lessee should be required to minimize surface disturbances by utilizing design and engineering techniques which will be the least consumptive of surface area, such as well head islands, directional drilling techniques and minimum space use for buildings, equipment, etc.

#### Alternative Action #3/Decision Not to Lease

This alternative would not provide the applicant an opportunity to lease the subject lands for geothermal exploration and development. This action would provide maximum protection to all surface resources at the expense of geothermal resource development.

#### Intergovernmental Relationships

The applicants believe that a viable prospect exists in the study area and rate it as a high priority target in a statewide exploration program. These proposed lease actions will be the first step in defining more accurately sources of geothermal energy potential within the Glamis and Dunes prospects.

The County of Imperial has promulgated a Geothermal Element to its County General Plan, and this Element sets forth the County's policy towards geothermal development and outlines its rules and regulations. These rules parallel the Geothermal Resource Orders issued by the U.S. Geological Survey (USGS) under the authority of the Geothermal Steam Act of 1970 (PL 91-581). GRO's control all operations on Federal geothermal leases. The County's Element does not presently recognize that portion of the study area outside of the designated KGRA as a potential geothermal resource area. However, Imperial County is on record as officially favoring geothermal development, but only under closely regulated conditions.

If leases are awarded, the USGS becomes the lead agency in the preparation of the additional required EA's soliciting input from BLM and other responsible and concerned agencies. Prior to any activity in a lease, the lessee must submit detailed plans of operation (PO) to the USGS who subsequently directs a cooperative (BLM-USGS) preparation of an EA which specifically addresses the impacts of the identified activity in the PO. Subsequent phases of development are addressed in a like manner. BLM concurrence is necessary for approval of all post-lease activities requiring surface disturbance.



## CHAPTER II - DESCRIPTION OF EXISTING ENVIRONMENT

### Introduction

The geothermal potential of the Glamis/Dunes area is considered to be excellent for both high temperature (electrical power generation) and low temperature applications.

The Dunes KGRA was drilled in 1973 by DWR (State of California Department of Water Resources) to a total depth of 2,016 feet (location is Sec. 33, T 15 S, R 19 E). Bedrock was encountered at 300 feet below surface and the rest of the well was drilled through hydrothermally scaled sandstone and shales. They were sealed with silica. Water temperatures encountered were 218°F at 600 feet, 218°F at 850 feet, and 200°F at 2,000 feet. This well is at the extreme western edge of the dunes anomaly and does not represent the true potential of the geothermal resources present. The presence of intensely silicified rocks indicates that a geothermal system has been in operation for a long period of time (several hundred thousand years).

The Glamis KGRA has been drilled for temperature gradient wells to depths from 300 to 2,000 feet. The one 2,000 foot well intersected granitic gneisses at 600 feet in the vicinity of the Glamis Store.

A temperature gradient well (located in Sec. 34, T 14 S, R 19 E) intersected volcanic rocks at 472 feet below surface. An intrusive dike was intersected at 565 feet below surface. The measured temperature gradient was 10°F/100'. Another temperature gradient well has been drilled in Sec. 31, T 15 S, R 20 E. Its gradient is 2°F/100'.

Two wells drilled east of the sand dunes (Sec. 34, T14 S, R 19 E and Sec. 27, T 13 S, R 18 E) intersected bedrock at 200 feet below sea level. The well drilled in Sec. 33, T 15 S, R 19 E intersected bedrock at 140 feet below sea level. This indicates that east of the Coachella Canal (the approximate location of the San Andreas fault) the desert sediments are a thin veneer and bedrock of various lithologies are close to surface.

The bedrock is highly varied, ranging from apparently young volcanics and intrusives, to continental clastic sedimentary rocks, to preoambrian granitic gneisses. As high heat flows are reported in the bedrock, the heat sources may be young intrusive magmas cooling. At shallow (6-11 km) depths. The multitude of faults in the area are providing the plumbing system for carrying water down to the heat sink and back. Reservoirs in this rock will be controlled by fractures and faulting. The potential for a hot dry rock reservoir and possible fracture controlled steam areas is considered good.

The San Andreas fault zone appears to be a boundary for the Imperial Valley, both geologically and geothermally.

East of the fault zone, bedrock is at approximately 200 feet mean sea level and will contain either hot dry rock resources, localized fracture controlled steam, or hot water resources.

West of the fault, bedrock is at an approximate depth of 15,000 to 20,000 feet (based on seismic, resistivity, and gravity surveys). Due to the high saturation and very high permeability and porosity of the Central Valley sediments, the geothermal resources are liquid-dominated and controlled by the intersection of major faults with suitable sandstone/siltstone horizons to act as reservoir walls.

Table II-1 presents characteristics of the central and eastern portions of the Imperial County from which the preceding discussion was drawn.

TABLE II-1  
Geothermal Characteristics of the Central and Eastern  
Imperial Valley

KGRA or (Prospect)	2) Temperature Gradient ( $^{\circ}\text{F}/100'$ )	1) Reservoirs Temps. in $^{\circ}\text{F}$	1) Reservoir Volume in cubic miles	1) Power Ratings MWe
Salton Sea	7-19	620	28.3	3400
Brawley	4-18	490	8.3	640
Heber	7-12	350	17.3	650
East Mesa	6-10	330	8.8	360
Dunes	7-27	295	2.2	?
Glamis - East	3-12	295	0.8	?
Glamis - West	3-12	295	1.2	?
(Westmoreland)	6-15	426	30.0	1710
(East Brawley)	4-6	?	?	?
(North East Mesa)	3-8	?	?	?

- 1) Circular 790, "Assessment of United States Geothermal Resources - 1978," U.S. Geological Survey.
- 2) Morton, Paul K: 1977: "Geology and Mineral Resources of Imperial County, California," County Report #7, California Division of Mines and Geology.

## GEOLOGY

### Physiography and Topography

The study area is located in the Southern California portion of the Colorado Desert Physiographic Province along the southeast margin of the Salton Trough. This area consists primarily of a gently sloping bajada with drainage to the southwest. The southwestern edge of the Chocolate Mountains and the Imperial Sand Hills provide the only topographic relief in the study area. This relief is between 100' and 250' for the Sand Hills and up to about 500' above the sloping plain for the edge of the Chocolate Mountains.

### General Geology

The study area is underlain by sedimentary rocks which range in age from Pliocene to Recent (see Table II-2). These units reach a maximum estimated thickness of about 10,000' (Rex, 1970) and unconformably overlie older basement rocks which are exposed in the northeastern part of the study area. The basement rocks consist of metamorphic and siliceous intrusives (Morton, 1977).

### Sedimentation and Stratigraphy

The oldest stratigraphic unit exposed in the study area is the Chuckwalla Complex. A Precambrian age has been assigned to the Chuckwalla Complex by Miller (1944, p. 20), although an absolute age has not been determined (Morton, 1977). This complex is composed of quartz biotite gneiss and various types of foliated granitic rocks and granophyres which range in composition from gabbro to granite. This unit is unconformably overlain by clastic rocks composed of non-marine interbedded siltstone, sandstone, and conglomerate. The conglomerate contains angular clasts of metamorphic, granitic and volcanic rocks. Minor flows of vesicular basalt also unconformably overlie the Chuckwalla Complex, but the age relationship with the clastic rocks is uncertain (Morton, 1977).

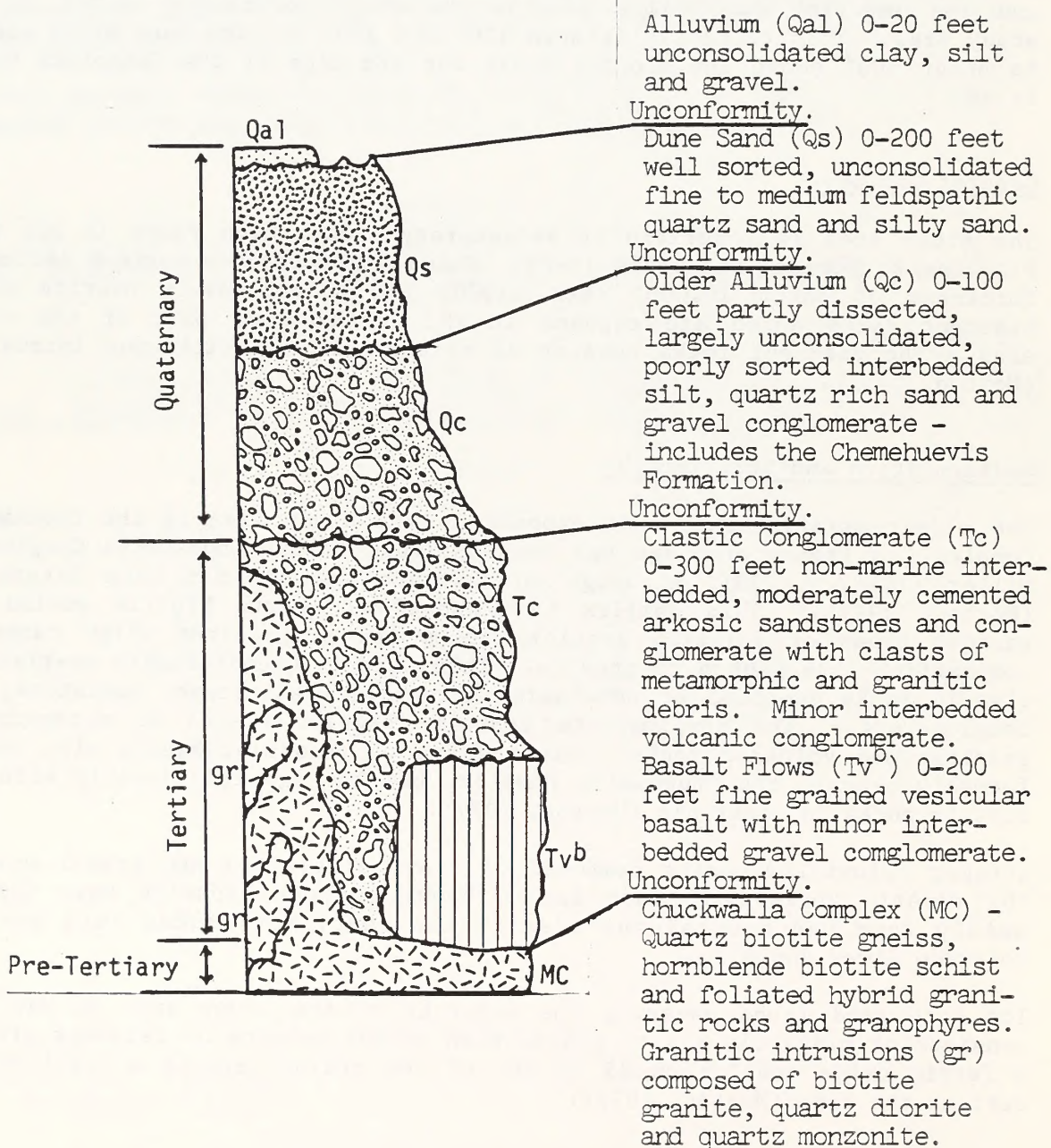
Younger alluvial deposits composed of clay, silt, sand and gravel overlie the clastic rocks and minor basalt flows. These deposits were derived mainly from the mountainous area to the east, but grades into ancient Colorado River deposits.

The dune sand found covering the majority of the study area on Map II-1 consists of primarily quartz grains with lesser amounts of feldspar grains. A ferric oxide coating on 25 to 60% of the grains imparts a light orange cast to the sand (Morton, 1977).

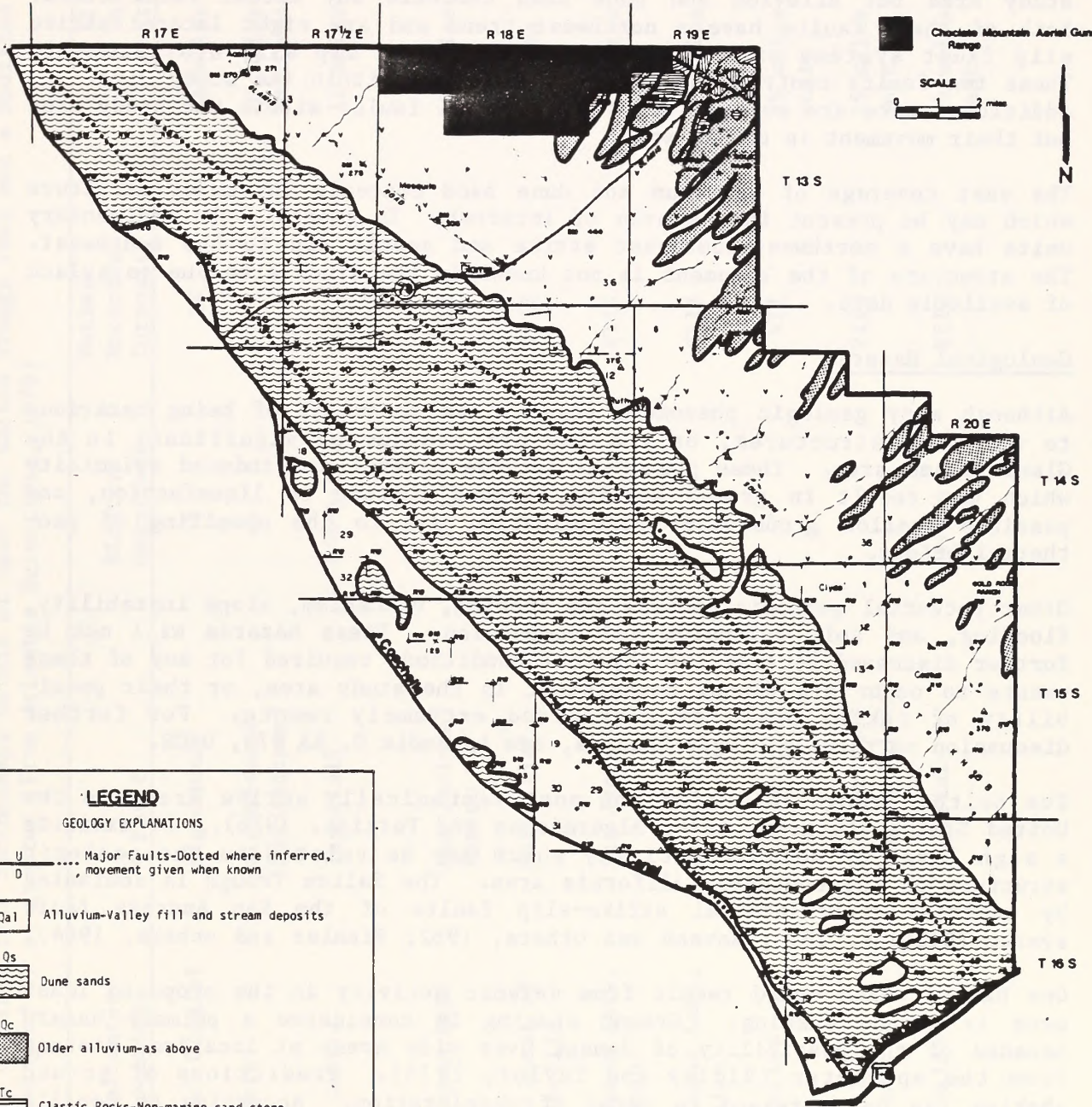
TABLE II-2

A GENERAL STRATIGRAPHIC COLUMN

THE GLAMIS/DUNES AREA



GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



Map II-1

**LEGEND**

GEOLOGY EXPLANATIONS

U Major Faults-Dotted where inferred,  
D movement given when known

- |              |     |   |
|--------------|-----|---|
| QUATERNARY   | Qa1 | Alluvium-Valley fill and stream deposits  |
|              | Qs  | Dune sands  |
|              | Qc  | Older alluvium-as above   |
| TERTIARY     | Tc  | Clastic Rocks-Non-marine sand stone and conglomerate                            |
|              | Tvb | Basalt flows- fine grained vesicular basalt with minor interbedded conglomerate |
| PRE-TERTIARY | gr  | Granite Rocks   |
|              | mc  | Chuckwalla Complex- metamorphic rocks   |

## Tectonism and Structure

The Salton Trough is a rift valley that was produced by the same tectonic forces that created the Gulf of California. Table II-3 indicates the recent seismicity of the Salton Trough. Geophysical evidence indicates that the San Andreas fault and the minor Sand Hills fault transect the study area but alluvium and dune sand conceals any actual fault trace. Both of these faults have a northwest trend and are right lateral strike slip fault systems with some minor vertical or dip slip displacement. These two faults control the geologic structure within the study area. In addition, there are several other small local faults within the study area but their movement is not known.

The vast coverage of alluvium and dune sand conceals any major structure which may be present in the area of interest. In general, the sedimentary units have a northwest-southeast strike and gently dip to the southwest. The structure of the basement is not known in the study area due to a lack of available data.

## Geological Hazards

Although many geologic phenomena possess the potential of being hazardous to man-made structures, only a few are considered significant in the Glamis/Dunes area. These phenomena include natural and induced seismicity which may result in ground shaking, ground rupture or liquefaction, and possible shallow groundwater contamination due to the upwelling of geothermal brines.

Other potential geologic hazards are erosion, volcanism, slope instability, flooding, and soil expansion and compaction. These hazards will not be further discussed because the physical conditions required for any of these events to occur are almost nonexistent in the study area, or their possibility of taking place is considered extremely remote. For further discussion on these geologic hazards, see Appendix D, EA #78, USGS.

The Salton Trough is one of the most tectonically active areas in the United States (Lofgren, 1974; Algermissen and Perkins, 1976). It exhibits a high level of seismic activity which may be related to the geologic structure of the southern California area. The Salton Trough is dominated by numerous right-lateral strike-slip faults of the San Andreas fault system (Dibbles, 1954; Kovach and others, 1962; Biehler and others, 1964).

One hazard which could result from seismic activity in the proposed lease area is ground shaking. Ground shaking is considered a primary hazard because of the possibility of damage over wide areas at locations distant from the epicenter (Ridley and Taylor, 1975). Predictions of ground shaking can be expressed in terms of acceleration. According to Bonilla and Buchanan (1971), peak rock acceleration value for the Glamis/Dunes area could be between 0.4 and 0.5 g. According to Algermissen and Perkins (1976), there is a 10% chance that ground motion of 0.4 to 0.47 g would be exceeded in the next 50 years.



Table II-3. A list of historical earthquakes within or near the Salton Trough that had a Modified Mercalli Intensity of VI or greater (From Atlantis Scientific, 1978)

Date	Epicenter Location	Fault	Richter Magnitude	Maximum Recorded Intensity	Distance and Direction From Site
11-9-1852	Yuma? Glamis?	Algodones?	?	IX	46 miles (74 km)? East?
4-18-1906	Glamis	Algodones? San Andreas?	6	VIII	20 miles (32 km)? Northeast
6-22-1915 (2 earthquakes, 1 hour apart)	El Centro	Imperial?	6-1/4-6-1/2	VIII	12 miles (20 km)? West
11-20-1915	Volcano Lake	San Jacinto? Mexico	7.1	VII	60 miles (96 km)? South
5-27-1917	Southeast of Holtville	Holtville?	?	VIII	5 miles (8 km)? South
9-29-1919	Volcano Lake, Mexico	San Jacinto?	?	VIII	60 miles (96 km)? South
10-1-1919	Volcano Lake, Mexico	San Jacinto?	?	VIII	60 miles (96 km)? South
11-5-1923	Calexico	San Jacinto?	?	VII	18 miles (29 km)? South-west
11-7-1923	South of Calexico	San Jacinto? Laguna Saloda?	?	VIII	25 miles (40 km)? South-west
1-1-1927	Calexico	Imperial	5-3/4	VIII	25 miles (40 km)? South-west

Table II-3. Continued.

Date	Epicerter Location	Fault	Richter Magnitude	Maximum Recorded Intensity	Distance and Direction From Site
2--25-1930	East of Westmorland	Brawley	5.0	VIII	15 miles (24 km)? North- west
12-30-1934	Laguna Saloda	Laguna Saloda?	6.5	IX	42 miles (60 km)? South- west
12-31-1934	El Doctor	San Jacinto?	7.1	X	63 miles (101 km) South
2-24-1935	Baja California	?	6.0	?	60 miles (96 km)? South
5-18-1940	East of Calexico	Imperial	7.1	X	11 miles (18 km) South- west
10-21-1942	Borrego Valley	Superstition Hills	6.5	VII	44 miles (70 km) North- west
3-19-1954	Santa Rosa Mountains	San Jacinto	6.2	VI	63 miles (101 km) North west
4-8-1968	Borrego Mountains	Coyote Creek	6.3	VII (IX)	57 miles (91 km) North- west
10-15-1979	East of Calexico	Imperial	6.4		2 miles (3 km) Southwest

The California Division of Mines and Geology's Urban Geology Master Plan (1973) estimates the maximum probable intensity which may be expected in a given area in California (Jennings and others, 1975). For the Glamis/Dunes area, a maximum intensity of IX or X on the Modified Mercalli scale is given.

Another effect of seismic activity is surface rupture. Surface rupture has occurred along faults within the Salton Trough but has not been detected in the East Mesa area.

A third phenomena that may pose a hazard as the result of seismicity is liquefaction. Preliminary geotechnical investigations indicate that near surface deposits are dry to moist and, therefore, a shallow quick condition failure type appears unlikely for the proposed lease area (RGI, 1978).

Deeper seated quick conditions (6 m or more) could occur due to groundwater saturation. Such liquefaction at depth may pose no hazard and may, in fact, act as an insulator impeding the transmission of vibrational energy to structures on the surface (Youd, 1973).

For a more detailed discussion on seismicity, see Geologic Hazards, Appendix D, EA #78.

#### HYDROLOGY

The groundwater reservoir in the Imperial Valley region is composed of a thick sequence of Cenozoic valley-fill. The thickness of this reservoir may be up to 6,100 m beneath the proposed lease area (Rex, 1970). The flow of groundwater at Glamis/Dunes is westward.

The ground aquifer system underlying the study area can be divided into two main zones. The deep zone lies below 600 feet; the shallow zone lies from near the surface to about 600 feet. In general, the shallow groundwater zone has the best quality for the east-to-west flow is most probably rapid until it reaches the San Andreas fault zone where it mixes with the Central Valley waters. The deep zone waters are slow moving through the sandstone and siltstone bedrocks, flowing again from east to west until reaching the fault zone at which time they will most probably traverse the fault and enter the Central Valley system.

Glamis/Dunes is located within the Salton Sea Drainage Basin. Within the Salton Sea Drainage Basin lies the Salton Sea, Imperial, Coachella, and Mexicali agricultural valleys and the All American Canal and irrigation system. The All American Canal diverts water from the Colorado River for agricultural production in the Imperial and Coachella Valleys. The sink of this hydrologically closed basin is the Salton Sea.

Over 99% of the approximately 3.7 billion M<sup>3</sup> of Colorado River water that enter the All American Canal System each year is used for agriculture. The surface water channels on the East Mesa and Glamis/Dunes are the East Highline (which defines the eastern edge of the Imperial Agricultural Valley) and the Coachella Canal (which supplies the water to the north end of the Coachella Agricultural Valley). These canals branch off the All American Canal and flow by gravity northward along the eastern edge of the agricultural valley and the western edge of the Imperial Sand Dunes.

Surface water quality in the Imperial Valley is fair. Total dissolved solids (TDS) concentrations average around 900 mg/l. This water can be consumed by humans, although the U.S. Public Health Department recommends a maximum TDS concentration of 500 mg/l. The TDS concentration in the Salton Sea is over 38,000 mg/l, more than that of ordinary sea water.

### CLIMATE

Imperial County is dry with very hot summers and pleasant winters. A west wind prevails, averaging 10-15 mph, but occasionally exceeds 50 mph. Rainfall varies from year to year, but averages about 3 inches. The humidity averages 30%, usually less the year round, and the heat and dry air combine to produce a very high evaporation rate (+ 100 in/yr).

Inversion layers forming during the night are prevalent throughout the year. The bases of these layers may be on or near the surface and extend as high as 600 feet (180 meters) to 1,500 feet (450 meters). These inversions tend to be destroyed early in the day during the summer, but persist throughout much of the day during the winter months (December, January, and February).

### AIR QUALITY

The study area is located in the Southeastern Desert Air Quality Control Region, California. This air basin has been designated a Class II air quality basin under the E.P.A. significant air quality deterioration regulations.

The air quality for the study area is variable. Some pollutants are transported into the area from Mexico when the wind is from the southeast.

It has been determined that ambient ozone and particulate standards are violated in the study area. The following tables present the standards for, and measurements taken, within this basin. (Tables II-4, -5, -6 and -6A.)

Fugitive dust and suspended particulate matter are high measuring at times as high as 645 ug/m<sup>3</sup> concentration in a twenty-four hour period.

Table II-4. Ambient Air Quality Standards Applicable in California\*

Pollutant	California Standards(1)		National Standards (2)	
	Averaging Time	Concentration (3)	Methods (4)	Primary (3)(5)   Secondary (3)(6)   Method (7)
Oxidant	1 hour	0.10 ppm (200 ug/m3)	Ultraviolet Photometry	-
	1 hour	-	-	-
Ozone	1 hour	-	-	240 ug/m3 (0.12 ppm)
	12 hour	10 ppm (11 mg/m3)	Non-Dispersive	Same as Primary Standard
	8 hour	-	Infrared	Same as Primary Standards
	1 hour	40 ppm (46 mg/m3)	Spectroscopy	Spectroscopy
Nitrogen Dioxide	Annual Average	-	-	100 ug/m3 (0.05 ppm)
	1 hour	0.25 ppm (470 ug/m3)	Saltzman Method	Same as Primary Chemiluminescence
Sulfur Dioxide	Annual Average	-	-	80 ug/m3 (0.03 ppm)
	24 hour	0.05 ppm (131 ug/m3)	Conductimetric Method	365 ug/m3 (0.14 ppm)
	3 hour	-	-	1300 ug/m3 (0.5 ppm)
	1 hour	0.5 ppm (1310 ug/m3)	-	-

Table II-4. Continued

Pollutant	Averaging Time	California Standards(1)		Primary (3)(5)	Federal Standards (2)	
		Concentration (3)	Methods (4)		Secondary (3)(6)	Method (7)
Suspended Particulate Matter	Annual Geometric Mean	60 ug/m3	High Volume Sampling	75 ug/m3	60 ug/m3	High Volume Sampling
	24 hour	100 ug/m3		260 ug/m3	150 ug/m3	
	24 hour	25 ug/m3	AIHL Method No. 61	-	-	-
Sulfates	30 day Average	1.5 ug/m3	AIHL Method	-	-	-
	Calendar Quarter	-	-	1.5 ug/m3	1.5 ug/m3	Atomic Absorption
Hydrogen Sulfide	1 hour	0.03 ppm (42 ug/m3)	Cadmium Hydroxide Stractan Method	-	-	-
	3 hour (6-9 a.m.)	-	-	160 ug/m3 (0.13 ppm)	Same as Primary Standards	Flame Ionization Detection Using Gas Chromatography
Vinyl Chloride (Chloroethene)	24 hour	0.010 ppm (26 ug/m3)	Gas Chromatography (ARB staff report 78-8-3)	-	-	-
	8 hour	0.1 ppm	-	-	-	-
Ethylene	1 hour	0.5 ppm	-	-	-	-
	1 Observation	Insufficient amount to reduce the prevailing visibility to less than 10 miles when the relative humidity is less than 70%	(8)	-	-	-

Table II-4 - Continued

NOTES:

1. California standards are values that are not to be equaled or exceeded.
2. National standards, other than those based on annual averages or annual geometric means, are not to be exceeded more than once per year.
3. Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25° C and a reference pressure of 760 mm of mercury. All measurements of air quality are to be corrected to a reference temperature of 25° C and a reference pressure of 760 mm of Hg (1,013.2 millibar); ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.
4. 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.
5. 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).
6. 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.
7. 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" and must be approved by the EPA.
8. 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.
9. At locations where the state standards for oxidant and/or suspended particulate matter are violated. National standards apply elsewhere.
10. Measured as ozone.

\*Data from California Air Resources Board, 1979.  
California Air Quality Data

Table II-5. Allowable Pollution Increases for Various Area Classifications

Pollutant	EPA Area Classification (see below)		
	Class I (ug/m <sup>3</sup> )	Class II (ug/m <sup>3</sup> )	Class III *
<b>Particulate matter:</b>			
Annual geometric mean	5	10	*
24-hour maximum	10	30	*
<b>Sulfur dioxide:</b>			
Annual arithmetic mean	2	15	*
24-hour maximum	5	100	*
3-hour maximum	25	700	*

**Area Classifications:**

Class I: Areas in which almost any change in air quality is significant.

Class II: Areas in which determination accompanying well-controlled growth is considered insignificant; values shown are allowable increases over baseline concentrations.

\*Class III: Areas where concentrations are limited to national air quality standards.

Source: Federal Register 1974



Table II-6. State Mobile Unit Monitoring Data\* (Near Niland, Winter 1976)

CONTAMINANT	MONITORING PERIOD	NUMBER of OBS	Hourly Concentrations				AVERAGE ALL CONCS.	AVERAGE MAX HOURS	CONCENTRATIONS OVER STANDARDS				
			RANGE OF CONCS.		HI	1 HR			3 HR	8 HR	24 HR	30 DAY	
			LO	HI									
O <sub>3</sub> ppm	Jan 6 - March 15, 1976	1393	0	.10	.02	.04	5 a	0 c					
CO ppm	Jan 8 - March 15, 1976	1367	0	2	.1	.3	0 b						
NO ppm	Jan 6 - March 15, 1976	1647	0	.09	.01	.02							
NO <sub>2</sub> ppm	" " " "	1647	0	.09	.01	.02	0 d						
NO <sub>x</sub> ppm	" " " "	1647	0	.11	.02	.04							
TS ppm	Feb 25 - March 15, 1976	437	0	.03	.01	.01							
H <sub>2</sub> S ppm	Feb 11 - March 15, 1976	552	0	0	0	0	0 1						
SO <sub>2</sub> ppm	Feb 11 - March 15, 1976	730	0	0	0	0	0 e			0 f			
THC ppm	Jan 8 - March 15, 1976	1367	1.4	5.1	1.9	2.8							
CH <sub>4</sub> ppm	Jan 8 - March 15, 1976	1367	1.4	5.1	1.9	2.7							
NMHC ppm	Jan 8 - March 15, 1976	1367	0	1.1	.1	.1	4 1						
COH	Jan 13 - March 15, 1976	737	0	1.9	.2	.6							
TSP ug/m <sup>3</sup>	Jan 10 - March 15, 1976	10	37	124	85					4 g			
LEAD ug/m <sup>3</sup>											h		

Notes: \*One hour averages in units of parts per million by volume, except particulate matter which are 24-hour averages in units of uf/m<sup>3</sup>.

- (1) Average of daily maximum one-hour averages.
- (2) Largest one-hour average for the period (early January through mid-March), except sulfur measurements (mid-February through mid-March).
- (3) Gaseous pollutant concentrations are shown in parts per million (ppm). Concentrations of particulate matter and lead are shown in micrograms per cubic meter (ug/m<sup>3</sup>).
- (4) The letters a through j, in the right part of each table, refer to the air quality standards for the pollutants. The numbers next to the letters are counts of occurrences in excess of the standards. The standards are:
  - (a) Oxidant - hours > .08 ppm
  - (b) Carbon Monoxide - hours > 35 ppm
  - (c) Carbon Monoxide - occurrences with eight-hour average > 9 ppm
  - (d) Nitrogen Dioxide - hours > .25 ppm
  - (e) Sulfur Dioxide - hours > .5 ppm
  - (f) Sulfur Dioxide - days with 24-hour average > .04 ppm
  - (g) Total Suspended Particulate - days with 24-hour average > 100 ug/m<sup>3</sup>
  - (h) Lead - yes indicates the 30-day average of 1.5 ug/m<sup>3</sup> was exceeded
  - (i) Hydrogen Sulfide - hours > .03 ppm
  - (j) Non-methane hydrocarbons, NMHC - days with 6-9 a.m. average > .24 ppm

Table II-6A.

1979 Annual Air Quality Statistics for Imperial County\*\*  
oxidant and ozone

Annual Statistics  
Hourly Conc. Annual Means  
(ppm)

Occurrences of Hourly  
Concentrations > or = .10 ppm

<u>Station</u>	<u>High</u>	<u>All Hours</u>	<u>Daily Max Hour</u>	<u>Hours</u>	<u>Days</u>
El Centro	.12	.025	.050	23	10

Sulfur Dioxide

Annual Statistics  
Hourly Conc. 24 Hour Mean  
(ppm)

<u>Station</u>	<u>High</u>	<u>1st High</u>	<u>2nd High</u>
	.06*	.009*	.005*

Total Suspended Particulate Concentrations  
Micrograms per Cubic Meter

Annual Statistics

No. of Samples

<u>Station</u>	<u>High</u>	<u>2nd High</u>	<u>Low</u>	<u>Geometric Mean</u>	<u>Geometric Standard Deviation</u>	No. of Samples				<u>Num of OBS</u>
						<u>&gt; or = 100</u>	<u>&gt; 150</u>	<u>&gt; or = 260</u>	<u>&gt; or = 375</u>	
Brawley	645	439	94	215.8*	1.3*	56	48	17	4	57
Calexico	520	499	86	228.9*	1.3*	56	49	22	7	58
El Centro	406	305	31	114.0*	1.4*	36	14	4	1	58

Lead Concentrations  
Micrograms per Cubic Meter  
(Monthly Means)

Quarterly Means

<u>Station</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Sep.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	Quarterly Means				<u>Num of OBS</u>
													<u>1st</u>	<u>2nd</u>	<u>3rd</u>	<u>4th</u>	
El Centro	.36	.30	.36	.17	.21	.23	.17	.19	.37	.59*	.48	.58	.34	.20	.24	.54*	57

Table II-6A Continued.

Suspended Sulfates Concentrations  
Micrograms per Cubic Meter

Station	Annual Statistics				Number of Samples				Num of OBS	
	High	2nd High	Low	Geometric Mean	Geometric Standard Deviation	> or = 10.0	> or = 20.0	> or = 25.0		> or = 30.0
El Centro	10.8	10.7	1.8	4.42*	1.36*	3	0	0	0	57

\*Denotes statistics that do not meet the criteria for representativeness.

\*\*California Air Resources Board, 1979. California Air Quality Data.

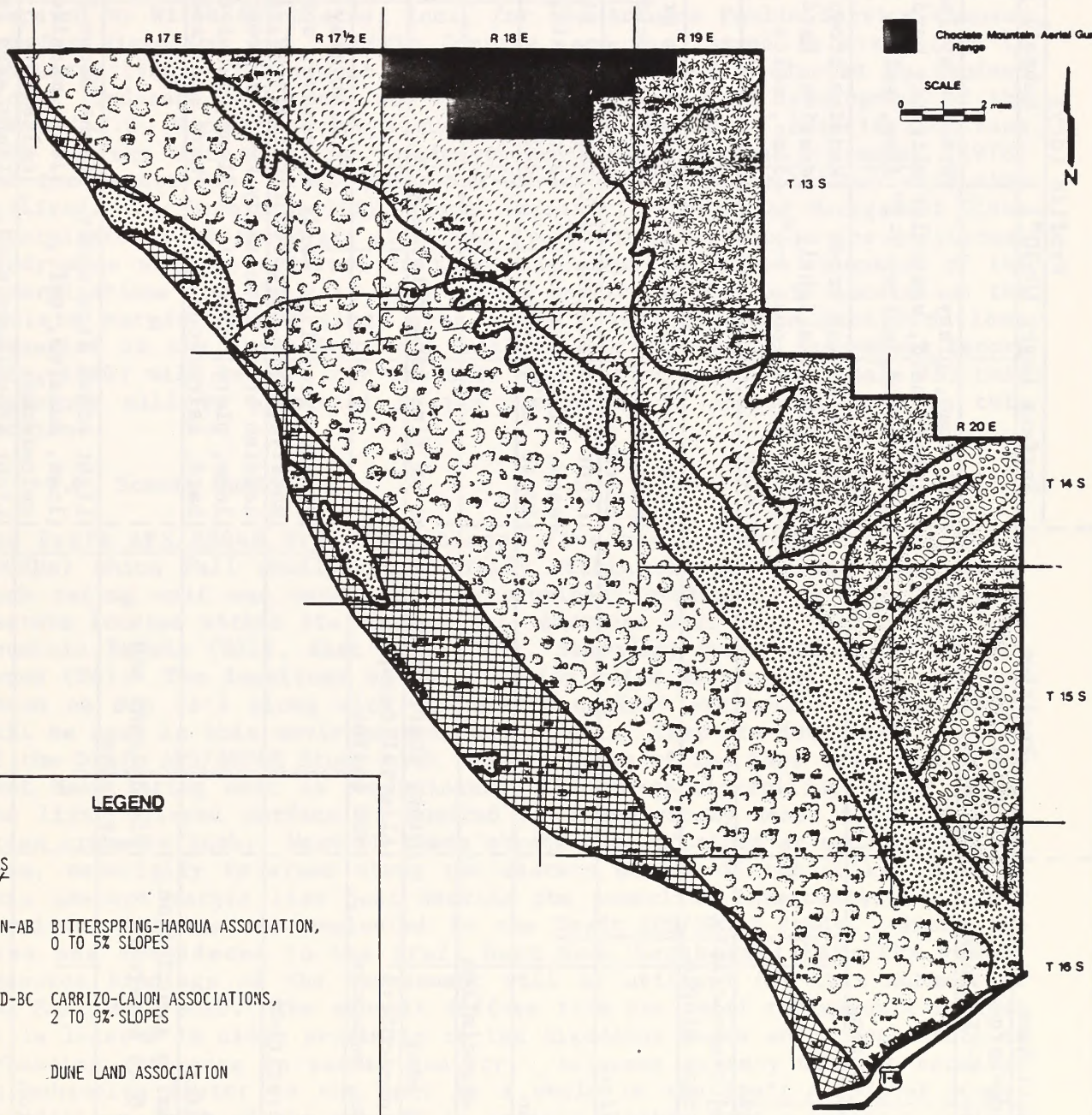
Ambient levels of atmospheric hydrogen sulfide in the Imperial Valley were measured at six stations as part of the Imperial Valley Environmental Project (U.S. Dept. of Energy, 1980). The annual frequency of occurrence of concentrations exceeding the California standards of  $42 \text{ ug/m}^3$  (one hour) was less than 5% of the time. The majority of one hour concentrations were below  $14 \text{ ug/m}^3$ . Agricultural use of liquid sulfur fertilizer in irrigation water may be the primary source of elevated levels of atmospheric hydrogen sulfide.

### SOILS

The soils (Map II-2) are in large part very sandy, with properties listed in Table II-7. Percolation is high and compactibility is high.

A rating of compaction hazard has not been made because compaction potential is not solely dependent on soil factors. Generally, the amount of soil moisture and the amount of traffic on soil will be of greater importance in determining the intensity of soil compaction. Soils which can compact to the greatest extent are those with a combination of fine and coarse particles which will allow packing of the fine material into the voids between the larger particles. Loose sands, such as dunes or those in the Cajon series, will have the lowest potential for compaction.

GLAMIS/DUNES GEOTHERMAL STUDY AREA



Map.II-2

**LEGEND**

SOILS






- 
BY-HN-AB BITTERSPRING-HARQUA ASSOCIATION,  
0 TO 5% SLOPES
- 
CR-CD-BC CARRIZO-CAJON ASSOCIATIONS,  
2 TO 9% SLOPES
- 
DL- DUNE LAND ASSOCIATION
- 
SS-AB-A SUPERSTITION-ACOLITA ASSOCIATION,  
HUMMOCKY
- 
VO-BM-ABI VINTON-BRAZITO ASSOCIATION, HUMMOCKY,  
0 TO 9% SLOPES

TABLE II-7

## Soil Properties in the Glamis KGRA Area\*

Map Symbol	Soil Name	Position	Profile (dry)	
			Surface Layer (0-10")	Subsoil (10-40")
By-HN-AB	Bitterspring-Harqua association, 0-5% slopes	Alluvial fans and terraces	Pink loam, platy, slightly hard, vesicular, calcareous, salts, 1-3" thick	Brown clay loam, blocky, slightly hard, vesicular, calcareous, lime, salts, 3-12" thick
	Bitterspring		Light yellowish brown loam, platy, slightly hard, calcareous, 1-4" thick	Reddish brown clay loam, massive, hard, calcareous, lime, salts
	Harqua			
Cr-Cd-Bc	Carrizo-Cajon association, 2 to 9 percent slopes		Pale Brown coarse sand, massive, soft, calcareous	Pale brown gravelly sand, massive, soft, calcareous
	Carrizo			
	Cajon		Light brownish gray fine sand, single grain, loose, calcareous	Light gray fine sand, single grain, loose, calcareous
DL	Dune land association			
	Dune land	High, shifting dune areas of		
as-Ab-A	Superstition-Acolita association, hummocky	Alluvial fans, terraces and basins		
	Superstition		Pinkish gray fine sand, massive, soft, calcareous	Pinkish gray fine sand, massive, soft, calcareous, lime
	Acolita		Reddish brown fine sandy loam, platy, slightly hard, calcareous	Reddish brown fine sandy loam, massive, slightly hard, calcareous, lime
Vo-BM-AB1	Vinton-Brazito association, hummocky, 0 to 5 percent slopes	Floodplains and terraces		
	Vinton		Light brown fine sandy loam, massive, soft, calcareous	Light brown fine sandy loam, massive, soft, calcareous
	Brazito		Light gray loamy sand, single grain, loose, calcareous	Light gray loamy sand, single grain, loose, calcareous

\*Source: Report for General Soil Map, Imperial County, California, 1967. Imperial Irrigation District in cooperation with U.S. Department of Agriculture, Soil Conservation Service.

## VISUAL RESOURCES

The Glamis/Dunes geothermal lease study area was recently inventoried using the Bureau's VRM system (BLM Manual 8400) during preparation of the APS/SDG&E Interconnection Project Environmental Study. This study is being prepared by Wirth Associates, Inc., for the Arizona Public Service Company and San Diego Gas and Electric Company, and was issued in draft form in February, 1980. The visual resources inventory was conducted by professional landscape architects who had earlier assisted in development of the BLM and U.S. Forest Service visual management systems. Existing BLM base data sources including the Sundesert Draft Environmental Statement (1978) and the Desert Plan Staff (DPS) VRM inventory (1979 Completion) were also utilized. The Scenic Quality, Visual Sensitivity, and Land Management Class determinations of the Draft APS/SDG&E Study which pertain to the geothermal study area will be utilized in this assessment, with the exception of the determinations for the East Mesa scenic quality rating unit located on the western margin of the study area. The visual resource determinations presented in the Draft East Mesa Geothermal Environmental Assessment Record (BLM, 1980) will be used for the East Mesa rating unit. Rationale for this departure will be presented in the discussion of scenic quality in this section.

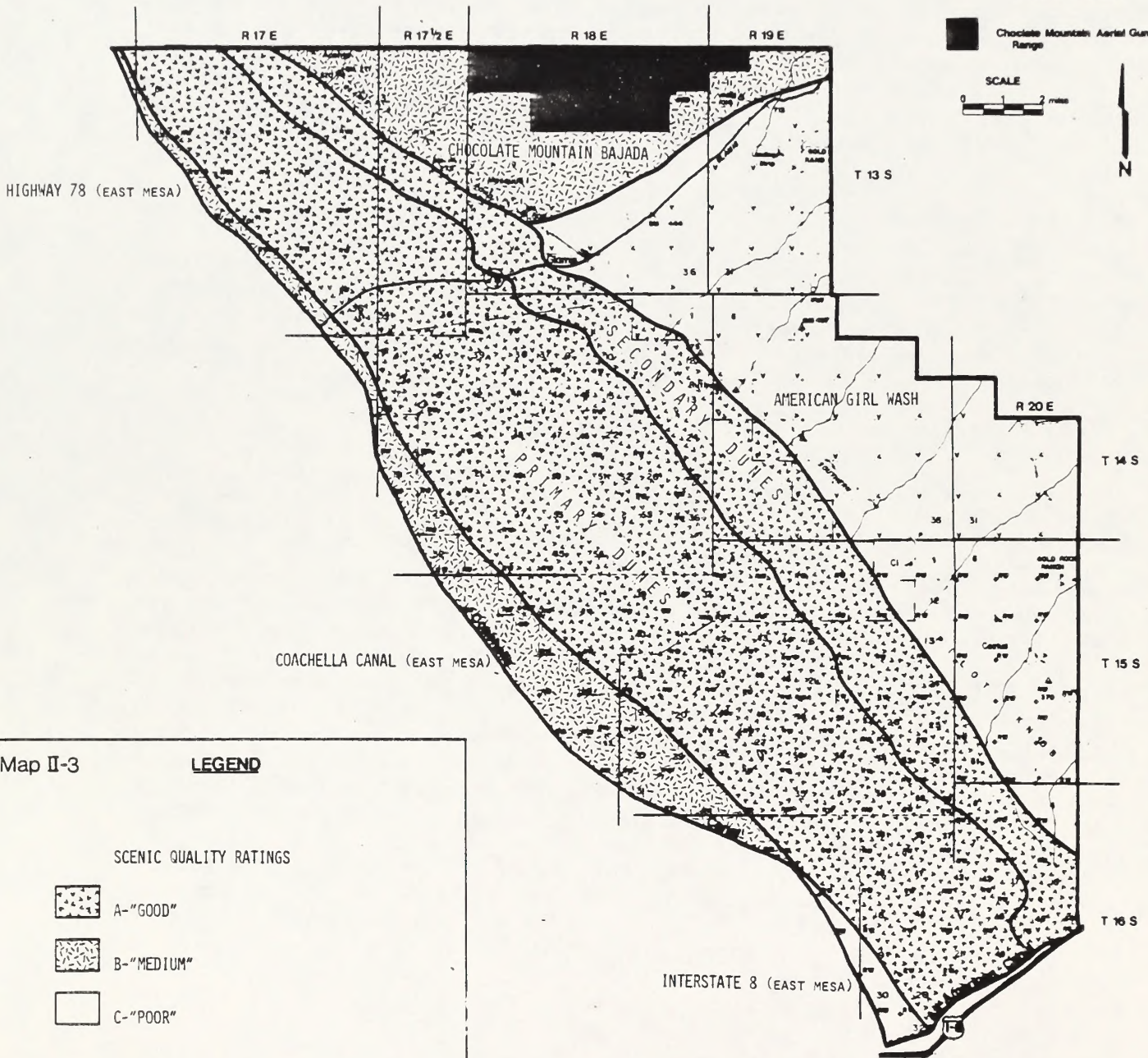
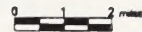
### 1. Scenic Quality

The Draft APS/SDG&E Study delineated five scenic quality rating units (SQRUs) which fall wholly or partially within the geothermal study area. Each rating unit was named after a prominent geographic or physiographic feature located within its boundaries: American Girl Wash (B20), Chocolate Mountain Bajada (B21), East Mesa (B22), Secondary Dunes (D3), and Primary Dunes (D4). The locations of these rating units within the study area are shown on Map II-3 along with the scenic quality evaluation results which will be used in this environmental assessment. They are identical to those of the Draft APS/SDG&E Study with the exception of the East Mesa Unit. The East Mesa rating unit is predominantly flat-to-gently-rolling sandy plain. The light colored surface is covered by a moderately dense stand of dark green creosote bush. Many of these shrubs have attained an unusually large size, especially in areas along the eastern margin of the unit. Most of this eastern margin lies just outside the powerline interconnection study corridor, and was not evaluated in the Draft APS/SDG&E Study. Since the area was considered in the Draft East Mesa Geothermal EAR, the visual resource findings of the assessment will be utilized for this subunit of the East Mesa SQRU. The subunit differs from the total rating unit in that it is located in close proximity to the Algodones Dunes which constitute an enhancing influence on scenic quality. Adjacent scenery was not rated as an enhancing factor on the unit as a whole in the Draft APS/SDG&E Study. In addition, much of the subunit is readily visible from a superior vantage point at developed recreation sites in the northern portion of the dunes.

GLAMIS/DUNES GEOTHERMAL  
STUDY AREA

Chocolate Mountain Aerial Gunnery Range




SCALE



Map II-3

**LEGEND**

SCENIC QUALITY RATINGS

-  A-"GOOD"
-  B-"MEDIUM"
-  C-"POOR"



This close proximity and superior viewing angle enable the viewer to perceive a greater variety of colors than can be readily seen from the flat vantage points in other parts of the total SQRU. Vegetative colors range from deep green (predominant) to tan, with localized patches of grey-green along the canals. Soil color varies from light tan to grey. These differences in the influence of adjacent scenery and perceived variety of color are enough to raise most of the subunit from "Class C" to "Class B" scenic quality. Only the southern portion near Interstate 8 is rated "Class C." This because fewer superior vantage points exist and less color contrast is found in that area.

Pertinent scenic quality rating areas delineated in the Draft APS/SDG&E Study and the Draft East Mesa Geothermal EAR are presented in Table II-8.

The Primary Dunes rating unit contains the major portion of the Algodones Dunes, which constitute strong color, vegetational, landform, geometric, and line contrasts with the nearby creosote bush flats of East Mesa. The dunes rise abruptly to a height of several hundred feet above the flats to form massive rounded hills of a uniform light tan color. Color shades vary mainly with the slope of the dunes and differences in the angle of incidence of sunlight. The dune surface is smooth to lightly rippled, and the dune skyline presents a maze of intersecting undulations which stretches away from the viewer for miles. Many of the higher sloping surfaces are nearly devoid of vegetation, but lower flatter surfaces are often peppered or mottled with small shrubs and herbaceous plants. In some areas, drainage patterns result in irregular or free flowing streaks of vegetation across the dunes. Predominant vegetation colors are light to dark green, providing varying degrees of contrast with the light and brightly reflecting dunes. Structural intrusions are limited to the All-American Canal, which forms the southern boundary of the study area, and the black-to-gray lines of State Highway 78 and short recreational roads which enter the dunes from that highway. In addition to all of the other factors which enhance its scenic quality, the unique character of this extensive dune system enhances its scenic appeal.

