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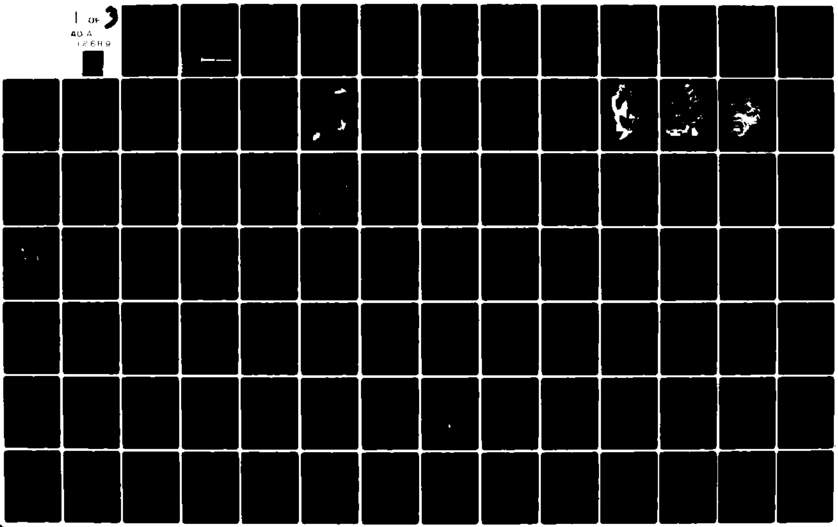

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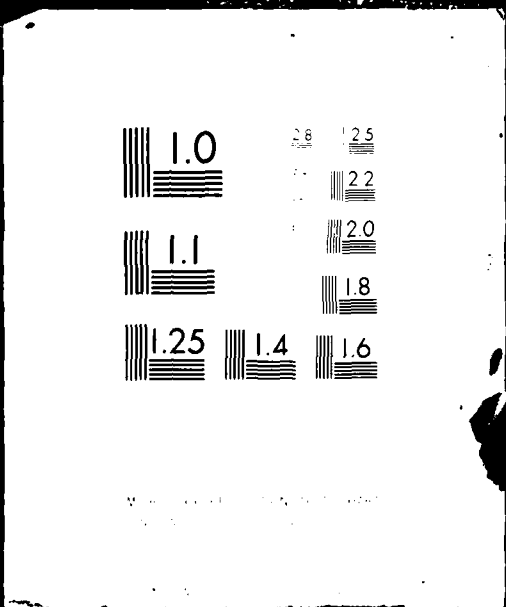

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# ENVIRONMENTAL ASSESSMENT REPORT: GEOTECHNICAL FIELD INVESTIGATIONS

Conducted for:

DEPARTMENT OF THE AIR FORCE
SPACE AND MISSILE SYSTEMS ORGANIZATION (SAMSO)
Contract No. F04701-74-D-0013

BY:

FUGRO NATIONAL, INC.

Project No. N-74-066-EG

30 June 1975

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The purpose was to assess the potential environmental impacts of activities included in the recommended geotechnical field investigation program in three MX siting areas. Siting areas are in Nevada, Arizona, New Mexico, and Texas.


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# 1.0 INTRODUCTION

## 1.1 FORWARD

This report was prepared for the Department of the Air Force, Space and Missile Systems Organization (SAMSO) in compliance with the statement of work in Contract No. F04701-74-D-0013 and deals with siting of the MX Land Mobile Advanced ICBM system. This contract was authorized under program Element 63305F as described in 26 February, 1973, Missile X Program Plan.

Technical sections of this report (Volume IV of IV) were prepared and reviewed by Kenneth L. Wilson, Senior Geologist, and Elaine J. Bell, Staff Geologist. Impact evaluation and overall review were performed by NUS Corporation under the supervision of C. G. Mattsson. Technical data were derived predominantly from the Geotechnical Reports, Volumes IIA, IIB and IIC and from the Recommended Geotechnical Field Investigation Report, Volume III.

The MX Siting Investigation deals with three separate Department of Defense (DoD) areas shown in Figure 1.1-1: the combined White Sands Missile Range/Fort Bliss Military Reservation (WSMR/FBMR); the combined Yuma Proving Grounds/ Luke-Williams Bombing and Gunnery Range (YPG/LWBGR; and the Nellis Air Force Base Bombing and Gunnery Range (NBGR).