The Secondary Dunes rating unit possesses greater variation in landform than the primary dune area because relatively flat vegetation-covered areas almost devoid of sand are interfingered with relatively stable vegetated dunes. While the secondary dunes are relatively small when compared with the primary dunes, the contrast with the small meandering valleys enhances the interest and uniqueness of the area. The overall form of the dunes is similar to that of the primary dunes' rolling, undulating rounded hills, but reduced in size and interrupted by relatively flat openings. The smooth surface texture of the dunes is often masked by vegetation cover, which in places gives them a more coarse appearance and interrupts the smooth flowing lines. Vegetation consists of shrubs and herbaceous plants on the dunes with more of the same plus small trees in the valley areas. Vegetation texture varies from mottled and spotted to almost solid in some areas, and colors vary from dark green through light grey-green to tan. Cultural modifications consist of Highway 78 and the Glamis development, which includes several cubical to rectangular solid-shaped buildings with flat or peaked roofs, several natural sand parking lots, and the Glamis International Sandway, which includes a grandstand and sand dragstrip.

Table II-8

Glamis Dunes Geothermal Study Area  
Scenic Quality Ratings

Scenic Quality Rating Unit	Land-form	Color	Water	Vegetation	Uniqueness	Modifications	Adjacent Scenery	Total	Scenic Quality Rating
B 20 American Girl Wash*	1	2	0	3	1	0	2	9	C
B 21 Chocolate Mtn. Bajada*	1	2	0	3	2	2	2	12	B
D 3 Secondary Dunes*	4	4	0	1	6	1	2	18	A
D 4 Primary Dunes*	2	3	0	4	5	1	3	18	A
<u>East Mesa:</u>									
1. Highway 78**	1	3	0	3	2	0	3	12	B
2. Coachella Canal**	1	3	0	3	2	0	3	12	B
3. Interstate 8**	1	1	0	2	1	-2	3	6	C

\*Source: Draft APS/SDG&E Interconnection Project Environmental Study - Phase II Corridor Studies - Visual Resources. Prepared for Arizona Public Services Company and San Diego Gas and Electric Company by Wirth Associates, Inc., February 1980.

\*\*Source: Draft East Mesa Proposed Geothermal Leasing Environmental Assessment Record. Riverside District Office, U.S. Bureau of Land Management, April 1980.

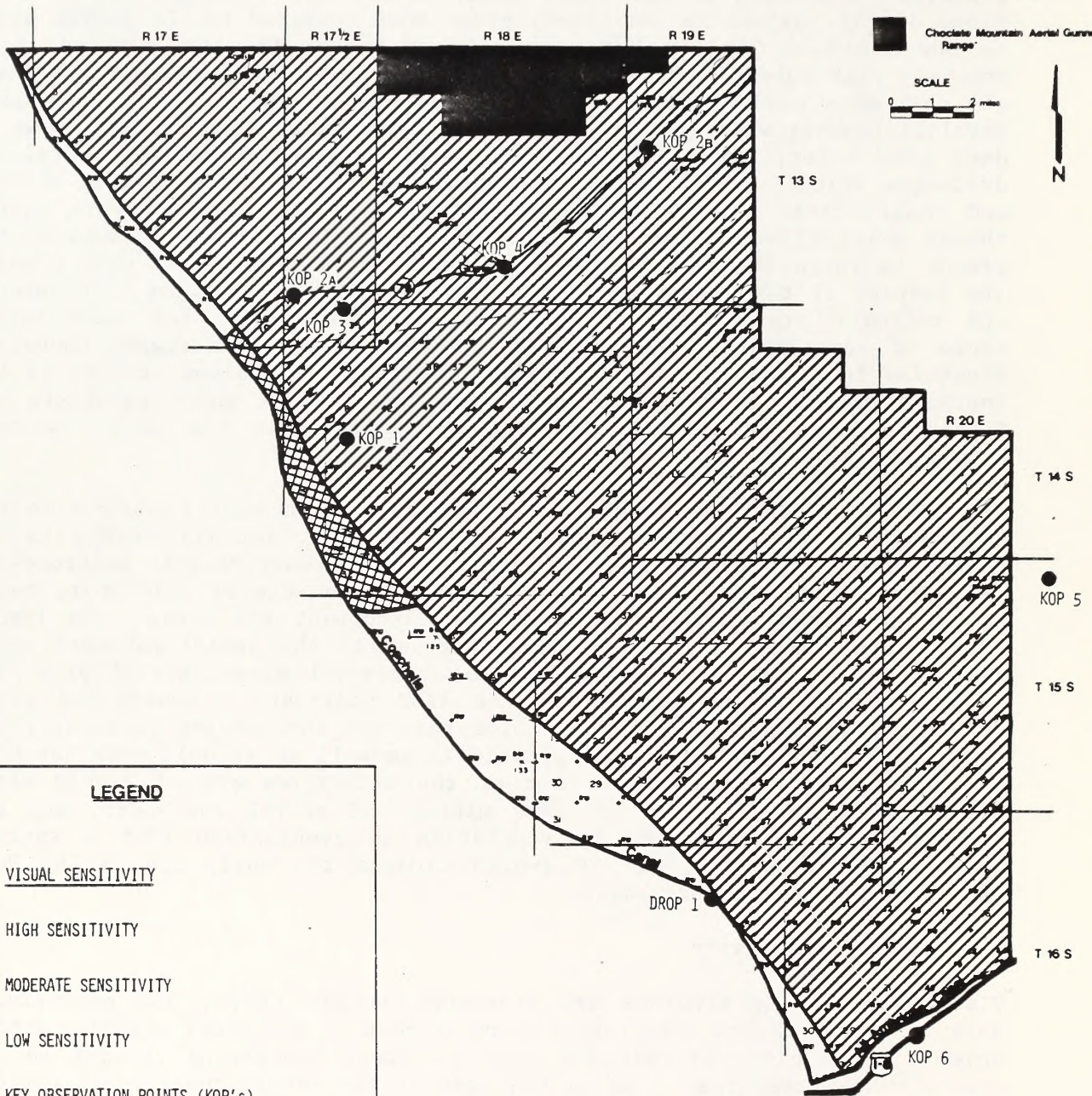
The Chocolate Mountain Bajada rating unit consists of an area of roughly parallel drainages which slope from the base of the Chocolate Mountains (located just north of the study area) toward the secondary dunes. The slope of this bajada is relatively great when compared to the gentle slope in the American Girl Wash rating unit to the south. This slope angle combines with superior vantage points along Highway 78 in the dunes to make the unit more readily visible. The bajada consists of a series of roughly parallel benches with flat to undulating rocky surfaces of reddish brown to dark grey color, separated by free-flowing (but again, roughly parallel) drainages which support vegetation consisting of herbaceous plants, shrubs, and small trees. Predominant vegetation colors are light to dark green, though some yellow is apparent in the spring. The surface texture of the ground is rough (because of the covering of cobblestone-size rocks) while the texture of the vegetation varies from spotted and mottled to clustered and tufted. Predominant lines are formed by drainages and accompanying lines of vegetation. The proximity of the unit to the rugged Chocolate Mountains increases its scenic appeal. Cultural intrusions consist of the Southern Pacific Railroad and an unpaved county road which parallels it. Together, they form a straight line which parallels the entire western margin of the unit.

The American Girl Wash rating unit is similar in most respects to the Chocolate Mountain Bajada unit. The most important difference is the higher number of cultural modifications. The Southern Pacific Railroad and associated county road also parallel the western edge of this unit, and a system of informal roads has developed throughout the area. The light-colored roads present a conspicuous contrast to the desert pavement which covers most of the undisturbed surfaces. Several mines, gravel pits, and trash dumps create similar color and line contrasts. Houses and other structures (generally lighter in color than the surrounding landscape) are found at some of the mines and gravel pits as well as at Gold Rock Ranch at the south end of the unit. Most of the structures are of single story height with the exception of some mining and gravel equipment, and are screened from distant view by vegetation in combination with a shallow viewing angle from Highway 78 (which crosses the unit) and Ogilby Road (which skirts its eastern edge).

## 2. Visual Sensitivity

Visual Sensitivity findings are presented on Map II-4. The sensitivity data reflect both the high user volume of most of the study area and a high level of community interest and user attitudes concerning changes to the area's visual resources. As in the case of the scenic quality evaluation, data from the Draft East Mesa Geothermal EAR are utilized for the western margin of the study area.

GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



Map II-4

**LEGEND**

VISUAL SENSITIVITY



HIGH SENSITIVITY



MODERATE SENSITIVITY



LOW SENSITIVITY



KEY OBSERVATION POINTS (KOP'S)

The high use volume is a product of both proximity to major travel routes and the dunes' status as the most heavily visited recreational area on the California Desert. The California Department of Transportation estimates that approximately 4600 vehicles per day pass along the southern boundary of the study area on Interstate Highway 8, while about 1000 vehicles per day pass through on State Highway 78. Though no use volume figures are available for Ogilby Road (which skirts the eastern edge of the study area), it is estimated to have high use volume sensitivity by the Imperial County Road Department. Recreational use of the study area was estimated at 444,000 visitor use days (VUDs) for 1978, based on BLM aerial visitor count data.

The high overall visual sensitivity rating for the areas north and east of the sand dunes is a product of high use volume sensitivity associated with Highway 78 and Ogilby Road and medium user attitudes concerning changes in visual resources. The overall rating for the dune areas is a product of both high use volume sensitivity and high user attitudes concerning change.

Low to medium sensitivity has been determined along the East Mesa Strip in the western margin of the study area. This is due to a combination of low perceived user attitudes concerning change to East Mesa's visual resources and low use volume sensitivity. While Highway 78 and Interstate Highway 8 pass through or along the area, this narrow strip is in the foreground/midground visual range of highway motorists for only a short time. Only where high use volume is associated with the recreational developments along Gecko Road in the dunes immediately to the east was the East Mesa Strip determined to have medium sensitivity. (Note: the Draft East Mesa Geothermal EAR also determined that an area of medium sensitivity existed around the bridge over the Coachella Canal at "Drop 1," since access to the dunes provided by the bridge has contributed in the past to a considerable level of recreational use in the area. Construction of a new concrete-lined Coachella Canal which will not be bridged at any point between Interstate 8 and Highway 78 is currently under way. Its completion is expected to dramatically reduce the use volume of the Drop 1 area. The medium sensitivity determination for that area is therefore omitted from this assessment).

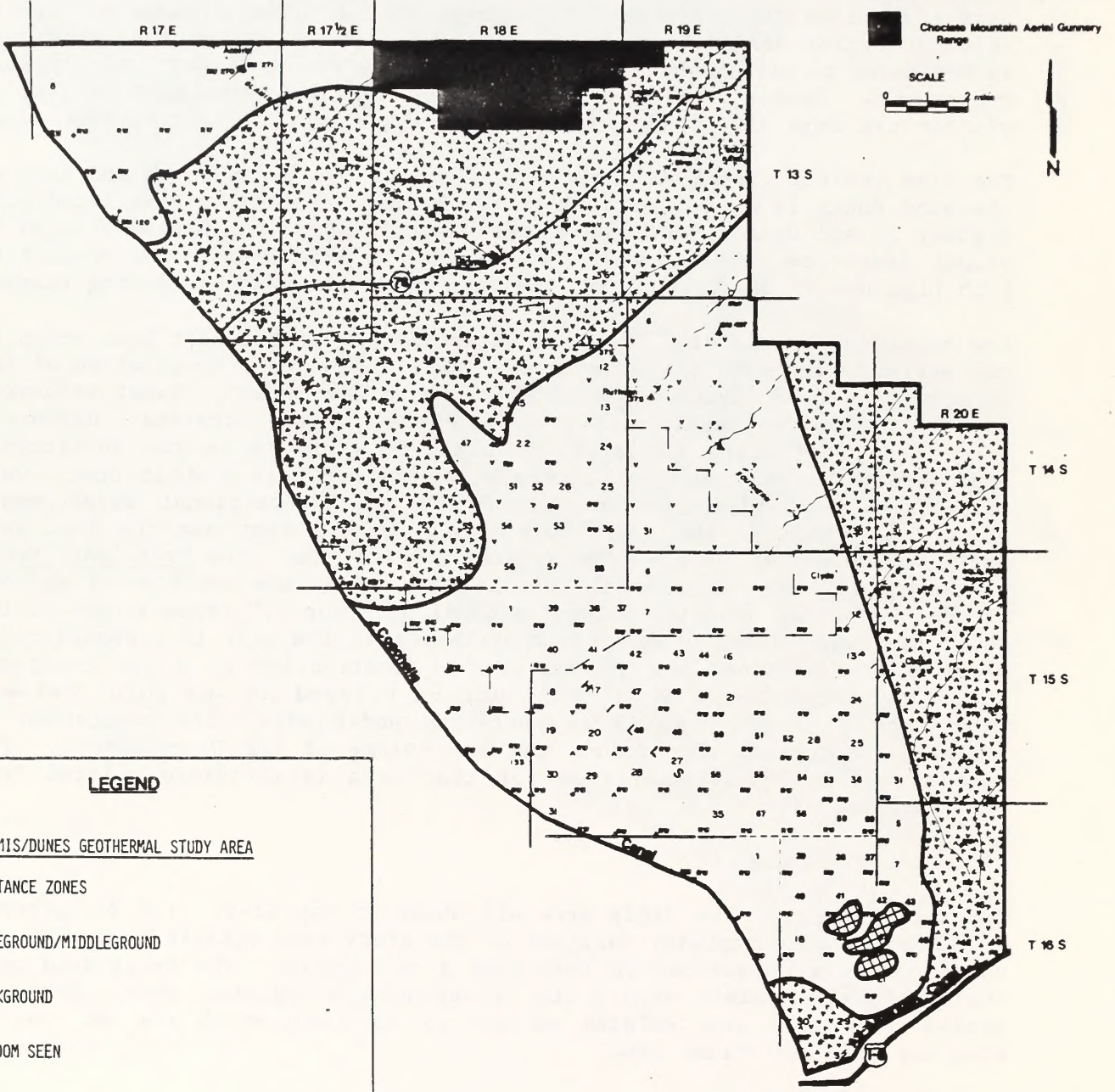
### 3. Distance Zones

Distance zones for the study area are shown on Map II-5. The foreground/midground zone includes portions of the study area visible from high use volume areas at distances of less than 3 to 5 miles. The background zone includes areas visible beyond the foreground/midground zone, while the seldom seen areas are isolated valleys in the dunes which are not visible from any high use volume area.

### 4. Management Classes

The study area has been determined to contain four visual resources management classes (see Map II-6). These classes place limitations on management of the areas as follows:

GLAMIS/DUNES GEOTHERMAL STUDY AREA






Map II-5

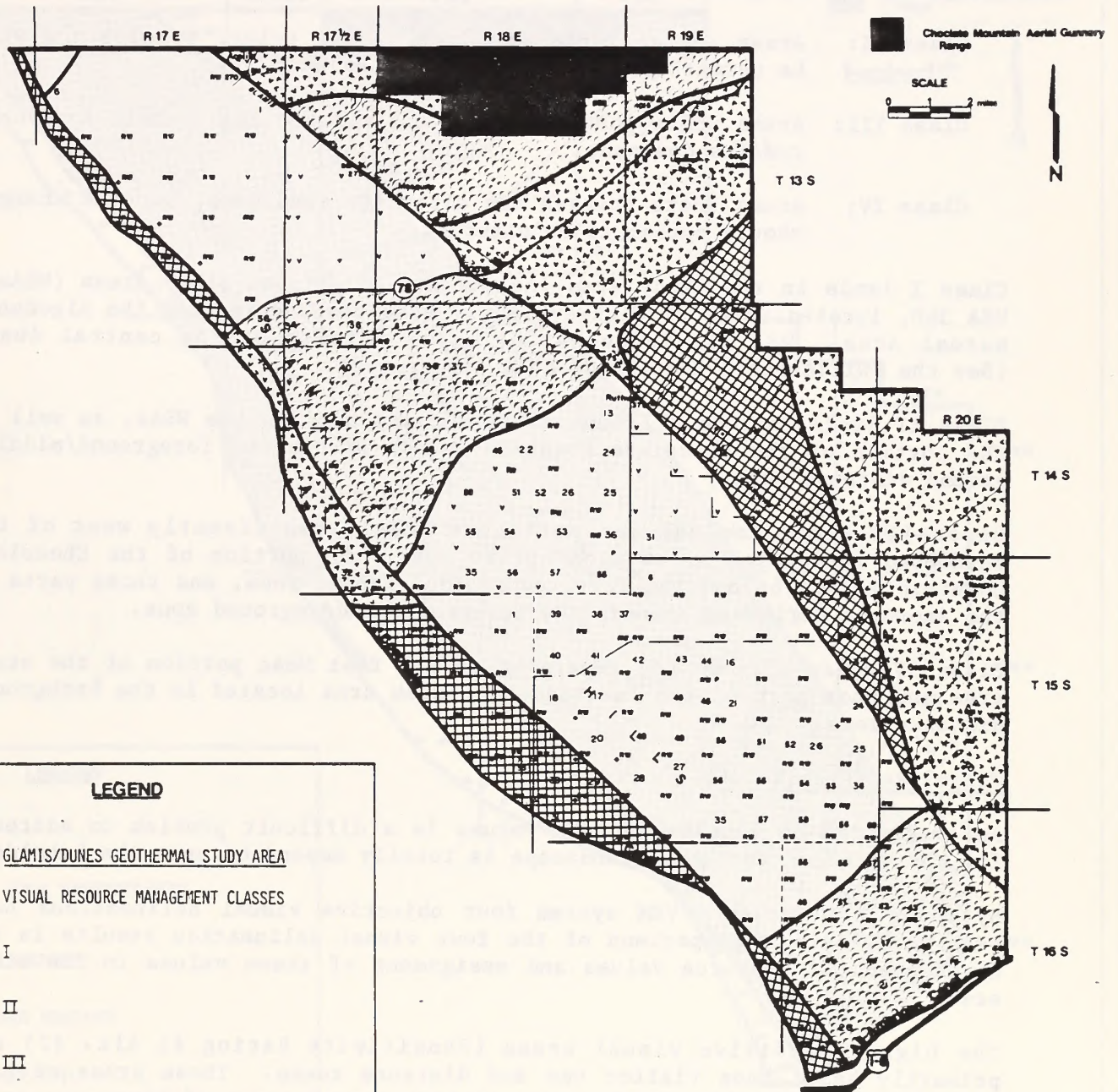
**LEGEND**

GLAMIS/DUNES GEOTHERMAL STUDY AREA

DISTANCE ZONES

-  FOREGROUND/MIDDLEGROUND
-  BACKGROUND
-  SELDOM SEEN

GLAMIS/DUNES GEOTHERMAL STUDY AREA



Map II-6

**LEGEND**

GLAMIS/DUNES GEOTHERMAL STUDY AREA

VISUAL RESOURCE MANAGEMENT CLASSES

- I 
- II 
- III 
- IV 

Class I: This class provides primarily for natural ecological changes, with very limited management activity. It is limited to natural areas or wilderness areas established by legislation or policy.

Class II: Areas where changes in line, form, color, and texture will be permitted, but should not be evident.

Class III: Areas where changes may be noticed but the overall landscape remains dominant.

Class IV: Areas where changes may alter the landscape, but the changes should appear to be natural.

Class I lands in the study area include two Wilderness Study Areas (WSAs). WSA 360, located north of Highway 78 has also been designated the Algodones Natural Area. WSA 362 includes the major portion of the central dunes (See the "Wilderness" Section of this assessment).

Class II lands include all dune areas not included in the WSAs, as well as the portion of the Chocolate Mountain Bajada within the foreground/middle-ground distance zone.

Class III areas include the portion of East Mesa directly west of the developed recreation sites along Gecko Road, the portion of the Chocolate Mountain Bajada beyond the foreground/middleground zone, and those parts of the American Girl Wash area in the foreground/middleground zone.

Class IV areas include the remainder of the East Mesa portion of the study area and that part of the American Girl Wash area located in the background distance zone.

#### Visual Resource Values

An evaluation of visual resource values is a difficult problem to address, for the value of any scenic landscape is totally dependent upon the beholder.

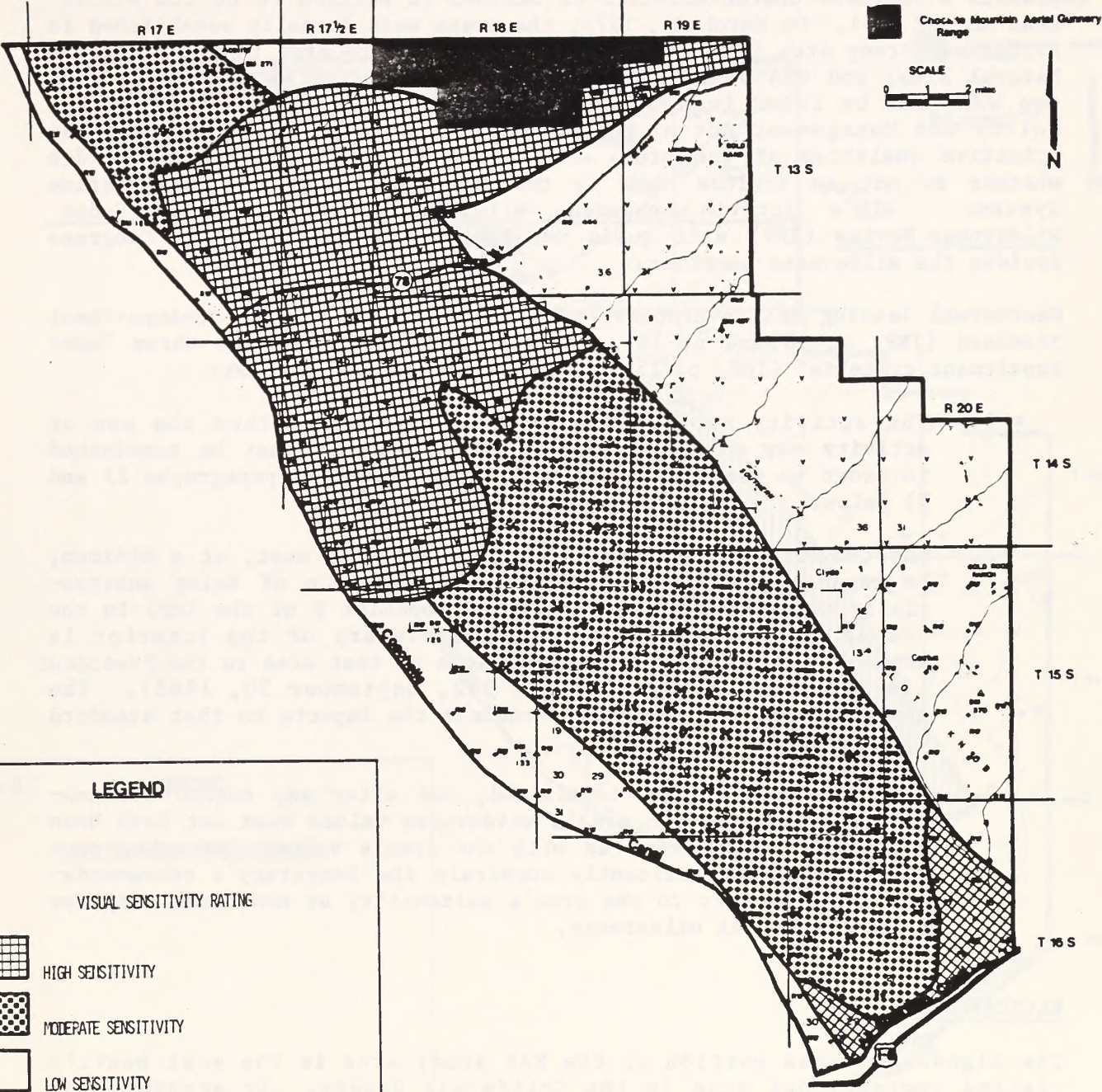
By using the Bureau's VRM system four objective visual delineations have been analyzed. A comparison of the four visual delineation results in the development of resource values and assignment of these values to the study area.

The highly sensitive visual areas (Sensitivity Rating #1 Alt. #2) are primarily based upon visitor use and distance zones. Those areas of high visitor use and within the foreground/middleground zones of these use areas have been assigned the highly sensitive rating. See Map II-S-1.

The moderately sensitive visual areas (Sensitivity Rating #2 Alt. #2) are primarily those portions of the background zone visible from great distances. See Map II-S-1.






GLAMIS/DUNES GEOTHERMAL STUDY AREA



Map II -s1 **LEGEND**

VISUAL SENSITIVITY RATING

-  HIGH SENSITIVITY
-  MODERATE SENSITIVITY
-  LOW SENSITIVITY

## WILDERNESS

The Bureau has determined that two large areas of the Algodones Dunes possess wilderness characteristics as defined in section 2C of the Wilderness Act of 1964. On March 31, 1979, the areas were formally established as Wilderness Study Area (WSA) 360 (which corresponds in area to the Algodones Natural Area) and WSA 362 (see map II-7). Descriptive narratives for the two WSAs can be found in Appendix A. Section 603 of the Federal Land Policy and Management Act of 1976 (FLPMA) requires BLM to protect the primitive qualities of the study areas until Congress ultimately decides whether or not to include them in the National Wilderness Preservation System. BLM's Interim Management Policy and Guidelines for Land Under Wilderness Review (IMP) will guide management of the WSAs until Congress decides the wilderness question.

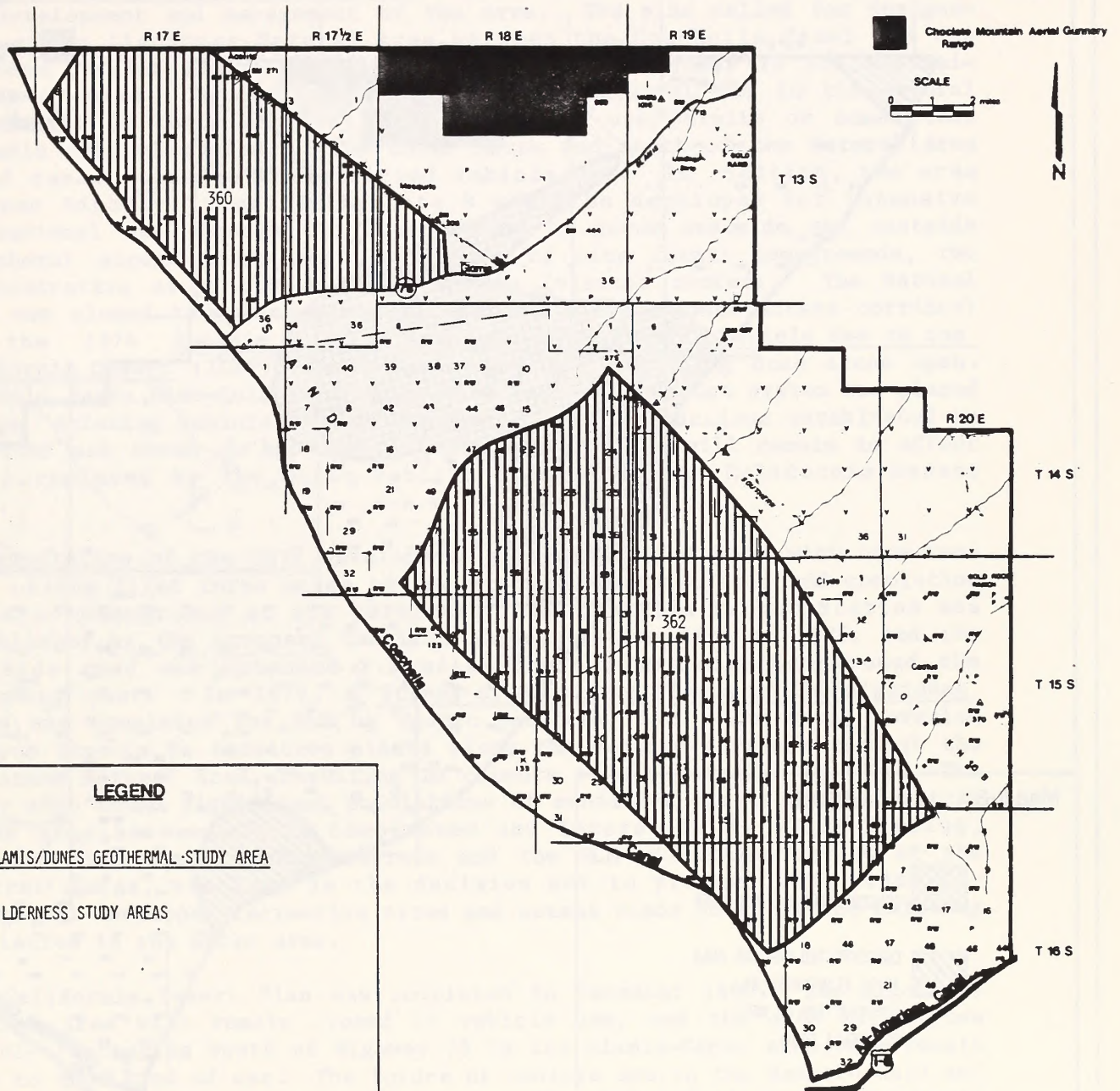
Geothermal leasing and development of WSAs is subject to the Nonimpairment Standard (IMP, p. 10 and p. 14), and therefore must meet the three "non-impairment criteria" (IMP, p. 15). The criteria stipulate that:

1. The activity must be temporary. This means that the use or activity may continue until the time when it must be terminated in order to meet the reclamation requirement of paragraphs 2) and 3) below.
2. Any temporary impacts caused by the activity must, at a minimum, be capable of being reclaimed to a condition of being substantially unnoticeable (as defined in Appendix F of the IMP) in the WSA as a whole by the time the Secretary of the Interior is scheduled to send his recommendations on that area to the President (in the case of WSAs 360 and 362, September 30, 1982). The operator will be required to reclaim the impacts to that standard by that date.
3. When the activity is terminated, and after any needed reclamation is complete, the area's wilderness values must not have been degraded so far, compared with the area's values for other purposes, as to significantly constrain the Secretary's recommendation with respect to the area's suitability or unsuitability for consideration as wilderness.

## RECREATION

The Algodones Dunes portion of the EAR study area is the most heavily visited recreational area in the California Desert. It accounts for approximately one sixth of the total concentrated use in the CDCA. Recreational use of the dunes centers around the operation of off-road vehicles (ORVs), principally dune buggies and all-terrain vehicles (ATVs). The most intensely used area is a 50-square-mile section south of State Highway 78 between the Coachella Canal and Glamis. On such winter holiday weekends as Thanksgiving and Washington's Birthday, this area is commonly visited by between ten and fifteen thousand recreationists. This and other areas of concentrated ORV activity are shown on Map II-8.

GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



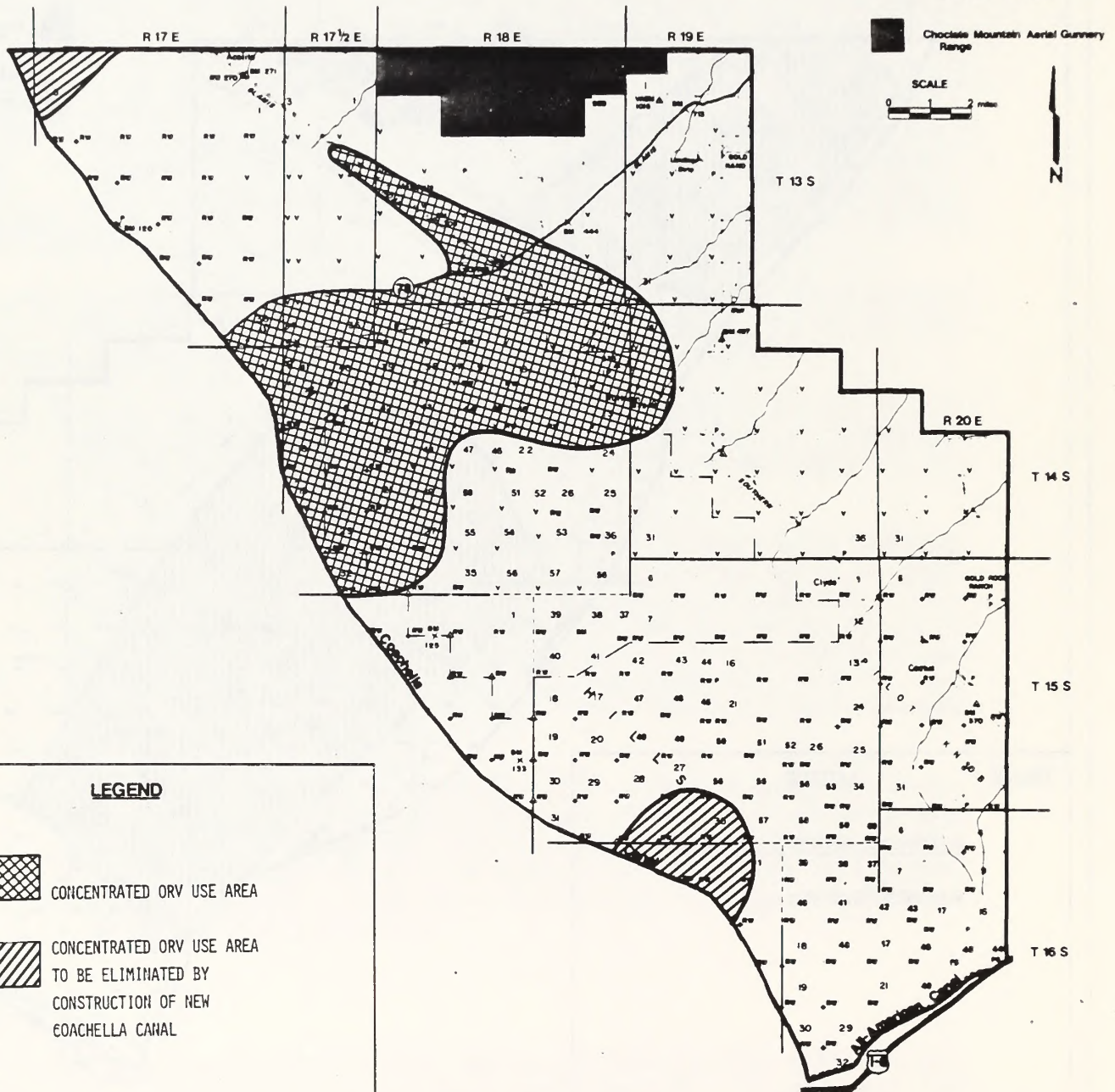
Map II-7

**LEGEND**

GLAMIS/DUNES GEOTHERMAL STUDY AREA

WILDERNESS STUDY AREAS

GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



Map II-8

**LEGEND**



CONCENTRATED ORV USE AREA



CONCENTRATED ORV USE AREA  
TO BE ELIMINATED BY  
CONSTRUCTION OF NEW  
COACHELLA CANAL

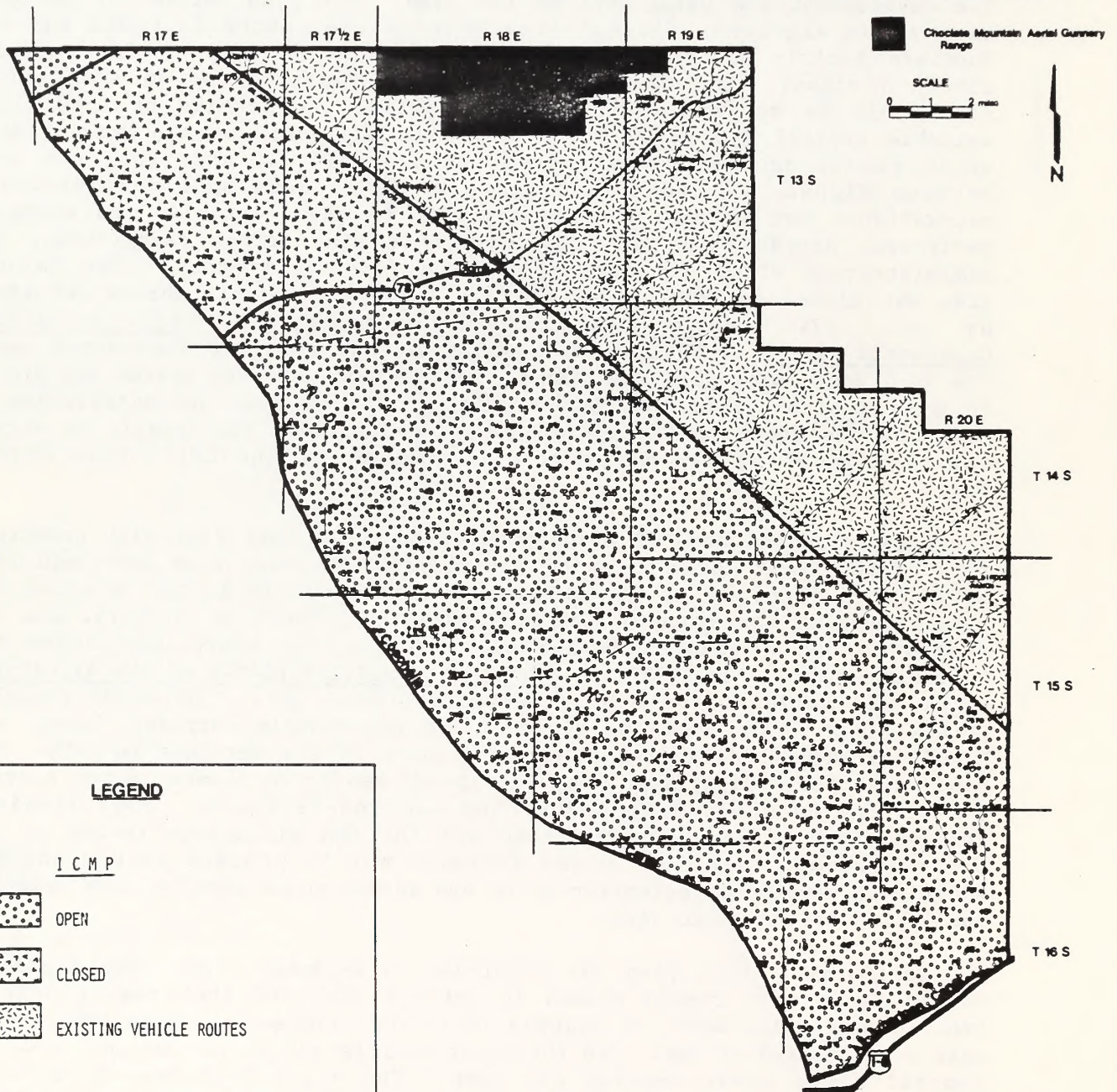
## 1. Management History.

In 1972, the Bureau of Land Management (BLM) completed a plan entitled Imperial Sand Dunes Recreation Area, intended as a comprehensive guide for the development and management of the area. The plan called for designation of an Algodones Natural Area between the Coachella Canal and the Southern Pacific Railroad, and north from State Highway 78 for approximately 8 miles. According to the plan, recreational use in the Natural Area would be controlled "by issuing special use permits or some other suitable control system." The dunes north and south of the Natural Area would remain open to unrestricted vehicle use. In addition, the area between Highway 78 and Interstate 8 would be developed for intensive recreational use through the construction of paved westside and eastside peripheral access roads and development of nine formal campgrounds, two administrative sites and one way station (visitor center). The Natural Area was closed to vehicle use (except for a north-south access-corridor) by the 1974 Interim Critical Management Program for Vehicle Use on the California Desert (ICMP), which designated the remaining dune areas open. The Gold Basin Mine-Gold Rock Ranch area east of the dune system was placed in the "existing vehicle routes" category. Use restrictions established by the ICMP are shown on Map II-9. These restrictions will remain in effect until replaced by the motor vehicle element of the California Desert Plan.

Implementation of the 1972 development plan began that year with construction of the first three miles of the proposed westside road and completion of Gecko Campground at its terminus. The Cahuilla Ranger Station was established at the proposed Cahuilla Administrative site in 1975, and the westside road was extended 2.5 miles south from Gecko Campground the following year. In 1977, a Survey of Sensitive Plants of the Algodones Dunes was completed for BLM by Westec Services, Inc. The study revealed serious impacts to sensitive plants along the vehicle corridor through the Algodones Natural Area, resulting in closure of the corridor in 1978. The study also found significant populations of sensitive plants in the central dunes area between Gecko Campground and Interstate 8. This finding, combined with fiscal considerations and the BLM wilderness review of the central dunes, resulted in the decision not to proceed with plans for additional developed recreation sites and access roads south of the existing facilities in the Gecko area.




The California Desert Plan was completed in December 1980. The Algodones Natural Area will remain closed to vehicle use, and the area of intense vehicle recreation south of Highway 78 in the Glamis-Gecko area will remain open to that kind of use. The future of vehicle use in the Mammoth Wash and central dunes areas remains the same. The Pilot Knob Mesa-Gold Basin Mine area east of the dunes will remain open to vehicle use under either the "designated roads and trails" or "existing vehicle routes" category.

GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



Map II-9

**LEGEND**

- I C M P
-  OPEN
  -  CLOSED
  -  EXISTING VEHICLE ROUTES

## 2. Recreational Activities

Recreational pursuits currently popular in the EAR study area will be reviewed here by visitor use polygon. (See Map II-10 for location of visitor use polygons.)

### Mammoth Wash Open Wash

Most of the dune buggy and ATV activity occurring in this open area is centered in the small corner included within the EA study area. This is due to the availability of access across the Coachella Canal at Titsworth Road, which marks the northern boundary of the Algodones Natural Area. Hunting opportunities for upland game are good immediately adjacent to the Coachella Canal in this area and extending down the entire length of the canal throughout the Glamis Dunes Study Area.

### Algodones Natural Area

This area is not at present used extensively for recreation though it is entered periodically by a number of colleges and universities for field trips and research projects. Contemplative recreational activities, including wildlife viewing, photography and hiking are also known to occur. Hunting opportunities for both upland game and big game are found in the more vegetated areas along the eastern border of the Natural Area.

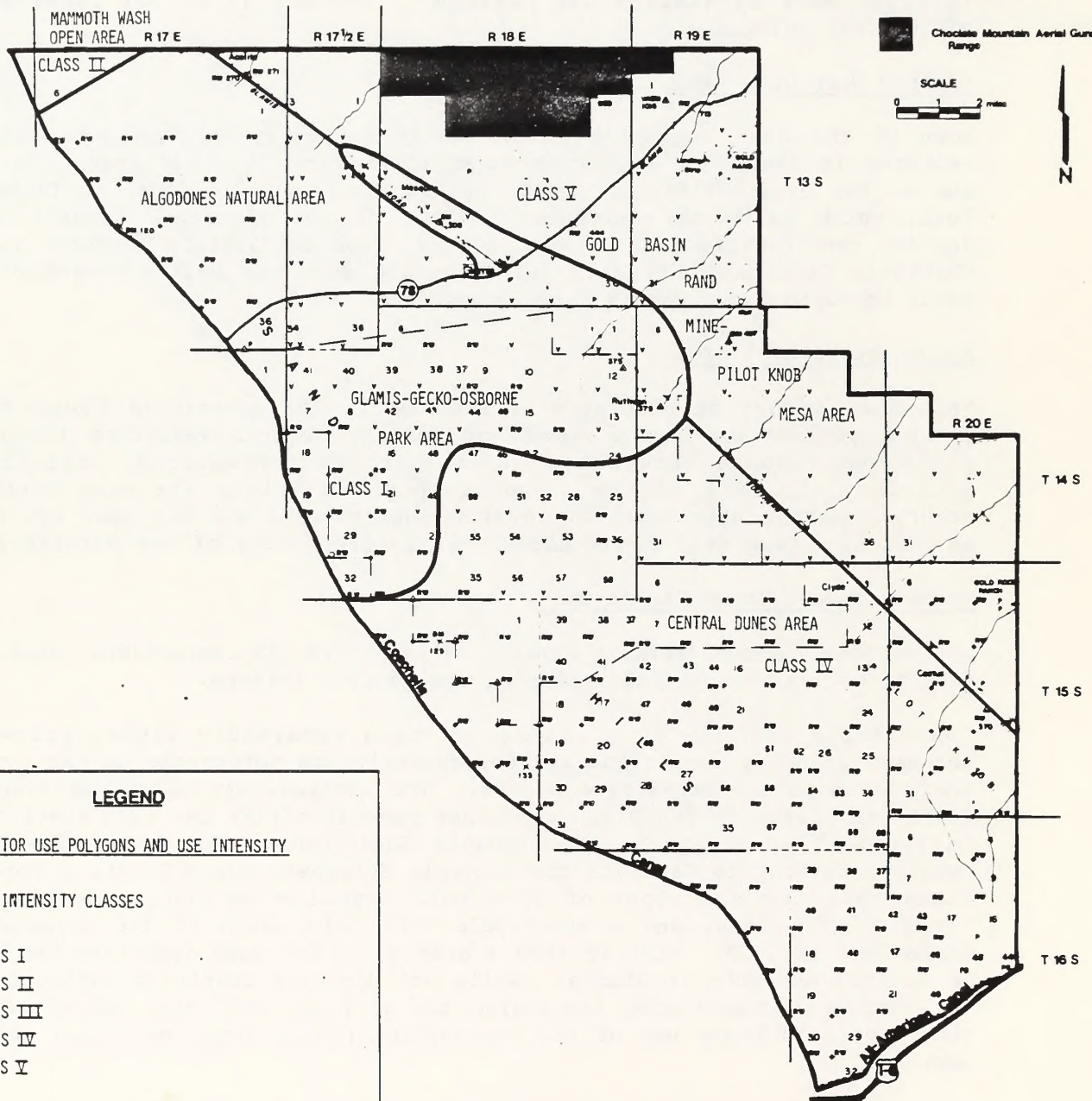
### Glamis-Gecko-Osborne Park Area

As previously noted, this is an area of intensive ORV recreation. Ancillary activities include vehicular camping and general leisure.

Competitive ORV use of the area has been remarkably light, primarily because the sandy conditions are not conducive to motorcycle or car racing, the most popular competitive events. The availability of racing areas at locations closer to San Diego and other coastal cities has also contributed to the lack of events in the Imperial Sand Dunes. The only competitive events occurring to date are the Multiple Sclerosis Super Twist, a two-mile timed race for all types of ORVs held annually on public land in the vicinity of Glamis, and a motorcycle race held south of the terminus of Gecko Road in 1979. Also in 1979 a drag strip for sand dragsters was built on private property at Glamis. While not directly involving public lands, the sand drag competition (including the National Sand Drag Championships) contributes to heavy use of the surrounding public lands on winter holiday weekends.

Gecko Campground, with parking space for approximately 200 recreational vehicles, serves users of the western half of the dunes. Plans call for the expansion of parking facilities within the campground and the construction of additional parking areas along the westside access road (known as Gecko Road) in FY 81-82. The Cahuilla Ranger Station, located near the campground, is staffed during times of high visitor use. Osborne County Park is located about midway between Glamis and Gecko Campground and is also a popular camping and staging area for ORV users.

GLAMIS/DUNES GEOTHERMAL STUDY AREA



Map II-10

**LEGEND**

VISITOR USE POLYGONS AND USE INTENSITY

USE INTENSITY CLASSES

- CLASS I
- CLASS II
- CLASS III
- CLASS IV
- CLASS V



The recreational users of this area are typically free-spirited with an appreciation of open spaces and lack of restrictions. The ORV opportunities available provide a release from the tensions of city life through the challenge of testing the machines against the terrain. Freedom of movement is a very important element in such recreational experiences.

#### Central Dunes Area (S of Gecko Road, N of the All-American Canal)

Because of limited access, ORV use of this section of dunes is, for the most part, restricted to a few peripheral areas. Since most ORV users stage from motor homes or campers, ORV activity is usually concentrated within a two to three mile radius of points accessible to these large vehicles. The Coachella Canal, All-American Canal and Southern Pacific Railroad all restrict such access to the central dunes. At present, the westside access points consist of the bridge over the Coachella Canal at Highway 78. Eastside access is limited to an unpaved railroad maintenance road which parallels the west side of the tracks between Glamis and Ogilby, and two railroad crossings providing access from the Ted Klipf Road. The condition of the maintenance road varies considerably according to weather conditions and the central section is often not passable to motor homes. In addition, the design of the railroad crossings makes them difficult to negotiate with motor homes. Most use therefore occurs within a few miles of Glamis or Ogilby, but use levels do not normally approach those of westside access points. Excellent hunting opportunities for deer and upland game are found along the eastern edge of the central dunes area.

#### Pilot Knob Mesa-Gold Basin Mine Area

This area is lightly used for recreation. Most users are individuals or small groups in search of privacy and solitude. Predominant activities are rockhounding and dispersed site camping. Some "snowbirds" establish camps for the entire winter. Secondary activities are ORV touring, ORV play, "plinking" or target shooting and hunting for deer and upland game.

### 3. Visitor Use

Total visitor use of the study area in 1978 was approximately 444,000 visitor use days (VUDs). In addition, an estimated 65,000 VUDs can be attributed to incidental or casual sightseeing by travelers on Interstate Highway 8, State Highway 78 and Ogilby Road.

Refer to Map II-10 for visitor use count polygon areas. Table II-9 presents recreation visitor use by polygon for each sample category, while Table II-10 indicates the intensity of visitor use by polygon.

Table II-9 Visitor Use Days (VUDs)  
 Glamis Dunes Geothermal Study Area  
 By Sample Category for 1978\*

<u>Polygon</u>	<u>Weekday</u> <sup>1)</sup>	<u>Weekend</u> <sup>2)</sup>	<u>Holiday</u> <sup>3)</sup>	<u>Total</u>
Mammoth Wash	872	3,612	14,844	19,328
Algodones Natural Area	0	50	150	200
Glamis-Gecko- Osborne Park	8,715	140,414	230,480	379,609
Central Dunes	1,743	13,545	27,515	42,803
Pilot Knob Mesa- Gold Basin Mine	<u>0</u>	<u>903</u>	<u>1,426</u>	<u>2,329</u>
	11,330	158,524	274,415	444,269

\*1978 was the last year in which a full schedule of visitor count flights was flown.

1) Projected total for 249 weekdays.

2) Projected total for 43 weekends (86 weekend days).

3) Projected total for 10 holidays (31 holiday weekend days).

Table II-10 Intensity of Visitor Use\*

Glamis Dunes Geothermal Study Area

By Use Polygon for 1978

<u>Polygon</u>	<u>Total VUDs</u>	<u>Polygon Area (Sq Mi)</u>	<u>Approximate<sup>1)</sup> Intensity (VUDs/Sq Mi)</u>
Mammoth Wash	19,328	21	920
Algodones Natural Area	200	37	52)
Glamis-Gecko- Osborne Park	379,609	48	7,908
Central Dunes	42,803	135	317
Pilot Knob Mesa- Gold Basin Mine	2,329	84	28

\*Expressed in Visitor Use Days (VUDs) per square mile.

1) Use Intensity Classes

Class I	5,000+	VUDs/Sq Mi
Class II	1,000-5,000	VUDs/Sq Mi
Class III	500-1,000	VUDs/Sq Mi
Class IV	100- 500	VUDs/Sq Mi
Class V	25- 100	VUDs/Sq Mi

2) Statistically insignificant value

### Recreation Resource Values

Considering the high intensity of use for recreation activities in the study area only two values of resource sensitivity have been assigned to the recreation resource.

The highly sensitive areas are those areas where the highest concentrations of recreational activities take place. The rest of the study area is considered to have a moderate value as a recreational resource. (See Map II-S-2).

### SOCIO-ECONOMICS

The study area is entirely within the rural and agricultural Imperial County of California. Most of the county's population of 91,800 (State of California, Dept. of Employment Development 1979 estimate) live in and around the six major towns of the Imperial Valley. Estimates provided by the Employment Development Department indicate that 62% of the population is Mexican-American, 3% is of black heritage, and 3% are other non-white. The economy of the county is dependent upon irrigated agriculture, as large parts of the fresh winter vegetables for the United States are grown here. Imperial County is one of the top five agriculturally producing counties in the United States. The major portion of the irrigation and public water supply is imported from the Colorado River through the All-American Canal System. Imperial Irrigation District is responsible for the operation of the irrigation system and obtains the Colorado River water through an allotment provided by Federal treaty with Mexico, state contracts, and Federal and state agreement.

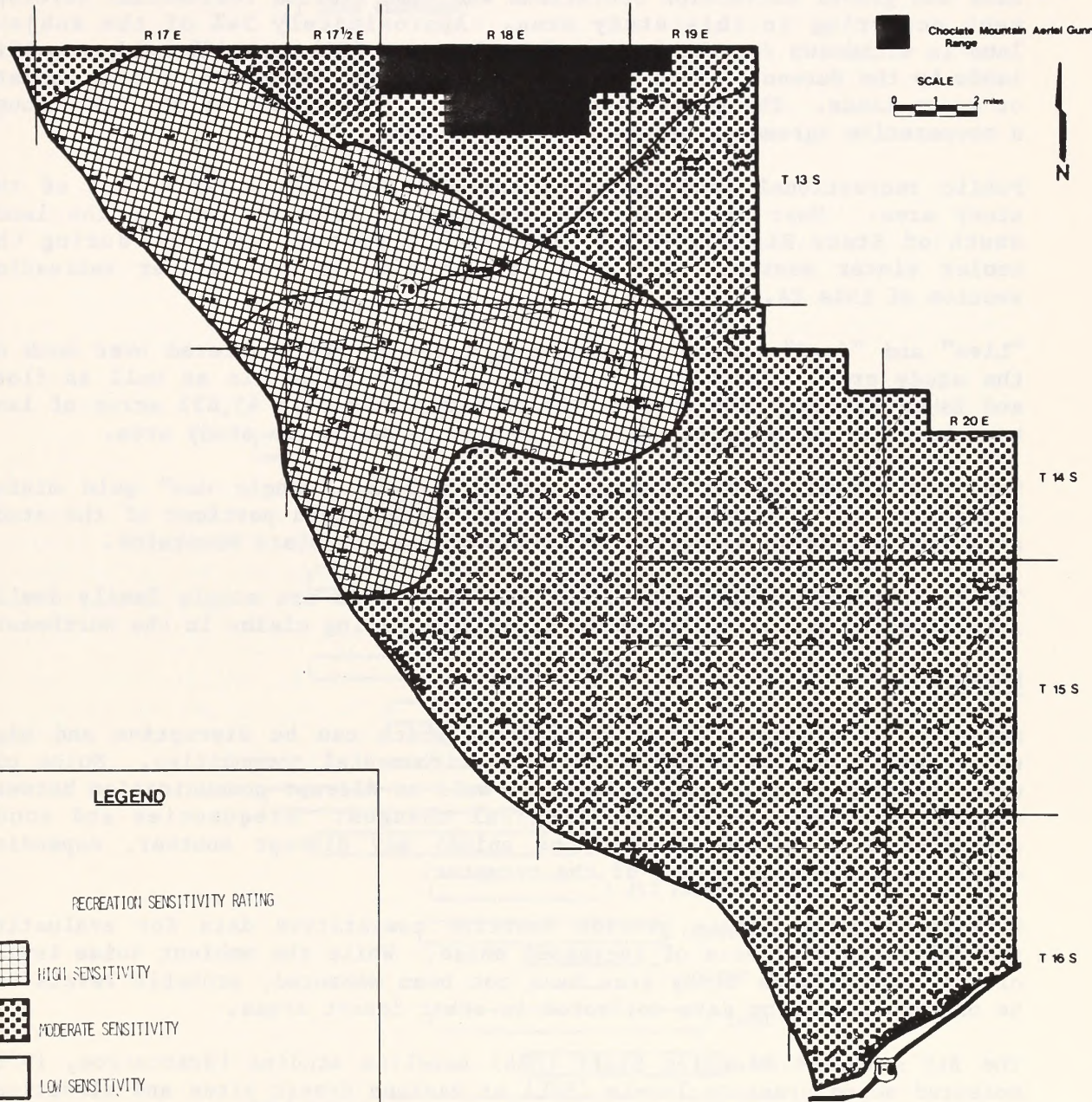
The economic, social and political life of the area is strongly influenced by agribusiness. Any large scale development could conflict with water allocations and land use for agriculture, although industrial growth would diversify the economic structure of the county.

A high proportion of employment is in agriculture, and Imperial County has very few people skilled in drilling wells or constructing power plants. Unemployment is usually several points above the state average, partly because of seasonal labor needs. This unemployment pattern is expected to continue.

A survey by Butler and Pick (1977) found that the majority of the population is in favor of geothermal development as long as environmental protection is foremost, although they feel inadequately informed.

The study area is sparsely populated with several mining claims located primarily north and east of the townsite of Glamis. The Glamis store is the most prominent structure providing commercial sales predominantly directed at the large weekend and holiday recreation users of the dunes. The current economic uses of the study area are sand and gravel production, highway corridors, mining activities, and desert recreation.




GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



Map II -s2

**LEGEND**

RECREATION SENSITIVITY RATING

-  HIGH SENSITIVITY
-  MODERATE SENSITIVITY
-  LOW SENSITIVITY

## LAND USE

Existing land use can be characterized as open space with vehicular oriented recreation as the most areally extensive use. However, there are several sand and gravel extraction operations and some limited residential development occurring in this study area. Approximately 54% of the subject land is withdrawn for the Bureau of Reclamation (BR) with 42% held as public lands by the Bureau of Land Management (BLM). The balance is either private or state lands. The BR withdrawn lands are administered by the BLM through a cooperative agreement between the BLM and BR.

Public recreational land uses are the most predominant land uses of the study area. Most recreationists are vehicle oriented and use the lands south of State Highway 78 to Interstate 8 only on weekends during the cooler winter months. For more detail refer to the earlier recreation section of this EA.

"Live" and "dead" bombs and 20mm cannon rounds are scattered over much of the study area. These are a potential threat to people as well as flora and fauna values. BLM records indicate approximately 45,633 acres of land have been contaminated by military ordinance within the study area.

Sand and gravel extraction and several minimal "single man" gold mining operations are scattered throughout the northeastern portions of the study area east of Glamis along the foothills of the Chocolate Mountains.

The residential development within the study area are single family dwellings directly associated with the individual mining claims in the northeast.

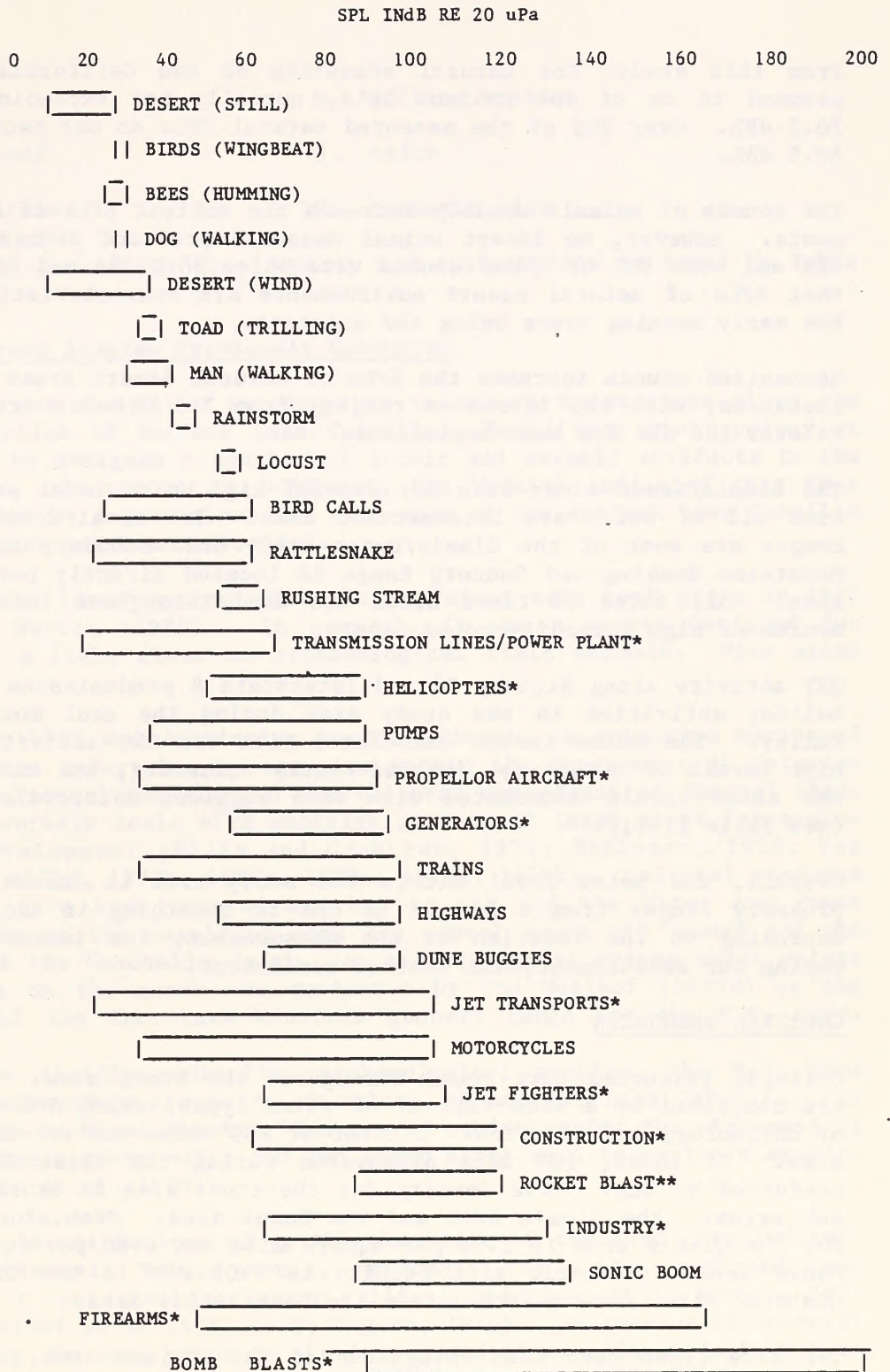
## NOISE

Noise is an element of the environment which can be disruptive and high noise levels can do damage to other environmental communities. Noise can cause hearing loss in some animals as well as disrupt communication between animals and thus cause physiological changes. Frequencies and sound pressures that do not disturb one animal may disrupt another, depending solely upon the sensitivity of the receptor.

Background noise levels provide baseline comparative data for evaluating the deleterious effects of increased noise. While the ambient noise levels of the Glamis/Dunes Study Area have not been measured, probable levels can be extrapolated from data collected in other desert areas.

The BLM's Desert Planning Staff (DPS) baseline studies (Brattstrom, 1978) measured sound pressure levels (SPL) at various desert sites and elevations for natural and mechanized sound sources (Table II-11). Natural sounds included wind, rain, water, birds, rattlesnakes, and insects. Mechanized sources measured included aircraft, highways, trains, ORVs, transmission lines, power plants and stationary facilities, and impulse sounds such as gunfire or bombs.

TABLE II-11 RELATIVE SOUND PRESSURE LEVELS OF NATURAL AND MECHANIZED SOUND SOURCES OF THE CALIFORNIA DESERT



\*Upper limit from previous report.

\*\* Both limits from previous reports.

Source: Brattstrom, B. II 1978. Ambient sound pressure levels in the California Desert. Report to Bureau of Land Management. Contract CA-060-CT7-2737.

From this study, the natural acoustics of the California Desert can be assumed to be of low ambient SPLs, normally not exceeding 66.0 dBA and 70.5 dBL. Over 90% of the measured natural SPLs do not exceed 50.5 dBA and 60.5 dBL.

The sounds of animals usually increase the ambient SPLs of natural environments. However, no desert animal measured produced sounds that exceed 56 dBA and over 90% of these sounds were below 50.5 dBA and 60.5 dBL, showing that SPLs of natural desert environments are characteristically low, with the early morning hours being the quietest.

Mechanized sounds increase the SPLs of natural desert areas in all measured instances, with the increases ranging from 3.0 dBA for transmission lines to over 160 dBA for bomb explosions.

The Glamis/Dunes study area has several high noise level producing activities all of which are intermittent uses. Two naval bombing and gunnery ranges are west of the Glamis/Dunes study area boundary and the Chocolate Mountains Bombing and Gunnery Range is located directly north of the study area. All three of these areas are used throughout the year and are a source of high intensity noise level.

ORV activity along Highway 78 and Interstate 8 predominates the weekend and holiday activities in the study area during the cool months in Imperial Valley. The noise levels associated with the ORV activities are also at high levels of intensity, intermittently occurring, and can be compared to the noise levels associated with dune buggies, motorcycles, and highways (see Table II-11).

Overall, the noise level within the study area is inconsistent and most probably ranges from a low of 40 dBA to something in excess of 120 dBA, depending on the location of the measurement, the intensity of activity during the measurement, and weather conditions.

#### CULTURAL RESOURCES

Cultural resources were found throughout the study area. These resources are comprised of a wide variety of sites types, which are diverse in terms of chronology and function. A total of 269 sites are recorded in the study area. Of these, 186 were discovered during the Class II sample survey conducted by BLM. Site density for the study area is broken down into two sub areas: the Glamis area and the Dunes area. Prehistoric site density for the Glamis area is 2.34 per square mile and 4.80 per square mile in the Dunes area. Historic site density is 7.08 PSM in the Glamis area. No historic sites were recorded from the Dunes study area.

Ten site types have been recognized in the project area. These reflect a wide range of occupational activities throughout time and space, indicating high site diversity and high site complexity. The site types are:

1. temporary camp
2. small dense lithic scatter
3. small light lithic scatter
4. pottery scatter



- |                    |                    |
|--------------------|--------------------|
| 5. trails          | 8. milling station |
| 6. isolated finds  | 9. cairn           |
| 7. sleeping circle | 10. historic site  |

[Additional data concerning site density and distribution is found on Table II-12].

#### Cultural Resources Studies Previously Conducted

Malcolm Rogers was the first investigator to record Yuman sites along the East Mesa shoreline of Ancient Lake Cahuilla. Based upon his typology of their ceramics he assigned a scatter of lithic and ceramic artifacts to the Yuman II phase. On record as 4-IMP-135, Von Werlhof indicated that this site was recorded by Rogers about one mile east of the ancient Lake Cahuilla shoreline. It has not been relocated.

The next recorded investigation within the project area took place in 1970 by Barker and Burton (1970). In general, it was a survey designed for instruction of a field class on archaeological field methods. Five sites were located.

Beginning about 1973 and continuing to the present, an intensive series of surveys have been undertaken by agencies within the Department of Interior to comply with Federal mandates in the cultural management of Federal land. Most of these surveys dealt with defining geothermal lease areas for exploration and development (Ellis and Crabtree, 1974; McKinney, 1973; Von Werlhof, 1975, 1977a, 1977b, 1977c, 1978a, 1979a, 1979b). Cultural resource investigations have been carried out by the BLM and the Water and Power Resource Service as the result of sand and gravel needs ORV events and the realignment of the Coachella Canal. An archaeological survey which enters the study area on the north was conducted by Von Werlhof (1977d) on the southern end of the Chocolate Mountain gunnery range for the U.S. Navy.

One of the few rigidly controlled archaeological samples, the East Mesa project, was undertaken along the shoreline of Ancient Lake Cahuilla. In an area selected by Magma Electric Company as conducive for the placement of a geothermal plant, seven major and two minor sites were intensively examined (Von Werlhof, et al, 1979).

The results of investigations along the shoreline of the East Mesa indicate that late prehistoric Yuman people, presumably the Kamia, utilized Lake Cahuilla when it contained freshwater (Ellis & Crabtree, 1974; Barker, 1970 & 1975; Von Werlhof et al 1978, 1979; Rogers, 1945). No remains of cultural groups occupying the area prior to the last stand of Lake Cahuilla have been reported.

Reports as the result of surveys in the Glamis area on the east side of Algodones Dunes have shown the presence of Yuman and San Dieguito age sites. (McKinney 1973; Ritter 1975; Von Werlhof 1977d and Eckhardt 1979a).

TABLE II-12  
PREHISTORIC SITES

<u>Zone</u>	<u>Transect Number</u>	<u>Site Number</u>	<u>Site Type</u>	<u>Description</u>	<u>Elevation (feet)</u>	<u>Size (m<sup>2</sup>)</u>
Glamis	12	1	2	Sleeping circle/rock ring	620	0.45
Glamis	33	4	2	9 sleeping circles with lithics	480	27
Glamis	60	1	2	Hamlets (circa 1939)	390	
Glamis	62	2	2	Sleeping circle with sherd	470	175
Dunes	83	1	2	2 potsherds, flakes	N.R.*	144
Dunes	86	1	2	Campsite (aboriginal)	133	9,000
Dunes	93	1	2	2 potsherds, flakes	N.R.	N.R.
Dunes	95	1	2	Fossil bone, lithics	150	25
Dunes	95	4	2	3 potsherds, chert core	150	N.R.
Glamis	15	1	5	Lithic scatter	395	1
Dunes	98	4	5	Flakes, hammerstone	135	25
Glamis	22	3	7	Potsherd scatter	340	6
Glamis	40	2	7	Potsherd scatter/hearth	438	560
Glamis	44	1	7	Potsherd scatter	532	5
Glamis	66	1	7	Potsherd scatter	431	4
Dunes	75	1	7	Potsherd scatter	130	1
Dunes	76	1	7	Potsherd scatter	N.R.	1
Dunes	77	1	7	Potsherd scatter	120	1
Dunes	82	1	7	Potsherd scatter with chert	125	1,800
Dunes	86	2	7	Potsherd scatter	N.R..	100
Dunes	90	1	7	Potsherd scatter	133	4
Dunes	91	1	7	Potsherd scatter	N.R.	N.R.
Dunes	91	2	7	Potsherd scatter	N.R.	8
Dunes	95	2	7	Potsherd scatter	150	N.R.
Dunes	98	3	7	Potsherd scatter	135	81
Dunes	100	1	7	Potsherd scatter	140	14
Dunes	103	1	7	Potsherd scatter, cobble core	145	490
Glamis	12	2	14	Aboriginal trail with sherds	620	<1,000
Glamis	24	2	18	Sleeping circle	420	6
Glamis	26	4	18	Sleeping circles	N.R.	N.R.
Glamis	34	6	18	2 sleeping circles	N.R.	N.R.
Glamis	62	1	18	3 circular areas	N.R.	24

\*N.R. = not recorded

According to von Werlhof (1977d:B-75) most of the cultural materials found around the western perimeters of the Chocolate Mountains were predominantly of San Dieguito origin with a few Yuman sites intermixed. This was interpreted as signifying a greater amount of exploitation of the region on the part of the San Dieguito while the scarcity of the Yuman sites may indicate small groups simply passing through the area.

Based upon the data generated by McKinney during his 1973 survey, it was determined that a large portion in the Chocolate Mountain Area (a segment of which occurs adjacent and north of the study area) was eligible for National Register. Since this determination was made, von Werlhof (1977) has completed an inventory of cultural resources in the area. From his study, 183 sites were identified. Site types included sleeping circles, house rings, cairns, trails, pottery and lithic scatters. The chronology of these sites range from San Dieguito to Yuman.

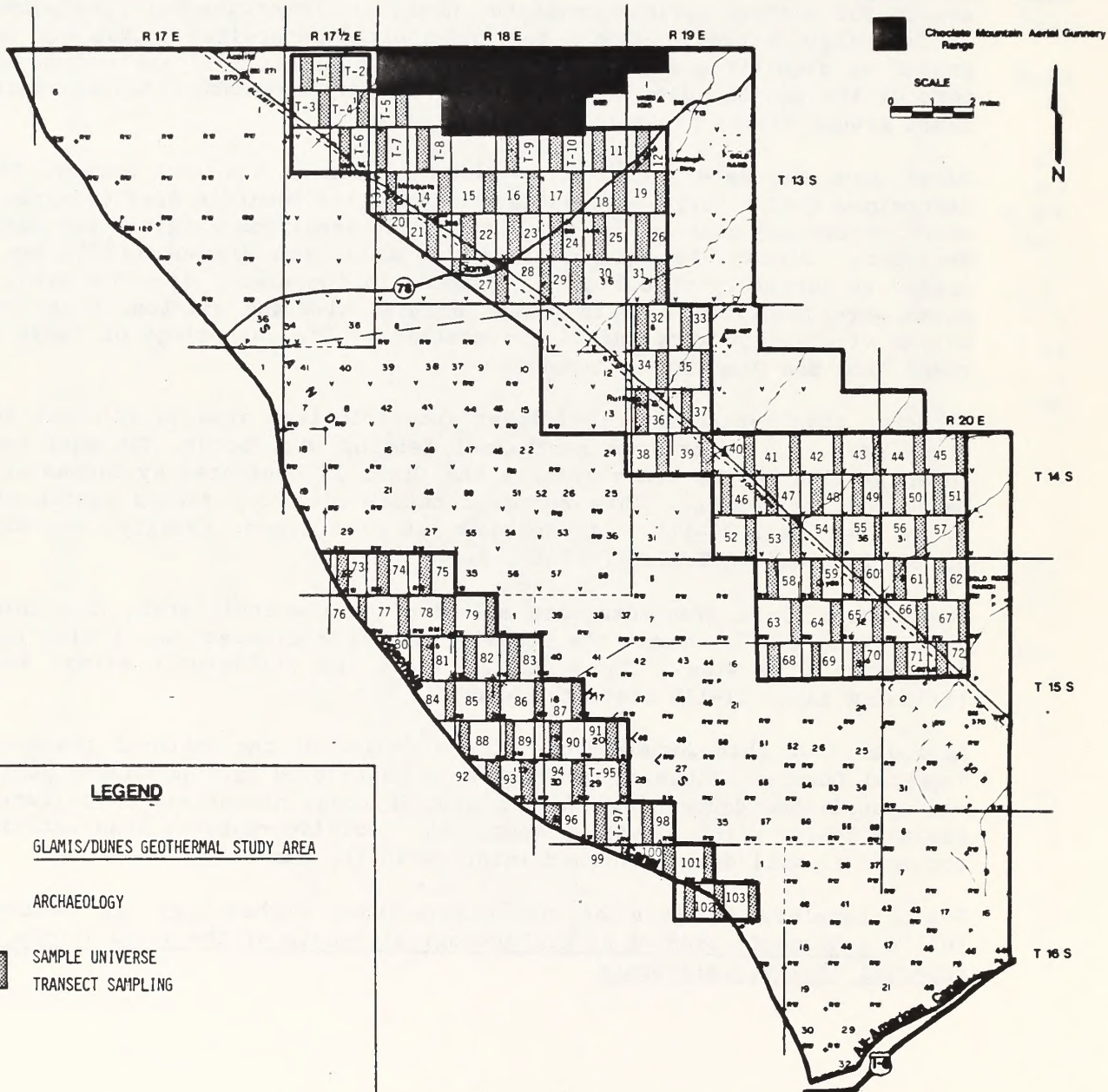
Although this apparently significant archaeological area is adjacent to the study area, no impact from geothermal leasing will occur. The most germane investigation to the study area is the Class II conducted by Bureau of Land Management personnel. This survey constituted a 25% random sample of the study area (Map II-11). A breakdown of site types, density, and distribution is found on Table II-12 A & B.

One hundred three transects were selected for the study area, 72 within the Glamis zone and 31 within the Dunes zone. Each transect was 1 mile long by one-fourth mile wide. Table II-12D lists the prehistoric sites, and the following table II-12E lists the historic sites.

Appendix B of this document contains a review of the cultural resources in Imperial County. These papers have been abstracted from pertinent published and unpublished documents. The purpose of these narratives is to familiarize the reader with cultural properties. A bibliography is also included in the hope it will direct further interest in the subject.

For a complete analysis of the Glamis/Dunes archaeology see Charles S. Bull's A Summarization of An Archaeological Sample of the Glamis/Dunes Area, Imperial Valley, California

GLAMIS/DUNES GEOTHERMAL STUDY AREA



Map II-11

**LEGEND**

GLAMIS/DUNES GEOTHERMAL STUDY AREA

ARCHAEOLOGY



SAMPLE UNIVERSE  
TRANSECT SAMPLING

TABLE II-12A  
MILITARY SITES

<u>Zone</u>	<u>Transect Number</u>	<u>Site Number</u>	<u>Site Type</u>	<u>Description</u>	<u>Elevation (feet)</u>	<u>Size (m<sup>2</sup>)</u>
Glamis	1	2	13	Hearth/circular depression	300	
Glamis	7	1	13	Foxhole/boot sole	300	
Glamis	8	1	13	Foxhole/ammunition sheets	370	
Glamis	9	1	13	Military camp	470	5,000
Glamis	11	1	13	Bomb craters	595	
Glamis	17	1	13	Hearth with cans	480	
Glamis	18	4	13	Campfire (foxhole?)	540	
Glamis	19	5	13	Rock alignment	570	
Glamis	19	1	13	Foxhole with cans	570	
Glamis	19	2	13	Large campsite	580	
Glamis	19	4	13	Concentration of cans	570	
Glamis	19	3	13	Foxhole with cans	590	
Glamis	22	2	13	Runway	345	
Glamis	24	1	13	Foxhole with cans	420	
Glamis	26	5	13	Foxholes	490	
Glamis	30	4	13	U-shaped crater	390	
Glamis	30	1	13	Tent clearings	415	
Glamis	31	1	13	Cleared rectangles	485	
Glamis	31	2	13	Hearth, cleared squares	510	
Glamis	33	2	13	Foxhole with cans	480	
Glamis	33	3	13	Semicleared areas	460	
Glamis	34	1	13	Military camp (?)	395	
Glamis	34	9	13	Campfires	405	
Glamis	34	7	13	Tent rectangle		
Glamis	34	8	13	Historic dump	415	
Glamis	39	7	13	U.S. Army buttons	400	
Glamis	39	8	13	Foxhole (?)	400	
Glamis	40	4	13	Foxhole	420	
Glamis	42	2	13	Foxhole	460	
Glamis	45	1	13	Military camp	560	
Glamis	47	3	13	Foxhole	400	
Glamis	47	4	13	Army emplacement	405	N.R.*
Glamis	48	5	13	Military camp	420	
Glamis	51	5	13	Sleeping squares	500	
Glamis	51	3	13	Military camp	523	
Glamis	51	1	13	2 hearths with cans	540	
Glamis	51	7	13	Hearth with cans	505	
Glamis	51	6	13	5 foxholes	510	8.75
Glamis	54	4	13	Military camp (probable)	410	
Glamis	57	1	13	Hearth, foxhole	500	
Glamis	57	3	13	Charcoal hearth with metal	530	
Glamis	57	5	13	Camping activity	500	
Glamis	57	2	13	Hearth, foxhole	500	
Glamis	61	6	13	Sleeping area	430	
Glamis	61	5	13	Foxhole	450	

\*N.R. = not recorded

TABLE II-12B  
NONMILITARY SITES

<u>Zone</u>	<u>Transect Number</u>	<u>Site Number</u>	<u>Site Type</u>	<u>Description</u>	<u>Elevation (feet)</u>	<u>Size (m<sup>2</sup>)</u>
<u>Miscellaneous Resources</u>						
Glamis	2	2	34	Circular depression	350	
Glamis	2	3	34	Military camp	320	40 m*
Glamis	2	1	34	Hearth	335	
Glamis	16	1	34	Hearth/modern	442	
Glamis	17	2	34	Furrows	N.A.+	
Glamis	18	1	34	Campfire	520	
Glamis	18	3	34	Campfire	545	
Glamis	18	5	34	Campfire	515	
Glamis	23	4	34	Hearth	375	
Glamis	23	1	34	Hearth	365	
Glamis	23	2	34	Hearth	368	
Glamis	23	3	34	Hearth	370	
Glamis	23	5	34	Hearth	362	
Glamis	25	3	34	U-shaped furrow	415	1
Glamis	25	1	34	Hearth	485	
Glamis	25	2	34	Hearth	478	
Glamis	26	8	34	Furrows	615	
Glamis	26	1	34	Hearth with cans	530	
Glamis	26	6	34	Names spelled in quartz	510	
Glamis	26	3	34	Hearth (rock ring)	500	
Glamis	26	2	34	Hearth with glass	510	
Glamis	26	7	34	Hearth	510	
Glamis	30	6	34	Small depression	410	
Glamis	30	2	34	Circular depression	425	
Glamis	30	3	34	Hearth	405	
Glamis	31	3	34	Campfire cave with glass	505	
Glamis	33	1	34	Depression	490	
Glamis	34	2	34	Charcoal concentration	410	
Glamis	34	4	34	Horseshoe	425	
Glamis	34	5	34	Charcoal concentration	430	
Glamis	34	3	34	Charcoal concentration	420	
Glamis	39	3	34	Charcoal hearth	400	
Glamis	39	1	34	Telephone poles	380	
Glamis	39	4	34	Hearth with cans	400	
Glamis	41	2	34	Charcoal concentration	450	
Glamis	42	3	34	Hearth with cans	460	
Glamis	46	1	34	Trail (aboriginal/ORV?)	380	
Glamis	46	2	34	Telegraph poles	385	N.A.
Glamis	47	1	34	1940 nickle	400	
Glamis	47	2	34	Hearth	400	
Glamis	47	5	34	Hearth with cans	390	

TABLE II-12B  
NONMILITARY SITES  
(Continued)

<u>Zone</u>	<u>Transect Number</u>	<u>Site Number</u>	<u>Site Type</u>	<u>Description</u>	<u>Elevation (feet)</u>	<u>Size (m<sup>2</sup>)</u>
<u>Miscellaneous Resources (cont.)</u>						
Glamis	48	2	34	Rock alignment	410	<10
Glamis	48	3	34	Charcoal hearth	420	
Glamis	48	4	34	Charcoal hearth	420	
Glamis	48	1	34	Hearth	435	
Glamis	50	2	34	Hearth with cans	500	
Glamis	50	1	34	Scattered charcoal	485	
Glamis	51	2	34	Charcoal hearth	525	1
Glamis	51	4	34	Campfire	518	
Glamis	54	3	34	Hearth with cans	435	
Glamis	54	6	34	Charcoal hearth	420	
Glamis	54	5	34	Axe-cut ironwood tree	520	
Glamis	54	2	34	Axe-cut ironwood tree	410	
Glamis	57	4	34	Charcoal hearth	530	
Glamis	58	1	34	Charcoal hearth	360	
GHlamis	61	2	34	Charcoal hearth	455	
Glamis	61	1	34	Depression	425	
Glamis	62	3	34	Sign (arrow shaped)	480	
Glamis	65	1	34	Metal shovel blade	400	
Glamis	65	4	34	Charcoal hearth	415	
Glamis	66	3	34	Charcoal hearth	465	
Glamis	66	2	34	Charcoal hearth	470	
<u>Graves</u>						
Glamis	28	1	30	Chinese graveyard (1878)	335	
<u>Roads</u>						
Glamis	67	1	26	Wagon tracks (possible)	450	
<u>Dumps</u>						
Glamis	11	2	31	Historic dump	595	
Glamis	18	2	31	Dumps with cans	540	5 m*
Glamis	32	2	31	Scattered cans	420	
Glamis	41	1	31	Can scatter with bottles	430	
Glamis	56	1	31	Can dump	420	

\*This is linear meters, not square meters.

+N.A. = not available.

TABLE II-12C  
 PROJECTED SITE TOTALS  
 GLAMIS/DUNES STUDY AREA

Based upon the recorded sites and those encountered by the BLM inventory, the following are the number of projected sites within the Glamis/Dunes Study Area:

<u>Area by Site Classification</u>	<u>Number of Resources</u>	
	<u>Minimum</u>	<u>Maximum</u>
<u>Sampled Area at Large</u>		
Both historic and prehistoric	618	1,026
Prehistoric only	185	358
Historic only	379	733
<u>Glamis zone</u>		
Both historic and prehistoric	529	738
Prehistoric only	87	192
Historic only	315	580
<u>Dunes Zone</u>		
Both historic and prehistoric	38	121
Prehistoric only	38	121
Historic only	0	0

(Bull 1981:41)



Table II-12-D

Prehistoric Sites

Type No.*	Type Description	Class II Inventory Number	% of Total	Previously Recorded Number	% of Total	No. of Sites Found	% of Sites Found
02	temporary camp	8	11.76	7	8.43	15	9.74
04	milling station	1		1	1.20	1	.65
05c	small dense lithic scatter	1	1.40	15	18.07	18	11.68
05d	small light lithic scatter	2	2.81				
07	pottery scatter	16	22.53	9	10.84	25	16.23
014	trail	1	1.40	30	36.14	31	20.12
016	isolated find	39	54.92	4	4.81	43	27.92
017				6	7.22	6	
018	sleeing circles	4	5.63	11	13.25	15	9.74
Total		71		83		154	

\* BLM Code number for type descriptions

Table II-12-E

Historic Sites

Type Number	Type Description	Number	% of Total
02	Hamlet	1	.8
013	Camp (WW II)	25	21.7
026	Wagon Road	1	.8
030	Cemetery	1	.8
031	Trash Dump	7	6.1
034	Isolated Find	80	69.6
Total		115	

### Native American Concerns

The Bureau of Land Management recognizes the need to communicate with local American Indian groups in order to inform them of the various archaeological activities initiated by the Bureau. Because of this, the Quechan people, who live on the Fort Yuma Reservation, were contacted by the Native American Contact Specialist to inform them of the Class II inventory and the preparation of this document.

During this initial meeting, two major concerns of Quechan were discussed: 1) preservation of Native American sites (especially those of ceremonial significance, and 2) the continuance of communication between the BLM and Quechan people throughout the project implementation stage. In response to these concerns, the BLM intends to preserve all shrines, trails, intaglios and sites deemed ceremonially significant by the Quechan people. All such sites discovered during the project implementation will be reported to the Quechan people for concurrence of proper mitigation procedures.

Comments have also been solicited from the Native American Heritage Commission. Necessary changes in this document will be made after comments are received and reviewed.

### National Register Sites

The study area contains many resources which may yield information important to pre-history. Some of these sites may possess criteria to include them within the National Register of Historic Places as stated in 36 CFR 800-10A. They may possess integrity of location, design, siting, material, workmanship, feeling, and association.

These sites include trails, sleeping circles, and cairns. Because of their potential significance, it is required that they be preserved in situ (see Table II-12 A & B).

Some of the historic sites, may also be eligible for inclusion in the National Register.

The majority of the resources found during the present investigation would not qualify for the National Register. All isolated finds and recent historic trash must be dismissed as not potentially eligible. The isolated materials do not represent sufficient information potential to qualify under criteria D, and the majority of the historic material cannot pass the 50-year threshold criteria.

Prehistoric sites which may qualify for the register include T12-2, T33-4, T82-1, and T98-3. The remaining prehistoric sites are small ceramic and lithic scatters. Their low variability and size make them unlikely candidates for register status. T12-2 is a trail with associated artifacts. It represents a rare opportunity to examine the nature of aboriginal travel in the desert, assess trade practices, and ultimately approach the role of different use areas (e.g., the role of Lake Cahuilla) in the settlement patterns of local inhabitants. T33-4 is a concentration of sleeping circles

and artifacts of particular scientific importance. Only through examination of these types of sites can cultural affiliation, resolution of temporal questions, and determination of function be achieved. T82-1 gains its potential importance from the variety of materials present and the size of the deposit. While the majority of resources found in the lease area represent, at most, a single event, this site reflects either multiple use or use by a larger than usual group. T98-3 has a unique combination of materials. The existence of a piece of shell permits the association of the group responsible for this resource with groups from either the coast or the gulf areas. Additional investigation of this site may provide an expanded series of diagnostic traits for cultural/temporal affiliation of resources throughout the desert.

It should be emphasized that information about these sites is presently limited to survey results. It is possible that upon collection of additional data, they will not, in fact, prove to be eligible for the National Register. At the present time, however, the information potential appears sufficient to justify their consideration for listing.

The military occupation of the area is the only historic component found within the study area which might be considered eligible for the register. The center of the World War II desert use, Desert Center, is located north of the project area. While the use of the desert by Patton's forces is less than 50 years old, it is a significant element of America's history. The military resources found during the present survey are individually limited in type and scope. When considered in association with the other military features in the California deserts, the area is potentially eligible for the National Register.

The remaining historic resources cannot provide sufficient information to qualify for listing under criteria D and provide no basis for rejecting the 50-year limitation on eligibility.

### Cultural Resource Values

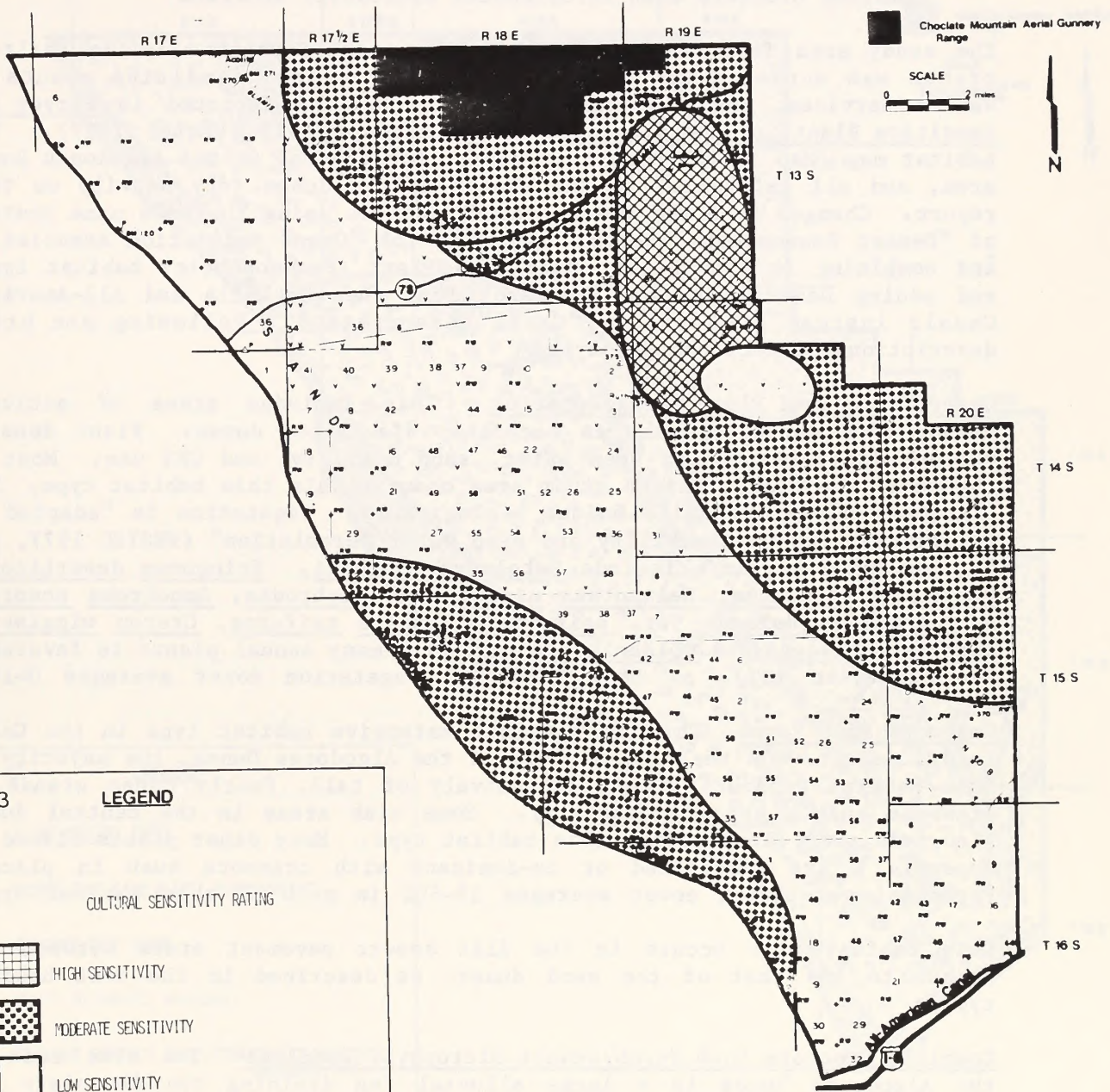
Archaeological sensitivity in the study area was determined by examining site density, site type, and physiographic factors (e.g., presence or absence of past or present water sources). From this examination, the area was broken down into three categories: high, medium, and low sensitivity. As these categories have only a relative value, predictive evaluation for each zone must remain general (see Map II-S-3).

## FLORA AND FAUNA

### Habitat Types

Four plant communities described by Thorne (1976) are considered habitat types for this EAR. For the purposes of this EAR, two of those plant communities are also combined into a fifth habitat type. Thus, the five habitat types considered in the study area are:




GLAMIS/DUNES GEOTHERMAL STUDY AREA



Map II -s3

**LEGEND**

CULTURAL SENSITIVITY RATING

-  HIGH SENSITIVITY
-  MODERATE SENSITIVITY
-  LOW SENSITIVITY

Desert Dune Sand Plant (Psammophytic)  
Cresote Bush Scrub  
Desert Microphyll Woodland  
Desert Riparian Woodland  
Combined Creosote Bush Scrub/Desert Microphyll Woodland

The study area from the Coachella Canal to the Southern Pacific Railroad tracks was surveyed and mapped for vegetation and sensitive plants by Westec Services, Inc., under contract to BLM and reported in Survey of Sensitive Plants of the Algodones Dunes, August, 1977 (Westec 1977). The habitat map (Map II-12) uses this report for its map of the Algodones Dunes area, and all references to the plants of the dunes rely heavily on this report. Changes from the Westec report include using Thorne's name instead of "Desert Psammophytic Scrub," dropping the "Open" vegetation association and combining it with Desert Dune Sand Plant (Psammophytic) habitat type, and adding Desert Riparian Woodland along the Coachella and All-American Canals instead of Westec's "Canal" association. Following are brief descriptions of each habitat type:

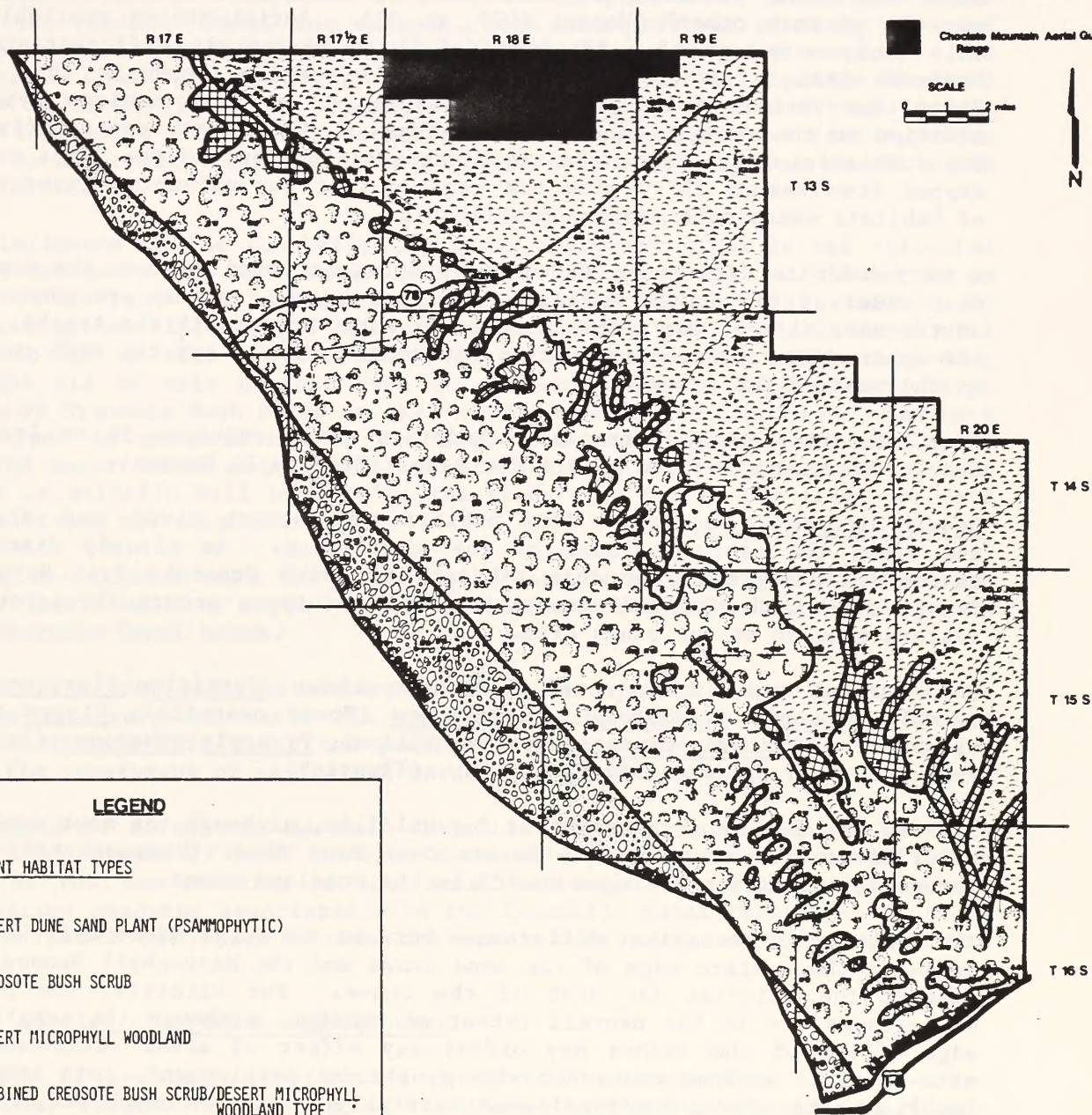
Desert Dune Sand Plant (Psammophytic) This includes areas of actively moving sand dunes as well as partially stabilized dunes. Plant density varies widely, depending upon water, sand mobility, and ORV use. Most of the sensitive plants in the study area occur within this habitat type. The Algodones Dunes are quite unique biologically. Vegetation is "adapted to relatively high sand mobility and deep water percolation" (WESTEC 1977, pg. 58) and common plants include Petalonyx thurberi, Eriogonum deserticola, Panicum urvilleanum, Helianthus niveus ssp. tephrodes, Ammobroma sonorae, Astragalus magdalanae var. peirsonii, Ephedra trifurca, Croton wigginsii, Dicoria canescens and Coldenia plicata, with many annual plants in favorable years (Westec 1977, p. 58). Perennial vegetation cover averages 0-10%.

Creosote Bush Scrub This is the most extensive habitat type in the California desert. On the western edge of the Algodones Dunes, the majority of this habitat consists almost exclusively of tall, fairly dense stands of creosote bush (Larrea tridentata). Some sink areas in the central dunes also fall most closely into this habitat type. Many other plants listed in Appendix C are associated or co-dominant with creosote bush in places. Perennial vegetation cover averages 25-50% in much of this habitat type.

This habitat also occurs in the flat desert pavement areas between the washes to the east of the sand dunes, as described in the next habitat type:

Combined Creosote Bush Scrub/Desert Microphyll Woodland The area east of the Algodones Dunes is a large alluvial fan draining the Chocolate and Cargo Muchacho Mountains. The alluvial fan is dissected into numerous washes and plains. Most of these washes support elements of Desert Microphyll Woodland while the plains support Creosote Bush Scrub elements. The area east of the Southern Pacific railroad tracks is a complicated maze of intergrading (often sparse) Creosote Bush Scrub and generally fairly dense but narrow Desert Microphyll Woodland. Intergrading of the two habitats is so extensive that to try to map differences in that area was felt not to be as accurate as combining the two types together.






GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



Map II-12

**LEGEND**

PLANT HABITAT TYPES

-  DESERT DUNE SAND PLANT (PSAMMOPHYTIC)
-  CREOSOTE BUSH SCRUB
-  DESERT MICROPHYLL WOODLAND
-  COMBINED CREOSOTE BUSH SCRUB/DESERT MICROPHYLL WOODLAND TYPE
-  DESERT RIPARIAN WOODLAND

THIS MAP IS ADAPTED FROM MAPS PREPARED FOR BLM  
IN 1977 BY WESTEC SERVICES, INC.

Along the eastern flanks of the Algodones Dunes (west of the RR tracks), Westec maps the differences between the two types while noting that "because of the meandering of the [stream] channels, elements of the Creosote Bush Scrub and Desert Psammophytic Scrub were often mixed with Woodland elements as well as each other" (Westec 1977, p. 57). Aerial photos available for this study were not of sufficient detail to adequately differentiate the Creosote Bush Scrub from Desert Microphyll Woodland even in this area. Field observation of extensive intergrading of the two habitat types in addition to the above, prompted the mapping of most of the eastern flank as the combined habitat type. Desert Microphyll Woodland in the Dunes area is mapped from Westec 1977, with the caution that the extensive intergrading of habitats makes such mapping problematic.