The three DoD siting areas lies within the states of Nevada (NBGR), Arizona (YPG/LWBGR), and New Mexico and Texas

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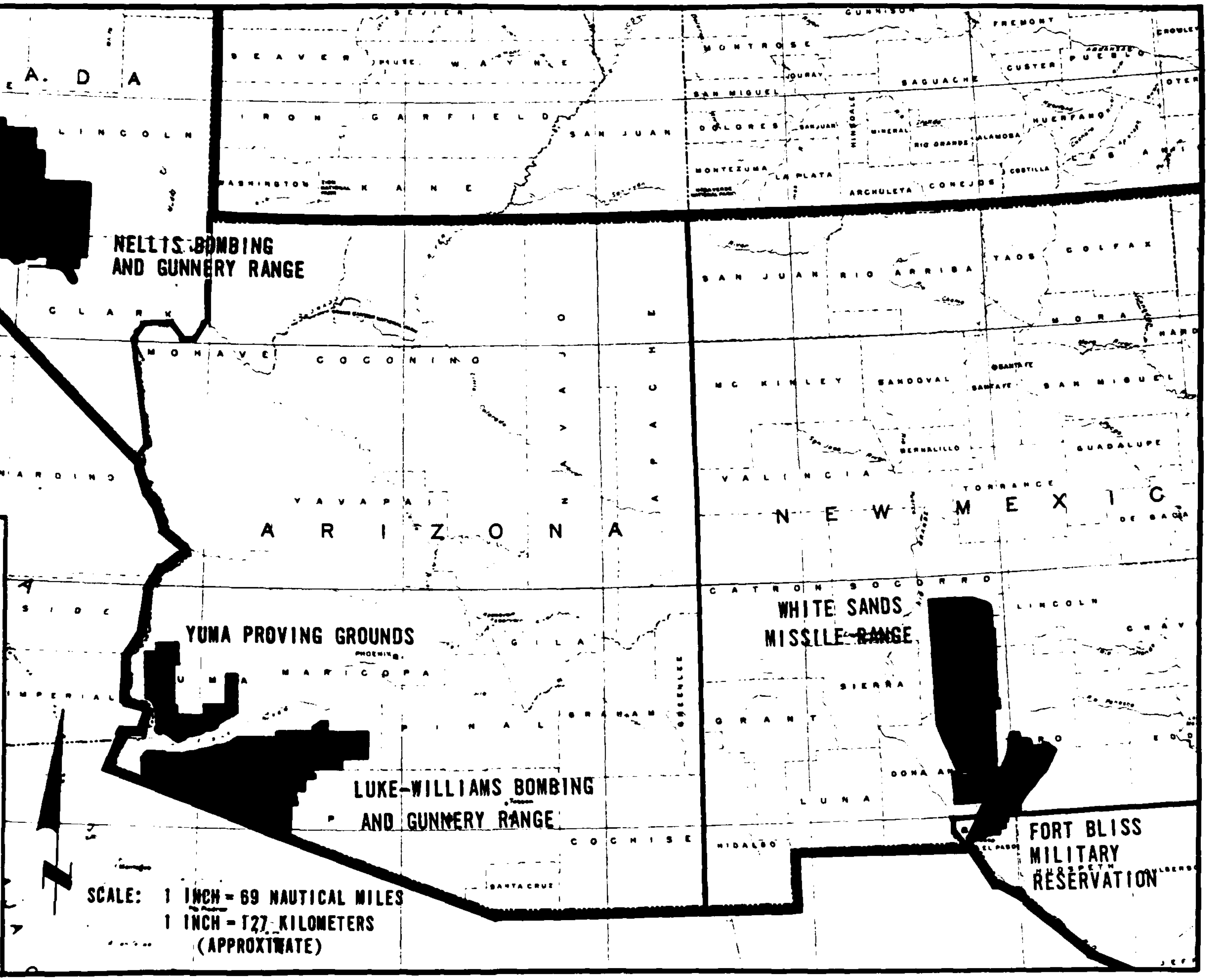


SITING AREA LOCATIONS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 1.1-1

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(WSMR/FBMR). They encompass a total of approximately 12,880 square nautical miles ($nm^2$).

Written material for the total MX Siting Investigation is presented in four volumes which specifically consist of:

| | |
|---|---|
| Volume I | Siting Evaluation Report |
| Volumes IIA, IIB, and IIC | Geotechnical Reports |
| | IIA WSMR/FBMR<br>IIB YPG/LWBGR<br>IIC NBGR |
| Volume III | Recommended Geotechnical Field Investigations |
| Volume IV | Environmental Assessment Report: Geotechnical Field Investigations |

## 1.2 PURPOSE

The purpose of this environmental report is to assess the potential for environmental impacts of activities included in the recommended geotechnical field investigation program on the three DoD siting areas. The assessment relates only to those field activities of significant impact outlined in Recommended Geotechnical Field Investigations, Volume III. It is intended that this report will serve as a source document to which very brief environmental statements will be referenced prior to the initiation of a specific field task or group of related tasks within DoD. The descriptions of environmental parameters are more detailed than necessary to describe impacts related to the field investigation recommended in Volume III in order that the document remain flexible enough to handle an increased scope of activities or later phase field investigations.