A very definite difference in the vegetation is noted between the east and west sides of the Southern Pacific Railroad tracks. Berms are constructed on the east side of the tracks to channel water underneath the tracks. This has apparently created a much drier environment in all but the wash channels to the west of the tracks.

Over the whole area, perennial vegetation cover averages 5% or less for desert pavement areas and 15-20% for Desert Microphyll Washes.

Desert Microphyll Woodland This habitat type occurs along wash channels and along the eastern flanks of the sand dunes. As already discussed, extensive intergrading of this habitat type with Creosote Bush Scrub and Desert Dune Sand Plants (Psammophytic) habitat types occurs throughout the eastern portion of the study area.

This habitat type is dominated by tree species: Cercidium floridum (Palo verde), Prosopis glandulosa var. torreyana (Honey mesquite), Olneya tesota (Ironwood), Chilopsis linearis (Desert Willow), Prosopis pubescens (Screwbean mesquite), and occasionally Tamarix sp. (Tamarisk).

This is the most important habitat for wildlife, although the most sensitive wildlife species occur in the Desert Dune Sand Plant (Psammophytic) type. Perennial vegetation averages 60-70% in the woodland areas.

There appear to be habitat differences between the large Microphyll Woodland areas on the eastern edge of the sand dunes and the Microphyll Washes which dissect the alluvial fan east of the dunes. For wildlife, the primary differences are in the overall extent of habitat, although the substantial edge effect of the washes may offset any effect of areal extension. In site-specific actions connected with geothermal development, both areas are important and should be considered carefully. As mentioned earlier, the washes are not mapped for this EAR, and the woodlands are mapped directly from Westec's maps with no attempts to reconcile them on the ground.

Desert Riparian Woodland Along both the Coachella and All-American Canals, a water-loving flora has become established on the canal banks and in the water. In addition, several large ponds or marshes occur along the Coachella Canal due to seepage of water from the unlined canal, providing habitat for



wetland plant and animal species. The canals have been a major biotic influence in the area, accounting for an increase in the numbers of native plants and animals which occur throughout the study area and an increase in the density and/or occurrence of water-loving plants and animals in areas near the canals. Deer, for example, have been observed crossing the sand dunes in areas of Desert Microphyll Woodland penetration to use the Coachella Canal as a water source. Some of the Desert Riparian Woodland areas on Map II-12 contain primarily Pluchea sericea (arrowweed) and Tamarix sp. (Tamarisk), while others contain primarily marsh species (see Appendix C). No major wetland areas occur adjacent to the All-American Canal in the study area.

The influence of the Coachella Canal has decreased since it was relocated and concrete-lined. The water table near the canal may be lowered by as much as 60 feet (USDI, Bureau of Reclamation 1975). Approximately 70 percent of the riparian and open water areas along the Coachella Canal will be lost due to this project (USDI, Bureau of Reclamation 1975), including perhaps all of this habitat type in the study area. In addition, large areas of Creosote Bush Scrub on the western side of the Algodones Dunes have been lost to construction of the new canal, and may be affected by the lowered water table as a result of this project. Most of the access to the water by wildlife will be lost in the study area due to the steep concrete sides of the new canal.

It is anticipated that the only significant portion of this habitat type which will remain in a few years will be the portion immediately along the All-American Canal banks.

It is noted that all vegetation classification systems are at least to some degree arbitrary and serve the purposes of the classifiers. This is the case with this EAR, since the proposed treatment appears to be consistent with the assessment of geothermal development impacts.

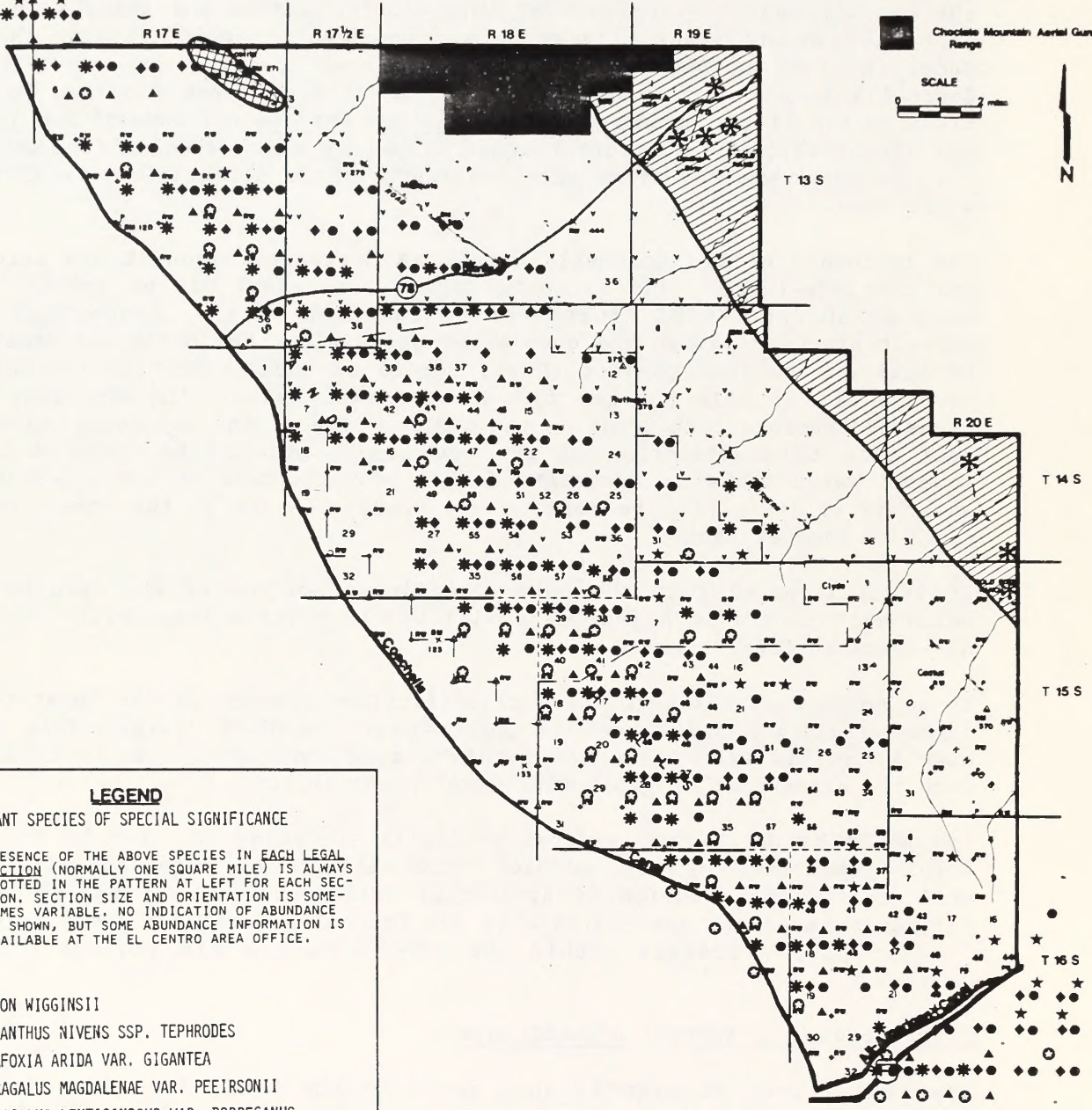
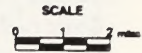
It should be noted that several windmills are being proposed by the California Department of Fish and Game which will provide water for wildlife as well as for the creation of artificial wetlands. These projects will be mitigation measures associated with the Coachella Canal realignment project. Two proposed sites are within the study area and are indicated on Map II-14.

#### Plant species of special significance

Species of special significance found in the study area include three candidate species for listing as threatened by the U.S. Fish and Wildlife Service, and three listed as Endangered by the State of California. In addition, five other plant species are listed by the California Native Plant Society (CNPS) and two others have been recently taken off the CNPS list but are still of some significance. The plants and their status and habitat are shown in Table II-13.

GLAMIS/DUNES GEOTHERMAL STUDY AREA

Chocolate Mountain Aerial Gunnery Range



Map II-13

LEGEND

PLANT SPECIES OF SPECIAL SIGNIFICANCE



PRESENCE OF THE ABOVE SPECIES IN EACH LEGAL SECTION (NORMALLY ONE SQUARE MILE) IS ALWAYS PLOTTED IN THE PATTERN AT LEFT FOR EACH SECTION. SECTION SIZE AND ORIENTATION IS SOMETIMES VARIABLE. NO INDICATION OF ABUNDANCE IS SHOWN, BUT SOME ABUNDANCE INFORMATION IS AVAILABLE AT THE EL CENTRO AREA OFFICE.

- \* CROTON WIGGINSII
- ◆ HELIANTHUS NIVENS SSP. TEPHRODES
- PALAFOXIA ARIDA VAR. GIGANTEA
- ▲ ASTRAGALUS MAGDALENAE VAR. PEEIRSONII
- ★ ASTRAGALUS LENTIGINOSUS VAR. BORREGANUS
- AMMOBROMA SONORAE

\* CALLIANDRA ERIOPHYLLA

PROBABLE LOCATIONS FOR CALLIANDRA ERIOPHYLLA IN WASHES

APPROXIMATE LOCATION FOR SPECIMENS OF CRYPTAMTHA COSTATA AND LYRO CARPA COULTERI VAR. PALMERI.

MAPPING OF THE ALGODONES DUNES IS AN ADAPTATION OF MAPS PREPARED FOR BLM IN 1977 BY WESTEC SERVICES, INC. THE LOCATIONS IN WESTEC'S SPECIAL GRID SYSTEM WERE TRANSFERRED TO THE LEGAL SECTIONS ON A 1/2" : 1 MILE MAP AND THEN REDUCED. THE GRID SYSTEM AND LEGAL SECTION LINES DO NOT CORRELATE AT ALL. THE SYMBOLS SHOWN GIVE A GENERAL INDICATION OF POPULATION EXTENT, NOT SPECIFIC LOCATIONS OR ABUNDANCE.

In the study area, six of these plants are known to occur only in the Algodones Dunes, i.e., the area between the Coachella Canal and the Southern Pacific Railroad tracks. These plants are identified under the "Comments" column in Table II-13 as "Dunes Only." The Algodones Dunes are the largest continuous belt of sand dunes in California (Armstrong, 1980) and provide a unique ecosystem in which specialized plants and animals have evolved. Some of these plants and animals are found almost exclusively here. This fact has been recognized by designation of a portion of the dunes as a BLM Outstanding Natural Area, a National Natural Landmark by the Heritage Conservation and Recreation Service, and as an area closed to off-road vehicles by BLM. Most of this designation was due to the unique assemblage of rare plants present in the dunes system, and concern with survival of these plants and their ecosystem in the face of serious pressures from human disturbance.

Map II-13 shows the distribution of the sensitive species. Almost all of the locations within the Algodones Dunes area are from Westec 1977. In addition to these Westec locations, Cryptantha costata and Lyrocarpa coulteri var. palmeri were tentatively identified by Westec close to the northern boundary of the study area in the vicinity of the railroad tracks. Calliandra eriophylla is a common plant in most of the shallow washes cutting the alluvial fan east of the Algodones where locations for it are shown on Map II-13. Eriogonum deserticola and Euphorbia parishii are not shown because they are no longer considered rare enough by the CNPS to present significant concern to management. They are former candidates for rare status which are now considered to be abundant enough that no danger to their existence currently exists.

The CNPS ranks plants in a numbered code according to each plant's Rarity, Endangerment, Vigor, and Distribution (R-E-V-D codes) (Powell, 1974). Based upon the CNPS codes, BLM Riverside District Office has found it convenient to lump together similar combinations of R-E-V-D ratings into sensitivity levels. Plants are broken into categories as shown below:

A) Plants of Special Management Concern

- a) Critically sensitive plants
- b) Highly sensitive plants
- c) Moderately sensitive plants

In general, these plants must receive "special consideration" in BLM's planning process, which includes maintaining or enhancing the ecosystems they occupy, as required in BLM Instruction Memos No. CA-79-64, No. CA-77-256, and No. CA-79-136, Change 1. These plants represent the greatest constraints for management. In the Critically and Highly Sensitive categories, all impacts may have to be mitigated in some way.

B) Plants of Lesser Management Concern

- a) Plants Very Rare or Rare and Endangered in California but Not Rare Outside California
- b) Limited Distribution
- c) Plants Not Rare Outside California and of Limited Distribution in California.

TABLE II-13

## PLANT SPECIES OF SPECIAL SIGNIFICANCE

	CNPS R-E-V-D- Code (1980)	State of California Dept. of Fish & Game R&E Plant Program	U.S. Fish & Wildlife Service Federal T&E Species List	<u>Habitat in            Study Area</u>	<u>Comments</u>
<u>Ammobroma sonora</u> Sand Food	2-2-2-2	--	Candidate Threatened	Sand dunes, canal banks, sandy soils DDSP, CBS	Dunes only
<u>Astragalus lentiginos</u> var. <u>borreganus</u>	2-2-1-1	--	--	Sink areas and transitions between dunes and scrub DDSP, CBS/DMW	Dunes only
<u>Astragalus magdalenae</u> var. <u>peirsonii</u>	3-2-1-2	Listed Endangered	Candidate Threatened	Sand dunes only DDSP	Dunes only
<u>Calliandra eriophylla</u> Fairy Duster or Mesquitilla	3-1-1-1	--	--	Shallow washes in desert pavement areas, alluvial fan CBS/DMW	
<u>Croton wigginsii</u>	2-2-1-1	Listed Endangered	--	Sand dunes, mostly west side DDSP, CBS	Dunes only
<u>Cryptantha costata</u> Ribbed Forget-me-not	1-1-1-2	--	--	Single collection from north of Glamis CBS/DMW	
<u>Helianthus nivens</u> ssp. <u>tephrodes</u> Silver-leaved Sunflower	3-2-2-2	Listed Endangered	Candidate Threatened	Active sand dunes DDSP	Dunes only
<u>Lyrocarpa coulteri</u> var. <u>palmeri</u> Coulter's Lyrepod	1-1-1-1	--	--	Tentative identification from wash north of Glamis (from Westec) CFS/DMW	

<u>Palafoxia arida var. gigantea</u> Giant Spanish Needles	1-1-1-2	--	--	Sand dunes DDSP	Dunes only
<u>Pilostyles thurberi</u>	1-1-2-2	--	--	Not found, however host plant Dalea emoryi is present	
<u>Former Candidates</u>					
<u>Eriogonum deserticola</u> Desert Buckwheat	0-1-1-1	--	--	Sand dunes and washes DDSP, CBS/DMW	
<u>Euphorbia parishii</u> Parish's spurge	0-1-1-1	--	--	Single collection from north of Glamis CBS/DMW	

In general, these plants place fewer constraints on management, and mitigation is more discretionary. Caution is in order; however, the more impacts which occur to a species, the more restrictive management of the species becomes in order to ensure its survival.

Superseding the above classification system are Federal and state Rare, Threatened, and Endangered Species lists. According to Instruction Memos No. CA-77-256, and No. CA-79-64, all plants listed or proposed for listing must receive the full protection of the Endangered Species Act of 1973, amended 1978. The State Director does have discretion to allow impacts on a case-by-case basis. Ammobroma sonorae, Astragalus magdalenae var. peirsonii, Croton wigginsii, and Helianthus niveus ssp. tephrodes are all state-listed and/or proposed for Federal listing. All occur in the Algodones Dunes.

All of the above species except Croton wigginsii are already of Special Management Concern in the most restrictive categories. Taxonomic problems apparently exist with Croton, and BLM El Centro Resource Area Office has requested the state to review its listing of this species as Endangered and possibly de-list it based upon its revised CNPS R-E-V-0 Code. Until that happens, it is still listed and must be of primary concern.

#### Plants of Special Management Concern

##### Critically Sensitive Plants

Plants in this category are very rare due to their highly restricted distribution, and are generally endangered in part or all of their range. Plants also appear in the Critically Sensitive category if they are listed by State or Federal agencies as Threatened or Endangered. Four critically sensitive plants occur in the Algodones Dunes. Three are listed as Endangered by the State of California, and three are candidates for listing as Threatened by the U.S. Fish and Wildlife Service (USFWS).

Ammobroma sonorae (Sand Food) (R-E-V-D 2-2-2-2) is a root parasite which uses several perennial shrubs as its host. It occurs in sandy soils in Imperial County and south into Sonora. In the dunes, it tends to grow mostly on stabilized sand slopes and level areas (Westec 1977). It also occurs on the Coachella Canal bank in a few places. It has been used as an important food source by local Indians, and may grow several feet away from its host. Only its flowering heads can be seen above the sand in the springtime. Sand Food is proposed for listing as Threatened by USFWS.

Astragalus magdalenae var. peirsonii (R-E-V-D 3-2-1-2) is known only from the Algodones Dunes and Borrego Valley (Westec 1977). It occurs on stable slopes and dune depressions primarily in western and central portions of the dunes.

Croton wigginsii (R-E-V-D 2-2-1-1) occurs in the Algodones Dunes and south into Sonora. According to some taxonomists, this species may be the same as a common Arizona species, hence not really very rare. Although its only California population occurs in the Algodones Dunes, it appears to vigorously colonize disturbed areas such as roadsides and is very common, sometimes almost dense, in the western part of the dunes. It occurs only infrequently, however, in the eastern part. It is currently listed as Endangered by the State of California, thus it must be afforded the same protection as a Federally listed species. It is not a candidate for Federal listing.

Helianthus niveus ssp. tephrodes (R-E-V-D 3-2-2-2) Silver-leaved Dune Sunflower is known also from dunes in Arizona and Sonora (Westec 1977). It appears to be best developed in active dune areas and also grows along the disturbed sides of Hwy 78 in the dunes. It is State listed and a candidate for Federal listing.

No highly or moderately sensitive plants have been found in the study area.

#### Plants of Lesser Management Concern

Plants Very Rare or Rare and Endangered in California but Not Rare Outside California. These plants, if they were rare outside the state, would be Critically or Highly Sensitive. Plants may be listed as Rare or Endangered by the State of California even if they are not rare outside the state. These plants may thus carry the same management constraints as if they were rare over their total range, because BLM considers state-listed species the same as Federal-listed species for management.

Astragalus lentiginosus var. borreganus (R-E-V-D 2-2-1-1) is known from locations in the Mojave Desert, Borrego Valley, Coachella Valley, the Yuma Desert, and the eastern portion of the Algodones Dunes. It tends to occur in dune depressions and sinks in the transition areas between dunes and scrub.

Calliandra eriophylla (Fairy Duster) (R-E-V-D 3-1-1-1) is quite commonly found in the shallow washes which dissect the alluvial fans in the eastern portion of the study area. Map II-13 shows a general distribution pattern from limited field observations, although any wash in the eastern portion of the study area appears to be potential habitat. Overall distribution of Fairy Duster has not been researched for this writing; however, this area may be the only California location for this species. If so, it deserves special consideration due to its high rarity rating.

Limited Distribution Plants which are distributed widely enough that the potential for extinction is presently low, but which are still rare.

Cryptantha costata (Ribbed Forget-me-not) (R-E-V-D 1-1-1-2) is known from a single collection in the study area (Westec, 1977). According to Munz 1974, it is uncommon in sandy and gravelly places below 1500 ft. elevations in the Colorado Desert near Needles and western Arizona. It was not found in the limited field work performed for this EAR.

Palafaxia arida var. gigantea (Giant Spanish Needles) (R-E-V-D 1-1-1-2) is restricted to the Algodones Dunes, although one or two specimens west of the dunes in East Mesa have been tentatively identified as var. gigantea also. Palafaxia arida var. arida is widespread throughout the California deserts, Nevada, Arizona, Baja California, and Sonora. It also occurs in Creosote Bush Scrub areas on the fringes of the Algodones Dunes and east of the dunes.

Plants Not Rare Outside California and of Limited Distribution in California  
Plants which are of limited distribution throughout their range, so of lesser management concern than the above two categories. These plants are still rare, however, and increasing impacts to the species may eventually raise its sensitivity to a more restrictive category.

Lyrocarpa coulteri var. palmeri (Coulter's lyrepod) (R-E-V-D 1-1-1-1) was tentatively identified from a depauperate specimen taken in a wash area north of Glamis. Further verification is needed of this species' occurrence.

Pilostyles thurberi (R-E-V-D; 1-1-2-2) is a minute stem parasite primarily found on Dalea emoryi, a common shrub in the study area. Leaves of Pilostyles are reduced to flower bracts and only small brown flowers and bracts approximately 1/4 inch long are visible on the host. There are few known locations of this plant. The host Dalea emoryi occurs in several habitat types within the study area, all of which must be considered as potential habitat for Pilostyles thurberi. Additional study will further define the habitat of this parasite.

Plants No Longer Considered Rare These plants have either been found in new locations or have increased their ranges so that they are not as rare as previously thought. They have recently been removed from the main CNPS lists, but are still of some concern in that new impacts may occur or new information may become available about these plants which causes their status to change again to a more sensitive level. Two plants in the study area are in this category: Eriogonum deserticola (Desert Buckwheat) and Euphorbia parishii (Parish's Spurge). Desert Buckwheat is widespread throughout the Algodones Dunes, but Parish's Spurge is known only from a single collection in the area on Map II-13 shown for Cryptantha costata and Lyrocarpa coulteri var. palmeri.

#### Flora Resource Value

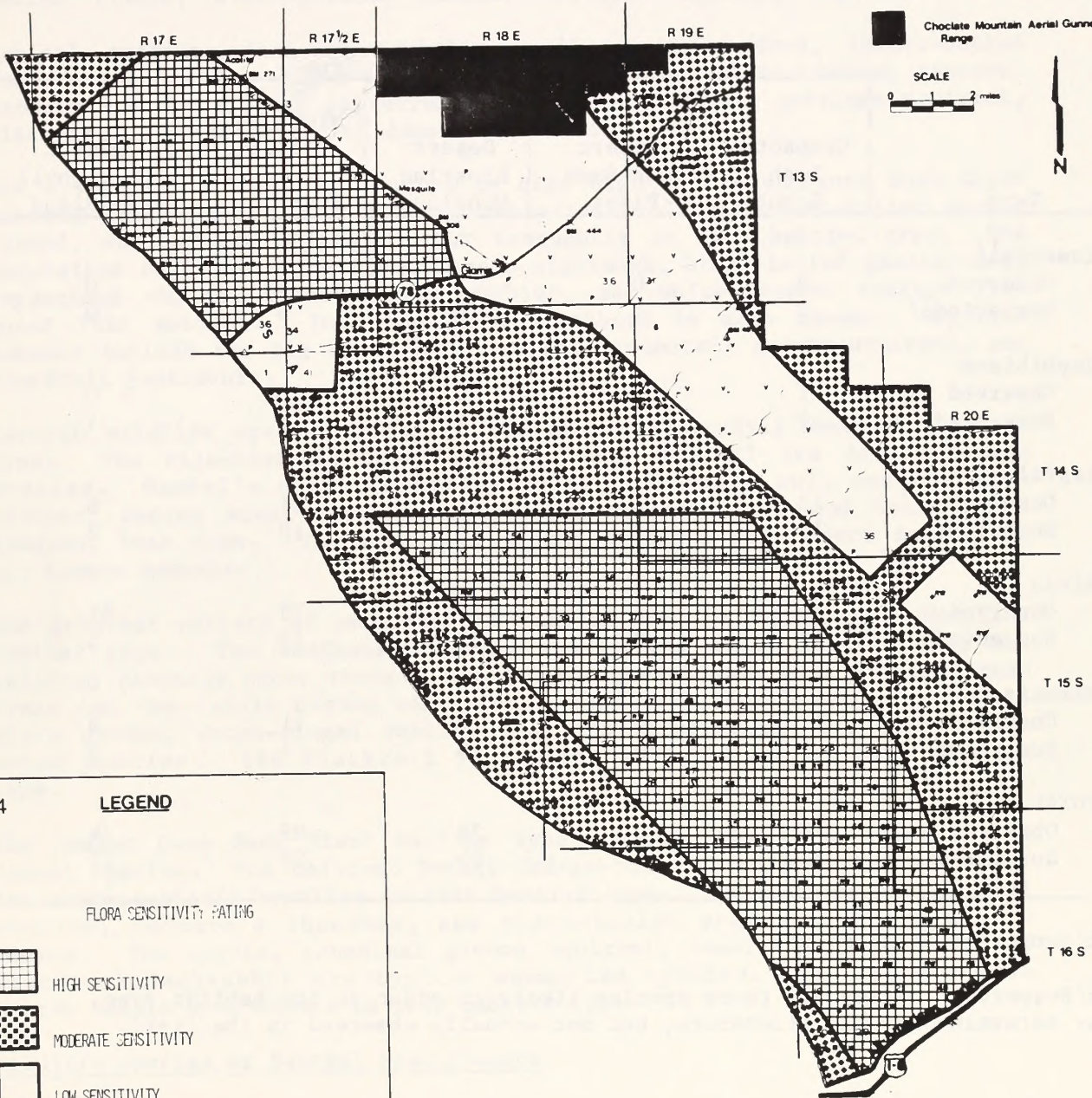
In review of the data known for the study areas, values of resource sensitivity can be delineated. Map II-S-4 presents these delineations.

#### Wildlife Species Present

The diversity of wildlife species inhabiting the Glamis/Dunes KGRA study area is quite high (see Table II-14). A total of 139 species were observed during inventories conducted in the study area; an additional 48 species were listed as probably occurring in the area according to previous studies (CDFG 1974; USDI, BR, 1975; Engineering Science 1980), field guides, and other literature (Appendix D). Special inventories for the Yuma clapper rail, California black rail, flat-tailed horned lizard, and Andrew's dune scarab beetle have been conducted in the lease area.



GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



Map II -s4

**LEGEND**

FLORA SENSITIVITY RATING



HIGH SENSITIVITY



MODERATE SENSITIVITY



LOW SENSITIVITY

TABLE II-14

WILDLIFE SPECIES DIVERSITY OF THE GLAMIS/DUNES  
GEOTHERMAL LEASE AREA, ACCORDING TO HABITAT TYPE

Taxa	Habitat Type						TOTAL
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Woodland/ Creosote Bush Scrub	Desert Microphyll Woodland		
Insects <sup>1/</sup>							
Observed	0	0	0	0	0	0	0
Suspected <sup>2/</sup>	0	1	0	0	0	0	1
Amphibians							
Observed	1	1	0	0	0	0	2
Suspected	1	0	4	1	1	1	7
Reptiles							
Observed	13	7	1	11	6	6	38
Suspected	11	15	14	10	2	2	52
Birds							
Observed	53	27	34	73	62	62	249
Suspected	13	13	35	14	5	5	80
Mammals							
Observed	11	5	3	11	6	6	36
Suspected	9	10	10	4	5	5	38
TOTAL							
Observed	78	40	38	95	74	74	325
Suspected	34	39	63	29	13	13	178

<sup>1/</sup>Sensitive Species only.

<sup>2/</sup>Suspected species are those species likely to occur in the habitat type, as determined by the literature, but not actually observed in the field.

This wildlife summary does not include the fish occupying the canals.

Wildlife diversity is greatest in the Desert Microphyll Woodland/Creosote Bush Scrub habitat type. Common reptiles in the area include the zebra-tailed lizard, side-blotched lizard, western whiptail, and sidewinder.

Typical avifauna includes Gambel's quail, mourning dove, ladder-backed woodpecker, verdin, black-tailed gnatcatcher, and white-crowned sparrow. Mammals include western pipistrelle, kit fox, whitetail antelope squirrel, black-tailed jackrabbit, and desert cottontail.

The diversity of wildlife species is also high in the Creosote Bush Scrub habitat type. The desert iguana, zebra-tailed lizard, flat-tailed horned lizard, and western whiptail occur frequently in this habitat type. The red-tailed hawk, mourning dove, lesser nighthawk, black-tailed gnatcatcher, loggerhead shrike, yellow-rumped warbler, and white-crowned sparrow frequent this habitat. The red-winged blackbird is also common. Typical mammals include the big brown bat, kit fox, roundtail ground squirrel, and blacktail jackrabbit.

Several wildlife species occur in the Desert Microphyll Woodland habitat type. The side-blotched lizard and western whiptail are fairly common species. Gambel's quail, mourning dove, long-eared owl, western flycatcher, cactus wren, warbling vireo, Wilson's warbler, and house finch frequent this type. The roundtail ground squirrel and desert cottontail are common mammals.

The greatest variety of amphibians occurs in the Desert Riparian Woodland habitat type. The Woodhouse's toad, red-spotted toad, leopard frog and bullfrog probably occur there. Several species of waterfowl utilize these areas and the canals during migration. The ferruginous hawk, roadrunner, black phoebe, rough-winged swallow, and lesser goldfinch are also common avian species. The blacktail jackrabbit also occurs in this habitat type.

The Desert Dune Sand Plant habitat type contains the least diversity of faunal species. The Colorado Desert fringe-toed lizard and the sidewinder are characteristic reptiles in this habitat type. The mourning dove, cliff swallow, LeConte's thrasher, and black-tailed gnatcatcher are fairly common. The coyote, roundtail ground squirrel, desert kangaroo rat, and blacktail jackrabbit are typical mammalian species. The Andrews dune scarab beetle also occurs in this habitat type.

#### Wildlife Species of Special Significance

The criteria used to determine significant species include the presence of a species by the State of California and/or the U.S. Congress on established lists of rare, threatened, or endangered species. Species of special significance also include those on the BLM (California) list of sensitive species, the Audubon Society Blue List (Arbib, 1978), and species with limited numbers due to restricted habitat or their position on the food chain. Species having special scientific and educational values are also included.

Table II-15 summarizes wildlife species of special significance. It should also be noted that herpetofauna is generally protected by the State of California by bag limits or other prohibitions to unlimited taking. These species are also subject to over-collection for pets. Table II-15 includes only the herpetological species of additional significance, although all others should be generally regarded as sensitive.

The Yuma clapper rail (Rallus longirostris yumanensis) is listed as a rare species by the State of California (CDFG, 1978) and as an endangered species by the U.S. Department of Interior (USDI, FWS 1979). Jurek (1975) indicated that the species occupied marsh habitat along the west side of Coachella Canal to the north of the lease area. Wetlands along the Coachella Canal probably could provide suitable habitat for the Yuma clapper rail since the species resides in shallow, freshwater marshes containing cattail and bulrush (Wilbur and Tomlinson, 1976).

The extent of breeding Yuma clapper rails in the lease area is unknown. Surveys conducted in late May, 1979, by BLM along the Coachella Canal found no Yuma clapper rails (Kramer, pers. comm., April, 1980).

Because the species could occur in the lease area, Section 7 of the Endangered Species Act of 1973, as amended, mandates that formal consultation should be initiated with the U.S. Fish and Wildlife Service if a proposed action may impact a Federally-listed species. However, upon the recommendation of the California BLM Endangered Species Coordinator (pers. comm., April, 1980) no formal consultation was initiated because of the following information.

Consultation for this species was initiated in 1975 in conjunction with the Coachella Canal realignment feature of the Colorado River Basin Salinity Control Project. This feature proposes a realignment of the present Coachella Canal route and the replacement of the southernmost 49 miles of the present unlined canal with a concrete-lined canal (USDI, 1975). The Yuma Clapper Rail Recovery Team, a panel of experts on the species which is mandated by the U.S. Fish and Wildlife Service to produce a plan designed to improve the status of the rail so that it will no longer be Endangered, indicated that the canal realignment project "does not jeopardize the continued existence of the Yuma Clapper Rail nor does it significantly destroy habitat critical to the survival of this endangered species" (Delaney, pers. comm. to Faulkner). The canal realignment will have a much greater impact on the Yuma clapper rail and its habitat than is anticipated for geothermal energy development in the Glamis/Dunes lease area.

The California black rail (Laterallus jamaicensis coturniculus) is a California State-listed Rare Species (CDFG, 1978). Jurek (1975) found this rail in wetlands between the Coachella and East Highline canals north of Highway 78; these records document the species as occurring just northwest of the study area boundary. Although BLM surveys of marshes within the study area did not locate California black rails, the species may occupy some wetlands in the study area.

TABLE II-15

## WILDLIFE SPECIES OF SPECIAL SIGNIFICANCE

<u>Species</u>	<u>Significance</u>	<u>Occurrence</u>	<u>Status</u>
Desert Tortoise <u>Gopherus</u> <u>agassizi</u>	Listed as BLM (California) sensitive species	Desert Microphyll Woodland/Creosote Brush Scrub	Uncommon
Colorado Desert Fringe-toed Lizard <u>Uma notata</u>	Protected by bag limit; limited, specialized habitat	Desert Dune Sand Plant habitat; associated with loose windblown sand substrate	Common
Flat-tailed Horned Lizard <u>Phrynosoma</u> <u>mcallii</u>	Fully protected by State of California; pro- posed BLM (Cali- fornia) sensitive species; under status review by USF&WS.	Primarily Creosote Bush Scrub	Populations generally low except in some areas in the South- west of the lease area
Canvasback <u>Aythya</u> <u>valisneria</u>	Blue List	Probably occurs along canal	Uncommon
Cooper's Hawk <u>Accipiter</u> <u>cooperii</u>	Blue List	Open woodlands and wood margins; possibly also in Creosote Bush Scrub and along canals	Uncommon migrant, southwestern popula- tion declining
Sharp-skinned Hawk <u>Accipiter</u> <u>striatus</u>	Blue List	Widespread	Migrant; south- western population appears stable
Red-tailed Hawk <u>Buteo</u> <u>jamaicensis</u>	Used by falconers	Widespread	Common
Swainson's Hawk <u>Buteo</u> <u>swainsoni</u>	Blue List; southern coastal population extirpated	May occur in open Creosote Bush Scrub	Rare migrant
Ferruginous Hawk <u>Buteo regalis</u>	Blue List	Open country; along canal	Uncommon

TABLE II-15 (Continued)

## WILDLIFE SPECIES OF SPECIAL SIGNIFICANCE

<u>Species</u>	<u>Significance</u>	<u>Occurrence</u>	<u>Status</u>
Marsh Hawk <u>Circus cyraeneus</u>	Blue List	Widespread except in Desert Dune Sand Plant habitat	Uncommon winter inhabitant
Osprey <u>Pandion haliaetus</u>	Blue List; proposed BLM (California) sensitive species	Probably along canals	Unknown
Prairie Falcon <u>Falco mexicanus</u>	Blue List; subject to nest robbing by falconers	Widespread in open country	Uncommon
American Kestrel <u>Falco sparverius</u>	Blue List	Widespread in open country	Uncommon
Gambel's Quail <u>Lophortyx gambelii</u>	Game species	Widespread, especially near water	Common
California Black Rail <u>Laterallus jamaicensis cortuniculus</u>	Rare species (CDFG)	May occur in wetlands along canal	Unknown
Yuma Clapper Rail <u>Rallus longirostris yumanensis</u>	Federally listed endangered species; Rare species (CDFG)	May occur in wetlands along canal	Unknown
White-winged Dove <u>Zenaida asiatica</u>	Game Species	Widespread	Uncommon
Mourning Dove <u>Zenaida macroura</u>	Game Species	Widespread, near water	Common
Ground Dove <u>Columbigallina passerina</u>	Fully protected by State of California	Widespread	Uncommon

TABLE II-15 (Continued)

## WILDLIFE SPECIES OF SPECIAL SIGNIFICANCE

<u>Species</u>	<u>Significance</u>	<u>Occurrence</u>	<u>Status</u>
Burrowing Owl <u>Speotyto</u> <u>cunicularia</u>	Blue List	Creosote Bush Scrub; may occur in Desert Riparian Woodland	Uncommon; may breed in Creosote Bush Scrub
Blue-gray Gnatcatcher <u>Polioptila caerulea</u>	Limited numbers; restricted habitat	Microphyll washes	Uncommon
Loggerhead Shrike <u>Lanius</u> <u>ludovicianus</u>	Blue List	Widespread in open country	Fairly common
Warbling Vireo <u>Vireo gilvus</u>	Blue List	Widespread, especially in denser microphyll habitats	Uncommon
Yellow Warbler <u>Dendroica</u> <u>petechia</u>	Blue List	Microphyll washes	Unknown; migrant
Hooded Oriole <u>Icterus</u> <u>cucullatus</u>	Limited numbers due to limited habitat	Open country	Uncommon
Scott's Oriole <u>Icterus</u> <u>parisorum</u>	Limited numbers due to restricted habitat	Open country	Uncommon
Vesper Sparrow <u>Pooecetes</u> <u>gramineus</u>	Blue List	Microphyll habitats	Uncommon
Desert Song Sparrow <u>Melospiza</u> <u>melodia</u>	Limited numbers due to restricted habitat	Microphyll habitat near canals	Uncommon
Raccoon <u>Procyon lotor</u>	Furbearer	Canals; riparian	Unknown
Coyote <u>Canis latrans</u>	Furbearer	Widespread	Common

TABLE II-15 (Continued)

## WILDLIFE SPECIES OF SPECIAL SIGNIFICANCE

<u>Species</u>	<u>Significance</u>	<u>Occurrence</u>	<u>Status</u>
Kit Fox <u>Vulpes macrotis</u>	Fully protected furbearer	Widespread; breeds in Creosote Bush Scrub	Unknown
Little Desert Pocket Mouse <u>Perognathus</u> <u>arenerius</u>	Limited distribu- tion and habitat	May occur in Creosote Bush Scrub and Desert Dune Sand Plant habitats	Unknown
Blacktail Jackrabbit <u>Lepus</u> <u>californicus</u>	Game species	Widespread; especially in Creosote Bush Scrub	Common
Desert Cottontail <u>Sylvilagus</u> <u>auduboni</u>	Game species	Widespread, especially along microphyll washes and in microphyll woodlands	Common
Burro Mule Deer <u>Odocoileus</u> <u>hemionus eremicus</u>	Game species	May occur in Creosote Bush Scrub	Uncommon
Andrew's Dune Scarab Beetle <u>Pseudocotalpa</u> <u>andrewsi</u>	Candidate Federal Threatened Species; proposed BLM (California) sensitive species	Imperial Sand Hills	Uncommon



The flat-tailed horned lizard (Phrynosoma mcallii) is fully protected by the State of California. It is also a proposed BLM (California) sensitive species. The species is also currently under status review by the Endangered Species Office, U.S. Fish and Wildlife Service, Sacramento, California (Franzreb, pers. comm., November, 1980).

The flat-tailed horned lizard has a limited range within the United States. It occurs in desert areas of southeast California, primarily in Imperial County, with a few populations in San Diego and Riverside Counties and in southwestern Arizona (Turner et. al., 1980). It feeds primarily on ants.

BLM-funded studies in 1978, 1979, and 1980 have been aimed at determining the status and distribution of the lizard in southern California. Results to date indicate that the lease area is included within the range of the lizard, except for the sand dunes area per se.

Although the lizard occurs within the lease area, its numbers do not appear to be high. To date, concentrations appear to be centered in the southwest of the study area, as determined by fairly high densities of lizard sign. The habitat type is Creosote Bush Scrub. Primary areas are: T. 16 S., R. 20 E., Sections 19, 30, and 32. In addition, several areas of prime potential habitat occur in the study area (Map II-14).

The desert tortoise (Gopherus agassizi) is a listed BLM (California) sensitive species, and is protected by the State of California.

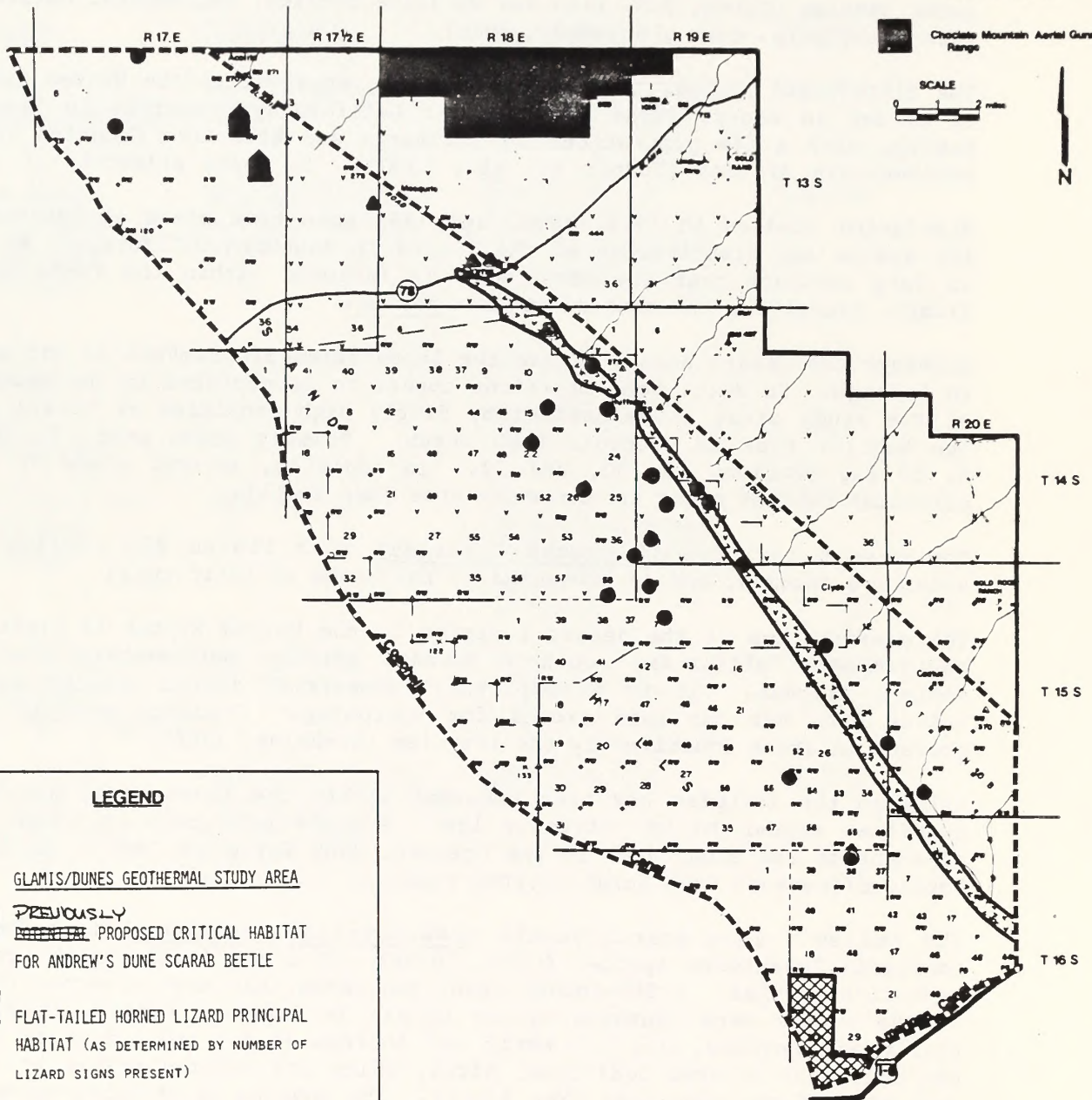
The distribution of the desert tortoise in the United States is limited to southeastern California, southern Nevada, extreme southwestern Utah, and western Arizona. It is a completely terrestrial desert species and requires firm but not hard ground for burrowing. Creosote bush is often present in areas inhabited by the tortoise (Stebbins, 1966).

Although the tortoise has been recorded within the lease area, population densities appear to be extremely low. Animals have been recorded in or adjacent to the study area in the Creosote Bush Scrub and Desert Microphyll Woodland/Creosote Bush Scrub habitat types.

The Andrew's dune scarab beetle (Pseudocotalpa andrewsi) is a Federal Candidate Threatened species (USDI, 1978b) and a BLM (California) proposed sensitive species. A BLM-funded study indicates that most previous records of the beetle were centered around Glamis in Imperial County, California (Hardy and Andrews, n.d.). Hardy and Andrews (n.d.) were able to locate the beetle at several additional sites, which are located primarily on the east side of the dune mass (Map II-14). The species is probably endemic to the Algodones Dunes in Imperial County, California, and to the portion of this dune system which occur in Baja California Norte, Mexico.




The beetle specifically inhabits troughs of loose drifting sand between the dunes (USDI, FWS 1978b). A substantial portion of the lease area has been proposed previously as critical habitat for the beetle (Map II-14) (USDI, 1978). Although this proposal has been withdrawn for administrative reasons, critical habitat will be re-proposed and will include at least part of the Algodones Dunes (Swanson, pers. comm., November, 1980).

GLAMIS/DUNES GEOTHERMAL STUDY AREA



Map II-14

**LEGEND**

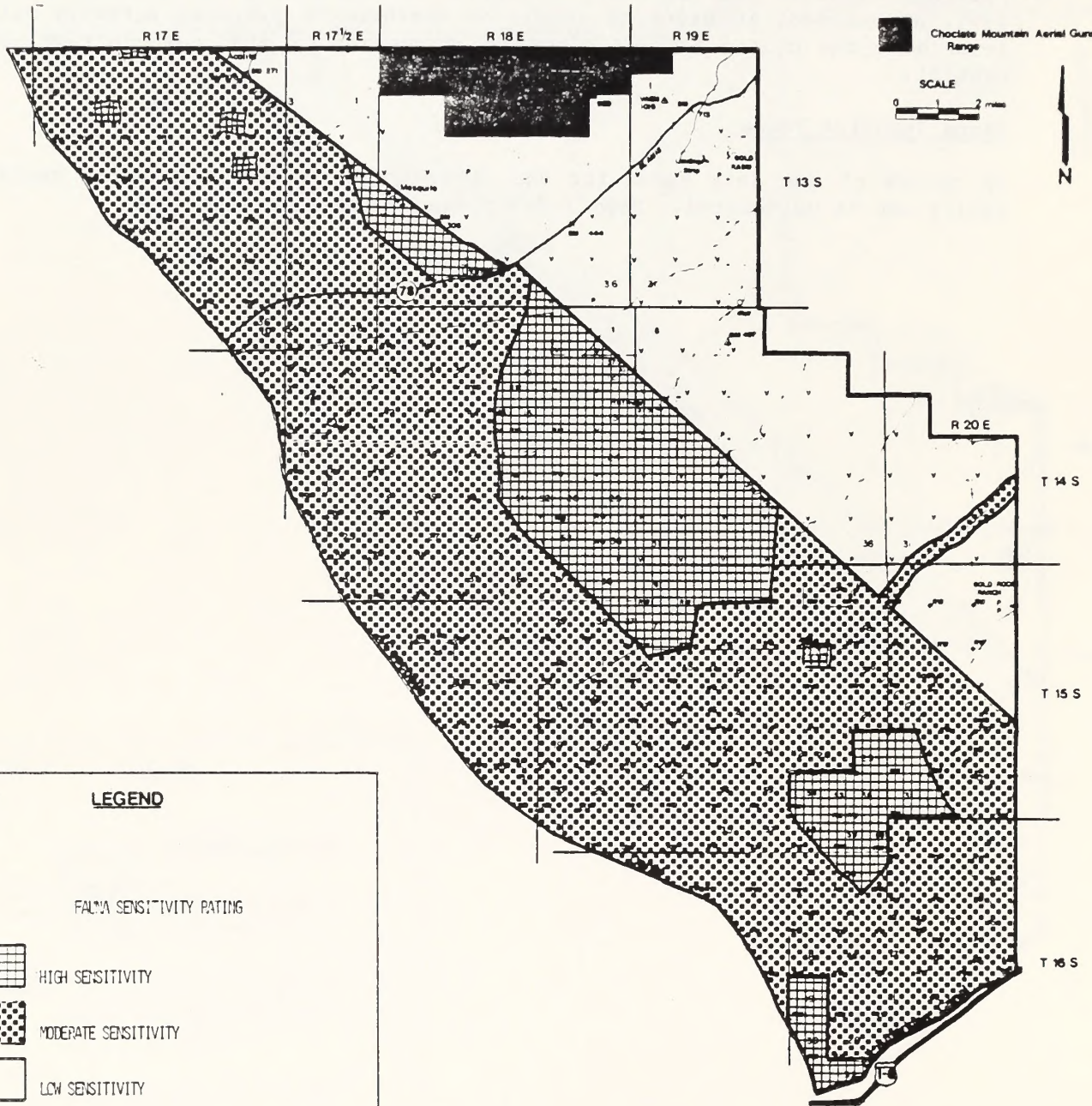
- GLAMIS/DUNES GEOTHERMAL STUDY AREA
-  PREVIOUSLY PROPOSED CRITICAL HABITAT FOR ANDREW'S DUNE SCARAB BEETLE
-  FLAT-TAILED HORNED LIZARD PRINCIPAL HABITAT (AS DETERMINED BY NUMBER OF LIZARD SIGNS PRESENT)
-  FLAT-TAILED HORNED LIZARD POTENTIAL PRIME HABITAT
- — ANDREW'S DUNE SCARAB BEETLE LATEST RECORD
- ▲ — ANDREW'S DUNE SCARAB BEETLE FORMER RECORD
- — SITE OF PROPOSED WINDMILL & ARTIFICIAL WETLANDS DEVELOPMENT BY CALIFORNIA DEPT. FISH & GAME

Because the species is known to occur in the lease area, and because much of what will probably be re-proposed as its critical habitat is included in the lease area, the BLM has entered into informal consultation with the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act of 1973, as amended, in order to determine whether the proposed activity will jeopardize the continued existence of the species or its possible critical habitat.

Fauna Resource Value

In review of the data known for the study area, values of resource sensitivity can be delineated. Map II-S-5 presents these delineations.

GLAMIS/DUNES GEOTHERMAL  
STUDY AREA



Chocolate Mountain Aerial Gunnery Range




SCALE  
0 1 2 miles



Map II -s5

**LEGEND**

FALMA SENSITIVITY RATING

-  HIGH SENSITIVITY
-  MODERATE SENSITIVITY
-  LOW SENSITIVITY

## CHAPTER III - IMPACTS

Chapter III of this document will address the impacts associated with each of the geothermal leasing actions discussed in Chapter I. Each of the resource specialists has separated their discussions by alternative action presenting a summary of the impacts for that specific alternative.

The following discussion will primarily address the impacts associated with Alternative Action One, for it is this alternative which presents the greatest potential impact to the fragile desert environ of the Glamis/Dunes Study Area.

Alternative Action Two represents the assessment team's proposal for leasing with mitigation measures beyond those provided in Alternative Action One. Although the impacts of Alternative Action Two could be similar to the impacts of Alternative Action One, the intensity of and surface area affected should be greatly reduced.

Alternative Action Three would result in no impacts upon the existing environment of Glamis/Dunes Area in Imperial County. It would, however, impact to some extent the future of the geothermal industry and the economic growth of Imperial County (see Socio-Economic discussion).

### GEOLOGY - Actions One and Two

1. Seismicity poses the major geologic hazard within the study area, with associated ground shaking and ground rupture the phenomena of most concern.

As the result of natural seismicity, ground motion of about 0.4 g may be reasonably expected in the vicinity of the study area. Duration of ground shaking, based on mathematical calculations developed by Holt (1973) for accelerations greater than or equal to 0.05 g and at frequencies greater than or equal to 2 Hz, may range from 9 to 24 seconds. It should be noted, however, that although these estimates of duration are based on curves which include a high percentage of available data, longer durations are possible and could occur.

2. Liquefaction and the resulting differential settlement in areas of saturated, poorly consolidated sediments may also induce damage to surface facilities. The extent and effect of potential liquefaction and settlement are unknown at this time.
3. Ground rupture could inflict damage to surface facilities. However, damage due to ground rupture seems remote at the present time. No surface displacement is known in the study area and faulting there is merely inferred. If, however, rupture should occur, the extent of damage would depend primarily on the extent of the ground surface rupture and its location relative to surface facilities.

4. Seismicity induced by geothermal withdrawal and injection activities is a potential hazard undergoing study and research. An induced seismicity study was conducted at the East Mesa KGRA from December 9, 1974 to December 31, 1975 (Combs, 1976). This induced seismicity study concluded that seismicity of the East Mesa area consists primarily of discrete events and swarms. This study also concluded that the seismicity before, during, and after injection and withdrawal of geothermal fluids at the East Mesa field did not change significantly (Combs, 1976).

Based on Combs' study, induced seismicity does not appear to be a potential hazard at East Mesa. However, if active faults occur in the proposed area of operations, the possibility exists that a proposed injection well could directly penetrate such a fault. Injection of geothermal effluent directly into the fault plane could increase the likelihood of induced seismicity considerably.

Action #3

No impacts anticipated.

#### HYDROLOGY

1. There is a possibility of degrading the shallow groundwater aquifer by poorer quality geothermal fluids via casing leakage or surface pipe rupture. However, protective measures against such occurrences are respectively specified in Geothermal Resource Operation (GRO) Order 2 and GRO Order 6. The USGS Area Geothermal Supervisor (AGS) is responsible for, and assures that the operation complies with these GRO Orders. Usable water is at a premium in Imperial Valley, thus strict compliance to the GRO Orders must be enforced.
2. Serious consideration should be given to designing power plants in the study area that can at least be self-sustaining with respect to water. Should the study area and other KGRAs of the Imperial Valley be geothermally developed to their anticipated potential, the total excess water may prove to be a substantial amount. Much concern has been expressed about the use and quantity of water needed by the geothermal industry. For analysis purposes a development model assumes construction of a powerplant similar to that proposed by Republic Geothermal, Inc. (RGI) located on the East Mesa KGRA. RGI's plant proposes to utilize a combination of condensers and forced-air draft cooling to condense and cool the turbine exhaust steam. Since the plant system produces more condensed steam than would be evaporated in the cooling towers, no outside make-up water is required for the cooling system. However, about 700,000 gallons of water would be required for the initial start-up.

If a wet cooling system other than the one discussed above is utilized, total water use may prove to be a substantial amount.

3. Injection of geothermal brines into the subsurface could build up sufficiently to force the geothermal effluent upward into the shallow groundwater aquifers. Such pressure buildup could result if: 1) the permeability of the reservoir is lower than expected and is not sufficient to handle the projected high volume of injected fluids; or 2) the injection zone is confined.

There is a possibility that the inferred lateral faults traversing the area may act as barriers to groundwater movement. Likewise, this could increase reservoir pressures with the creation of a possible confined aquifer situation.

Available evidence does not permit a definite determination of whether injection activities would result in an upwelling of geothermal fluids and resultant contamination of shallow groundwater aquifers. Several parameters could exist to increase the potential for the hazard; however, the specific conditions cannot be known without long-term monitoring of injection activities.

#### Action 3

No impacts anticipated.

#### CLIMATE - Actions 1 and 2

Geothermal operations impacts will be limited to the microclimate of the area near the power plant sites.

The addition of the proportionally large amount of water vapor released from the cooling towers to the atmosphere could cause a significant increase in humidity, especially to the areas that are downwind. The increase in atmospheric moisture would also increase the insulation properties of the atmosphere, thus decreasing the radiational cooling of the surface at night. This change in insulation properties would cause a moderation of diurnal air temperature, especially when wind speed is low and stable meteorological conditions exist. Of these two impacts, the moderation of air temperature would most probably be a minor disturbance while the increase in humidity might be significant.

#### Action 3

No impacts anticipated.

#### AIR QUALITY - Actions 1 and 2

1. During the exploratory phase impacts to air quality will occur from exhaust emissions of diesel and gasoline powered equipment, and dust from ground breaking activities and vehicular movement. Emissions from equipment will include NO<sub>x</sub> species, hydrocarbons, and CO. NO<sub>x</sub> and hydrocarbons will increase the potential for production of oxidizing smog. Production of dust will increase levels of Total Suspended Particulate matter. The degree of impact during this phase is expected to be insignificant.

2. During the field development stage, impacts to air quality will occur from exhaust emissions of diesel and gasoline powered equipment, emissions from wells, and dust from ground-breaking activities and vehicular movement. Emissions from equipment will include NO<sub>x</sub> species, hydrocarbons, and CO. NO<sub>x</sub> and hydrocarbons will increase the potential for production of oxidizing smog. Production of dust will increase levels of Total Suspended Particulate matter. Primary receptors would be persons working in the area and visitors to the area. Very few persons live within or in close proximity to the study area. The amount of pollutants released is not expected to impact receptors outside of the immediate study area.
3. During the production and operation stage, increased levels of noncondensable gases such as CO<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, H<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub> may result.

Without knowledge of the geothermal fluid of the KGRAs, any attempt to predict whether or not standards of air quality will be exceeded is senseless. A binary system would not release these emissions to the atmosphere. A flash-steam method would release emissions but the amount would depend both on the chemistry and the thermal characteristics of the geothermal fluid. At this time these factors are unknown.

Gudiksen, et.al., (1979) presented gas concentrations of the steam phase of geothermal fluids and estimates of the potential emission per unit power output for the Salton Sea and East Mesa KGRA. This data is presented in Table III-1. Characteristics of the geothermal fluids of the Glamis/Dunes KGRAs may be comparable.

A prediction of possible violation of air quality standards may be possible during the Environmental Analysis of the leasee's Plan of Operation.

4. The closedown phase is expected to produce impacts similar to, but less than, the field development stage.

### Action 3

No impacts anticipated.

### SOILS - Actions 1 and 2

1. Soil impacts will be slight on the dune land association. Bureau of Land Management measurements in the Algodones Dunes showed negligible compaction from off-road vehicles on the Algodones Dunes. The dunes are resistant to accelerated wind and water erosion (wind erosion is very high in an undisturbed condition and will not be increased appreciably by disturbance). Fine dust emission from dunes will also be very low.



TABLE III-1

Table III-1: A summary of the gas concentrations in the steam phase of geothermal fluids and estimates of the potential emission per unit power output.\*

	Salton Sea KGRA			East Mesa KGRA			
	Concentrations (mg/kg of fluid)		Emissions	Concentrations (mg/kg of fluid)		Emissions	
	Range	Mean	mg/kWh	Range	Mean	mg/kWh	
H <sub>2</sub>	1.6-6.0	3.2	160	H <sub>2</sub> S	0.12-1.6	0.54	55
NH <sub>3</sub>	20-41	35	1750	NH <sub>3</sub>	1.3-8.1	4.5	455
CO <sub>2</sub>	110-3800	1700	8.5 x 10 <sup>4</sup>	CO <sub>2</sub>	270-2300	1100	1.1 x 10 <sup>5</sup>
CH <sub>4</sub>	3.0-10	6.0	300	CH <sub>4</sub>	4.0-56	33	3.3 x 10 <sup>3</sup>
Hg	0.0016-0.002	0.0018	0.090	Hg	0.005-0.007	0.006	0.6
Rn	540-1080 <sup>a</sup>	810 <sup>a</sup>	4.1 x 10 <sup>4</sup> <sup>b</sup>	Rn	420-540 <sup>a</sup>	480 <sup>a</sup>	4.9 x 10 <sup>4</sup> <sup>b</sup>

<sup>a</sup> pCi/kg of fluid

<sup>b</sup> pCi/kWh

\*Gudiksen, P.H., Evmak, D.L., Lamson, K.C., Axelrod, M.C., Nyhalm, R.A. (1979) The Potential Air Quality Impact of Geothermal Power Production in the Imperial Valley, DOE/UCRL, Report UCRL-5279.

2. Soils in the Carrizo-Cajon association are very sandy. Compaction and dust emission will occur at slower rates than in the soils with more fine particles. The soils have limited potential for accelerated water erosion because of their level, very sandy nature. Where crusts occur, disruption will cause some increase in wind erosion.
3. The superstition - Acolito soils have low potential for accelerated water erosion because the sandy soils are typically on level terrain. Disruption of crusts can produce increased wind erosion. The soils are susceptible to compaction, especially when wet. Considerable fine dust may be emitted from these soils during disturbances, particularly from the Acolito series, which have a surface texture of fine sandy loam.
4. Soils in the Vinton-Brazito association have sandy loam and loamy sand surface textures and will be susceptible to compaction, accelerated wind erosion, and substantial dust emission during disturbance. These soils have low potential for accelerated water erosion.
5. The greatest potential for soil impacts occurs in the Bitterspring-Harqua association. Many of these soils are covered by desert pavement and surface soils are primarily loams, with relatively large amounts of fine particles. The SE soils will be the most susceptible to long-lasting scars and dust emission of any of the soils. These soils will also be susceptible to increased wind and water erosion and compaction after disturbance.

### Action 3

No impacts anticipated.

### VISUAL RESOURCES - Actions 1 and 2

Visual contrasts which would be created by actions 1 and 2 were analyzed from six key observation points (KOPs) located within or adjacent to the study area (Map II-3). The KOPs were selected on the basis of their representative landscape character, the level of public use, and favorable viewing conditions present at each location. Consult Appendix E for panoramic views from each KOP.

1. Results of the analysis indicate that potential contrasts created by unmitigated leasing and development of VRM Class I areas would not fall within acceptable class limits. Contrasts created by development of Class II lands would also not fall within acceptable limits. In the case of Class I and II dune areas, contrasts center around form, line, and particularly color differences between the geothermal development structures and the natural dunes. While the dunes are generally a uniform light tan or

yellow-brown, with undulating, curving lines and a massive, rounded form, most geothermal structures are darker in color (partially due to an angular form which creates distinct shadows) and are laid out with roads, pipelines, and powerlines which follow straight lines with abrupt angular turns. Form, line, and color contrasts would also reach unacceptable levels on the Class II Chocolate Mountain Bajada lands. The major contrasts there would be color and line, in this case because much of the bajada is covered with a moderately-developed layer of desert pavement which, when disturbed by construction activity, reveals a lighter substrate underneath. Conspicuous lines would thus be created by road, pipeline, and powerline construction.

2. Leasing and development of most Class III lands would create contrasts which would fall within acceptable VRM class limits. This is due to the relatively flat nature of the terrain and the shielding effects of vegetation in most Class III areas, as well as the distance of the areas from zones of high use sensitivity. An exception is the Class III area visible to the west from KOP #1 (Gecko Road). Developments in this area would be visible at a distance of less than 1 1/2 mile from elevated vantage points along the road, which would reduce the shielding effect of vegetation. Line and color contrasts produced by structures and the clearing of vegetation exceed acceptable limits for the class in this area.
3. Contrast ratings in Class IV areas were found to be within acceptable limits.
4. Medium height developments such as geothermal powerplants and cooling towers would create moderate to high contrasts in the foreground/middleground zone and low contrasts in the background zone. Steam plumes would be at their visual peak during the cooler winter months when recreational visitation is at its height. The greatest potential contrasts from steam plumes are at KOPs #1, 2, and 3, from which the white steam would be silhouetted against dark backgrounds in some directions.
5. High-profile developments such as high-voltage transmission lines are considered to produce high-to-moderate contrasts in the foreground/middleground zone and low-to-imperceptible contrasts in the background zone. At KOP #6, transmission lines would be less intrusive as such lines are already a dominant visual feature.

Action 3

No impacts anticipated.

## WILDERNESS - Actions 1 and 2

When the typical development sequence for geothermal power production is measured against the nonimpairment criteria, it becomes obvious that the only element of the sequence allowable in the two WSAs is preliminary exploration. Exploration drilling would require more time than is available before reclamation must be accomplished. Geothermal development of the two WSAs can therefore proceed beyond preliminary exploration only if Congress rejects the areas as components of the wilderness system. Though such a decision by Congress would remove the legal obligation to protect wilderness values, these values would of course remain, and would be seriously impaired if development were to take place. Roads, pipelines, powerplants, cooling towers, and steam plumes would be substantially noticeable as human intrusions. Their presence would reduce opportunities for primitive and unconfined types of recreation.

### Action 3

No impacts anticipated.

## RECREATION - Actions 1 and 2

Mammoth Wash Open Area - Although the intensity of use in this area is not as high as that in the Glamis-Gecko-Osborne Park area, the type of use is much the same; therefore, any impacts to recreation here will be similar to those found in the Glamis area and will be discussed in that section. The severe impact on recreation in this area expected from the loss of access via Titsworth Road due to the Coachella Canal realignment would be offset by increased access created by geothermal development.

### Algodones Natural Area

1. While it is doubtful that geothermal development would be permitted in an Outstanding Natural Area (also designated as Wilderness Study Area 360), it is not specifically prohibited by regulation. Assuming that such development will take place, impacts to existing recreation activities in this area would be severe. The major types of activities taking place are either research, study or contemplative in nature (photography, hiking, wildlife viewing, etc.). Success of these endeavors depends on an undisturbed environment. The only other recreation activity of any significance in the area is hunting, which would be impacted, as wildlife habitat would be adversely affected. Also, shooting activity would be restricted, as it has been traditionally prohibited from geothermal areas for safety reasons.
2. The construction of roads associated with geothermal development would result in increased management problems since the Natural Area is closed to vehicles. Permitted access to those involved in the geothermal process and the increased access on improved roads into the area could entice ORV recreationists and other vehicle users, who have in the past cooperated with the "Closed Area" designation, to enter the Natural Area in their vehicles.

### Glamis-Gecko-Osborne Park Area - Action 1

1. Because of the extremely high intensity of use in this area, the proposed action would severely impact recreation activities. The major impact would be that the road and pipeline construction necessary in geothermal development would greatly restrict access throughout the area. Freedom of movement is a most important value associated with ORV recreation in the sand dunes and any restrictions would be considered a serious imposition to the ORV recreation experience.
2. Due to a combination of physical characteristics of the dunes, which often limits visibility, and the nature of the ORV activity in the area, which is generally free-wheeling and often takes place at night, safety hazards created by geothermal development in this area would be of major concern. This is especially true of pipelines, and to a lesser degree, of the ancillary vehicular traffic associated with the development.
3. With such a high intensity of use in a relatively small area, many of the social problems traditionally associated with large crowds of people are found in this area. Vandalism has been a continual problem in the past and the facilities and equipment used for geothermal projects would be obvious targets for vandals.

### Action 2

The impacts for this proposed action would be similar to those for Action 1, but less severe, as facilities and equipment would be concentrated in smaller areas and would not be quite as restricting or hazardous.

### Central Dunes Area - Action 1 and 2

1. Since this area has limited use due to restricted access, the major impact of the proposed actions here would be the opening of new roads and providing opportunities for ORV recreation not now available because of the difficulty of access.
2. The other expected impacts would be similar to those in the Glamis-Gecko-Osborne Park area, but much more moderate since there is less activity in this area. However, if the improved access made possible by new roads creates a higher intensity of use, the severity of the impacts in this area could approach that in the Glamis area.
3. Hunting would be impacted by the general reduction of habitat caused by the disturbance of the development plus by restrictions on shooting in geothermal areas for safety considerations.

### Pilot Knob Mesa-Gold Basin Mine Area - Actions 1 and 2

1. Because this area is lightly used for recreation, it is anticipated that impacts will be moderate to low. The disruption of the natural character of the region by geothermal development will be distracting to the major users, who are generally seeking the solitude found in this little-used area.
2. Rockhounding will be beneficially impacted because of better access in remote areas as a result of construction and improvement of roads as part of the development. The construction will expose new rock materials, aiding collection. This same improved access will also allow for more ORV use of the area. However, rockhounders and ORV enthusiasts could, at the same time, lose access to favorite sites as new roads and pipelines cut across existing accesses.
3. Hunting and shooting in the area would be restricted due to safety precautions in effect in areas surrounding geothermal development sites.

### Action 3

No impacts anticipated.

### SOCIO-ECONOMICS - Actions 1 and 2

1. The proposed action is consistent with prevailing public sentiment on geothermal development in Imperial County, but there is a potential conflict between agricultural and geothermal interests. Water availability is the key but the potential for conflict is no greater in the study area than in any of the other geothermal sites in the county. The threshold for conflict is five years after the first demonstration plant begins operation in the study area. At that time the county (as directed by the county geothermal element) would decide whether to permit agricultural water to be diverted for permanent geothermal use in this area.
2. Transmission line routes and land occupation will also cause problems between the two interests (agriculture and geothermal) but in all, development in the study area would probably be less disruptive to public attitudes than would equivalent development at other sites because it is currently outside the developed agricultural area.
3. Property tax revenues for a 50-MW plant would be approximately \$250,000 per year based on an assumption of \$5,000 in taxes for each megawatt (Imperial County Geothermal Element). Tax revenues prior to development of the power plant would be negligible. Likewise, additional costs to public agencies to provide service to people employed by the project would be negligible.

Table III-1-A shows employment associated with the development model. Due to the specialized nature of the work, most of the employment would go to people outside the county, thereby not reducing the county's unemployment. Since as much as 75% of the employees prior to the production and operation stage would come from outside the county, they would constitute an increase in demand for motels and rental housing. This increase might not be noticeable except during the winter harvest season when temporary quarters are hard to find. The effect would be to make a contribution to higher rental and motel rates in the nearby communities. If extensive geothermal development results from this action, its impact on the housing (temporary or permanent) is not calculable.

TABLE III-1-A  
EMPLOYMENT FOR MODEL LEASE

Stage	Number of Employees	Duration
Preliminary exploration	6-10	6 months
Exploration drilling	20	1 year
Field development		
Well drilling and pipeline construction	105	1 year
Plant construction	110	1-1/2 years
Electrical transmission line	20	3 months
Production and operation		

(Employment impacts have been based on the environmental impact report for the proposed Heber Geothermal Demonstration Project VTN, 1978.)

- Rental fees received from issued noncompetitive leases would be \$1.00 per acre per year. Fifty percent of these fee payments would be returned to the State of California. When any lease enters the production stage an initial royalty of ten percent will be paid on production, again fifty percent will be returned to the state.

Rental fees received from issued competitive leases would be \$2.00 per acre per year plus a competitive bid initial fee. Fifty percent of these fees are returned to the State of California. When any lease enters the production stage, a royalty of 10% will be paid each year and the rental fee dropped; again, 50% of these royalty payments will return to the state of origin.

The Federal Land Policy and Management Act of 1976 (FLPMA) suggests that rentals and royalties distributed to states are to be used to offset impacts to communities where the mineral development is occurring. However, the states are free to use these monies in any way they may choose.

5. The higher cost of dune stabilization necessary for the development of geothermal resources in the Algodones Dunes may effectively eliminate any impacts which could affect recreation activities in the area.
6. We have considered the impacts of geothermal development on the social and economic aspects of recreational activity. However, no data exist to support an assessment of impacts. Our professional opinion and knowledge of the local area indicate that recreational and socio-economic impacts would be directly related to a reduction in recreational activity. Thus, a significant reduction in the recreational population would represent an impact on the economy of the local area.

### Action 3

1. A decision not to lease the study area for geothermal development could have a deleterious effect upon the future economics of Imperial County. With a reduction in the area available for development of geothermal energy, there could be a measurable decrease in the economic potential and diversity of the currently agriculturally dependent economy.
2. Action 3 could have an effect upon the future job market by reducing the number of full and part-time positions available in the geothermal industry.
3. The alleviation of geothermal development from the study area would reduce the potential public tax dollars available for the support of public facilities such as: schools, fire and police protection, water and sewer, electricity, etc. The Federal and state governments would also lose potential rental and royalty monies.



## LAND USE - Action 1

1. Action 1 is a major deviation from the historic and current land uses as described in the current environment section of this document. The two primary uses of the area to date have been recreation and military gunnery ranges. The impacts on recreation have been described in the recreation portion of this chapter.
2. As described in the current environment section, the Imperial County general plan land use element and geothermal element do not recognize the study area as having potential for geothermal resource development. Without this formal recognition established, the county is not able to approve any permanent geothermal land action in the study area. The county can permit exploration for geothermal resources in any area of the county without a formal designation of a geothermal resource area; however, no additional approvals may be given without such a designation.

## Action 2

The application of Action 2 to the study area would provide for a greater diversity in land use types, thus providing for the multi-use format of development prescribed by BLM policy.

## Action 3

No impacts anticipated.

## NOISE - Actions 1 and 2

Several geothermal activities produce noise levels that can be deleterious to surrounding environs. Tables III-2, III-3, and III-4 present noise levels that can be expected during geothermal exploration and development operation in the project area.

1. Noise levels during the exploration and construction stages are short lived and at times, highly intense, possibly reaching levels of 100 dBA or higher.
2. Noise levels during plant operation, production well flowing, and injection well pumping will all be long term impacts which will have some effect upon the wildlife appearing in the area. Further discussion of the impact of noise levels on wildlife appear in the flora and fauna section of this document.
3. Although well venting is the loudest noise source associated with geothermal operations, it is such that distance and obstacles easily attenuate it.
4. Cooling tower noise is a source with more potential for impact beyond the project boundaries because its frequency distribution makes it more difficult to attenuate (Lawrence Livermore Laboratory).

Table III-2. Construction Equipment Noise Ranges

		Noise Level (dBA) at 50 ft					
		60	70	80	90	100	110
	Compactors (Rollers)		●				
	Front Loaders		●	●	●		
	Backhoes		●	●	●	●	
	Tractors		●	●	●	●	
	Scrapers, Graders			●			
	Pavers			●	●		
	Trucks				●	●	
	Concrete Mixers			●	●		
	Concrete Pumps			●			
	Cranes (Movable)		●	●	●	●	
	Cranes (Derrick)			●	●		
	Pumps						
	Generators		●	●	●		
	Compressors		●	●	●		
	Pneumatic Wrenches			●	●	●	
	Jack Hammers and Rock Drills			●	●	●	
	Pile Drivers (Peaks)					●	●
	Vibrator		●		●		
	Saws		●	●			

- New measurements
- V U.K. data
- R European data
- M Manufacturer's data

Table III-3. Geothermal Power Plant Operational Noise Levels

<u>Source</u>	<u>Distance</u>	<u>Sound Level (dBA)</u>
Reinjection and production pumps <sup>(1)</sup>	5 feet	86-90
Condensate pump <sup>(2)</sup>	3 feet	81
Purge pump <sup>(2)</sup>	3 feet	88
Cooling water pump <sup>(2)</sup>	3 feet	77
Cooling tower <sup>(3)</sup>	5 feet	85
Turbine/generator <sup>(3)</sup>	3 feet	94
Switchyard <sup>(4)</sup>	200 feet	55
Transmission line <sup>(5)</sup>	50 feet	50

- Sources: (1) Chevron Resources Company, 1977
- (2) VTN and SDG&E measurements 7/21/77, geothermal test plant, Niland, California
- (3) Pacific Gas & Electric Company, 1976
- (4) Southern Engineering Company, 1975
- (5) Bonneville Power Administration, 1977

Table III-4. Predicted Noise Impact From Geothermal Development

Activity	Source/Distance	Predicted Noise Level Ranges (dBA)			
		Distance From Source			
		500'	1,000'	1/2 Mile	1 mile
Construction	85-90/50 feet	65-75	59-69	51-61	45-55
Drilling	66-71/200 feet	58-61	52-55	44-49	38-43
Plant Operation					
Power Plant	60/500 feet	60	54	46	40
Pumping Island	86-90/500 feet	46-50	40-44	32-36	26-30

Source: VTN Calculations 1977

## CULTURAL RESOURCES

Because of the prehistoric subsistence patterns in this area, (highly mobile hunters and gathering strategies) prehistoric sites are of a temporary nature. Most of the sites are surface scatters of lithics and/or pottery. Consequently, all prehistoric sites in the study area are highly susceptible to surface disturbance impacts. The same situation is applicable to historic sites.

The opening of the Glamis/Dunes study area to geothermal development would impact cultural resources in two ways:

1. Exploration and development activities will directly impact surface lands and may alter or completely destroy surface sites.
2. Opening new areas for public access will create indirect impact activities, such as ORV disturbance and unauthorized collections that have the potential of becoming serious and long range.

### Action #1

#### 1. Preliminary Exploration

Cultural resources within the construction area will be partially or completely destroyed. Consequent stages will have increased impacts, depending on site location and site density.

Activities during this stage will modify the surface and produce either the direct or indirect impact of surface alteration or destruction impact of easier accessibility which will increase worker/visitor use of the area. This could result in destruction of the resource by vehicular activity or in some cases, actual collection of the resource.

#### 2. Exploration

The impacts discussed for Phase I can be anticipated in this phase also; however, it is expected that exploration will increase surface disturbance and access.

#### 3. Field Development

Since the greatest amount of surface disturbance will occur during this stage, there exists the greatest potential impact to cultural resources. Destruction or alteration of some cultural resources is likely. The impacts discussed previously apply here as well.

#### 4. Production and Operation

No additional sites are anticipated during this stage unless new wells or waste disposal sites are developed. Such impacts would produce the same results as in field development.

## 5. Close Down

No impact anticipated.

### Action #2

1. Geothermal leasing under Action 2 would not allow surface disturbance of identified significant cultural resources, thus negating the impacts described in Action 1.
2. Impacts to cultural resources as described in Action 1 will still exist, but to a lesser degree.

### Action #3

There will be no impacts to cultural resources.

### FLORA AND FAUNA - Action 1

General Impacts - Major impacts to vegetation and wildlife will occur during all phases of development and will include: 1) vegetation and habitat lost due to surface disturbance and pollution; 2) disruption of wildlife behavior and possible physiological changes caused by noise and human activities; 3) crushing of wildlife and vegetation by vehicles or other accidental injuries and deaths; 4) displacement of wildlife into adjacent areas which are generally already at carrying capacity; 5) possible lowering of the water table because of well water use, influencing plant and (indirectly) animal survival.

Impacts during preliminary exploration will be low because smaller machinery will be used in localized areas. However, as few roads exist, some off-road travel will be necessary, causing the same types of impacts as ORVs. Also, exploration during springtime may result in the disruption of breeding, nesting, or brooding activities (USDI, FWS 1978a).

Through the remaining development and production stages, impacts will increase as surface disturbance, pollution potential, and noise level increase. The closedown phase will begin to repair damage due to project development impacts because structures and equipment will be removed and rehabilitation efforts will be initiated.

As development progresses and the intensity of the impacts increases, however, efforts to rehabilitate impacted areas to predevelopment conditions will have increasingly less chance of success. Loss of native vegetation and topsoil may be permanent due to low moisture and fragile soils. Natural revegetation success often depends upon the degree of soil alteration, the extent of vegetation destruction, the extent of exotic plant introduction, the degree of aridity of the disturbed area, and climatic factors (USDI,

BLM, 1974; USDI, BLM, 1976; USDI, BLM, 1977, Gillette et al, 1974, Vasek et al, 1975a and b). Displaced wildlife may not return. Exotic plants which invade disturbed areas may permanently establish themselves, making rehabilitation to predevelopment conditions impossible. The extensive drainage system east of the railroad tracks may be altered by roads and/or structures, causing potentially permanent changes in downstream vegetation and wildlife habitat. Also, any compaction, oiling, or paving of roadways occurring in the sand dunes may be permanent effects of this action.

The composition and density of the plant community are major factors in determining wildlife composition, abundance and diversity. The loss of vegetation, and thus of wildlife habitat, will reduce the long-term productivity of the area, resulting in a decline in population numbers and in less diversity. This decreases the stability of the biota in the area (USDI, BLM 1977).

Habitat loss will have the greatest impact in areas of high wildlife use. Many species will be impacted regardless of the habitat types affected. Especially important would be the loss of extensive desert pavement areas with loose sand and the loss of partially stabilized dunes because these are prime habitat areas for the flat-tailed horned lizard and the Colorado Desert fringe-toed lizard. In addition, loss of sand dune areas may impact the Andrew's dune scarab beetle. Although withdrawn as proposed critical habitat for administrative reasons, at least part of the Dunes will be included in the re-proposed critical habitat for this species (Swanson, pers. comm., April 1980). Desert Riparian Woodland areas along the Coachella Canal will be lost regardless of geothermal development because of the projected Canal realignment. Thus, in that habitat type, the impacts of Canal realignment would be far greater type than those which might be projected for geothermal development.

The Algodones Dunes provide a unique vegetation resource where six sensitive plant species occur. Impacts to these sensitive plants are discussed later. Geothermal resource development in the Algodones Dunes could have far reaching effects on all of the dunes vegetation. Areas of the dunes currently closed to off-road vehicles or otherwise undisturbed may be open to extensive disturbance from geothermal development.

Construction Activities - The most severe impact of the construction of roads, drill sites and well pads, pipelines, power plants and transmission lines is the loss of vegetation and hence the loss of wildlife habitat. The primary causes of vegetation loss include: 1) surface disturbance, 2) crushing and uprooting by machinery, and 3) soil compaction.

Construction would also result in the loss of wildlife by direct crushing of animals and their burrows or by displacement due to noise, harassment, and surface occupancy. Displaced animals will disperse into nearby areas which may already be at carrying capacity. They may become subject to increased predation and stress, and thus may be lost indirectly (USDI, FWS 1978a).

Roads represent a cumulative impact. Even though existing roads will be used where possible, major improvements to existing roads or new roads will be needed for full field development. This is especially true in the Algodones Dunes. Roads in sandy areas will have to be paved or scraped down to hard layers. This would totally disrupt soil development and increase the difficulties of rehabilitation during closedown.

New roads facilitate the invasion of exotic plant species which may affect the health and vigor of native plants and animals (Johnson et al., 1975). New roads facilitate the use of new areas by ORVs, which can have great direct and indirect impacts on these areas (USDI, BLM, 1977). If new roads are created in areas of the Algodones Dunes currently closed to off-road vehicles or otherwise inaccessible, then all of these effects are possible and Federal listing of the sensitive plants and animals found in the Dunes becomes much more likely. Roads can also increase erosion from wind (through disruption of soil structure) and water (through modifications in drainage patterns, loss of vegetation protecting the soil from the impacts of raindrops, and rapid runoff along roadways).

Studies in the Mojave Desert have shown that areas adjacent to paved and unpaved roads tend to have more shrub biomass and annual plant diversity than nearby areas without roads (Johnson et al., 1975). Apparently this is due to relatively mesic conditions at the edge of the roadway. This effect has potentially negative aspects also, as the proliferation of annuals in the above study was found to completely change the vegetative composition of the area. The effects of such habitat alterations are difficult to predict, but may be extensive and permanent. Whether such habitat alteration is a positive or negative impact can be decided only after extensive study.

Soil compaction and surface disturbance represent serious longlasting impacts to the environment (Vollmer et al 1976; USDI, BLM, 1978; Stebbins, 1974). Highly significant erosional problems have occurred in other remote, arid KGRAs in conjunction with even minimal disturbances of vegetation and substrate (USDI, 1978). Soil provides physical support, water, and mineral nutrients for plants growing in it as well as providing habitat for burrowing animals. Surface disturbance generally increases erosion of the soil layer, and disturbs soil horizons. Compaction produces an increase in soil bulk density and a loss of soil pore spaces which may reduce or eliminate penetration of water and roots, increase the volume and rate of water runoff (which increases erosion rates), and alter the soil temperature regime Snyder et al, 1976; Stebbins, 1974; Hausenbuiller, 1972). Seedbeds and root systems can be destroyed by the increased density of soil, lack of air and water, and increased rate of temperature fluctuation in compacted soil. All of these factors may make it difficult or impossible for animals to construct and live in burrows in compacted soils.

Chances of vegetation recovery in compacted areas are poor. Generally, the greater the degree of soil compaction, the longer the time period required for habitat recovery. Depending upon the combination of variables in each case, natural revegetation in a desert climate may occur as quickly as 30-40



years in areas of high productivity (Vasek et al, 1975a) or as slowly as never in highly disturbed, low productivity areas. The study area would in general be of substantially lower productivity than the areas of Mojave Desert studied above.

Sandy soils, especially coarse sand, tend to resist compaction, minimize evaporation, and maximize water penetration. In many places in the sand dunes, even without canal seepage, the water table may be within 5 feet of the surface. Seedlings may have difficulty establishing themselves in the sand dunes if they cannot withstand occasional "sandblasting" and if their roots cannot reach the permanent water quickly enough. However, once established, plants and their associated animals can flourish in these sandy soils. The looser and coarser-grained the surface soil is, the less attraction the soil particles will have for water. Thus, water penetrates beneath the surface and less water will be at the soil surface where it can evaporate and draw more water to the surface to replace it. This is known as "capillary action," and occurs in compacted and fine-textured soils.

Wildlife may be lost to transmission lines through collision and electrocution. Pipelines resting on the ground could reduce the mobility of small animals, thereby affecting foraging, reproductive and social behavior, and perhaps reducing population vigor by limiting the gene pool.

ORV Use - ORV impacts have been documented and referenced in the North Salton Sea Geothermal EAR--Final (USDI, BLM, 1979). In summary, studies show that ORV use reduces shrub density, canopy cover, and diversity; reduces the diversity of annual and perennial herbaceous species; reduces the germination of wildflowers and increases the density of weedy species; compacts the soil; and creates new noise levels and other human disturbance which directly affect wildlife. These factors affect the amount and kind of vegetation available to wildlife for forage, as well as for nesting and other activities.

New roads may increase public access and thereby increase ORV impacts, because most of the study area is well suited for off-highway travel, especially in the sand dunes. Until the Route Designation process is finalized, the status of this area for ORV management will be uncertain. In any case, trail designations and closures have not been effectively enforced in the past (primarily due to lack of Ranger citation authority and too few Rangers). All habitat types will be susceptible to ORV impacts. The Algodones Dunes north of Highway 78 is currently closed to ORVs. Geothermal development in the closed area may invite ORV users back into that area and create many impacts to plants and animals.

In many areas, ORVs will have difficulty operating without running over substantial amounts of vegetation and crushing wildlife.

Noise - Noise will impact wildlife during all development and production stages. Several authorities (Romney, 1976; Miller as cited by Stebbins, 1974; Bondello, 1976) have documented noise impacts on reptiles, birds

and mammals. Noise has limited the auditory acuity of desert iguanas. Hearing loss in the Mohave fringe-toed lizard has occurred after exposure to dune buggy sounds of 95 dBA and 100 dBL (Brattstrom and Bondello, 1979). Operation and construction, with the associated noise levels of 100 dBA or greater, could cause hearing loss in similar species such as the Colorado Desert fringe-toed lizard.

Very little of the lease area is heavily vegetated. This, coupled with the fairly level substrate in most areas, would allow sound waves to travel freely rather than being muffled by natural features of the terrain.

The operation of powerplants and related facilities produces sound levels which approach 100 dBA noise levels at distances between 3 to 50 feet (Table III-3). However, the distance between the noise source and the edge of the undisturbed habitat should be greater than 50 feet thus the dBA level should be lower. This represents a long-term impact, for these noise levels are above the estimated ambient noise levels of the desert. Smaller animals seem more susceptible to noise impacts and are less able to adjust. Larger animals tend to become habituated to higher noise levels, although they may also suffer hearing loss (USDI, FWS, 1978a; Brattstrom and Bondello, 1979).

Noise can disrupt the social and reproductive functions of birds that rely on auditory signals. It may alter predator-prey relations to one or the other's disadvantage by affecting hunting or defense strategies. The greatest impact would occur during spring and early summer and in areas of high wildlife densities.

Noise is especially detrimental in areas such as undeveloped desert which has low baseline sound levels areas (USDI, FWS 1978a).

Pollution - Pollution of air, soil, and water can occur from sump failure, well testing, well casing leaks, spillage (of gas, oil, and detergents), and acid washes. The degree of impact depends on the location, amount, type, and concentration of the pollutant, and drainage patterns, type of habitat, season of the year, and climatic factors associated with pollutant release. The most sensitive season is spring when new plant growth and most wildlife reproductive efforts are taking place.

Spillage of liquid wastes could accelerate soil erosion, reduce productivity or actually sterilize the soil, and may contaminate groundwater, causing severe and far-reaching consequences. In the worst case, a large uncontrolled or undetected spill in the alluvial fan east of the Algodones Dunes could contaminate the dunes, East Mesa, and Imperial Valley farmlands downstream to the west. Most liquid pollution would probably have only localized impacts around the site of the spill, and wastes are not expected to be highly toxic from evidence gained so far.

Gases and vapors which may be released include carbon dioxide, carbon monoxide, oxides of nitrogen, ammonia, hydrogen, boron, and hydrogen sulfide. Some of these chemicals have the potential to cause severe impacts of long duration (USDI, FWS, 1976). They could modify the nutrient cycle and destroy wildlife habitat, usually in a localized area near the pollution source. They could also kill plants which come in contact with the pollutants, or severely retard growth and productivity. Odors could cause wildlife to be displaced into other areas presumed already to be at carrying capacity which are further away from the pollution source.

Wildlife Species of Special Significance - The Yuma clapper rail (Rallus longirostris yumanensis) is listed as an Endangered species by the Federal government. The Yuma clapper rail and the California black rail (Longirostris jamoidensis coturnicus) are listed as Rare by the State of California. These species will be impacted by changes in wetland habitats. Destruction, drainage or pollution of wetlands will remove necessary habitat or kill food sources of these species.

While 1978 surveys did not reveal either species along the canal-influenced marshes, past surveys have recorded the rails in similar habitats near the study area. Therefore, it is possible that the rails occur there now. Protection of existing washes is important, particularly because the realignment of the Coachella Canal will result in the loss of about 1,200 acres of wetland-riparian habitat. It is also important that protection be given to artificial wetlands which have been proposed within the study area (see Map II-14).

Impacts by geothermal development on these rails will occur, but will be much less severe than those associated with the realignment and concrete lining of the Coachella Canal.

The flat-tailed horned lizard (Phrynosoma mcalli) is a BLM (California) proposed sensitive species and is fully protected by the State of California.

Recent studies show that the southern most portion of the Glamis/Dunes KGRA may have relatively high populations of the lizard. Because this species has a limited range and its populations are generally low and variable, this portion of the lease area provides important habitat for the flat-tailed horned lizard. Habitat destruction by roads and other construction activities in prime habitat areas (Map II-14) will have a locally high impact on this lizard. There are three sections of land within the study area which are known to have high densities of flat-tailed horned lizards. Other planning efforts by BLM (USDI, BLM 1980a, 1980b) have identified an additional 14 sections of BLM-administered land with high lizard densities. Given that 57% of the known optimal habitat for the species is within areas subjected to uses such as sand and gravel quarries, oil and gas development, geothermal development, agriculture, pesticide spraying, and recreation (Rado 1980). Local highly negative impacts within the three sections having high lizard densities could be at least moderately detrimental to the vigor of this species.

The Colorado Desert fringe-toed lizard (Uma notata) occurs in specialized habitat consisting of sparse vegetation and windblown sand. If these areas are lost to surface occupancy or heavy ORV traffic, impacts to the local populations could be high due to loss of specialized habitat and crushed animals. Assuming a "worst case" situation of full development of the study area, approximately a third of the known range of this species could be subject to negative impacts. Other portions of the probable range are subject to geothermal development, sand and gravel operations, recreation, and other activities which negatively impact habitat. Therefore, full development in suitable habitat within the study area could contribute significantly to the decline of the species.

The desert tortoise (Gopherus agassizi) occupies and hibernates in underground burrows. Tortoises would be subject to crushing during construction activities. Impacts, however, are expected to be low due to the apparent low numbers of tortoises in the study area.

The Andrew's dune scarab beetle (Pseudocotalpa andrewsi) is a candidate federal Threatened species. Much of what may be proposed as its critical habitat is included in the lease area (Map II-14). Geothermal development in prime habitat areas would have a highly negative impact on this species as a whole. The dune troughs which the beetles inhabit could be impacted by construction and vehicular activities, which would prevent the accumulation of dead organic matter upon which the larvae feed (USDI, 1978). Beetles could be crushed either as they mate or rest on the surface of the sand or as they spend the day below the surface at the wet sand interface, usually at a depth of 5-30 cm. Increased access to presently remote and infrequently used areas could increase the severity of these impacts. Since 91% of the known locations of the beetle in the United States occur within the study area, full development could be highly detrimental to the continued existence of the species.

Wildlife Species of Special Significance - The Yuma clapper rail (Rallus longirostris yumanensis) is listed as an Endangered species by the Federal government. The Yuma clapper rail and the California black rail (Longirostris jamoidensis coturnicus) are listed as Rare by the State of California. These species will be impacted by changes in wetland habitats. Wetland destruction, drainage or pollution will remove necessary habitat or kill food sources of these species.

While 1978 surveys did not reveal either species along the canal-influenced marshes, past surveys have recorded the rails in similar habitats near the study area. Therefore, it is possible that the rails occur there now. Protection of existing washes is important, particularly because the realignment of the Coachella Canal will result in the loss of about 1,200 acres of wetland-riparian habitat. Impacts to these species would be high.

The flat-tailed horned lizard (Phrynosoma mcalli) is a BLM (California) proposed sensitive species and is fully protected by the State of California. Recent studies show that the southwestern corner of the Glamis/Dunes KGRA may have relatively high populations of the lizard. Because this species has a limited range and its populations are generally low and variable, this portion of the lease area provides important habitat for the flat-tailed horned lizard. Habitat destruction by roads and other construction activities in prime habitat areas (Map II-14) will have a high impact on this lizard.

The Colorado Desert fringe-toed lizard (Uma notata) occurs in specialized habitat consisting of sparse vegetation and windblown sand. If these areas are lost to surface occupancy or heavy ORV traffic, impacts to the local populations could be high due to loss of specialized habitat and crushed animals.

The desert tortoise (Gopherus agassizi) occupies and hibernates in underground burrows. Tortoises would be subject to crushing during construction activities. Impacts, however, are expected to be low due to the apparent low numbers of tortoises in the study area.

The Andrew's dune scarab beetle (Pseudocotalpa andrewsi) is a federally-proposed Threatened species. Much of what will be proposed as its critical habitat is included in the lease area (Map II-14). Geothermal development in prime habitat areas would have a highly negative impact on this species. The dune troughs which the beetles inhabit could be impacted by construction and vehicular activities, which would prevent the accumulation of dead organic matter upon which the larvae feed (USDI, 1978). Beetles could be crushed either as they mate or rest on the surface of the sand or as they spend the day below the surface at the wet sand interface, usually at a depth of 5-30 cm. Increased access to presently remote and infrequently used areas could increase the severity of these impacts.

Plant Species of Special Significance - The plant species of special significance will receive the same type of impacts already discussed for vegetation. Surface disturbance in areas inhabited by these plants will probably remove existing plants and may destroy the habitat necessary for their reestablishment after close down of the facility due to soil disturbance, pollution effects, and/or increased competition with other plants. This would be especially true in the Algodones Dunes where oiling or paving of roads or drill sites, etc., would be necessary.

Most of the sensitive plant species in the study area are found in the Algodones Dunes (see Map II-12). Approximately 25% of the dunes is intensely impacted by ORVs, approximately 25% is protected as a material area closed to vehicles, and the remainder receives moderate to very low ORV use. This ration has been considered in BLM planning and policy, a reasonable and manageable minimum to protect the sensitive plant and animal species and unique natural values of the Algodones Dunes. This has proved

to be a sensitive and controversial political issue, even involving lawsuits. Reasonable compliance with the closure by the ORV public is almost realized now after several years of work by BLM. Any development in the dunes which destroys sensitive plants could compromise the political balance now achieved with ORV users, and short-circuit voluntary compliance with vehicle closures.

The impacts of major geothermal development in the dunes could be much greater than the effects of ORVs. If development occurs in the area closed to vehicles, impacts to sensitive plants in the entire dunes will probably increase significantly. At least two of the sensitive plant species may then warrant listing as Endangered by the U.S. Fish and Wildlife Service because the cumulative effects of ORVs in the Open Areas and geothermal development in the Closed Area will affect significant portions of the total distribution of those plants.

ORVs would probably also be encouraged to violate the vehicle closure if geothermal development occurs in the Closed Area.

The general management constraints associated with sensitive plants are discussed under the Existing Environment section titled "Plant Species of Special Significance." Almost all impacts to State listed endangered species must be mitigated.

Any liquid pollution east of the Algodones Dunes which reaches one of the numerous drainages could affect Calliandra eriophylla which grows in the washes. All of those drainages empty into the Algodones Dunes so that a major toxic spill could have far-reaching effects throughout the dunes and its groundwater basin. The sensitive plants in the area could be destroyed in such a "worst case" occurrence.

With favorable rainfall the last few years, all of the sensitive sand dunes species appear to be increasing in abundance despite intense ORV disturbance in part of the dunes. This increase is expected to be reversed as dry years return to the desert.

Areas of development which will least affect sensitive plants are desert pavement sites east of the Algodones Dunes area if drainages are adequately protected.

Areas of development which will most affect sensitive plants are the Algodones Dunes themselves and the adjacent areas within the Coachella Canal to railroad tracks boundaries. An exception to this would be the area near Highway 78 which has been extensively disturbed in constructing the new Coachella Canal. The remainder of the Open Area south of Highway 78 has been disturbed by ORVs. Geothermal development would increase impacts to the sensitive plants in that area considerably, however, not nearly as much as in areas less disturbed by ORVs.

Action #2

Through Alternative Action #2 the impacts of geothermal development to sensitive flora and fauna locations would be greatly reduced. The limitation of surface access and the use of minimum surface design techniques would maximize the ability of the flora/fauna environ to adjust to the intrusion of geothermal development.

The impacts of Action #2 would be much like Action #1; however, the areal extent of these impacts should be much smaller, thus greatly reducing the overall impacts to a level that will have minimal effects on wildlife (see discussion on unavoidable adverse impacts).

Action #3

No impacts anticipated.





## CHAPTER IV - MITIGATION MEASURES

### Introduction

Chapter IV of this document is proposed appropriate mitigation measures which could be added to the standard lease contract to lessen or eliminate the impacts described in Chapter III. It is the intention of BLM that this chapter be the basic reference for the design and development of surface protection features within the described study area.

The following stipulation is generally attached to all geothermal leases let by BLM on lands covered by this EAR:

"Prior to the development of a plan of operation (43 CFR 3203.6 30 CFR 270.34) the lessee shall contact the area geothermal office, USGS, Menlo Park, and authorized officers of BLM and Imperial County to review local and state regulations, the Geothermal Resources Operational Orders 1-7 (USDI, USGS, 1976) and those special stipulations provided for in the EAR on Glamis/Dunes noncompetitive leases for geothermal exploration/development."

GRO Orders 1-7 address general and specific environmental protection measures to be applied to geothermal exploration and development on Federally administered lands. However, the application of the GRO Orders can vary somewhat because many of the provisions are general in nature. Also, the Bureau's standard lease form (3200-21-May-1974) contains stipulations which are somewhat general. The GRO Orders and the standard lease stipulations are not repeated here for they are part of the proposed action. The following mitigation measures have been developed as additional mitigation measures not addressed by the GROs and will produce additional protection of the sensitive resources found in the Glamis/Dunes study area.

The presentation of the following mitigation measures is addressed in two phases. Some of the mitigation measures discussed in the following paragraphs apply to the overall study area and should be applied as lease stipulations. Others of the following proposed mitigation measures are specific to a possible site location within the study area boundary. It is recommended that these site specific mitigations be used as guidelines for mitigation on each of the plans of operation as it occurs. A designation within parentheses located at the end of a proposed mitigation indicates whether the proposed mitigation is intended as a lease stipulation (LS) or a plan of operation mitigation (POM).

## Mitigation for Alternative Action #1

### Geology

1. Injection of spent geothermal fluids from production facilities on Federal leases is a standard requirement. Theoretically, injection should alleviate any unnatural subsidence or seismic activity caused by withdrawal of fluids from the subsurface.

GRO Order #4 covers subsidence and seismicity in great detail. However, the installation of seismic monitoring instrumentation is optional and is only required after a tectonic event has taken place.

Therefore, the field developer should be required to provide for attachment to and participate in the local survey network of benchmarks, tiltmeters, and extensor meters to monitor and objectively separate geothermally induced tectonic occurrences from regional historic subsidence, uplift and horizontal movements. (LS)

If, through this monitoring, it is determined that development is the primary contributor to an observed increase in tectonic activities that are harmful to the environment, then action should be taken to correct the situation. These actions could include the following:

- a. A change could be made in production quantities or pressure.
  - b. A change could be made in injection quantities or pressure.
  - c. A shutdown of operations.
2. Mitigation measures to reduce potential impacts associated with seismic activity include both site engineering (civil/soils, geological/earthquake, design) and continued site monitoring.

All proposed construction and site preparation activities should be developed on the basis of site data, both surface and subsurface, developed by professionally registered engineers and geologists. This information should include recommendations and conclusions regarding the nature, strength, and adequacy of site materials and any design measures to compensate and correct for inadequate site materials. Measures should be taken to identify the potential for and provide correction measures to eliminate or reduce impacts associated with liquefaction and differential site subsidence. Seismic design criteria should also be included in all plans for construction of the power block and attendant facilities. No powerplant facilities should be located directly above or across the trace of any active or potentially active fault. All state and local building and construction codes, such as the Uniform Building Code (1976), should be followed. (POM)

## Hydrology

1. The California Regional Water Quality Control Board - Colorado River Basin - will have jurisdiction over the geothermal development characteristics that might affect water resources. Through application procedures set by the state board, discharge requirements and monitoring and reporting programs will be established. This will be based upon process criteria, working program goals, and state and Federal regulations, thus no additional mitigation is necessary.

## Climate and Air Quality

1. If quantities of H<sub>2</sub>S are found in the geothermal resource, the effect of H<sub>2</sub>S emissions on ambient air quality will be quantified through an air quality and meteorological monitoring system to be established and operated by the lessee. Daily records will be kept and monthly reviews made by the Office of the Area Geothermal Supervisor, USGS, Menlo Park, California. Appropriate mitigation measures will be developed by USGS and implemented by the lessee. Development and implementation of mitigation measures will be done in accordance with Geothermal Resource Order No. 4. Mitigation measures may include but will not necessarily be limited to the technology identified in "Identification of Environmental Control Technologies for Geothermal Development in the Imperial Valley of California" (Snoeberger and Hill, 1978; DOE/UCLLL Pub. UCRL -52548). (POM)

## Soils

1. Disturbance of areas of desert pavement should be avoided whenever possible. (POM)
2. Road and site construction should be controlled so as to not block natural drainage patterns. Suitable crossings should be installed on drainages, sites and roads should be drained or bermed as necessary to prevent erosion to maintain natural drainage patterns. (POM)
3. Downspouts will be provided where culvert drains might cause fill cutting and accelerated erosion. (POM)
4. The slope of cut banks and fill slopes will not be such that slope failure and sliding occur. (POM)
5. All new permanent roads should be surfaced and maintained in such a manner as to prevent erosion and maintain safe and efficient vehicle transit. All roads no longer required for the operation of any stage of development should be reclaimed. Such reclamation should include, but not be limited to, scarification of compacted soils, where feasible revegetation, and temporary watering of revegetated areas. (LS)

6. All rehabilitation measures will be designed to restore the area to as near a natural condition as possible. The topsoil on all disturbed areas, except where permanent facilities are located, will be stockpiled for use in reclaiming sites and compacted areas will be scarified. Under no circumstances will the soil be turned over. (POM)

## Visual Resources

### Class I Areas

Class guidelines effectively preclude geothermal development beyond the preliminary exploration stage in the foreground/midground zone. The minimal contrasts created by this preliminary activity would not normally require extra VRM mitigation in a sand dune area already under interim wilderness study area management. However, crews entering the Algodones Natural Area should be required to restrict the use of vehicles to the area more than one-half mile north of Highway 78 in order to avoid creating tracks visible from the highway. Geothermal developments in the background zone of Class I areas could be made to fall within acceptable class limits with the following mitigations:

1. Structures should be buried to the maximum extent feasible. (POM)
2. If burial is not feasible, structures should be painted a light tan color simulating that of the sand. Roads should be sealed with light tan (if available) or light grey chips. (POM)
3. Roads and pipelines should be laid out to conform to the natural topography, and should be predominantly oriented in an east-west direction parallel to the major highways crossing the area. Other facilities should be located in low areas not readily visible from a distance. The greater incidence of deep basins on the east side of the dune crest makes this side most desirable from a visual standpoint, since facilities could be more easily hidden in the low spots. (POM)
4. In cases where the preceding mitigation measures are not technically feasible, development should be prohibited unless other measures are developed to reduce contrasts to acceptable levels. (POM)

### Class II Areas

1. As with Class I areas, the contrasts created by geothermal development beyond the preliminary exploration stage in the foreground/midground zone exceed class standards. Development should take place only in the background or seldom seen zones of Class II areas. (POM)
2. Recommended mitigating measures for background or seldom seen zones are identical to those discussed for Class I areas.

### Class III Area West of Gecko Road

1. It is recommended that geothermal developments be minimized within this area, since contrasts created by such developments could not be adequately mitigated to reduce them to acceptable levels. (LS)

### Other Class III Areas

Although Alternative Actions #1 and #2 meet VRM Class III contrast limits, the following mitigation measures are recommended to insure minimum visual contrasts:

1. Exterior colors of buildings and pipelines shall be of dark hues, preferably olive drab, grey or dark brown. Light colors or reflective surfaces shall not be used. (POM)
2. Where technically and politically feasible, existing or designated utility corridors should be used (California Desert Plan). When not possible, transmission lines should be located at distances greater than 1-1/2 miles from Highway 78 or the Ogilby Road. (LS)
3. Roads and pipelines intersecting major vehicle routes, such as Ogilby Road or Highway 78, should do so at right angles and run for a short distance before turning in the desired direction. This would provide the maximum possible screening and minimum viewing time. (LS)
4. Transmission line towers shall be painted in dark hues with no reflective surfaces visible. (LS)
5. Where land cuts are made in view of major travel routes, natural vegetation shall be planted to screen these intrusions. Ideal locations would be on the berms of cooling ponds or drill pads. (POM)
6. Pipelines buried underground shall be covered with excess fill contoured to conform to the surrounding landscape. (POM)
7. Where technically feasible, powerplants or any other permanent steam releasing facility will be located at least one and one-half miles from the nearest major travel route (Highway 78 or Ogilby Road). By doing so, steam plumes coming from permanent sources would be effectively screened from most visitors or users of the area except during cool, still weather when plumes would be at their peak height. (LS)

### Class IV Areas

Recommended mitigating measures are identical to those for Class III areas.

## Wilderness - Actions 1 and 2

If preliminary exploration is conducted within the WSAs, the following mitigations should be imposed in addition to the standard stipulations contained on Form 3200-9 "Notice of Intent to Conduct Geothermal Resource Exploration Operations" and the "Recommended Special Stipulations for Shallow Temperature Gradient Holes Drilled Under BLM or Forest Service Exploration Permits" (USGS: CD August 1977 Revision):

1. No roads should be constructed. (LS)
2. All vehicles used must be approved by the authorized officer of BLM. A plan should be developed to insure efficient use of vehicles and eliminate unnecessary trips. Mobile drilling rigs with all-terrain capability and the capacity for transporting all necessary equipment to and from the drilling site in a single trip should be required where feasible. Helicopters may also be required to transport water or other needed materials to and from sites. (POM)
3. All evidence of exploration activity must be reclaimed to the point of being substantially unnoticeable (as defined in Appendix F of the IMP) by September 30, 1983, the scheduled date for the Secretary of the Interior to make his recommendations to the President concerning the WSAs. (LS)
4. The "Wilderness Protection Stipulation" (Appendix A of the IMP) will be attached to all leases issued (see Appendix A of this assessment). (LS)

If Congress rejects one or both of the WSAs as wilderness, some primitive values could be maintained by confining facilities to seldom seen low spots in the dunes. While not being "wilderness" in the legal sense, the dune system could still provide some opportunities for primitive and unconfined types of recreation.

## Recreation

1. Where technically feasible, locate areas of human occupation (power plants, drill sites, etc.) at least one-half mile from identified hunting areas located on the western and eastern edges of the dunes system. This will permit hunters to use these areas and keep facilities and geothermal workers out of range. (POM)
2. Roads entering the Algodones Natural Area should have access blocked through the use of locked gates or other such barricades to allow access for geothermal workers but not for the general public. (POM)
3. Where technically feasible, bury pipelines as deep as possible in the dunes in order to alleviate safety hazards and restriction of free access to ORVs. Frequent checks should be made to determine if shifting sand patterns have exposed buried pipes. When exposed pipes are detected, they should be reburied as soon as possible. Burying pipelines would also reduce impacts to the natural character of the dunes in the Algodones Outstanding Natural Area. (POM)

4. Well islands and directional drilling should be used whenever possible to consolidate facilities and equipment in order to lessen access restrictions. (POM)
5. All facilities and equipment should be well secured against vandalism. (POM)
6. Provide crossing points over pipelines in the Pilot Knob Mesa-Gold Basin Mine Area to allow vehicular access to camping and rockhounding locations. (POM)

#### Socio-Economics

1. The lessee should be made aware of the short term need for housing due to large work forces during construction and development activities. (LS)
2. The lessee should be made aware of the water use conflict between the geothermal activities and the agricultural activities. To date, the County geothermal element provides for the use of agricultural irrigation water during exploration and up to 5 years of power generation demonstration for each KGRA. However, this is conditioned on the developer researching and developing an alternative source of water supply other than the agricultural irrigation water. (LS)

#### Land Use

1. Before development of the projected geothermal resources in the study area there is a need to resolve the conflicts between land use allocation on Federal lands and Imperial County's general plan land use designation for the study area. There are two methods by which this conflict can be resolved:
  - a. Inform the lessee that he is responsible for submitting applications to the Imperial County Planning Director to change the geothermal element of the County's general plan to reflect the possible existence of geothermal resources within the study area and designate the study area as an area of geothermal development potential, thus providing for land development activities related to geothermal development. (POM)
  - b. Direct the lessee to submit data, required by the Area Geothermal Supervisor, USGS, that would provide the USGS the information necessary to designate the study area as a Known Geothermal Resource Area (KGRA), thus providing for the development of this area for geothermal resources under the existing geothermal element of Imperial County. (POM)

#### Noise

1. All well drilling and construction equipment shall be muffled in conformance with the Imperial County Geothermal Element of the General Plan. (LS)

2. Deliveries of supplies and equipment by heavy truck should be limited to daylight hours whenever technically feasible. Studies have shown that the nighttime hours are particularly noise sensitive and high noise levels will travel greater distances than during daylight hours. Thus, by eliminating nighttime high noise levels, less sensitive receptors will be impacted. (POM)
3. When technically feasible, the stacking and making up of drill line during drilling operations should be limited to daylight hours for the same reasons as stated in #2 above. (POM)
4. GRO Orders #4-11 provide for the monitoring of geothermal development and operational noise sources. However, prior to any exploration development or operation activities taking place within the study area, an ambient noise level must be established. Without an ambient noise level, no comparisons can be made to determine what noise attenuation measure must be taken to minimize the impacts of geothermal activities. Therefore, the lessee should perform an ambient noise level study for the lease area. (LS)

#### Cultural Resources

Bureau projects and Bureau assisted licensed projects must:

- A) Give adequate consideration to cultural resources.
- B) Do not inadvertently harm or destroy these resources.

In terms of mitigation it must first be known what cultural properties will be impacted by the proposed undertaking. This requires a complete inventory of all cultural resources within the project area prior to project implementation. A three part mitigation procedure must take place prior to project approval:

- 1) Since only portions of the project area have been intensively studied and inventoried for cultural resources the lessee will engage a qualified archaeologist acceptable to the Bureau of Land Management to conduct a thorough and complete inventory (Class III) of areas to be disturbed. (POM)
- 2) All efforts must be made to avoid cultural properties by shifting development away from cultural sites, at distances to be determined by cooperative agreement between the State Historic Preservation Officer and the Bureau of Land Management and the Advisory Council on Historic Preservation. (POM)
- 3) When it is determined by the area geothermal supervisor that the movement of a proposed site would deleteriously affect the production or operation of the geothermal resource, the lessee shall retain a qualified archaeologist for the purpose of removing as much archaeological data as possible from the site utilizing a research design to be outlined by BLM and SHPO. (POM)



## Flora and Fauna

Noise levels should be kept at or below the predevelopment ambient noise level (to be determined) during the five month breeding season of February to June. (LS)

Protective barriers shall be built around sumps to prevent wildlife from entering. (POM)

Transmission lines shall be constructed following design criteria suggested by the Raptor Research Foundation (1975) to reduce losses of raptors by electrocution. (LS)

Surface located pipelines shall be raised at least one foot off the ground to allow greater mobility of small animals. (LS)

Groundwater levels shall be monitored by the lessee when well water is being used so that consumption levels can be adjusted accordingly. (POM)

The lessee shall provide for site-specific assessments of flora and fauna impacts for surface activities. The biologist and study method shall be acceptable to the authorized officer of BLM. If any sensitive plant or animal species are located, action shall be taken to assure the protection of that species. (POM)

## Mitigation for Alternative Action #2

All mitigation measures present for Action 1 will also apply to Action 2. In addition, the following mitigation measures should be applied as specifically prescribed by the designated resource sensitivity (Map IV-1).

No additional mitigation is offered in Action 2 for Geology, Hydrology, Climatology, Air Quality, Soils, Wilderness, Recreation, and Socio-Economic resources.

## Visual Resources

When technically feasible, wellhead islands and directional drilling techniques should be used to lessen the visual contrasts by reducing the number of disturbance locations within the study area. The many low basins on the east side of the dune crest should receive priority consideration as locations for wellhead islands. (LS)

## Land Use

Where technically feasible, wellhead islands and directional drilling techniques will be used to minimize conflicts between present and future authorized land uses. (LS)

2. When technically feasible, sites for future wellhead islands, roads, powerplants, and transmission corridors will be selected by a process which will provide for the maximum protection of surface resources. (LS)

#### Noise

1. When technically possible, sites of proposed development will be selected to provide for the maximum separation between the noise source and any identified sensitive receptor. Ambient noise levels, noise attenuation characteristics, and noise levels of the various stages of geothermal development shall be determined prior to lease activities so that appropriate distances can be established. (LS)

#### Cultural Resources

1. Sensitive areas representing cultural resource values delineated on Map IV-1 are considered moderately sensitive. Surface occupancy will be allowed only after the mitigation measures outlined in Alternative Action 1 are followed. (LS)
2. Areas shown to be highly sensitive cultural resources should not be leased with surface occupancy provisions. These areas contain fragile and significant cultural resources, of a type which cannot be feasibly mitigated. Consequently, they should be preserved in-situ. (LS)

#### Flora and Fauna

1. There will be no surface occupancy of natural or artificial wetlands in the lease area. Additionally, no activity will be allowed elsewhere that will result in the deterioration of wetlands.

Wetlands provide potential habitat for the Yuma Clapper Rail and the California Black Rail as well as a high diversity of wildlife not otherwise found in deserts. See Sensitive Wildlife Species section (Chapter II). (LS)

2. There should be no surface occupancy of the three sections of land identified as actual prime habitat for the flat-tailed horned lizard, a sensitive species. Refer to the Sensitive Wildlife Species section (Chapter II). In addition, before allowing surface occupancy of the area designated as potential prime habitat for this species, surveys shall be conducted to determine whether the lizard is present. (LS)
3. Geothermal operations in the area which will be proposed as critical habitat for the Andrew's Dune Scarab Beetle (Map II-15) will be limited to those described above for the sensitive areas. Before surface occupancy will be granted in these areas, they will be surveyed

for the presence of the Beetle. In addition, there will be no surface occupancy of the portion of the area which will be proposed as critical habitat for the Beetle in which the Beetle has been determined to be present. Refer to the Sensitive Wildlife Species Section (Chapter II). (LS)

4. Development site selection shall avoid surface occupancy of the sensitive washes which occur to the east of the Southern Pacific Railroad tracks in the study area. (LS)
5. For the protection of sensitive plant species, including three proposed for Federal threatened status, and the Andrew's Dune Scarab Beetle those areas shown on Map II-15 will be removed from surface occupancy leasing. (LS)
6. Site development designs should minimize disruption of drainage systems east of the Algodones Dunes, and insure that fluid spills will be confined on site. (LS)

Mitigation for Alternative Action #3

No mitigation is deemed necessary.



## CHAPTER V - UNAVOIDABLE ADVERSE IMPACTS

### Geology - Actions 1 and 2

Tectonically induced subsidence, uplift and horizontal movements are a regional phenomena created by high levels of seismic events. Detailed monitoring of permanent seismic stations and first order leveling and geodetic triangulation networks provide data regarding the extent of these events. No mitigation measures can be instituted for regional earth movements.

Local occurrences of subsidence, uplift, and horizontal movements can be a result of the production and injection of fluids in a geothermal anomaly. Detailed monitoring throughout the life of geothermal activities may provide the data necessary to make determination of cause and effect. Thus, actions can be taken to eliminate cause if determined to be a result of geothermal activities. However, the effects resultant of a first event will most likely not be returnable to previous conditions.

#### Action 3

No unavoidable adverse impacts would occur.

### Hydrology - Actions 1 and 2

If the unlikely event of a well blow-out or rupture were to occur, the impacts to subsurface and surface water systems would be unavoidable, and could be very damaging to the immediate adjacent areas.

#### Action 3

No unavoidable adverse impacts would occur.

### Soils - Actions 1 and 2

The reclamation of disturbed soils to their former condition is not entirely possible. The time period involved for the complete reclamation of desert communities to a natural state is long and the scars of development remain for many decades.

#### Action 3

No unavoidable adverse impacts would occur.

### Climate - Actions 1, 2, and 3

No unavoidable adverse impacts are expected.

### Air Quality - Actions 1 and 2

Despite mitigating measures applied in Section IV, noncondensable gases may be released into the environment, resulting in some reduction in air quality. The odor of H<sub>2</sub>S may be present.

Air pollutants generated by the proposed action would increase the pollution levels of the Glamis/Dunes area. The proposed control methods attempt to ensure that local, state and Federal standards will not be exceeded, but there still may be enough residual effects to cause some environmental deterioration.

As stated in Section IV, at this time it is not possible to predict whether air quality standards will be violated. A better quantification of air quality impact may be possible during the Environmental Analysis of the lessee's plan of operation.

### Action 3

No unavoidable adverse impacts would occur.

### Visual Resources - Actions 1 and 2

1. No practical mitigating measures are known which would allow development of geothermal resources in the following areas without creating visual contrasts.
  - a. Class I foreground/middleground zone areas.
  - b. The Class II foreground/middleground zone areas.
  - c. The Class III area west of Gecko Road.
2. The primary residual visual contrast remaining in other areas after mitigating measures have been applied would be the seasonal existence of steam plumes. The only method of eliminating the plumes is to design powerplant facilities employing cooling ponds which also create visual contrasts.

### Action 3

No unavoidable adverse impacts would occur.

### Wilderness - Action 1 and 2

Any development of WSA 360 or WSA 362 beyond the preliminary exploration stage would constitute impairment of wilderness suitability which could not be mitigated to meet the requirements of Federal law and policy regarding interim management of areas under wilderness review. Development of the dunes after Congressional rejection of the WSAs as wilderness would disqualify them from possible future reconsideration.

### Action 3

No unavoidable adverse impacts would occur.

#### Recreation - Actions 1 and 2

1. Disturbance of wildlife and vegetative habitat will result in relatively permanent impacts to hunting throughout the Glamis/Dunes Study Area and to research, study and other activities occurring in the Algodones Natural Area.
2. Geothermal development will cause a drastic reduction of ORV opportunities due to reduction of open use areas. The impact cannot be mitigated as the specific resource values and freedom of use, especially in the Glamis-Gecko-Osborne Park Area, cannot be found elsewhere in the region.
3. Disturbance of the natural character of the Pilot Knob Mesa-Gold Basin Mine Area will result in displacement of the majority of its users, who are seeking solitary natural values in the area.

### Action 3

No unavoidable adverse impacts would occur.

#### Socio-Economic - Actions 1 and 2

The impacts on the social and economic environs of the community are considered to be beneficial, thus no adverse impacts are foreseen.

### Action 3

The elimination from the study area of geothermal development will reduce the potential overall economic and social environs impacts which the local community has determined to be of a beneficial nature.

#### Land Use - Action 1

Although all stages of development will have an unavoidable adverse impact to land use, site development will be the greatest. Geothermal development requires the commitment of large land areas to a single purpose. Therefore, once land is committed, other land uses will be limited or precluded during the life of the geothermal activities.

### Action 2

By reducing the areal expanse of geothermal development, a much greater multi-use of land can be established. However, the land dedicated to geothermal development will not be available for other uses during the life of the development.

### Action 3

No unavoidable adverse impacts would occur.

### Noise - Action 1

Despite mitigation there will be some effects upon the adjacent animal communities which may cause a change in breeding and communication habits.

### Actions 2 and 3

No unavoidable adverse impacts would occur.

### Cultural Resources - Action 1

Any development in the area will increase access, and with that, the indirect impacts described in the impacts section of this document. It is evident that impacts of this nature are occurring at the present, and more direct access will only increase these impacts.

When mitigation techniques require the removal of archaeological data, there will be residual impacts due to the loss of previously undisturbed archaeological data.

### Actions 2 and 3

The residual impacts should be greatly reduced or possibly become insignificant.

### Flora and Fauna - Action 1

Sensitive plant and animal species in the Algodones Dunes may be impacted, the degree of impacts depending upon location and extent of the disturbance. Impacts in the area closed to vehicles (the Outstanding Natural Area, National Natural Landmark) may be severe to the integrity of the dunes populations, because of the decisions to open other areas to ORV disturbance while protecting this area. Geothermal development in any area of the dunes except the Open ORV Area will probably cause the listing of one or two plant species as Federally Endangered.

Vegetation will be permanently lost in areas of intense soil disturbance because rehabilitation will not be totally successful. This will also mean lower wildlife populations or a change in diversity.

Birds will be killed because of collisions with powerlines and other structures, and animals will be crushed by vehicles and machinery. Noise during the non-breeding seasons will interrupt social behavior in birds and other animals and will disrupt predator-prey interrelationships. Environmental pollutants will probably be released by accident or spillage. These pollutants may kill wildlife or the invertebrates and plants upon which they feed. Of particular concern are the ants eaten by the flat-tailed



horned lizard, as well as the Andrew's Dune Scarab Beetle. Pollutants and surface disturbance will also prevent vegetation growth, thereby eliminating habitat and possibly killing sensitive plant species. Surface disturbances occurring in the Algodones Dunes could adversely affect habitat of sensitive plants.

Wildlife and wildlife habitat will be subject to disturbance from increased human activity in the area because access will be facilitated by new roads.

#### Action 2

The types of residual impacts under Alternative Action 2 will be similar to those described for Action 1 except the degree of impact will be lower.

In areas of no surface occupancy (highly sensitive), sensitive flora and fauna species such as the flat-tailed horned lizard will receive minor impacts from geothermal development activities originating outside the designated no surface occupancy area. These impacts will be in the form of noise, and air pollution, derived from short-term drilling operations, power production, and road construction outside of the designated no surface occupancy area. A liquid pollutant spill could affect plants and animals over a large area.

In areas of limited surface occupancy (sensitive), sensitive flora and fauna species will be subjected to fewer losses than described in Action 1 discussions simply because the total area of surface disturbance will be reduced from an Action 1 maximum of 25 percent to less than 7 percent under Action 2.

It should be noted that State-Listed Endangered and Candidate Federal Threatened Plant Species occur, and laws and policies required mitigation of almost all impacts to such species, or a determination that mitigations are not possible, that the economic gain outweighs the species damage, and that evidence shows that the action will not jeopardize the survival of the species.

#### Action 3

No unavoidable adverse impacts would occur.



## CHAPTER VI - SHORT-TERM VS. LONG-TERM PRODUCTIVITY

Due to a lack of resource data, at this time it is impossible to accurately estimate the life of the proposed project. Geothermal scenarios have been presented by several authorities (LLL September 1977--Dry Lands Research Institute January 1977) which have shown diverse opinions as to the production capabilities of the geothermal resources present in Imperial County. Conservative estimates indicate a 30-year period (based on amortization of generation equipment) and the more liberal have indicated up to 50 years of possible production capability if the resource is properly managed. There are some authorities who feel that with proper resource management the geothermal resources could be a constantly renewing source of energy.

Within the next 10 years with prompt exploration and a resource available, the project area would most probably be into the production phase of development. At this time, most of the significant impacts will have presented themselves.

Where land areas have to be cleared for construction purposes, revegetation will require long periods of time unless artificially assisted by watering. Those areas where shrubs can resprout from basal parts may revegetate quickly.

There will be some impacts to air quality because of increased dust and noncondensable gas releases. Occasionally state and Federal standards would most probably be exceeded and some of these pollutants could have noxious odors.

Because of the low growth potential of the desert ecosystem, disrupted visual contrasts will remain for many years.

It is assumed within this document that within a period of time (30 years) geothermal development will be dismantled and the land surface returned to a natural state; however, past history has shown that once industrialization is initiated, it is seldom easily reversed. Major man-made facilities involve large sums of money, jobs, and time, and are usually considered permanent.

Since these proposed facilities will remove land surface from production or use by other resources there will be short-term (life of geothermal activities) impacts on other resource uses. Impacts felt by recreationists will generally be short-term. Access lost during the exploration and development stages will be regained with close down. Upon close down of geothermal activities the disturbed areas will be returned to a desert environment. However, due to the slow healing process of the desert, the scars of development will continue to exist for many years.



## CHAPTER VII - IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The proposed geothermal development of the Glamis/Dunes will result in irreversible and irretrievable commitments of resources, both during the construction phase and after electrical energy production has begun. The construction phase of the project will commit limited resources in the form of building material, fuel and manpower. The powerplant, production and injection wells, fluid transmission facilities, and project offices will consume steel and other metal products which constitute an irreversible commitment of limited resources. Other building materials, including asphalt for road construction, will also result in an irreversible and irretrievable commitment of limited resources. The construction phase will require using scarce fuel supplies to operate construction equipment.

Extraction of the geothermal fluid for energy production will gradually diminish the commercial values of the reservoir until it is no longer economically usable. This reduction will occur despite reinjection of the fluid, if the rate of heat loss from extraction of energy exceeds the rate at which the anomaly is reheated. Although the anomaly may be reduced to nonviability, it might again become productive as heat is restored over geologic time.

The commitment of the study area to geothermal development will have an irreversible and irretrievable impact upon the other surface resources available in the study area.

Considering that wilderness resource values are extremely subjective, changes in public attitudes or changes in BLM evaluation criteria may result in areas such as the Dunes (current condition) again being considered as possible wilderness. Commitment of the study area to geothermal development will permanently commit potential wilderness resource values to other uses.

Any disturbance of fragile cultural material alters the data that are relevant for a precise understanding of prehistoric or historic behaviors making preservation the best alternative to insure protection of archaeological data. When it becomes imperative to mitigate direct project impacts, data recovery methods are the best tools available, even though excavation of a site destroys it and data not collected at that time are lost.



### VIII. PERSONS, GROUPS AND GOVERNMENT AGENCIES CONSULTED

The Draft EAR was submitted for public review in August 1979. A listing of the various agencies and groups which were sent a copy of the Draft EA is presented in the following pages.

#### FEDERAL AGENCIES

U.S. Department of Energy  
Division of Geothermal Energy  
Washington, DC 20545

Environmental Protection Agency  
Region IX Office  
San Francisco, CA 94105

U.S. Environ. Protection Agency  
Environmental Monitoring and  
Support Lab  
Las Vegas, NV 89114

U.S. Fish and Wildlife Service  
Sacramento, CA 95825

U.S. Fish and Wildlife Service  
Geothermal Advisor-Region I  
Boise, ID 83705

U.S. Geological Survey  
Conservation Division  
Area Geologist, Pacific Area  
Menlo Park, CA 94025

U.S. Geological Survey  
Conservation Division  
Conservation Manager  
Western Region  
Menlo Park, CA 94025

U.S. Geological Survey  
Palo Alto, CA 94303

U.S. Geological Survey  
Subsidence Research  
Sacramento, CA 95825

Bureau of Reclamation  
Region 5  
Boulder City, NV 89005

Soil Conservation Service  
El Centro, CA 92243

Bureau of Land Management  
Geothermal Specialist (D-310)  
Denver Federal Center  
Denver, CO 80225

#### STATE AGENCIES

Office of the Governor  
State Clearinghouse  
Sacramento, CA 95814

Dept. of Parks and Recreation  
State Resource Agency  
Sacramento, CA 95811

Dept. of Fish and Game  
Region 5  
Blythe, CA 92225

Public Utilities Commission  
San Francisco, CA 94102

Department of Fish and Game  
Sacramento, CA 95814

Water Control Board  
Colorado River Basin Region  
Palm Desert, CA 92260

Division of Oil and Gas  
North Long Beach, CA 90804

Native American Hert. Commission  
Sacramento, CA 95814

Water Resource Control Board  
Sacramento, CA 95801

COUNTY GOVERNMENTS AND CITY AGENCIES

Imperial County  
Planning Commission  
El Centro, CA 92243

Imperial County  
Health Department  
El Centro, CA 92243

Imperial County  
Board of Supervisors  
El Centro, CA 92243

Imperial County  
Agricultural Department  
El Centro, CA 92243

Imperial County  
Air Pollution Control  
El Centro, CA 92243

Imperial County  
Public Works Department  
El Centro, CA 92243

Imperial County  
Assessor's Office  
El Centro, CA 92243

Imperial County  
Sheriff's Department  
El Centro, CA 92243

SPECIAL INTEREST GROUPS

Lawrence Livermore Lab  
Livermore, CA 94550

Geothermal Environmental  
Advisory Panel  
Menlo Park, CA 94025

San Diego Evening Tribute  
San Diego, CA 92112

Geothermal Resources Council  
Davis, CA 95616

University of Utah  
Research Institute  
Salt Lake City, UT 84105

UTILITIES, CORPORATIONS AND OTHERS

San Diego Gas and Electric  
San Diego, CA 92112

Southern California Gas Co.  
El Centro, CA 92243

Pacific Telephone  
El Centro, CA 92243

Imperial Irrigation District  
El Centro, CA 92243

Magma Electric Co.  
Escondido, CA 92025

Republic Geothermal  
Santa Rosa, CA 95401

Geothermal Power Corp.  
Navato, CA 94947

Geothermal Ex., Inc.  
Berkeley, CA 94707

Farm Bureau Insurance  
El Centro, CA 92243



UTILITIES, CORPORATIONS AND OTHERS (Cont'd)

City Of Holtville  
Holtville, CA 92250

Holtville Unified School dist.  
Holtville, CA 92250

IVC Museum  
El Centro, CA 92243

San Bernardino Co. Museum  
Redlands, CA 92373

Anadarko Production Co.  
Houston, TX 77001

Bookman-Edmonston Eng., Inc.  
Glendale, CA 921203

California Energy Company  
Santa Rosa, CA 985402

CER Corporation  
Las Vegas, NV 89114

Chevron USA, Inc.  
San Francisco, CA 94119

Dresser Industries  
Denver, CO 80202

Science Applications, Inc.  
La Jolla, CA 92038

Getty Oil Company  
Bakersfield, CA 93308

Systems, Science, and Software  
La Jolla, CA 92038

Thermal Power Company  
San Francisco, CA 94108

Selected Properties  
Pasadena, CA 91101

Hydro-Search, Inc.  
Reno, NV 89501

ICF, Inc.  
Washington, DC 20036

AMAX Exploration  
Denver, CO 80212

Aminoil USA  
Santa Rosa, CA 95406

Energy and Natural  
Resource Consultants  
Richardson, TX 75080

Gulf Mineral Resource Co.  
Denver, CO 80222

Phillips Petroleum Co.  
Del Mar, CA 92014

Phillips Petroleum Co.  
Geothermal Operations  
Salt Lake City, UT 8411

Occidental Geothermal, Inc.  
Bakersfield, CA 93309

New Albion Resources Co.  
San Diego, CA 92112

Southland Royalty Co.  
Fort Worth, TX 76102

Sunoco Energy Development Co.  
Dallas, TX 75251

Union Oil Co. of California  
Geothermal Division  
Los Angeles, CA 90051

Hunt Oil  
Denver, CO



CHAPTER IX. INTENSITY OF PUBLIC INTEREST

To discern the degree of public interest concerning proposed geothermal leasing on public lands in the Glamis/Dunes study area, discussions were held with various government agencies, conservation groups, other interested groups, industry and interested individuals.

The draft EA was submitted for public review and comment in April and May 1981 for a 45-day period. No written comments were received from the general public, interest groups, or industry. Several agencies of the State of California and the Federal Government did respond and the following comments are in response to the concerns expressed by those agencies. You will read the formal comments first and then the BLM responses which are keyed to the numbers in the left hand column of the comments.



EDMUND G. BROWN JR.  
GOVERNOR OF  
CALIFORNIA



Air Resources Board  
Colorado River Board  
San Francisco Bay Conservation and  
Development Commission  
Solid Waste Management Board  
State Lands Commission  
State Reclamation Board  
State Water Resources Control Board  
Regional Water Quality Control Boards  
Energy Resources Conservation and  
Development Commission  
EL CENTRO, CA 92243

OFFICE OF THE SECRETARY  
RESOURCES BUILDING  
1416 NINTH STREET  
95814

(916) 445-5656

Department of Conservation  
Department of Fish and Game  
Department of Navigation and  
Ocean Development  
Department of Parks and Recreation  
Department of Water Resources

THE RESOURCES AGENCY OF CALIFORNIA  
SACRAMENTO, CALIFORNIA

MAY 11 1981

Mr. Joseph M. Edney  
Bureau of Land Management  
333 South Waterman Avenue  
El Centro, CA 92243

Dear Mr. Edney:

The State of California has reviewed the draft environmental assessment, Geothermal Exploration/Development--Glamis/Dunes, submitted to the Office of Planning and Research in the Governor's Office. This review, in accordance with Office of Management and Budget Circular A-95, was coordinated with the Energy and Public Utilities Commissions, the Air Resources and State Water Resources Control Boards, and the Departments of Conservation, Fish and Game, Parks and Recreation, Water Resources, Health, and Transportation.

The Department of Fish and Game (DFG) points out that the study area includes areas identified by DFG as locations where mitigation should be accomplished for the Coachella Canal Project. The mitigation recommended was the drilling of water wells and establishment of a storage tank and wildlife drinker.

Because wells will be drilled as part of the exploration in this area, DFG believes that it would be reasonable to develop additional wildlife watering sites as well. DFG, therefore, recommends that BLM include a statement in this report to the effect that the exploration will involve certain impacts to the environment and that the necessary mitigation would be to make whatever slight modification is necessary to the exploratory wells in order to supplement wildlife watering sites. In this regard, DFG would also appreciate the opportunity to work with the geothermal interests in the final selection of locations for wells to the extent feasible so that maximum benefit may be realized from the spacing of new water sites.

DFG is also concerned that it may be possible for upwelling geothermal brines to impact on the freshwater water table in the area, thus adversely affecting DFG's efforts to provide water for wildlife. If the exploration or subsequent development has this potential, DFG believes that the developer should be required to take appropriate measures to ensure that such an event could not occur.

On page 81 the document lists wildlife species of special significance. The spelling used for the burro mule deer is incorrect. It should be Odocoileus hemionus eremicus.

Questions regarding these comments should be directed to Ronald Powell, DFG, P.O. Box B-D, Blythe, CA 92225 or (714) 922-5613.

The California Energy Commission (CEC) staff, while encouraging exploration of geothermal resources as a preferred source of energy for electricity generation, has the following comments concerning the environmental impacts resulting from such exploration and development.

#### Public Health

- 4
1. Sections addressing public and worker health impacts from this project should be included in the report. To address these impacts adequately, the following information should be presented:
    - a. Occupational health - Concentrations of H<sub>2</sub>S, ammonia, arsenic, mercury, boron, benzene, silica, asbestos, and radon-222 in the non-condensable gases from representative wells (such as the other Imperial Valley developed wells) should be determined. These emissions levels should be compared with occupational standards. If the projected emissions exceed the occupational standards, appropriate mitigation procedures should be established. Lastly, a worker health program should be set up with Cal/OSHA Consultation Service specifically designed to protect workers involved in geothermal operations.
    - b. Public health - The maximum ambient pollutant concentrations of H<sub>2</sub>S, ammonia, arsenic, mercury, boron, benzene, silica, asbestos, and radon-222 should be determined, including estimates of existing background concentrations of these pollutants. The location of the nearest receptors should be compared to ambient air quality standards and recommended guidelines (for unregulated pollutants) to determine compliance. If violations or exceedances will occur, mitigation measures should be presented.
  - 5  
2. Any developer of exploratory wells should provide data on fluid contaminants, including H<sub>2</sub>S, ammonia, arsenic, boron, benzene, mercury, silica, asbestos, and radon-222, in order to provide a data base for future development decisions.

#### Noise

6  
The impacts described in the report (page 97) should be compared with local noise standards or ordinances to determine their compliance with applicable standards and regulations.

#### Air Quality

1. Existing environment.
  - 7  
a. Page 24, Air Quality section, third paragraph: The first sentence in this paragraph should simply state that the ambient ozone and particulate standards are violated in this area.

- 8
- b. Table II-4 (pp 25-27) appears to be out-of-date. Some of the standards shown here (e.g., ozone and sulfur dioxide) were changed two to three years ago.
  - c. Table II-6 (p. 29) also appears to be out-of-date. More recent Imperial County data is available from the Air Resources Board. Studies of the Imperial Valley area by Lawrence Livermore National Laboratory indicate that the ambient H<sub>2</sub>S standard is being violated. This pollutant is the greatest concern for geothermal development.

2. Impacts.

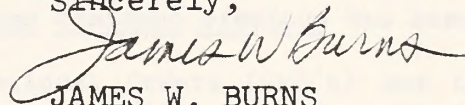
9

The description (p.89) is inadequate. It would appear that a part of this section may have been accidentally left out. This section should address all potential impacts, including unavoidable adverse impacts. The potential receptor areas affected by these actions should be identified. All impacts should be quantified. Estimates of the potential impacts should be based on the H<sub>2</sub>S content of geothermal fluids in other Imperial Valley wells.

Questions regarding these comments should be directed to David Maul, Energy Commission, 1111 Howe Avenue, Sacramento 95825 or (916) 920-7525.

We greatly appreciate having been given an opportunity to review this report.

Sincerely,



JAMES W. BURNS

Assistant Secretary for Resources

cc: Office of Planning and Research  
1400 Tenth Street  
Sacramento, CA 95814  
(SCH 81040306)





1. The BLM shares the DFG's concerns about wildlife watering needs, we lack legal authority to require an operator to convert shallow temperature gradient holes to water wells. Under current regulations the operator is obligated to return the land to its original condition upon abandonment of any well.

A possible course of action for your office could be to contact the appropriate operator prior to filing a notice of completion, offer to buy the hole and pay to convert the hole to a water well. Because most holes are drilled to 500 feet and are cased only to 250 feet, an additional 250 feet of steel casing must be purchased. The estimated cost of conversion, excluding pumping equipment, would range between \$7,500 - \$10,000 per hole. At the time the operator files the notice of completion, he would indicate that your office is in the process of purchasing the hole for water well conversion.

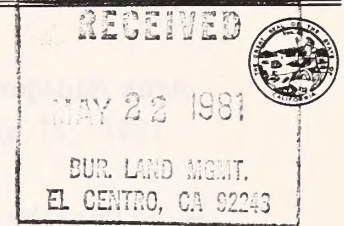
Although our office lacks the funding to purchase these holes, we could enter into a memorandum of understanding with your office which would codify the procedures, responsibilities and liabilities of this process. Prior to your acquisition of the hole a supplemental environmental analysis must be performed. If you wish to obtain a listing of the geothermal companies active in Imperial County, please contact our El Centro Resource Area Office.

2. The Geothermal Resource Operational Orders (GRO's) 1, 2 and 3 address both shallow and deep well drilling, use, and abandonment. Under these orders enforced by USGS, the operator is required to use the latest technology to prevent any upwelling or intermixing of geothermal brine with freshwater tables. The operator is also required to obtain all permits and licenses.
3. The spelling error of Odocoilcus hemiomus eremicus has been corrected.
4. The Geothermal Resource Operational Orders (GRO's) and the standard lease require that operators meet all standards set by OSHA and CAL/OSHA for worker health and safety. These standards are assumed to be a part of any proposed action so are not addressed by this document.
5. GRO order 2.3 through 2.4 require recording of all fluids use and produced in a well operation.
6. The standards set by mitigation in this report are based upon, and referenced to, the County of Imperial's Geothermal Element. The County's element sets standards and regulations for noise levels of geothermal operations in the County..
7. The Air Quality sections of the Draft Environmental Assessment has been rewritten to bring the data up to date and answer the concerns expressed by this and other respondents.
8. See #7.
9. See #7.



## AIR RESOURCES BOARD

1102 Q STREET  
P.O. BOX 2815  
SACRAMENTO, CA 95812



May 14, 1981

Area Manager  
Bureau of Land Management  
El Centro Resource Area Office  
333 S. Waterman Avenue  
El Centro, CA 92243  
ATTN: Joseph M. Edney

Dear Sir:

Subject: Comments on Draft Environmental Assessment (DEA) for Proposed Competitive and Non-Competitive Leasing in the Glamis and Dunes KGRA's of Imperial County, California.

### Introduction

We have been requested by the Governor's Office of Planning and Research to comment on the Draft Environmental Assessment (DEA). This DEA will only consider the Glamis and Dunes Known Geothermal Resources Areas (KGRA) which consist of 194,517 acres within Imperial County. Forty-one non-competitive lease applications have been received for the two KGRA's. The DEA analyzes the general impacts which might result from geothermal exploration and possible development for electrical production.

### General Comments

It is apparent from the Issue Identification, on the first page of the report, that the Bureau of Land Management (BLM) does not consider Air Quality Impacts associated with geothermal leasing in the Glamis/Dunes area a major issue. The DEA pays very little attention to air quality assessment and uses outdated information when addressing possible air quality impacts.

### Specific Comments

1. On page 24 the DEA states that the air quality for the study area is considered good. The draft then states that this region is designated as nonattainment for oxidant levels, and that total suspended particulate matter (TSP) concentrations as high as 100 ug/m<sup>3</sup> have been measured. However, in the CARB Summary of 1979 Air

10

Quality Data (attached), recorded TSP concentrations within Imperial County have been as high as 645 ug/m<sup>3</sup>. In view of the California ambient air quality standard for TSP being 100 ug/m<sup>3</sup> and the fact that the study area is already nonattainment for oxidant, it is unclear why the DEA considers air quality in this area as good.

11

2. Ambient Air Quality Standards (AAQS) applicable in California are presented in Table II-4 on page 25. These data were acquired from San Bernardino County, 1974. In the past seven years, there have been several changes and additions made concerning these standards. Attached is a copy of the current AAQS for your reference.

12

3. Table II-6 on page 29, displays ambient air quality data acquired by a state mobile monitoring unit near Nilan, 1976. This information is not only outdated, but is not complete as that which appeared in the CARB Summary of Air Quality Data (attached). The number of violations of the ambient air quality standards for Non-Methane Hydrocarbon (NMHC), Total Suspended Particulates (TSP), and Ozone (O<sub>3</sub>), were omitted from the table. Short term data (2-3 months) are questionable since they may not be indicative of the entire year. Ambient air quality data are continuing to be monitored in the El Centro area. These data should be more indicative of the present air quality in the study area.

13

4. Chapter III starts on page 86 and must be read in the following page order: 86, 87, 89, 88, 92, 90, 91, 93.

14

5. On page 89, the DEA states that impacts to air quality are expected to be insignificant during the exploratory phase. However, even though the exploratory phase is very short the DEA should have discussed the impact of this phase on the existing ambient air quality, especially oxidant and TSP.

The DEA states that impacts to air quality will occur during the field development, production, and operational phases. However, without an analysis of the constituents in the steam, it is not possible to predict whether or not standards of air emission levels will be exceeded. On page 112 the draft continues to state that if significant quantities of Hydrogen Sulfide (H<sub>2</sub>S) are found in the geothermal resources, appropriate mitigation measures will be developed by USGS and implemented by the leasee to assure that the H<sub>2</sub>S emissions do not exceed those levels established by the County's Air Pollution Control District. The DEA should include a list of the applicable rules established by the local APCD regarding emissions levels and discuss what mitigation measures would be needed to meet applicable rules.

Area Manager

-3-

May 14, 1981

- 15
6. While discussing unavoidable adverse impacts on page 122, the DEA states that despite mitigating measures applied in Section IV, the release of noncondensable gases would result in some reduction in air quality and in some odor problem when H<sub>2</sub>S is present. Again, the DEA does not specifically discuss the mitigation measures or whether or not standards will be exceeded.

If you have any questions, or if we can be of further assistance, please call Greg Allen of my staff at (916) 322-6038.

Sincerely,



Ronald A. Friesen, Chief  
Industrial Project Support Branch

Attachments

cc: State Clearinghouse  
Claude Finnell





Memorandum

- 10. See #7.
- 11. See #7.
- 12. See #7.
- 13. See #7.
- 14. See #7.
- 15. See #7.

Office of the Secretary  
 Department of Conservation  
 Bureau of Land Management  
 Planning for Southern  
 California and Other Areas  
 1501 17th Street  
 San Francisco, CA 94133

The project is a large agricultural water development for agricultural and non-agricultural uses of public lands. The project involves the construction and operation of a water control and distribution system. The project area is the Delta and Delta water control project, covering approximately 100,000 acres in the Delta region of California, under the jurisdiction of the United States Bureau of Reclamation.

The following are the objectives of the project and the results of the study are presented in the report. The objectives are to provide a comprehensive study of the project and to provide a basis for the development of a water control and distribution system.

1. The environmental impact study will evaluate the potential impacts of the project on the environment, including the effects on the Delta and Delta water control project.
2. A water control and distribution system will be developed to provide water control and distribution for the Delta and Delta water control project. The system will be designed to provide water control and distribution for the Delta and Delta water control project.

These comments were prepared by the staff of the Bureau of Land Management, Department of Conservation, and the staff of the Bureau of Reclamation, United States Department of the Interior.

*[Handwritten signature]*

June 18, 1974  
 Director, Bureau of Land Management

cc: Harry ...  
 Eric ...  
 Tom ...  
 Attachment





# Memorandum

To : Jim Burns  
 Assistant to the Secretary  
 Resources Agency

Joseph Edney, Area Manager  
 El Centro Resource Area Office  
 Bureau of Land Management  
 333 South Waterman Avenue  
 El Centro, California 92243

From : Department of Conservation—Office of the Director

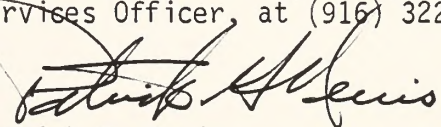
RECEIVED  
 MAY 13 1981  
 Date : May 1, 1981  
 BUR. LAND MGMT.  
 Subject: Draft Environmental  
 Assessment for U.S.  
 Bureau of Land Management  
 Leasing for Geothermal  
 Exploration and Development,  
 Glamis and Dunes KGRAs,  
 Imperial County  
 SCH #81040306

The subject document is a draft environmental impact assessment for proposed competitive and non-competitive leasing of public (Federal) lands for geothermal resource exploration and possible development for electrical energy production. The project areas are the Glamis and Dunes known geothermal resource areas (KGRA), covering approximately 194,517 acres of public land in Imperial County, under the jurisdiction of the United States Bureau of Land Management.

With the following two exceptions, the geological issues and proposed mitigating measures are adequately addressed at the draft EIS stage of the proposed project:

- 16 1. The environmental assessment should evaluate the potential hazard of land subsidence, in and around the proposed lease areas, due to fluid withdrawal.
- 17 2. A seismic monitoring network should be established to monitor geothermal related microseismicity. As recommended in Recommended Mitigating Measures, item 7, of California Division of Mines and Geology Special Report 122, Engineering Geology of The Geysers Geothermal Resource Area, transmitted herewith, a monitoring network should be established to monitor geothermal related microseismicity to evaluate possible future naturally occurring or induced changes in the geologic environment. Although there may be little potential for subsidence or other changes during the exploratory phase of geothermal projects, to be effective and obtain valid results, the monitoring network should be in operation prior to the commencement of the developmental phase of operations in geothermal resource areas.

These comments were prepared by Lynn Jones and Siang S. Tan, of the Department's Division of Mines and Geology. For questions regarding these comments, contact Perry Y. Amimoto, Advisory Services Officer, at (916) 322-3119.

  
 Patrick G. Nevis  
 Environmental Program Coordinator

cc: Perry Amimoto  
 Lynn Jones  
 Doug Stockton  
 Attachment









# United States Department of the Interior

## FISH AND WILDLIFE SERVICE

ECOLOGICAL SERVICES

24000 Avila Road

Laguna Niguel, CA 92677

April 27, 1981

### Memorandum

To: Area Manager, Bureau of Land Management  
El Centro, CA  
Attn: Joseph M. Edney

From: Field Supervisor (ES-LN), Laguna Niguel, CA

Subject: Draft Environmental Assessment Competitive and Non-Competitive  
Leases for Geothermal Exploration/ Development, Glamis/ Dunes;  
Reference 1791, 3200 (C-067.01).

We have examined the subject Draft Environmental Assessment (DEA) and offer the following comments.

### GENERAL COMMENTS

The impacts of the proposed action and alternatives upon fish and wildlife resources appear to have been adequately addressed for this stage of review. We strongly support the expressed concepts of maximal use of existing roads, minimal surface disturbance, raptor-proofing of power lines, and monitoring for and avoiding groundwater contamination. Since several species of special status and very unique/highly productive habitats occur in the study area, we urge that Alternative Action #2, "Leasing of all Geothermal Resources with Restricted Surface Access," be the alternative selected if leasing is to occur. This would allow for the development of geothermal resources while assuring minimal damage to both productive and unique habitats, as well as sensitive species. We also urge coordination with the California Department of Fish and Game (CDFG) for possible development of some of the exploratory wells as water sources for wildlife.

### SPECIFIC COMMENTS

18 | p. 43, paragraph 1: The two WSA's should be withdrawn from consideration for leasing or exploration until Congress decides the wilderness question, so as not to cloud that issue. The Federal Land Management Policy Act requires that no action be taken to Federal lands which would alter their existing condition or state which would, in turn, circumvent the option of Congress for designating such lands as wilderness.

19 | P. 68, last paragraph: Four sites of water development (associated with mitigation for the Coachella Canal project) for wildlife are apparently located within the study area. As we mentioned earlier, some of the exploratory well sites resulting from the proposed action should also be considered for this purpose (for further details, refer to comments from CDFG on this DEA).

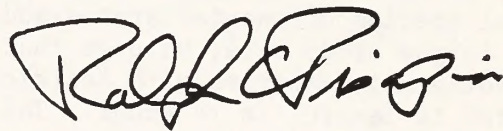
20 | Plant Species of Special Significance: Although Pilostyles thurberi has not been collected from the study area, it is known to occur on adjacent lands and a principal host plant, Dalea emoryi, is locally abundant on the study area. Considering the obvious potential for the occurrence of and some impact to Pilostyles, at least via impact to the principal host, some discussion of the species and potential impact is needed in the document.

| p. 74, paragraph 3: The discussion of Pilostyles thurberi (REVD1-1-1-1) should be included next.

21 | p. 65-85, Flora and Fauna: Considering the high number of species of special significance, the uniqueness of the dunes, and the productivity of some of the habitats found in the study area, selective surface occupancy (Alternative Action #2) would be more appropriate than the proposed action (Alternative Action #1), if leasing should occur.

| Because the Andrew's dune scarab beetle (Pseudocotalpa andrewsi), a candidate Federal threatened species, occurs in the project area, BLM initiated informal consultation with the Fish and Wildlife Service (FWS). As a result, additional information and comments concerning this species will be provided by the Endangered Species Office of FWS in the near future.

If you have any questions, please contact Richard Zembal or myself at (714) 831-4270, FTS 796-4270.



cc: Ronald Powell, CDFG, Blythe, CA

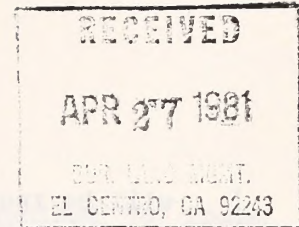
18. BLM does not have authority to withdraw WSA from consideration for mineral leasing. See FLPMA Sec. 603-C and Interim Management Policy and Guidelines for Lands Under Wilderness Review - Chapter 3, Part J-1-C and D.
19. See response #1.
20. Additional discussions of Pilostyles thurberi and Dalea emoryi have been inserted into the Floria sections as suggested.
21. Informal section 7 consultation has been initiated by this office with FWS. No response has been received as of this writing (8/6/81).







Department of Energy  
Washington, D.C. 20461



April 21, 1981

Mr. Joseph M. Edney  
Area Manager - BLM  
El Centro Resource Area Office  
333 South Waterman Avenue  
El Centro, CA 92243

Dear Mr. Edney:

The Draft Environmental Assessment (EA) for proposed competitive and non-competitive leasing in the Glamis and Dunes KGRA's of Imperial County, California [Ref. 1791-3200 (C-067.01)] has been reviewed by the Division of Geothermal Energy of the Department of Energy. The following comments are offered for your consideration in preparing a final document:

1. Chapter III-Impacts

Some changes in organization of this chapter would improve its readability. On pages 86 and 87, two subsections under GEOLOGY, "Natural Seismicity" and "Induced Seismicity," would help to distinguish between these totally different aspects of seismic concern.

22

It is also suggested that a sub-section on "Subsidence" be included in the GEOLOGY section. This subsection could present a rather brief discussion of the potential for subsidence since the consequences of subsidence in the study area are not likely to be serious. However, the general concern over impacts of subsidence on the agri-business in Imperial County may require injection of water equivalent in volume to that of the geothermal fluid produced.

Item 5 on page 87 should be moved to the HYDROLOGY section since it addresses potential effects on groundwater.

23

Items 2, 3, and 4 on page 88 belong under AIR QUALITY (p. 89).

Item 2 on page 89 addresses water use and should be moved to the HYDROLOGY section. Two sub-sections might be included under HYDROLOGY: (1) Groundwater and (2) Water Use. The water use subsection should recognize the possibility that 100 percent reinjection

will be required by county regulations. In that event, even if geothermal fluid condensate provides adequate power plant cooling water, additional (presumably surface) water will be required for injection. Thus it may not be feasible to design power plants that can "at least be self-sustaining with respect to water."

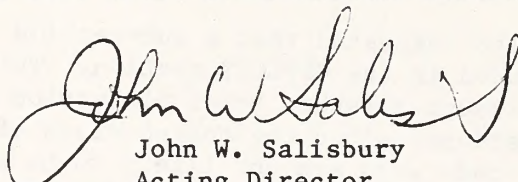
24 The AIR QUALITY section (page 89) should include some discussion of potential impacts of salt drift from cooling towers.

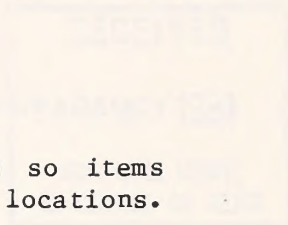
25 Items 3, 4, and 5 on page 90 belong under VISUAL RESOURCES on page 92.

The consideration of impacts resulting from Alternative Action 3 (decision not to lease) is not consistent.

26 On page 96, the absence of geothermal development is cited as resulting in adverse impacts on the local economy, job market, and tax base. To be consistent, either this discussion should be eliminated, or analogous discussions of the "beneficial" impacts of Action 3 should be included under the other impact sections. The beneficial economic aspects of geothermal development are already presented under Action 1 and 2 (page 94-95).

The opportunity to comment on this draft environmental assessment is appreciated.

  
John W. Salisbury  
Acting Director  
Division of Geothermal Energy



22. See response #23.

23. The Impact and Mitigation sections have been reorganized so items appearing out of order in the draft appear in the proper locations. Discussion of water resources appear in response #27.

24. See response #7.

25. See response #23.

26. The discussion appearing on Page 96 of the Draft EA discussing action 3's impact upon the socio-economic environment was intended to show possible future effects of a BLM decision not to lease public lands in Imperial County, and how such a decision might be interpreted by the local governing body.

The Environmental Protection Agency (EPA) has received and reviewed the Draft Environmental Statement (ES) submitted for review and comment on the proposed action to lease public lands in Imperial County, California.

While not stated explicitly, the ES does address quality concerns in the Delta and Lower Colorado of Imperial County, California. The ES still has reservations with respect to the cumulative environmental impacts of proposed activities within the California Desert Conservation Area (CDA).

It is our understanding that efforts are being made by BLM to address issues raised by various agencies through interagency coordination. The EPA continues to be interested in the CDA and protection of the environmental quality of this water resource area.

We appreciate the opportunity to review and comment on this draft ES. If you have any questions regarding our review, please contact your local BLM Service Coordinator at (951) 947-7000.

Sincerely yours,

Jake Redmond, Director  
Supervision and Analysis Division

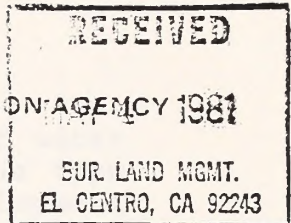
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY 1981

REGION IX  
215 Fremont Street  
San Francisco, Ca. 94105



Roger Zortman, Area Manager  
BLM - El Centro Resource Area Office  
333 S. Waterman Avenue  
El Centro, CA 92243

APR 29 1981

ATTN: Joseph M. Edney

Dear Mr. Zortman:

The Environmental Protection Agency (EPA) has received and reviewed the Draft Environmental Assessment (EA) entitled COMPETITIVE AND NON-COMPETITIVE LEASES FOR GEOTHERMAL EXPLORATION/DEVELOPMENT, GLAMIS/DUNES.

While our attached comments specifically discuss water quality concerns in the Glamis and Dunes KGRA's of Imperial County, California, the EPA still has reservations with respect to the cumulative environmental impacts of proposed activities within the California Desert Conservation Area (CDCA).

It is our understanding that efforts are being made by BLM to address issues raised by various agencies through interagency coordination. The EPA continues in its interest in the CDCA and protection of the environmental quality of this major resource area.

We appreciate the opportunity to review and comment on this Draft EA. If you have any questions regarding our review, please contact Susan Sakaki, EIS Review Coordinator, at (415) 556-7858.

Sincerely yours,

Jake Mackenzie, Director  
Surveillance and Analysis Division

Attachment



Water Comments

- 27
1. The Draft EA states that "about 700,000 gallons of water would be required for the initial start-up" of the type of power plant assumed by the geothermal development model (page 89). It is further stated that if a wet cooling system other than the type discussed in the Draft EA is utilized, "total water use may prove to be a substantial amount" (page 89). The Draft EA, however, does not disclose the source of water to be used for the initial start-up nor does it discuss the long-term water requirements of the proposed power plant. In view of the scarcity of water in the Imperial Valley, this is of major concern to EPA and should be addressed in the Final EA. The Final EA should also quantify the projected water requirements of a power plant utilizing a wet cooling system other than the system discussed in the Draft EA. The use of an alternate system should be addressed with respect to impacts on surface and subsurface water resources.

Given the limited water supplies in the project area, the Final EA should identify available surface and groundwater resources, indicate present demand for drinking water and project future demands placed by geothermal development (including the associated increase in work force) upon available water supplies. EPA believes that the cumulative effects of increased geothermal development upon ground and surface water resources (both quantitatively and qualitatively) in the project area should be given early consideration by BLM in the decision making process.

2. The Draft EA has not fully addressed the issue of conflict between agricultural and geothermal interests in terms of the availability of water. According to the Draft EA "the threshold for conflict is five years after the first demonstration plan began operation in the study area at (sic) that time the County (as directed by the County geothermal element) would decide whether to permit agricultural water to be diverted for permanent geothermal use in this area." (page 94)

28

The Final EA should examine the impact of water diverted for geothermal development on agricultural productivity. Other sources of water such as reclaimed water and water conservation measures should be identified as firm alternatives.

3. The Draft EA states that the "injection of geothermal brines into the subsurface could build up sufficiently to force the geothermal effluent upward into the shallow groundwater aquifers." (page 87)

29  
EPA questions whether there are additional measures beyond those discussed in the Draft EA that can be taken to minimize the risk of upwelling of geothermal fluids and the resultant contamination of shallow groundwater aquifers. If additional measures do exist, EPA strongly believes that they should be identified in the Final EA and implemented as an added precaution should geothermal power plant construction commence. The protection of groundwater quality is of principle concern to EPA. For this reason, EPA requests that the Final EA address the issues of groundwater overdraft, sump failures and spillage of liquid wastes in a more extensive discussion. So that ground water quality is adequately protected, EPA requests assurances that a groundwater monitoring program also include parameters such as gas, oil, detergents, and other pollutants. Additionally, water quality in the proposed injection wells should be monitored to determine that seepage does not occur and that shallow and production zones of the groundwater aquifer system are protected.

4. Table III-1 (page 95) of the Draft EA depicts the typical resources required for random stages of geothermal development based on a model geothermal lease. EPA has noted in its review that resource requirements for the production and operation activities associated with a geothermal power plant have been omitted. The Final EA should include a best estimate of the resource requirements for the above activities and BLM should ensure that the corresponding short and long-term impacts are documented in the Final EA together with appropriate mitigation strategies.

- 30  
5. Injection wells from geothermal operations are subject to EPA's Underground Injection Control (UIC) program (40 CFR 146). The proposed geothermal wells are defined as Class III wells. Prior to development and construction, the UIC technical requirements for Class III wells should be considered. Additionally, a Federal permit or equivalent will be required for the operation of a geothermal related injection well.

- 31  
6. The Final EA should discuss the existing wastewater treatment facilities in the project area in terms of capacity, average daily flows, and the projected increase in wastewater flows expected to result from the proposed action. This is of particular concern to EPA since the Draft EA states that "as much as 75% of the employees prior to the "production and operation stage would come from outside the County" (page 94). The ability of the wastewater treatment facilities to adequately accept and treat the projected increased wastewater flows should be examined in detail in the Final EA.



27. BLM has recognized that water use in Imperial County presents a conflict between the agricultural and geothermal industries. We also recognize the County's legal position as the agency directly responsible for developing policy, stipulations and regulations guiding the use of this limited water supply. In the past the County, Imperial Irrigation District, and the State of California Water Quality Control Agency-Colorado River Basin have been involved in several studies which address the water use conflict. It is the policy of BLM to abide by any and all water use policies and regulations which are promulgated by the local governing agency. At this time the only controls established by Imperial County are as stated in the Draft EA, Page 94. It is felt by the County that current data on water use is not adequate, and it will take a few years of experience and data collection before more indepth regulation can be developed. However, until that time water use is a top priority item and research is being accomplished through a team effort of geothermal industry, Imperial County, agricultural industry, State of California Water Quality Control and Imperial Irrigation District.
28. See #27.
29. See #2.
30. See #27.
31. See #2.
32. Within the study area there are no waste water treatment facilities. However, during field operations workers will use chemical-portable toilets. Permanent facilities will use septic tanks and filter fields approved by Imperial County Health Department. All other wastes will be temporarily stored on site and then trucked to proper disposal facilities. A Class II-1 dump is located west of the City of Westmoreland approximately 30 to 40 miles from the study area.





UNITED STATES  
DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY  
Reno District Geothermal Office  
Kietzke Plaza, Bldg. D, Suite 137  
4600 Kietzke Lane  
Reno, Nevada 89502

RECEIVED

APR 24 1981

OFFICE OF DCM, GEOTHERMAL  
CONSERVATION DIVISION  
U.S. GEOLOGICAL SURVEY  
MENLO PARK, CALIFORNIA

April 22, 1981

Memorandum

To: Chief, Environmental and Safety Section  
Through: Deputy Conservation Manager-Geothermal  
From: Reno District Geothermal Supervisor  
Subject: Review comments on BLM Glamis/Dunes Draft  
EAR for geothermal leasing

My staff has reviewed the subject EAR for proposed geothermal leasing in the Glamis and Dunes KGRA's and vicinity in the Imperial Valley, California, and found it to be a well-written and concise document. We hope that the following comments will provide some useful additions to your response to BLM's request for review comments:

33 | Comment 1, page 7 last paragraph continued on page 10.  
The first two sentences of this paragraph are very confusing and should be clarified. In addition, Map IV-2 (page 9) seems to show that all federal lands in the proposed leasing area are classified as "sensitive" and therefore cannot be leased until a resource is proven. Without leasing, the industry will not be able to drill any exploration wells, and therefore they would not be able to prove justification for surface occupancy.

| Again referring to Map IV-2 (page 9) the area recommended for no surface occupancy is so large that directional drilling from adjacent lands would only tap the fringes of the no surface occupancy area. Those areas which would be out of reach of economically feasible directional drilling should be eliminated from all leasing.

34 | Comment 2, paragraph 2, page 10.

1 | Geothermal operators/lessees are already required to impose only minimum surface disturbance under lease terms, GRO Orders, and 30 CFR 270 regulations.

Comment 3, paragraph 4, page 10.

Comparing surface disturbance from development to a 2560 acre lease is arbitrary and does not give a true indication of the impact on the entire study area, which is the subject of this EAR. Since, even with all areas open to leasing only a certain percentage of the study area would ever be leased, the impact on the 82,151 acres of the study area would be much less than the 5.7 pct of total surface area disturbed.

35 In fact, as discussed on page 11, actual case histories come closer to the 3 pct total disturbance minimum. In this regard also, it seems unreasonable that the BLM is unwilling to sacrifice less than 3 pct of the sensitive land of the study area to alternative energy development especially since from Map IV-2, sensitive land covers 100 pct of the study area.

Comment 4, paragraph 3, page 114.

36 This proposed stipulation is too vague. The lessee would have to know what kinds of operations are unacceptable e.g., just power plant construction? or is even drilling unacceptable?

Comment 5, paragraph 2, page 116 (Recreation 1.)

37 Hunting areas are where you find them but so are geothermal resources. From an economics standpoint, it makes more sense to close an area to a few hunters than to cost an operator tens of thousands of dollars more to directionally drill or worse yet, not to drill at all.

Comment 6, paragraph 2, under Noise.

38 Drilling operations run 24 hours a day and it is unreasonable to prohibit cement trucks from mobilizing at night. This puts an unreasonable economic burden on an operator.

Comment 7, Flora and Fauna No. 1 page 118.

39 Are other land uses similarly restricted? If not, geothermal development, which will affect less than 3 pct of the study area, should not have such constraints.

Comment 8, Flora and Fauna No. 2 page 118.

40 Does this mean covering sumps too? We know of no incidence of multiple wildlife deaths in geothermal sumps.

Comment 9, Flora and Fauna No. 4.

41 This proposed lease stipulation directly contradicts proposed Recreation stipulation No. 3, page 116, which requires burying of pipelines.

Comment 10, Land Use No. 2, page 119.

42 This stipulation is unnecessary since it merely describes the USGS post-lease EA process.

Comment 11, Flora and Fauna No. 6, page 120.

43 Natural drainage system disruption is avoided as a matter of course and considered in the USGS post-lease EA process. This concern is already covered under lease terms, GRO Orders, and 30 CFR 270 regulations.

General Comment.

44 This EAR should address only stipulations to be attached to leases and should not be used to develop stipulations for possible future plans of operation as has been done in the subject EAR.

*Douglas M. Kozar*

for Bernard Moroz

DMK:bj



33. This study area is an area of many resource values as shown by maps IV-1 and IV-2 and the concept for leasing (Alternative Action #2) is one way of addressing the many resource conflicts found. It is the intent to allow exploration on the sensitive areas, however, the resource discovered must prove to be economically viable for electrical production before further development will be considered. If proposals from lessee (see paragraph #2 page 10 of Draft) addresses other than electrical production use of the geothermal resource, then additional social, economic, and physical environmental impact studies should be done for this document.

We agree that if a highly sensitive area is so large that access to geothermal resources is technically not possible, then that area should not be leased. The description of Alternative 2 has been changed to reflect this concern.

34. We agree the minimum surface disturbance is addressed by GRO's and 30 CFR 270 regulations, however, it is the intent of this statement to make it clear as to those specific types of design features which would be considered as minimizing surface disturbance.
35. The Glamis/Dunes Study Area covers one of the largest dune eco-systems in the United States. The eco-system which has developed in this area is very fragile. The area is also the most heavily used recreational area in the California Desert. Considering the current use, the fragile eco-system and the proposal for additional development of the geothermal resource for electrical production, the concepts expressed by Alternative 2 fits the multiple-use policy of BLM more closely than either Alternative 1 or 3.
36. The area west of Gecko Road lies below the BLM campgrounds, thus is highly visible from those areas. The mitigation proposed does not suggest that geothermal development be eliminated from the area; only that it be minimized.
37. This statement is preceded by the phrase "where technically feasible" if it is determined to not be technically feasible to move a plant site for the protection of the plant works then the site should not be moved.
38. This statement is also posted with a "when technically feasible" notation.
39. Yes, any long term land uses in this area would be so restricted.
40. No, we have not suggested covering the sumps. However, it may be a point to consider.
41. The recreation stipulation applies only to those points of interest with a designated road, trail or ORV competition corridor.

42. In the course of development of this EA document it became clear to the EA team that it was necessary to make clear the importance of providing criteria that should be met by any developer in this study area. The resource values while not currently threatened, are vital, valuable, and fragile, thus care must be taken to insure that any development which may result from the exploration of the geothermal resource does not disrupt current eco-systems and land uses to the point of elimination.
43. See #42.
44. The intent of expanding the mitigation section to discuss plans of operation was only to give guidance to industry and future environmental documentation teams.



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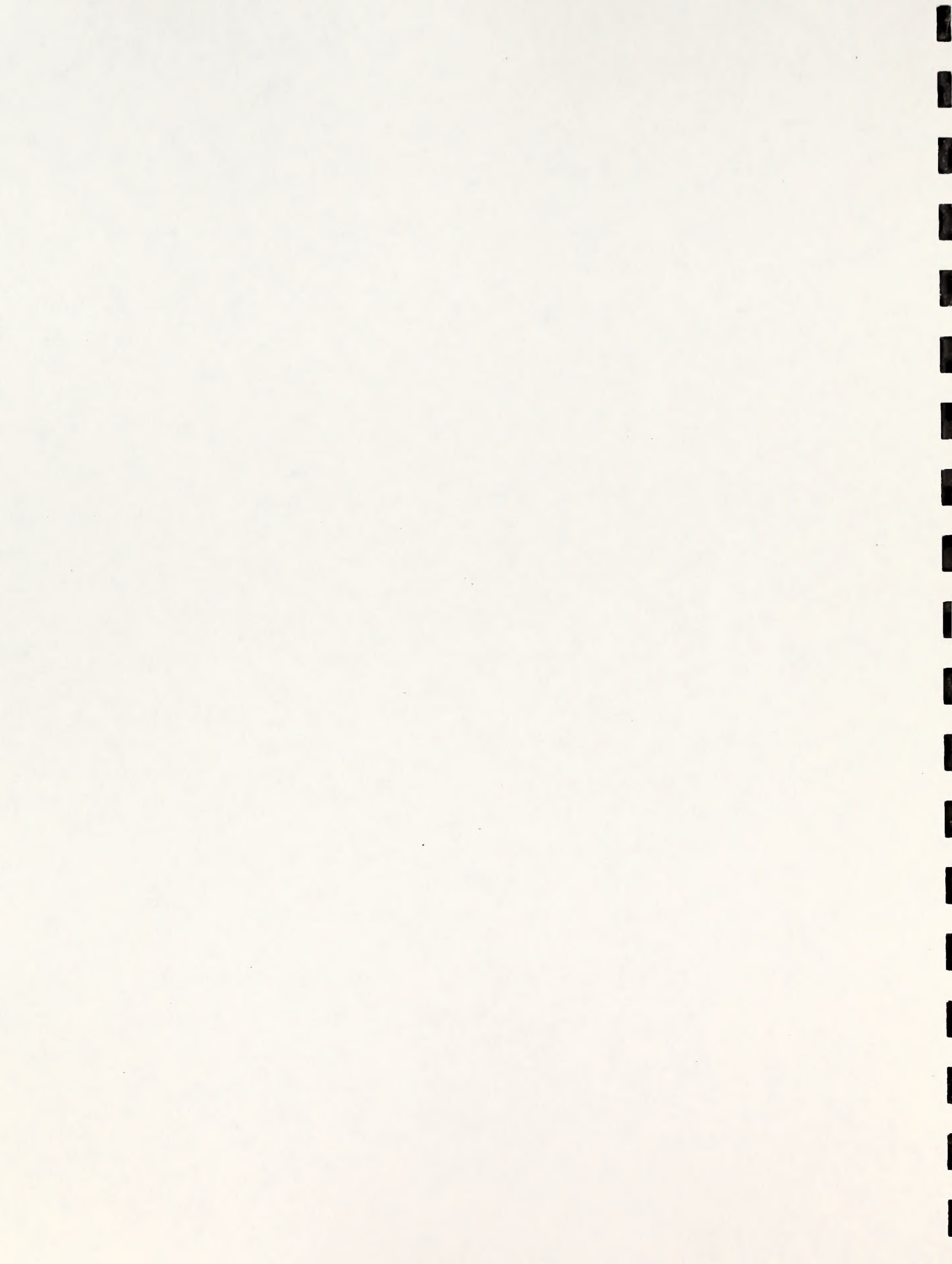
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APPENDIX A

Descriptive Narratives of  
Wilderness Study Areas  
and  
Wilderness Protection Stipulation

ALPHABETIC LISTING OF  
DESCRIPTIVE ARTICLES OF  
NORTH-WEST BRITISH ISLANDS  
AND  
ALPHABETIC LISTING OF  
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## DESCRIPTIVE NARRATIVES OF WILDERNESS STUDY AREAS

### AREA 360

#### I. PHYSICAL BOUNDARIES

This elongated, triangular-shaped roadless area is bounded on the northeast by a combination of the Southern Pacific Railroad and the Niland Glamis Road; to the south, by Highway 78; and, to the west, by a combination of the new, bulldozed route of the Coachella Canal and the old Coachella Canal and access road.

#### II. LANDOWNERSHIP

The boundaries include approximately nine sections of non-public land in a checkerboard pattern, accounting for approximately 35 percent of the land. This entire area is also a Bureau of Reclamation Withdrawal.

#### III. DESCRIPTION OF ENVIRONMENT

This area is characterized by large dunes as well as small, mesquite-covered dune masses. The southern half is a National Natural Landmark and an area which BLM closed to off-road vehicle activity in order to protect critical habitats for plant species endemic to the Imperial Sand Dunes which have been proposed for listing as threatened and endangered.

#### IV. NATURAL CONDITION

The portion of the area which retains its primeval character and influence, and generally appears to be affected primarily by the forces of nature, is that part presently recognized as a National Natural Landmark and is closed to motorized vehicle usage. In addition, this area contains only two sections of private land. The area to the north of this landmark boundary has been excluded from Wilderness consideration because of man's disturbances. It includes Mammoth Wash, which is heavily used by off-road vehicles, resulting in reduced natural vegetative cover. The area around Glamis has also been excluded due to the buildings, roads, and off-road vehicle scars.

#### V. OUTSTANDING OPPORTUNITIES FOR SOLITUDE ON A PRIMITIVE AND UNCONFINED TYPE OF RECREATION

The complexity of the dune system, as well as natural screening of visitors from one another by terrain and thick stands of mesquite vegetation provide outstanding opportunities for solitude or a primitive and unconfined type of recreation. Due to the unique natural qualities and the natural condition of the southern portion, freedom of movement is unimpeded.

## VI. SUMMARY OF PUBLIC COMMENTS

A majority of comments speaking to the inventory factors agreed with the present status of the area's boundaries or felt that they should be expanded. Other components said the area had roads that had not been included or that the works of man were evident. The area has been re-evaluated and changes have been made where appropriate. Many of the comments received dealt entirely with study phase factors.

### AREA 362

#### I. PHYSICAL BOUNDARIES

The northern boundary of this area parallels Highway 78; the western boundary, a combination of the Coachella Canal and access road and the new, bulldozed, Coachella Canal Route; the southern, a combination of the All-American Canal and Interstate 8; and, the eastern, a railroad.

#### II. LANDOWNERSHIP

The boundaries include approximately seven sections of non-public land scattered throughout and accounting for approximately 3% of the area. The area is a Bureau of Reclamation Withdrawal.

#### III. DESCRIPTION OF ENVIRONMENT

This area consists primarily of the Algodones Dune System which is one of the largest dune masses in the United States. The portion of this roadless area includes steep sandy slopes, while the central portion included more gently rolling dune masses with thickets of mesquite and palo verde. The steeper western flanks drop rapidly to Creosote Bush Scrub flats. Several plant species found in this area have been proposed for Federal listing as "endangered." In addition, the U. S. Fish and Wildlife Service has proposed "endangered" listing for the Andrew's scarab beetle and the Coachella Valley fringe-toed lizard.

#### IV. NATURAL CONDITION

The large central portion of the Algodones Dune system is affected primarily by the forces of nature and is an area where the earth and its community of life are undisturbed by man. The northern portion includes the Gecko Campground and Osborne County Park near Competition Hill. Off-road vehicle activity has severely reduced much of the natural vegetation cover and has compacted the northern sand mass. Similarly, use in the southern portion of the Algodones Dunes by off-road vehicles has reduced natural vegetation. Due to the alteration of the natural landscape by off-road vehicle activity which has resulted in the imprint of man's work being substantially noticeable, these areas, as well as those along the eastern and western borders for the same reasons, have been determined not to contain wilderness values and have been excluded from wilderness consideration.



V. OUTSTANDING OPPORTUNITIES FOR SOLITUDE OR A PRIMITIVE AND UNCONFINED TYPE OF RECREATION

Due to the extremely hilly and varied shape and size of the dune systems, as well as thick stands of mesquite and creosote vegetation, this area contains outstanding opportunities for solitude or a primitive and unconfined type of recreation. The area's topography, accentuated by changing patterns of light, shadow, and color tend to enhance feelings of vastness and solitude. Opportunities for nature study are extremely high due to the unique plant and animal populations which are found within this area.

VI. SUMMARY OF PUBLIC COMMENTS

The majority of the comments addressing inventory criteria indicated approval for including the area for further study or expanding the present boundaries. Other comments felt that man's influence on the area was significant. Many other comments spoke to study phase factors. Examples included potential for geothermal development, recreation use, and endangered species protection.

WILDERNESS PROTECTION STIPULATION

By accepting the lease, the lessee acknowledges that the lands contained in this lease are being inventoried or evaluated for their wilderness potential by the Bureau of Land Management (BLM) under section 603 of the Federal Land Policy and Management Act of 1976, 90 Stat. 2743 (43 USC Sec. 1782), and that exploration or production activities which are not in conformity with section 603 may never be permitted. Expenditures in leases on which exploration drilling or production are not allowed will create no additional rights in the lease, and such leases will expire in accordance with law.

Activities will be permitted under the lease so long as BLM determines they will not impair wilderness suitability. This will be the case either until the BLM wilderness inventory process has resulted in a final wilderness inventory decision that an area lacks wilderness characteristics, or in the case of a wilderness study area until Congress has decided not to designate the lands included within this lease as wilderness. Activities will be considered nonimpairing if the BLM determines that they meet each of the following three criteria:

- (a) It is temporary. This means that the use or activity may continue until the time when it must be terminated in order to meet the reclamation requirement of paragraphs (b) and (c) below. A temporary use that creates no new surface disturbance may continue unless Congress designates the area as wilderness, so long as it can easily and immediately be terminated at that time, if necessary to management of the area as wilderness.

- (b) Any temporary impacts caused by the activity must, at a minimum, be capable of being reclaimed to a condition of being substantially unnoticeable in the wilderness study area (or inventory unit) as a whole by the time the Secretary of the Interior is scheduled to send his recommendations on that area to the President, and the operator will be required to reclaim the impacts to that standard by that date. If the wilderness study is postponed, the reclamation deadline will not be changed. A full schedule of wilderness studies will be developed by the Department upon completion of the intensive wilderness inventory. In the meantime, in areas not yet scheduled for wilderness study, the reclamation will be scheduled for completion within 4 years after approval of the activity. (Obviously, if and when the Interim Management Policy ceases to apply to an inventory unit dropped from wilderness review following a final wilderness inventory decision of the BLM State Director, the reclamation deadline previously specified will cease to apply.) The Secretary's schedule for transmitting his recommendations to the President will not be changed as a result of any unexpected inability to complete the reclamation by the specified date, and such inability will not constrain the Secretary's recommendation with respect to the area's suitability or unsuitability for preservation as wilderness.

The reclamation will, to the extent practicable, be done while the activity is in progress. Reclamation will include the complete recontouring of all cuts and fills to blend with the natural topography, the replacement of topsoil, and the restoration of plant cover at least to the point where natural succession is occurring. Plant cover will be restored by means of reseeding or replanting, using species previously occurring in the area. If necessary, irrigation will be required. The reclamation schedule will be based on conservative assumptions with regard to growing conditions, so as to ensure that the reclamation will be complete, and the impacts will be substantially unnoticeable in the area as a whole, by the time the Secretary is scheduled to send his recommendations to the President. ("Substantially unnoticeable" is defined in Appendix F of the Interim Management Policy and Guidelines for Lands under Wilderness Review.)

- (c) When the activity is terminated, and after any needed reclamation is complete, the area's wilderness values must not have been degraded so far, compared with the area's values for other purposes, as to significantly constrain the Secretary's recommendation with respect to the area's suitability or unsuitability for preservation as wilderness. The wilderness values to be considered are those mentioned in section 2(c) of the Wilderness Act, including naturalness, outstanding opportunities for solitude or for primitive and unconfined recreation, and ecological, geological or other features of scientific, educational, scenic, or historical value. If all or any part of the area included

within the leasehold estate is formally designated by Congress as wilderness, exploration and development operations taking place or to take place on that part of the lease will remain subject to the requirements of this stipulation, except as modified by the Act of Congress designating the land as wilderness. If Congress does not specify in such act how existing leases like this one will be managed, then the provisions of the Wilderness Act of 1964 will apply, as implemented by rules and regulations promulgated by the Department of the Interior.





APPENDIX 2  
FEDERAL BUREAU OF INVESTIGATION  
WASHINGTON, D. C. 20535

## PREHISTORIC CULTURAL SEQUENCE FOR IMPERIAL COUNTY, CALIFORNIA

In view of recent discoveries and increased investigation into the question of human inhabitation in southeastern California, in particular, and the New World in general, what follows is a tentative sequence of cultural horizons/complexes found within Imperial County. Briefly, the presence of people in the New World before 12,000 to 20,000 years before present (B.P.) continues to be a controversy in academic circles. The sequence presented here in chronological order are Pre-Malpais, Malpais, San Dieguito, Pinto-Amargosan, Yuman, and Historic (European-American).

### Pre-Malpais (25,000 years + B.P.)

Morlin Childers has reported two loci of cultural deposits discovered in a cliff strata from the Pinto Wash, 25 meters below the surface (1977b). The timeframe of the geologic strata has been tentatively placed ca. 45,000 years B.P. San Dieguito artifacts were observed in the matrix of the desert pavement more than 75 feet above this deposit, so it is presumed the artifacts from the 25 meter sub-stratum are of considerable antiquity. Over 100 items were recorded, mapped, photographed, and collected and include both fossilized mammal bone and artifacts classified as scraper planes, fist axes, scrapers, "diggers", and cores.

### Malpais (CA 20,000-25,000 years B.P.)

The complex of artifacts designated Malpais has been a source of conflicting definitions and timeframes for some time. This is to be expected when all we have to evaluate of these ancient people are surface sites usually integrated within desert pavement. Malcolm Rogers, who first recorded this complex, as well as the later San Dieguito and Yuman Cultures, integrated the Malpais horizon into the San Dieguito I phase towards the end of his career (1966:37).

Recent discoveries in western Texas by Antonio Androetti (San Diego Museum of Man conf., 1979) and Julian Hayden (1976) have led to a re-evaluation of this complex and may substantiate Roger's first impression of the Malpais as a viable entity in their own right. The estimated timeframe given has been based primarily upon C-14 dating techniques performed upon ecofactual material from the strata directly above the Texas Malpais deposit.

Briefly, the Malpais stone tool assemblages are characterized by large de-cortication (teshoa) flakes, simple cobble tools, scraper planes, unifacial choppers, and occasional thick bifaces. Most of these artifacts possess a dark coating of desert varnish (purple to black) indicating possible great age. The Texas assemblage is unique in that milling implements were also found in the sub-surface site. These items include milling slabs (metates) and gyratory crushers, a form of mortar. To date, this is the oldest evidence that an early New World culture possessed a milling technology. Milling tools have not been firmly recorded yet in Imperial Valley in association with Malpais sites.

The complete absence of stone projectile points has led some investigators to identify the Malpais and other early horizon. Pre-Projectile Point cultures (M. Weide: 1974; Ellis B. Crabtree, 1944) with an economy based primarily on the gathering of plant materials and the hunting of small animals. However, since the known "tool kits" being analyzed consist of stone artifacts, it may be a mistake to disregard the possibility that organic materials such as bone, ivory, and wood items that decayed ages ago were not carved into formidable weapons. Thus, it may be wiser to refer to these ancient horizons as "Pre-Stone Projectile Point" cultures. The archaeological record of the Malpais is slim and all that is really known of their existence are the artifacts they left behind in areas now known as the Yuha Desert, Northern Mexico, Baja California, and West Texas.

#### Yuha Man (+21,500 years B.P.)

In 1974, Morlin Childers reported the discovery, excavation, and preliminary dates of a cairn burial located in the Yuha Desert, later called Yuha Man (Childers, 1974). Radio carbon analysis of a calcium carbonate (caliche) coating found on the bones derived dates of 21,500 years (+2,000, -1,000) B.P., 22,000  $\pm$  400 years B.P. Later in 1976, the Thorium 230 technique dated the caliche at 19,000  $\pm$  3,000 years B.P. (von Werlhof, 1977b:21). M. Weide (1974:78) leveled a justifiable criticism of using caliche as a dating substance considering the material as unstable. The results on amino acid racimization analysis of the bone have yet to be published. It is not known to what cultural horizon this burial belongs, but it may be the oldest dated human remains yet discovered in Imperial County.

It must be understood, in terms of this report, that the complexes spoken about until now (Pre-Malpais, Malpais, Yuha Man, origins of the first phase of the San Dieguito which follow and in general the cultural remains found in the New World dated before 12,000-20,000 years ago) still require a vast amount of investigation and elucidation before much, if anything, can be succinctly stated about who they were, who their ancestors were, when they existed, and how they survived. With more data being recorded each year, it is hoped that answers concerning the origins of human populations in the New World will become less of a subject for dispute.

#### San Dieguito (20,000 years-7,000 years B.P.)

Though there is rarely a dispute over the fact of a San Dieguito horizon, the origins and time slot is still something of a mystery.

Malcolm Rogers, who laid much of the groundwork for far southwestern archaeologists through his intense desire to perceive and record the activities of prehistoric cultures, was responsible for the term "San Dieguito horizon." In 1938 he reported the discovery of artifacts from an ancient river channel caused by the San Dieguito River in San Diego. He saw a relation between these artifacts and those he observed in the Colorado Desert region, and further analysis of these complexes convinced him of certain similarities. These assemblages were then lumped into one large group, called the San Dieguito, and separated into three phases based upon certain technological refinements and innovations that he believed were indicative of temporal evolution and/or the environmental pressures of a changing world.



The phases he observed are as follows:

Phase I: Thick ovate bifaces, spokeshaves, scraper planes, chopping tools (Malpais may be a possible prototype). These sites are usually found high above present water resources indicating, as elsewhere in the California Desert, a time of increased water supplies and richer biotic communities.

Phase II: A general refinement of the items from the above assemblage: thinner and lighter bifaces, and more types of choppers and scrapers. Phase I and II are usually regarded to be nomadic hunters and gatherers.

Phase III: The addition of crescentics and well-made projectile points indicate the advent of pressure flaking techniques into their technological inventory. Higher frequencies of siliceous materials, including jasper and chalcedony were worked. Otherwise, there is not much difference between other Phase III tool types and those from Phase II.

Both Phases II and III have been recorded within the Glamis Project area during von Werlhof's survey of the Chocolate Mountains (1979: pers. comm.). It has also been discovered (I. von Werlhof:IBID, and Kaldenberg, 1975) that milling technologies were not unknown to this extinct culture of southern California since grinding slabs have been found in San Dieguitoan sites. However, until more evidence is found, we may suppose that the employment of milling activities was minimal. There also exists the possibility that heat-treating of certain lithic materials was practiced to facilitate the newly acquired pressure flaking techniques.

Understanding the reasons for these technological improvements and changes of the San Dieguito tool kits is not easy to assess, nor is the delineation of the artifacts into the above-stated categories a settled question (San Diego Museum of Man Conf. 1979; von Werlhof, 1979 pers. comm.). It is apparent, however, that the changing environment in which the San Dieguitans lived had an impact on how they related to that environment. San Dieguito populations were found in the regions cited for Malpais deposits, and artifacts associated with their sites appear primarily designed to wood work (Rogers, 1966:142).

From their thousands of sleeping circles and hundreds of miles of well used trails, we can assess they were able to adapt quite well to the mildly fluctuating eastern California environments for a considerable length of time. Only when the desert began to form as a result of the cessation of the Glacial-Pluvial stage around 8,000 years B.C. did they have to move west to the Pacific littoral zone. Even here they prospered. While it is usually assumed that they were replaced by the La Jolla complex may be an expression of San Dieguito coastal adaptation (1976:3). At least some of the desert floor drawings (intaglios) found in the desert may be attributed to the San Dieguito horizon. Why they were constructed is difficult to say, but it seems to indicate an aesthetic or ceremonial sense among at least a portion of their population.

Pinto and Amargosan (7,000 years B.P. - 2,500 years B.P.)

The drying up of the Colorado Desert around 8,000 years ago is no doubt a main factor in the virtual absence of cultural materials belonging to this era. The Pinto and Amargosan horizon is more documented in the Mojave Desert, to the north. In Imperial County only a few of their highly diagnostic points attest to their limited occupation of this area. A cairn burial near Truckhaven was excavated by Imperial Valley College Museum. Though the date given by M. Weide of ca. 6,000 years B.P. (1974:80) is usually attributed to it, von Werlhof (1977d:B-26) indicates that the bone apatite sample radiocarbon dated was destroyed during the dating process and that the associated tools were identified by Dr. Paul Ezell as resembling those attributed to the San Dieguito I phase. Thus, we are not certain how Truckhaven Man fits into temporal sequence being attempted here.

The Yuman (2,500 years B.P. - Historic)

Around 2,500+ years ago the archaeological record indicates the intrusion of the Yuman culture along the Colorado River. Their origins are a mystery, but they may have moved west from Arizona regions.

Yuman is a name given to a broad linguistic group extending from western Arizona to the Pacific littoral of San Diego and North Baja, California.

The Yuman conglomerate includes the Kamia, a sub-dialect "tribe", of Imperial Valley, the Diequeno who lived in San Diego, and the Halchidoma and Quechan of the Colorado River, to name a few. Around 500 years after they moved into southern California a Shoshonean-speaking conglomerate moved into the north of them. These groups included the Mojave situated north of the Halchidoma, the Cahuilla and Chemehuevi in the northern Salton Sea area, and the Luiseno in northern San Diego County (Westec, 1979a: 42).

Yuman sites are distinguished by sites containing projectile points indicative of the use of bow and arrow. The Colorado River Yumans also started to make pottery around 500 A.D. and later spread west to San Diego by around 800-900 A.D.

Trails with occasional sherd scatters and nearby campsites indicate a great deal of intercommunication and trade between both Yuman and Shoshone.

Rogers felt the Yuman underwent three phases of development. The first stage was confined to the Colorado River, the second involved the exploitation of Lake Cahuilla, a fresh water lake, that may have been seasonally exploited while it dried up and the Yumans who occupied the lake and its rich biotic habitat, either moved back to the River or headed towards the Peninsular Range where the environment was more suitable (M. Weide: 82).

Recent investigations into the hydrologic history of Lake Cahuilla by Phil Wilke (briefly outlined in von Werlhof, et al., 1979:33) indicates the lake has filled up and dried up three times in the last 2,000 years. Von Werlhof suggests a possible correlation between the three stands of the lake and the three Yuman phases (1B10). Tentatively, Yuman Phase I is set around 5000 A.D. - 1000 A.D., Phase II at 1000 A.D. - 1500 A.D., and the third phase from 1500 A.D. Historic (1850 A.D.). The lake was full around 100 B.C., 600 A.D., 900 A.D.-1250 A.D., and 1300 A.D.-1500 A.D. It is possible, indeed probably, that the drying of the lake during these periods may have significantly factored in the re-adaptation of the Kamia and the Yuman desert populations in general during which the different phases were initiated.

The archaeological sites of the Yuman are mostly represented by temporary camps (where they would seasonally gather certain foods), lithic and sherd scatters, trails and intaglios. By far the highest site densities have been found along the East and West Mesas along the ancient shoreline of Lake Cahuilla.

The absence of villages along the East Mesa seems to indicate it was seasonally visited. However, this is not a hard and fast conclusion since the area is characterized by loose sand and dunes, so that if more substantially occupied sites do exist here the evidence may have been scattered by the winds of time, literally!

Along the shoreline they would collect and process plants such as the invaluable mesquite, fish, and hunt the many birds and other animals attracted by this freshwater habitat. The region was no doubt greener than today because a full lake implies a higher water table which would supply creeks and springs on a more permanent basis than today and support a larger biotic community. When an in depth pollen analysis of Imperial County is undertaken we will have a much clearer picture of what prehistoric Imperial County was really like, and so have a better idea of the Kamia's ancient homeland.

## Historic Period

### Introduction

The historic period of the study area offers little material for discussion. The European impact was relatively small until the latter portion of the 19th Century. The uninviting nature of the area encouraged those who wished to explore the northern reaches of New Spain, to seek routes along the Colorado River or the Pacific Coast. Later avenues of commerce and communication followed much the same routes.

In order to understand this lack of non-aboriginal activity in the area, one has only to examine the three major periods of historic activity. These are the Spanish Period (1769-1834), the Mexican Period (1834-1846), and the Anglo-American Period (1846-Present) (Burkenroad 1978:80-112).

### Spanish Period (1769-1834)

Although there were expeditions to the Colorado River as early as 1540 (Hammond and Rey 1940:124-155), it was not until the establishment of the San Diego Mission de Alcala in 1769 that a land route between Sonora and the Pacific Coast became a concern to the officials of New Spain. However, it was not until 1775 that an overland route to San Diego was opened by Juan Bautista de Anza (Bolton 1930, I:133-154). In 1786, this route, the Sonoran Road, was closed because of threats from the Yumans along the Colorado River and the Apaches in Arizona and Sonora (Forbes 1965:225-226).

### Mexican Period (1834-1846)

The new government sought to establish its control over California through the re-opening of the Sonoran Road to California as an official mail route (Bean and Mason 1962:8-9). Much the same route was followed by the Anglo-Americans.

### Anglo-American Period (1846-Present)

After California became a territory of the United States, the trails mentioned above achieved new importance. In 1848, the Southern Emigrant Trail was opened. During the Gold Rush and the Civil War periods, the trails saw a great deal of activity. Those seeking gold in California were the principle users of this route. This sudden influx of immigrants from the East brought about a great deal of conflict with the natives (Forbes 1965:297-340).

It was not until the 1880's that intensive interest in the specific study area was displayed by Europeans. The attraction was gold. Even though gold was mined during the Spanish Period, the construction of the Southern Pacific Railroad brought about a situation by which these resources could be fully exploited. Such mines as the Cargo Muchaco, Padre Madre, the American Girl and Tumco (also known as Gold Rock) provided the locus for development. The Picacho Mining District in the west was also developed. It has been reported that the town of Hedges numbered several thousand in the 1880's to the 1910's. (Morton, 1977:28-29, 46-49, 52-58; Clark, 1970:193).

To serve these mines, railroad stations at Ogilby and Glamis were built. The Ogilby Station served the mines in the Cargo Muchacho. The Glamis Station processed trade from the Paymaster Mine District (Crawford, 1894:239, 1896:347; Storms, 1893:386).

Agriculture also began to play an important factor in the study area. In 1901, the first water from the Colorado River was brought into the Imperial Valley. The period of 1905-1907 saw the creation of the Salton Sea. This was caused by the flow of the Colorado River flowing through the canal system and not to the Gulf of California (Dowd, 1956:28-30, 55-62, 67-68; Schoufeld, 1968:1:279-307, 11:279-307, 11:395-415; Sykes, 1937:108-119).

The desert area under study provided an excellent training area during the Second World War (see map). General George Patton selected this area to train his troops before facing German forces in North Africa (see Meller, 1946).



1948

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PLANT SPECIES LIST

<u>Plant Name</u>	<u>Family</u>	<u>Habitat Types In Study Area</u>
<u>Abronia villosa</u> var. <u>villosa</u> Sand verbena	Nyctaginaceae	DDSP, CBS
<u>Acacia greggii</u> Catclaw	Fabaceae	DMW
<u>Amaranthus palmeri</u>	Amaranthaceae	CBS
<u>Ambrosia dumosa</u> White bur-sage, Burrobush	Asteraceae	CBS, DMW
* <u>Ammobroma sonorae</u> Sand Food	Lennoaceae	DDSP, CBS
<u>Amsinckia tessellata</u> Tessellate fiddle-neck	Boraginaceae	CBS
<u>Argemone munita</u> ssp. <u>argentea</u> Broad-horned prickly poppy	Papaveraceae	CBS
<u>Aristida adscensionis</u> Six-weeks grass	Poaceae	CBS
<u>Aristida californica</u>	Poaceae	CBS
<u>Arundo donax</u> ** Giant reed	Poaceae	DRW
<u>Asclepias subulata</u> Rush milkweed	Asclepiadaceae	DDSP, DMW, CBS
<u>Aster spinosus</u> Mexican devil-weed	Asteraceae	DRW
* <u>Astragalus lentiginosus</u> var. <u>borreganus</u> Mottled Rattleweed	Fabaceae	DDSP, CBS
* <u>Astragalus magdalenae</u> var. <u>peirsonii</u>	Fabaceae	DDSP
<u>Atrichoseris platyphylla</u> Tobacco-weed	Asteraceae	CBS

<u>Plant Name</u>	<u>Family</u>	<u>Habitat Types In Study Area</u>
<u>Atriplex elegans</u> ssp. <u>fasciculata</u> Salton saltbush	Chenopodiaceae	CBS
<u>Avena fatua</u> ** Wild oat	Poaceae	DRW
<u>Baileya pleniradiata</u> Woolly marigold	Asteraceae	CBS, DMW
<u>Bebbia juncea</u> Sweetbush	Asteraceae	CBS, DMW
<u>Bouteloua barbata</u> Annual grama grass	Poaceae	CBS
<u>Brandegea bigelovii</u>	Cucurbitaceae	CBS, DMW
<u>Brassica tournefortii</u> Mustard	Brassicaceae	CBS, DMW
* <u>Calliandra eriophylla</u> Fairy Duster, Mesquitilla	Fabaceae	CBS, DMW
<u>Camissonia arenaria</u> Heart-leaved primrose	Onagraceae	CBS
<u>Camissonia boothii</u> ssp. <u>condensata</u> Booth's primrose	Onagraceae	CBS
<u>Camissonia cardiophylla</u> ssp. <u>cardiophylla</u> Heart-leaved primrose	Onagraceae	CBS
<u>Camissonia claviformis</u> ssp. <u>yumae</u> Clavate-fruited primrose	Onagraceae	CBS, DDS P
<u>Cercidium floridum</u> Palo verde	Fabaceae	DMW
<u>Chaenactis carphoclinia</u> Pebble pincusion	Asteraceae	CBS
<u>Chenopodium murale</u> Nettle-leaved or wall goosefoot	Chenopodiaceae	DRW
<u>Chilopsis linearis</u> Desert Willow	Bignoniaceae	DMW, CBS, DDS P
<u>Chorizanthe brevicornu</u> ssp. <u>brevicornu</u> Brittle Chorizanthe	Polygonaceae	CBS, DMW



<u>Plant Name</u>	<u>Family</u>	<u>Habitat Types In Study Area</u>
<u>Chorizanthe corrugata</u> Wrinkled spiny herb	Polygonaceae	CBS
<u>Chorizanthe rigida</u> Rigid Spiny Herb	Polygonaceae	CBS
<u>Coldenia palmeri</u>	Boraginaceae	CBS
<u>Coldenia plicata</u>	Boraginaceae	DDSP, CBS
<u>Conyza canadensis</u> Horseweed	Asteraceae	DRW
<u>Conyza coulteri</u>	Asteraceae	DMW
* <u>Croton wigginsii</u>	Euphorbiaceae	DDSP, CBS
<u>Cryptantha angustifolia</u> Narrow-leaved Forget-Me-Not	Boraginaceae	CBS, DMW
<u>Cryptantha barbiger</u> Bearded Forget-Me-Not	Boraginaceae	CBS
* <u>Cryptantha costata</u> Ribbed Forget-Me-Not	Boraginaceae	CBS
<u>Cryptantha ganderi</u>	Boraginaceae	DMW
<u>Cryptantha maritima</u> Guadalupe Forget-Me-Not	Boraginaceae	CBS
<u>Cucurbita palmata</u> Coyote melon	Cucurbitaceae	DMW, CBS
<u>Cynodon dactylon</u> Bermuda grass	Poaceae	DRW
<u>Dalea emoryi</u> Dyeweed, Indigo Bush	Fabaceae	CBS
<u>Dalea mollis</u> Silky dalea	Fabaceae	CBS
<u>Dalea spinosa</u> Smoketree	Fabaceae	CBS, DMW
<u>Datura discolor</u> Desert Thorn Apple	Solanaceae	CBS, DMW

<u>Plant Name</u>	<u>Family</u>	<u>Habitat Types In Study Area</u>
<u>Dicoria canescens</u> ssp. <u>canescens</u>	Asteraceae	DDSP, CBS, DMW
<u>Dicoria canescens</u> ssp. <u>clarkae</u> Desert Dicoria	Asteraceae	DDSP, DMW
<u>Ditaxis neomexicana</u> Common Ditaxis	Euphorbiaceae	CBS
<u>Echinochloa crus-pavonis</u> var. <u>crus-pavonis</u>	Poaceae	DRW
<u>Eclipta alba</u> False Daisy	Asteraceae	DRW
<u>Encelia farinosa</u> Brittlebush	Asteraceae	CBS, DMW
<u>Encelia frutescens</u> Bush Encelia	Asteraceae	CBS
<u>Ephedra trifurca</u> Mormon tea	Ephedraceae	DDSP, CBS
<u>Eremalche rotundifolia</u> Desert Five-spot	Malvaceae	CBS
<u>Eriogonum deflexum</u> ssp. <u>deflexum</u> Flat-crown Buckwheat	Polygonaceae	CBS, DMW
* <u>Eriogonum deserticola</u> Desert Buckwheat	Polygonaceae	CBS, DDSP, DMW
<u>Eriogonum inflatum</u> var. <u>deflatum</u> Desert trumpet	Polygonaceae	CBS
<u>Eriogonum thomasii</u>	Polygonaceae	CBS
<u>Eriogonum trichopes</u> Yellow or Little Trumpet	Polygonaceae	DMW
* <u>Euphorbia parishii</u> Parrish's spurge	Euphorbiaceae	CBS
<u>Euphorbia polycarpa</u> var. <u>polycarpa</u> Colondrina	Euphorbiaceae	CBS, DMW
<u>Fagonia pachyacantha</u> California fagonia	Zygophyllaceae	CBS

<u>Plant Name</u>	<u>Family</u>	<u>Habitat Types In Study Area</u>
<u>Fouquieria splendens</u> Ocotillo	Fouquieriaceae	CBS, DMW
<u>Geraea canescens</u> Desert Sunflower	Asteraceae	CBS
<u>Helianthus annuus</u> ssp. <u>lenticularis</u> Common sunflower	Asteraceae	DRW
* <u>Helianthus niveus</u> ssp. <u>tephrodes</u> Silver-leaved Dune Sunflower	Asteraceae	DDSP
<u>Heliotropium curassavicum</u> var. <u>oculatum</u> Seaside heliotrope	Boraginaceae	CBS
<u>Hesperocallus undulata</u> Desert Lily	Liliaceae	DDSP, CBS
<u>Heterotheca subaxillaris</u> Camphor weed	Asteraceae	CBS
<u>Hilaria rigida</u> Big Galleta Grass	Poaceae	CBS, DMW
<u>Hoffmannseggia microphylla</u>	Fabaceae	CBS
<u>Hymenoclea salsola</u> var. <u>salsola</u> Cheesebush	Asteraceae	CBS, DMW
<u>Krameria grayi</u> White ratany	Krameriaceae	CBS
<u>Lactuca serriola</u> Prickly lettuce	Asteraceae	DRW (Canal)
<u>Langloisia schottii</u>	Polemoniaceae	DDSP
<u>Larrea tridentata</u> Creosote Bush	Zygophyllaceae	CBS, DMW
<u>Lepidium lasiocarpum</u> Hairy-pod pepper-grass	Brassicaceae	CBS, DMW
<u>Lolium perenne</u> ssp. <u>perenne</u> ** Perennial or English rye-grass	Poaceae	DRW (canal)
<u>Lotus tomentellus</u> Desert Lotus	Fabaceae	CBS

<u>Plant Name</u>	<u>Family</u>	<u>Habitat Types In Study Area</u>
<u>Lupinus arizonicus</u> Arizona Lupine	Fabaceae	CBS
<u>Lycium</u> sp. Desert Thorn	Solanaceae	DMW, CBS
* <u>Lyrocarpa coulteri</u> var. <u>palmeri</u> Coulter's lyre-pod	Brassicaceae	CBS
<u>Melilotus albus</u> ** White sweet-clover	Fabaceae	DRW
<u>Mentzelia longiloba</u> Yerba Amarilla	Loasaceae	CBS, DMW
<u>Monoptilon bellioides</u> Desert Star	Asteraceae	CBS
<u>Myriophyllum exalbescens</u> American milfoil	Haloragaceae	DRW
<u>Nama hispidum</u> var. <u>revolutum</u>	Hydrophyllaceae	CBS
<u>Nicotiana trigonophylla</u> Desert Tobacco	Solanaceae	DMW
<u>Oenothera deltoides</u> Desert primrose	Onagraceae	DDSP, CBS, DMW
<u>Oligomeris linifolia</u>	Resedaceae	CBS, DMW
<u>Olneya tesota</u> Ironwood	Fabaceae	DMW
<u>Opuntia acanthocarpa</u> var. <u>coloradensis</u> Buckhorn Cholla	Cactaceae	CBS
<u>Opuntia basilaris</u> var. <u>basilaris</u> Beaver-tail cactus	Cactaceae	CBS
<u>Opuntia echinocarpa</u> var. <u>echinocarpa</u> Silver or Golden Cholla	Cactaceae	CBS
<u>Opuntia ramossissima</u> Lead Pencil Cholla	Cactaceae	CBS
<u>Orobanche cooperi</u> Cooper's or Desert Broomrape	Orobanchaceae	CBS

<u>Plant Name</u>	<u>Family</u>	<u>Habitat Types In Study Area</u>
<u>Palafaxia arida</u> var. <u>arida</u> Spanish needles	Asteraceae	CBS, DDS P
* <u>Palafaxia arida</u> var. <u>gigantea</u> Giant Spanish Needles	Asteraceae	DDS P
<u>Panicum urvilleanum</u> Desert Panicum	Poaceae	DDS P
<u>Pectis papposa</u> Chinch weed	Asteraceae	CBS
<u>Perityle emoryi</u> Emory Rock-daisy	Asteraceae	CBS, DMW
<u>Petalonyx thurberi</u> ssp. <u>thurberi</u> Common Sandpaper Plant	Loasaceae	DDS P
<u>Phacelia crenulata</u> var. <u>crenulata</u> Heliotrope Phacelia	Hydrophyllaceae	CBS
<u>Phoradendron californicum</u> Mistletoe	Viscaceae	DMW
<u>Plantago insularis</u> var. <u>fastigiata</u> Indian Wheat	Plantaginaceae	CBS
<u>Plantago purshii</u> var. <u>oblonga</u> Pursh's Plantain	Plantaginaceae	CBS
<u>Pluchea sericea</u> Arrowweed	Asteraceae	DRW
<u>Polygonum fusiforme</u> Willow Weed	Polygonaceae	DRW
<u>Potamogeton pectinatus</u> Fennel-leaved Pondweed	Potamogetonaceae	DRW
<u>Prosopis glandulosa</u> var. <u>torreyana</u> Honey mesquite	Fabaceae	DMW
<u>Prosopis pubescens</u> Screwbean mesquite	Fabaceae	DMW, CBS
<u>Psathyrotes ramosissima</u> Velvet Rosettes	Asteraceae	CBS
<u>Rafinesquia californica</u> California Chicory	Asteraceae	CBS

<u>Plant Name</u>	<u>Family</u>	<u>Habitat Types In Study Area</u>
<u>Salsola iberica</u> Russian thistle	Chenopodiaceae	CBS
<u>Schismus arabicus**</u>	Poaceae	CBS, DMW
<u>Schismus barbatus**</u>	Poaceae	CBS, DMW
<u>Simmondsia chinensis</u> Jojoba	Buxaceae	CBS, DMW
<u>Sisymbrium altissimum**</u> Tumble mustard	Brassicaceae	CBS
<u>Sonchus oleraceus**</u> Common sow-thistle	Asteraceae	CBS
<u>Sphaeralcea emoryi ssp. arida</u> Emory's desert-mallow	Malvaceae	CBS, DMW
<u>Sphaeralcea orcuttii</u> Orcutt's desert-mallow	Malvaceae	CBS, DMW
<u>Stephanomeria pauciflora</u> Wire-lettuce	Asteraceae	CBS, DMW
<u>Stillingia linearifolia</u> Linear-leaved stillingia	Euphorbiaceae	CBS, DMW
<u>Stillingia spinulosa</u> Annual stillingia	Euphorbiaceae	CBS
<u>Tamarix aphylla**</u> Tamarisk	Tamaricaceae	DMW
<u>Tamarix ramosissima**</u>	Tamaricaceae	DRW, DMW
<u>Tidestromia oblongifolia</u> Arizona honey-sweet	Amaranthaceae	CBS

\*Sensitive Plant Species

\*\*Non-native plant

Reference: Munz, Philip A. 1974. A Flora of Souther California. University of California Press, Los Angeles, 1086 pp.

CBS - Creosote Bush Scrub  
 DDSP - Desert Dunes Sand Plant (Psammophytic)  
 DMW - Desert Microphyll Woodlands  
 DRW - Desert Riparial Woodlands  
 DRW (canal) - Canal Banks

Wildlife Species List for the Grand/Dunes

Geographical Listing Area by Habitat Type/

Species	Habitat Type					
	Crookets Bush Scrub	Desert Dunes Sand Flats	Desert	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll Woodland

AMPHIBIANS

Spadefoot Toads: Pelobatidae

Coach's Spadefoot Toad

ponds

ponds

ponds

Bufo torosus

?

?

?

Tree Toads: Bufonidae

Colorado River Toad

Bufo alvarius

?

Woodhouse's Toad

Bufo woodhousei

Spotted Toad

Bufo punctatus

Great Plains Toad

Bufo macrotis

APPENDIX D

List of Animal Species/Habitat Type

Tree Frogs: Hylidae

Leopard Frog

Rana sierrae

Red Frog

Rana aurora

REPTILES

Slider and Box Turtles, Tortoises:

Testudinidae

Western Tortoise

Testudo agassizii

Spiny Softshell: Trionychidae

Spiny Softshell

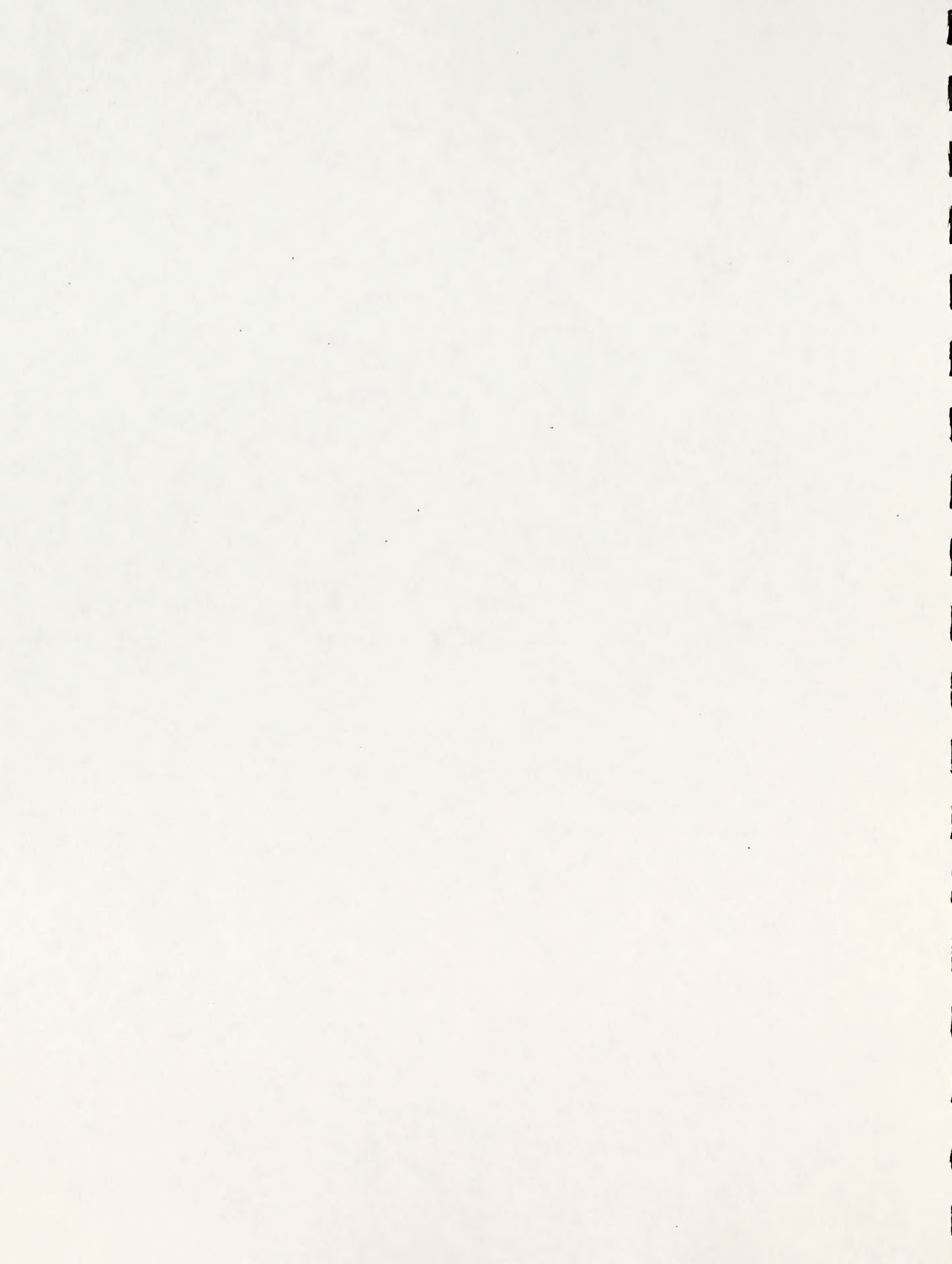
Apalone spiniferus

in ponds

Lizards: Gekkonidae

Spotted Lizard

Crotaphytus wislizenii





Wildlife Species List for the Glamis/Dunes

Geothermal Lease Area by Habitat Type<sup>1/</sup>

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll Woodland

AMPHIBIANS

Spadefoot Toads: Pelobatidae

Couch's Spadefoot Toad

ponds

ponds

ponds

Scaphiopus couchi

P

S

S

True Toads: Bufonidae

Colorado River Toad

Bufo alvarius

P

Woodhouse's Toad

Bufo woodhousei

S

Red-spotted Toad

Bufo punctatus

S

Great Plains Toad

Bufo cognatus

S

True Frogs: Ranidae

Leopard Frog

Rana pipiens

S

Bullfrog

Rana catesbeiana

S

REPTILES

Water and Box Turtles, Tortoises,

Allies: Testudinidae

Desert Tortoise

Gopherus agassizi

P

P

Softshell Turtles: Trionychidae

Spiny Softshell

Trionyx spiniferus

in canals

S

Geckos: Gekkonidae

Banded Gecko

Coleonyx variegatus

P

P

S

S

S

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll	Desert Woodland

Iguanids: Iguanidae

Desert Iguana						
<u>Dipsosaurus dorsalis</u>	P	P	P	P		P
Chuckwalla						
<u>Sauromalus obesus</u>	P			P		
Zebra-tailed Lizard						
<u>Callisaurus draconoides</u>	P	P	S	P		
California Desert Fringe-toed Lizard						
<u>Uma notata</u>	S	P				P
Collared Lizard						
<u>Crotaphytus collaris</u>				S		
Leopard lizard						
<u>Gambelia wislizenii</u>	P	S	S	P		
Desert Spiny Lizard						
<u>Sceloporus magister</u>	P	S	S	S		
Side-blotched Lizard						
<u>Uta stansburiana</u>	P	S		P		P
Long-tailed Brush Lizard						
<u>Urosaurus graciosus</u>	P	S		P		
Desert Horned Lizard						
<u>Phrynosoma platyrhinos</u>	S	S				
Flat-tailed Horned Lizard		edges				
<u>Phrynosoma mcallii</u>	P	S		S		

Whiptails: Teiidae

Western Whiptail						
<u>Cnemidophorus tigris</u>	P	S	S	P		P

Colubrids: Colubridae

Spotted Leaf-nosed Snake						
<u>Phyllorhynchus decurtatus</u>	S	S	S			
Coachwhip Snake						
<u>Masticophis flagellum</u>	P	P		S		P
Red Racer						
<u>Masticophis flagellum piceus</u>	S	S	S			S
Desert Patch-Nosed Snake						
<u>Salvadora hexalepis hexalepis</u>	P	P	S	P		

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/	Desert Microphyll	Desert Woodland

Glossy Snake <u>Arizona elegans</u>	S	S	S		P	
Gopher Snake <u>Pituophis melanoleucus</u>	S	S	S		S	
Yuma Kingsnake <u>Lampropeltis getulus yumensis</u>	S	S	S		S	
Checkered Garter Snake <u>Thamnophis marcianus</u>			S			
Colorado Desert Shovel-nosed Snake <u>Chionactis occipitalis annulata</u>	S	S				
Banded Sand Snake <u>Chilomeniscus cinctus</u>		S				
Sonora Lyre Snake <u>Trimorphodon biscutatus</u>					S	
Night Snake <u>Hypsiglena torquata</u>	S	S			S	
<b>Vipers: Viperidae</b>						
Western Diamondback Rattlesnake <u>Crotalus atrox</u>	S		S		S	P
Sidewinder <u>Crotalus cerastes</u>	S	P			P	

#### BIRDS

##### Grebes: Podicipedidae

Eared Grebe <u>Podiceps caspicus</u>					P	
Pied-Billed Grebe <u>Podilymbus podiceps</u>					P	

##### Herons and Bitterns: Ardeidae

Great Blue Heron <u>Ardea herodias</u>					P	
---	--	--	--	--	---	--

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll	Desert Microphyll Woodland

Swans, Geese, Ducks: Anatidae

Canada Goose						
<u>Branta canadensis</u>						S
Mallard						
<u>Anas platyrhynchos</u>						P
Green-winged Teal						
<u>Anas crecca carolinensis</u>						P
Cinnamon Teal						
<u>Anas cyanoptera</u>						P
Northern Shoveler						
<u>Spatula clypeata</u>						S
Redhead						
<u>Aythya americana</u>						S
Canvasback						
<u>Aythya valisneria</u>						S
Ruddy Duck						
<u>Oxyura jamaicensis</u>						P
Common Merganser						
<u>Mergus merganser</u>						P

American Vultures:

<u>Cathartidae</u>						
Turkey Vulture						
<u>Cathartes aura</u>	P	S			P	

Hawks, Harriers, Eagles:

<u>Accipitridae</u>						
Cooper's Hawk						
<u>Accipiter cooperii</u>	S				P	P
Sharp-shinned Hawk						
<u>Accipiter striatus</u>	S	S	S	S	S	S
Red-tailed Hawk						
<u>Buteo jamaicensis</u>	P	P	P	P	P	P
Swainson's Hawk						
<u>Buteo swainsoni</u>	S					
Ferruginous Hawk						
<u>Buteo regalis</u>	S		P			
Marsh Hawk						
<u>Circus cyaneus</u>	P		S	P	P	P

Species	Habitat Type					
	Creosote Bush Scrub	Dune Sand Plant	Desert	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll Woodland
<u>Osprey: Pandionidae</u>						
Osprey						
<u>Pandion haliaetus</u>						S
<u>Caracaras and Falcons: Falconidae</u>						
Prairie falcon						
<u>Falco mexicanus</u>	P	P				S P
American Kestrel						
<u>Falco sparverius</u>	P	P				P
<u>Quails, Partridges, Pheasants:</u>						
<u>Phasianidae</u>						
Gambel's Quail						
<u>Lophortyx gambelii</u>	P	S				P P
<u>Rails, Gallinules, Coots:</u>						
<u>Rallidae</u>						
Yuma Clapper Rail						
<u>Rallus longirostris yumanensis</u>						S
California Black Rail						
<u>Laterallus jamaicensis</u>						S
American Coot						
<u>Fulica americana</u>						P
<u>Plovers, Turnstones, Surfbirds:</u>						
<u>Charadriidae</u>						
Killdeer			by canal			
<u>Charadrius vociferus</u>			S			S
<u>Sandpipers, etc.: Scolopacidae</u>						
Long-billed Curlew						fly over
<u>Numenius americanus</u>						P
Spotted Sandpiper						
<u>Actitis macularia</u>						P
Least Sandpiper						ponds
<u>Calidris minutilla</u>						P
Western Sandpiper						ponds
<u>Calidris mauri</u>						P
<u>Avocets and Stilts:</u>						
<u>Recurvirostridae</u>						
American Avocet						ponds
<u>Recurvirostra americana</u>						P

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll Woodland	

Black-necked Stilt  
Himantopus mexicanus

S  
Ponds  
P

Pigeons and Doves: Columbidae

White-winged Dove

Zenaida asiatica

P P S P P

Mourning Dove

Zenaida macroura

P breeds P P P

Ground Dove

Columbigallina passerina

P S P P S

Cuckoos, Roadrunners, Anis:

Cuculidae

Roadrunner

Geococcyx californianus

breeds  
P P P P P

Owls: Strigidae

Screech Owl

Otus asio

S

Great Horned Owl

Bubo virginianus

S S

Burrowing Owl

Speotyto cunicularia

P S

Long-eared Owl

Asio otus

S breeds  
P

Goatsuckers: Caprimulgidae

Poor-will

Phalaenoptilus nutallii

P S P

Lesser Nighthawk

Chordeiles acutipennis

P breeds  
S S P P

Swifts: Apodidae

Vaux's Swift

Chaetura vauxi

P P P

White-throated Swift

Aeronautes saxatalis

S S

Hummingbirds: Trochilidae

Costa's Hummingbird

Calypte costae

S P

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll	Desert Woodland

Rufous Hummingbird  
Selasphorus rufus  
 Calliope Hummingbird  
Stellula calliope

S

S

Woodpeckers: Picidae

Flicker  
Colaptes auratus cafer  
 Ladder-backed Woodpecker  
Dendrocopos scalaris

S

P

S

S

S

P

P

Tyrant Flycatchers: Tyrannidae

Western Kingbird  
Tyrannus verticalis  
 Wied's Crested Flycatcher  
Myiarchus tyrannulus  
 Ash-throated Flycatcher  
Myiarchus cinerascens  
 Black Phoebe  
Sayornis nigricans  
 Say's Phoebe  
Sayornis saya  
 Traill's Flycatcher  
Empidonax traillii  
 Dusky Flycatcher  
Empidonax oberholseri  
 Gray Flycatcher  
Empidonax wrightii  
 Western Flycatcher  
Empidonax difficilis  
 Western Wood Pewee  
Contopus sordidulus  
 Olive-sided Flycatcher  
Nuttallornis borealis

P

P

P

S

P

P

P

P

P

P

breeds

P

P

P

P

P

S

S

S

P

P

P

P

P

P

P

P

Larks: Alaudidae

Horned Lark  
Eremophila alpestris

P

P

P

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll	Woodland/ Creosote Bush Scrub	Desert Microphyll Woodland

Swallows: Hirundinidae

Tree Swallow						
<u>Iridoprocne bicolor</u>	P	P		P		P
Rough-winged Swallow						
<u>Stelgidopteryx ruficollis</u>	P	P	P	P		P
Barn Swallow		breeds				
<u>Hirundo rustica</u>	P	P	P	P		P
Cliff Swallow						
<u>Petrochelidon pyrrhonota</u>	P	P	P	P		P

Jays, Magpies, Crows: Corvidae

Common Raven						
<u>Corvus corax</u>	S			S		S

Titmice, Verdins, Bushtits:

<u>Paridae</u>						
Verdin						
<u>Awriparus flaviceps</u>	P	P	S	P		P

Wrens: Troglodytidae

House Wren						
<u>Troglodytes aedon</u>	P			P		
Cactus Wren						
<u>Campylorhynchus brunneicapillum</u>	P	S	S	P		P
Long-billed Marsh Wren						
<u>Telmatodytes palustris</u>			P			
Rock Wren			canal edge			
<u>Salpinctes obsoletus</u>			P	P		

Mockingbirds and Thrashers:

<u>Mimidae</u>						
Mockingbird						
<u>Mimus polyglottos</u>	S		P	P		P
Le Conte's Thrasher		breeds				
<u>Toxostoma lecontei</u>	P	P		P		P
Crissal Thrasher						
<u>Toxostoma dorsale</u>	P	P	S	P		P



Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll Woodland	

Thrushes, Bluebirds, Solitaires:

Turdidae

Hermit Thrush

Hylocichla guttata

P

P

Mountain Bluebird

Sialia currucoides

P

Gnatcatchers, Kinglets, Old

World Warblers: Sylviidae

Blue-gray Gnatcatcher

Poleoptila caerulea

P

P

Black-tailed Gnatcatcher

Poleoptila melanura

P

P

S

P

P

Ruby-crowned Kinglet

Regulus calendula

P

P

S

P

P

Pipits, Wagtails: Motacillidae

Water Pipit

Anthus spinoletta

S

P

Silky Flycatchers: Ptilonotidae

Phainopepla

Phainopepla nitens

P

Shrikes: Laniidae

Loggerhead Shrike

Lanius ludovicianus

P

breeds

P

P

P

P

Starlings: Sturnidae

Starling

Sturnus vulgaris

S

P

P

P

Vireos: Vireonidae

Solitary Vireo

Vireo solitarius

S

P

Warbling Vireo

Vireo gilvus

P

P

P

P

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll	Desert Microphyll Woodland

Wood Warblers: Parvulidae

Orange-crowned Warbler <u>Vermivora celata</u>	P				P	P
Nashville Warbler <u>Vermivora ruficapilla</u>	P				P	P
Lucy's Warbler <u>Vermivora luciae</u>						P
Yellow Warbler <u>Dendroica petechia</u>	P		S		P	P
Yellow-rumped Warbler <u>Dendroica coronata</u>	P	P	P		P	P
Black-throated Gray Warbler <u>Dendroica nigrescens</u>	P				P	P
Townsend's Warbler <u>Dendroica townsendi</u>	P				P	P
Hermit Warbler <u>Dendroica occidentalis</u>					P	P
Blackpoll Warbler <u>Dendroica striata</u>					P	
MacGillivray's Warbler <u>Oporornis tolmiei</u>			S		P	P
Common Yellowthroat <u>Geothlypis trichas</u>			S		P	
Wilson's Warbler <u>Wilsonia pusilla</u>	P	P	S		P	P

Meadowlarks, Blackbirds, Orioles:

<u>Icteridae</u>						
Yellow-headed Blackbird <u>Xanthocephalus xanthocephalus</u>	P		S			
Red-winged Blackbird <u>Agelaius phoeniceus</u>	P		S		P	
Hooded Oriole <u>Icterus cucullatus</u>			S		P	
Scott's Oriole <u>Icterus parisorum</u>	S				P	
Northern Oriole <u>Icterus galbula</u>					P	
Brewer's Blackbird <u>Euphagus cyanocephalus</u>	P		S			
Brown-headed Cowbird <u>Molothrus ater</u>			S		P	

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll	Desert Microphyll Woodland

Tanagers: Thraupidae

Western Tanager

Piranga ludoviciana

S

P

P

Grosbeaks, etc.: Fringillidae

Black-headed Grosbeak

Peucliticus melanocephalus

P

P

P

Blue Grosbeak

Guiraca caerulea

S

Lazuli Bunting

Passerina amoena

S

P

P

House Finch

breeds

Carpodacus mexicanus

P

P

P

P

P

Lesser Goldfinch

Spinus psaltria

P

P

P

P

P

Green-tailed Towhee

Chlorura chlorura

P

P

Rufous-sided Towhee

Pipilo erythrophthalmus

S

Abert's Towhee

Pipilo aberti

P

Lark Bunting

Calamospiza melanocorys

P

S

P

Savannah Sparrow

Passerculus sandwichensis

S

P

Vesper Sparrow

Poocetes gramineus

P

P

Lark Sparrow

Chondestes grammacus

P

P

Black-throated Sparrow

Amphispiza bilineata

P

Sage Sparrow

Amphispiza belli

P

P

Dark-eyed Junco

Junco hyemalis

P

Chipping sparrow

Spizella passerina

P

P

P

Brewer's Sparrow

Spizella breweri

P

S

S

P

P

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/Creosote Bush Scrub	Desert Microphyll	Desert Woodland

White-crowned Sparrow <u>Zonotrichia leucophrys</u>	S	P	P			
Golden-crowned Sparrow <u>Zonotrichia altricapilla</u>	P		P	P		P
Lincoln's Sparrow <u>Melospiza lincolni</u>			P			along canal P
Desert Song Sparrow <u>Melospiza melodia</u>			P			

MAMMALS

Leafnose Bats: Phyllostomatidae

Leafnose Bat <u>Macrotis californicus</u>		S				
--	--	---	--	--	--	--

Plainnose Bats: Vespertilionidae

California Myotis <u>Myotis californicus</u>	P			flies through S		
Western Pipistrelle <u>Pipistrellus hesperus</u>	P		S		P	
Big Brown Bat <u>Eptesicus fuscus</u>	breeds P				P	
Spotted Bat <u>Euderma maculata</u>	S	S	S		S	S

Freetail Bats: Molossidae

Mexican Freetail Bat <u>Tadarida brasiliensis</u>	S	S	S		S	S
--	---	---	---	--	---	---

Raccoons and Coatis: Procyonidae

Raccoon <u>Procyon lotor</u>				S		
---------------------------------	--	--	--	---	--	--

Dogs, Wolves, Foxes: Canidae

Coyote <u>Canis latrans</u>	P	P	P		P	S
Kit Fox <u>Vulpes macrotis</u>	breeds P				P	P
Gray Fox <u>Urocyon cinereoargenteus</u>	S					

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/ Creosote Bush Scrub	Desert Microphyll Woodland	

Squirrels: Sciuridae

Roundtail Ground Squirrel

Citellus tereticaudus

P

P

P

P

P

Whitetail Antelope Squirrel

Ammospermophilus leucurus

P

Pocket Gophers: Geomyidae

Valley Pocket Gopher

Thomomys bottae

S

S

S

Pocket Mice, Kangaroo Mice

Kangaroo Rats: Heteromyidae

Little Pocket Mouse

Perognathus longimembris

S

S

S

S

S

Desert Pocket Mouse

Perognathus pencillatus

P

Spiny Pocket Mouse

Perognathus spinatus

S

S

S

S

S

Little Desert Pocket Mouse

Perognathus arenarius

S

S

Desert Kangaroo Rat

Dipodomys deserti

P

P

P

Merriam Kangaroo Rat

Dipodomys merriami

P

S

P

P

Mice, Rats, etc.: Cricetidae

Cactus Mouse

Peromyscus eremicus

S

Dear Mouse

Peromyscus maniculatus

S

Whitethroat Woodrat

Neotoma albigula

S

P

Desert Woodrat

Neotoma lepida

P

Muskrat

Ondatra zibethica

S

Hares and Rabbits: Leporidae

Blacktail Jackrabbit

Lepus californicus

P

P

P

P

P

Desert Cottontail

Sylvilagus auduboni

P

P

S

P

P

Species	Habitat Type					
	Creosote Bush Scrub	Desert Dune Sand Plant	Desert Riparian Woodland	Desert Microphyll Woodland/	Desert Microphyll	Desert Microphyll Woodland

Deer: Cervidae

Burro Deer

Odocoileus hemionus

S

INSECTS<sup>2/</sup>

Scarab Beetles: Scarabaeidae

Andrew's Dune Scarab Beetle

Pseudocotalpa andrewsi

S

1/ P = Presence confirmed.

S = Species suspected to occur within habitat type, as determined by the literature, but not observed.


2/ Sensitive species only.

APPENDIX E

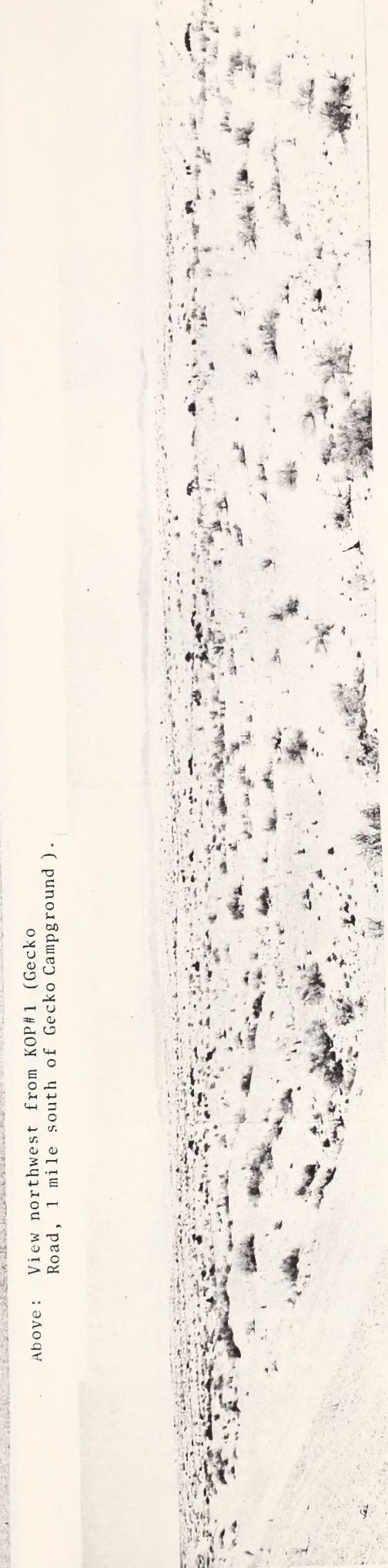
PICTORIAL VIEWS FROM "KNOWN OBSERVATION POINTS" (KOP)





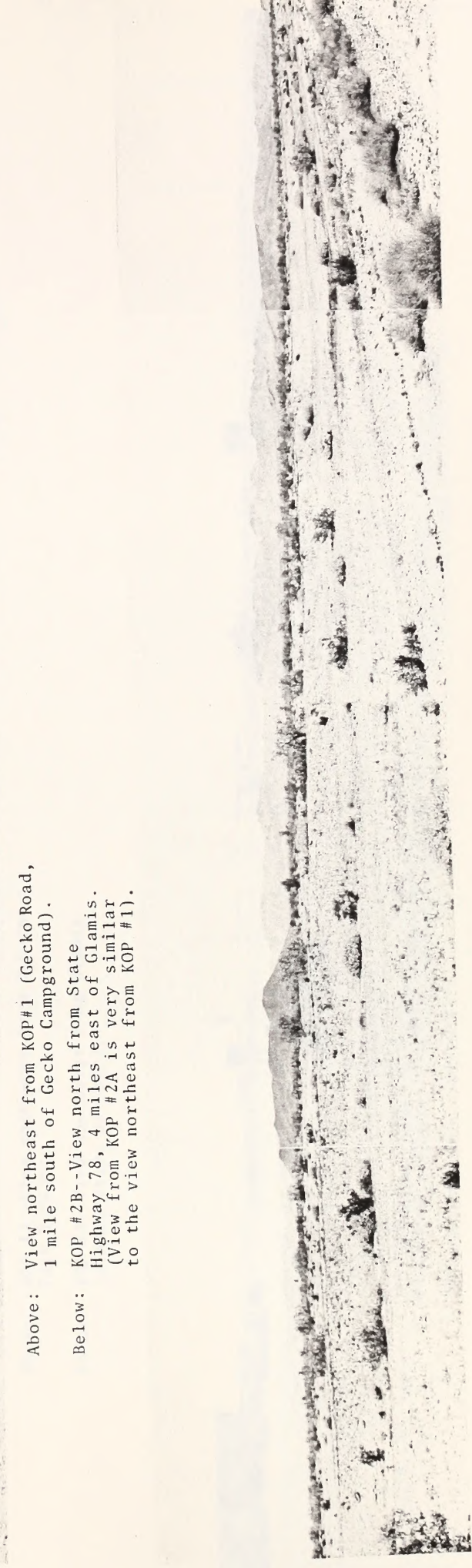


Above: View northwest from KOP#1 (Gecko Road, 1 mile south of Gecko Campground).

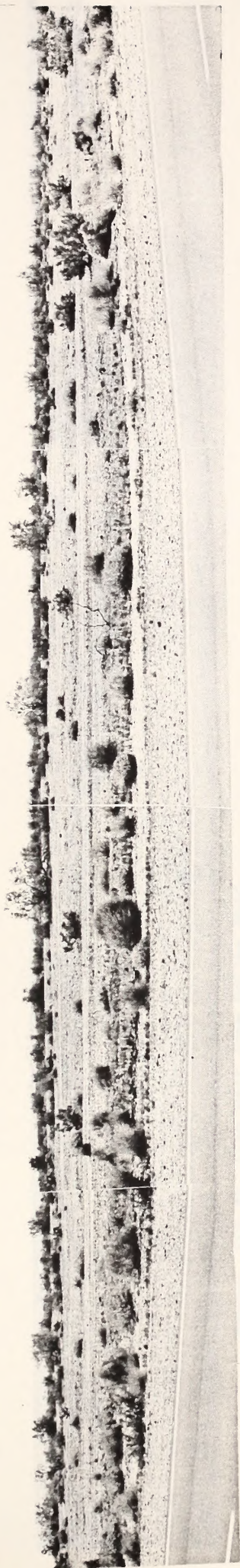


Above: View northeast from KOP#1 (Gecko Road, 1 mile south of Gecko Campground).

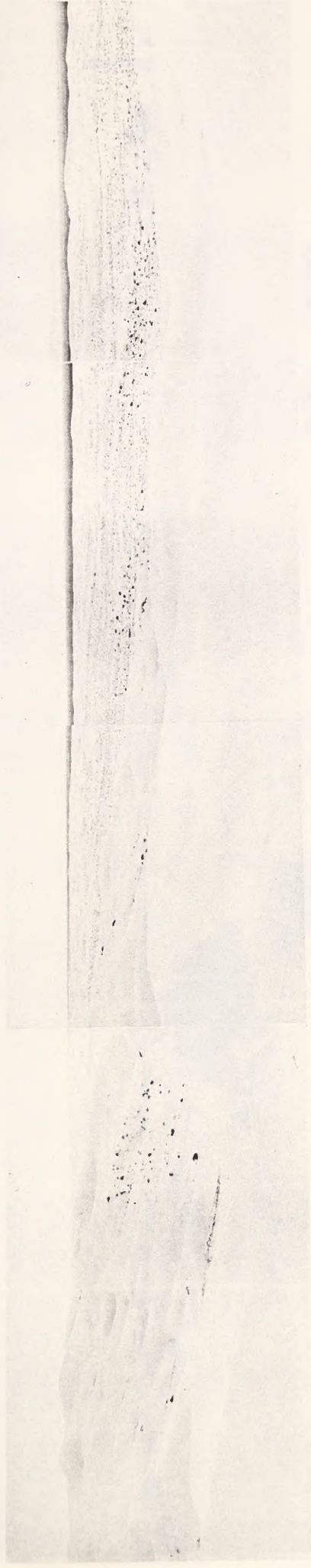
Below: KOP #2B--View north from State Highway 78, 4 miles east of Glamis. (View from KOP #2A is very similar to the view northeast from KOP #1).





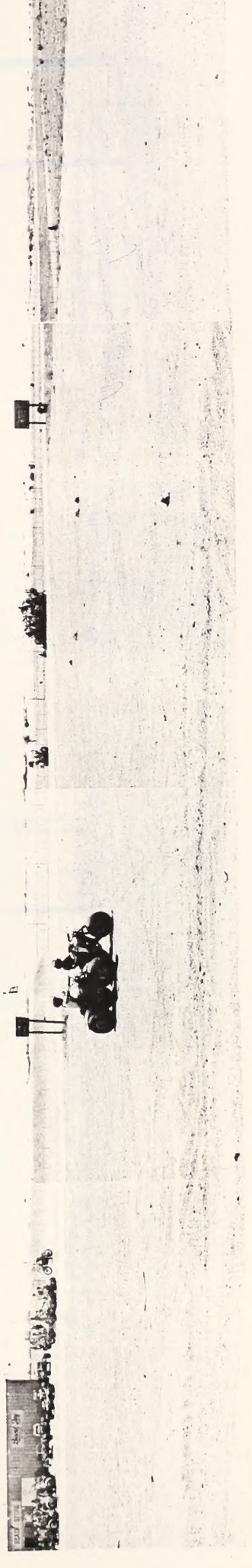


Above: KOP #2B--View south from Highway 78.



Above: KOP #3--View southwest from Osborne Park lookout.

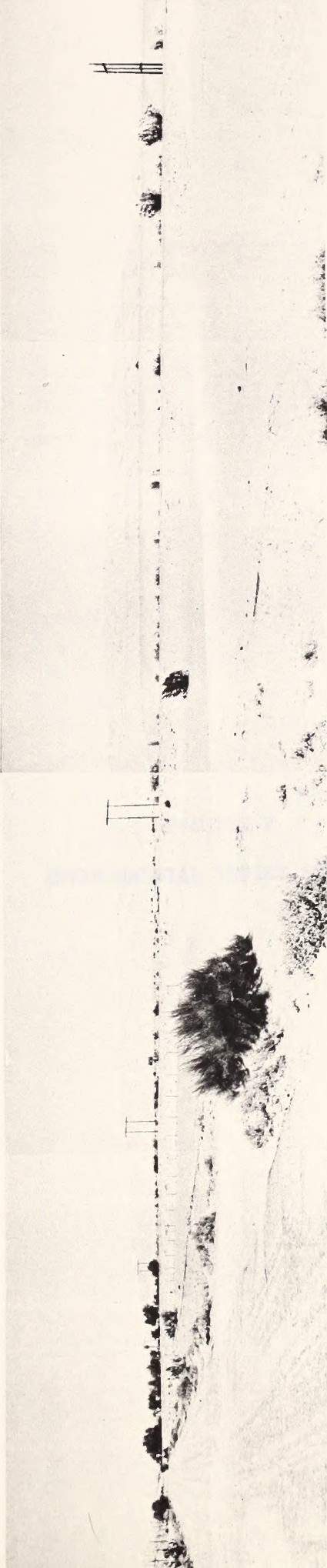
Below: KOP #4--View southwest from Glamis (Glamis Store at left).



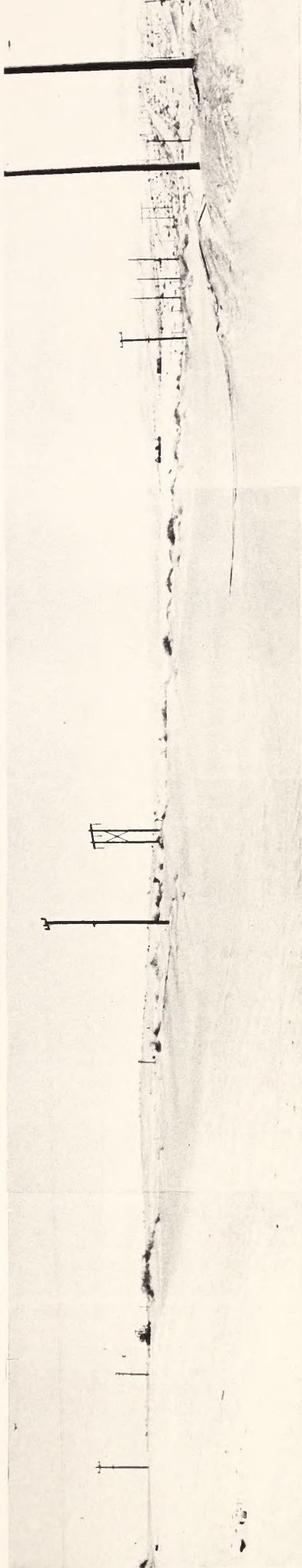




Above: KOP #5--View west from Ogilby Road near turnoff to Gold Rock Ranch.



Above: KOP #6--View northwest across Interstate 8 from Buttercup Valley area.



Below: KOP #6--View northeast across Interstate 8 from Plank Road area.











Table F continued.

Environmental Parameter	Impact Evaluation of Alternatives			Mitigating Measures for Alternatives			Unavoidable Impacts	Severity of Impact Level or Degree of Impact
	Alt. I.	Alt. II	Alt. III	Alt. I	Alt. II	Alt. III		
Soils	The soils of the Glamis/ surface area	The amount of surface area impacted by Dunes generally are easily compacted when wet. Compacted soils tend to lessen the ability of natural foliage to grow.	No impact	(1)Glamis/Dunes EA mitigation measure: Alt. #1 Soils 1,2,3,4,5,6, (2)GRO Order 4	(1)Same (2)Special lease stipulations	None	Some loss of agricultural land and minor erosion.	Not significant
	Air Quality	The production of H <sub>2</sub> S gases and dust from geothermal Production & construction may impact air quality.	Same	No impact	(1)Glamis/Dunes EA mitigation Action 1 (2)GRO Order 4	Same	Some increase in pollution levels.	Not significant
Visual	High profile projects such as transmission lines & cooling towers & steam plumes from KOPs. Low profile projects such as pipelines, roads & drill pads will produce varying contrast levels depending on their proximity to the KOPs.	Areas of high visibility will be designated for controlled surface occupancy.	No impact	(1)GRO Order 4 (2)Glamis/Dunes EA mitigation Action #1, visual	(1)All Alt. I (2)Glamis/ Dunes EA mitigation measures & Alt. #2 visual resources.	None	Some change in visual quality.	Not significant

Table F continued.

Environmental Parameter	Impact Evaluation of Alternatives			Mitigating Measures for Alternatives			Unavoidable Impacts	Severity of Impact Level or Degree of Impact
	Alt. I.	Alt. II	Alt. III	Alt. I	Alt. II	Alt. III		
Socio-Economics	Impacts considered to be a positive increase of the economic base.	Same	Impact considered to be a reduction in available geothermal development within the region, thus an overall reduction to base economy.	(1) Glamis/Dunes EA mitigation Action #1	Same	None	Some positive effects in economic base.	Alt. 1 & 2 positive Alt. 3 not significant
	Noise levels during exploration and construction are short lived but highly intensive reaching levels of 100 dBA and higher.	Areas of high sensitivity and well identified and leased with provisions for surface occupancy.	No impact	(1) GRO Order 4 EA mitigation #1 noise	(1) Same as Alt. (2) EA mitigation #2 noise mitigation	None	Some increase in ambient noise level.	Alt. 1 significant Alt. 2 not significant
	Noise levels during plant operation are long term and might affect wildlife outside plant site (see flora and fauna).							

Table F continued.

Environmental Parameter	Impact Evaluation of Alternatives			Mitigating Measures for Alternatives			Unavoidable Impacts	Severity of Impact Level or Degree of Impact
	Alt. I.	Alt. II	Alt. III	Alt. I	Alt. II	Alt. III		
Cultural	The majority of cultural resources are surface manifested and not leased with are extremely fragile and nonrenewable.	Areas of high sensitivity, well identified and leased with provisions for surface occupancy.	No impact	(1)GRO Order 4 Standard lease (3)Glamis/Dunes EAR mitigation	(1)Same Alt. 1 (2)No surface occupancy on identified highly sensitive resource site.	None	Some loss of cultural information.	Alt. 1 moderate to potentially significant Alt. 2 not significant
	Flora and Fauna	Loss of vegetation and habitat, disruption of wildlife behavior, and possible physiological changes caused by noise and human activities crushing of wildlife & vegetation by vehicles, lowering of water table influencing plant and wildlife survival.	Through an identification of and the limiting of surface occupancy in sensitive flora and fauna resources sites, the impacts upon these fragile resources will be greatly reduced.	No impact	(1)GRO Order 4 Standard lease strips. (3)EA mitigation Alt. #1	(1)Same Alt. 1 (2)No surface occupancy on identified highly sensitive resource sites.	None	Some loss or displacement of wildlife and vegetation.

Table F-2. The Level-of Significance Represented by each of the 10 Criteria Listed in 40 CFR 1508.27 for the Proposed Lease of Federal Lands in the Glamis/Dunes Area, Imperial County, California.

Key: NI - No Perceived Impact  
 MI - An Impact is Perceived but is not major and is Mitigateable  
 NS - An Impact is Perceived, is considered major but can be Mitigated  
 SI - A Significant Impact

<u>40 CFR 1508.27 Criteria</u>	<u>Alt. I</u>	<u>Alt. II</u>	<u>Alt. III</u>
1. Beneficial and/or Adverse Effects	NS	NS	MI
2. Public Health and Safety	NS	MI	NI
3. Unique Characteristics of the Geographical Area	NS	MI	NI
4. Effect Highly Controversial	NS	NI	NI
5. Highly Uncertain Effects or Unique or Unknown Risks	NS	MI	NI
6. Establishes Precedent for Future Actions or is a Decision in Principle About Future Action	NS	MI	MI
7. Assessment of Cumulative Actions and Impacts	NS	MI	NI
8. Effect on District, Sites, Highways, Structures, or Objects Listed in or Eligible for Listing in the National Register or Historic Places or may Cause Loss or Destruction of Significant Scientific, Cultural, Historical Resources	NS	MI	NI
9. Effects on Endangered or Threatened Species or Their Habitat that have been Determined to be Critical Under the Endangered Species Act of 1973	NS	MI	NI
10. Threatens a Violation of Federal, State or Local Law or Requirements Imposed for the Protection of the Environment	NS	MI	NI



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