Reporting on the existing characteristics of the environment and the potential impacts is weighted most heavily toward the ecological and physical aspects of the siting areas rather than the social, economic, land management, or other aspects. This is dictated by the relatively modest scale of the proposed action and the knowledge of which environmental factors will be subject to the most direct effects of such an action. It is not the purpose of this report to assess in any way the potential impacts associated with construction and deployment of the MX land mobile system.

This environmental assessment report is designed to follow the outline suggested in Air Force Regulations 19-1 and 19-2 and their Attachments 1 and 2. This volume will be used to support the more detailed studies necessary to satisfy the full intent of the regulations. In order to completely satisfy the regulations, detailed studies must be performed at the specific field investigation sites. This volume will be used as the data base for the site-specific detailed studies.

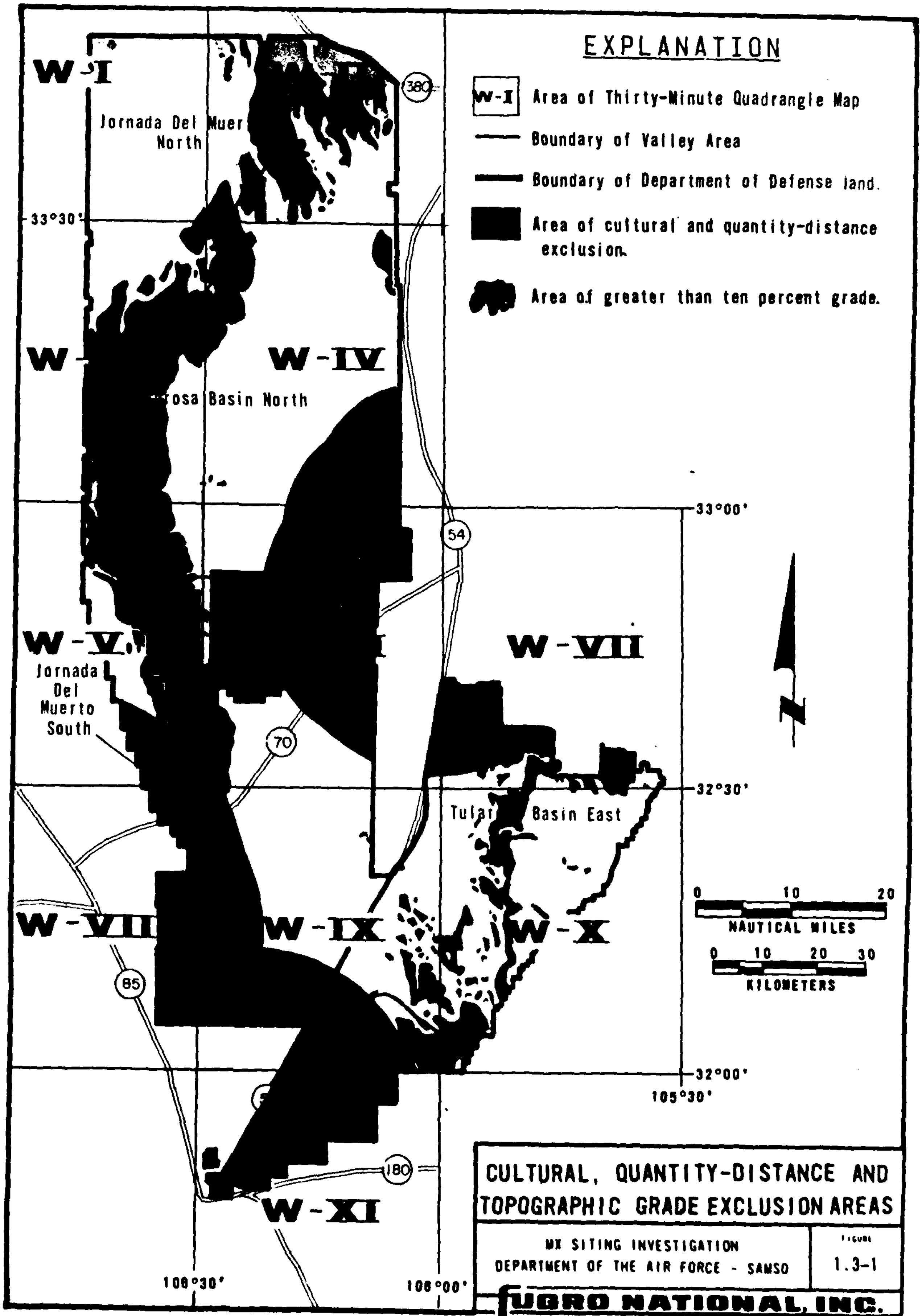
## 1.3 SCOPE

This report describes the three DoD siting areas shown in Figure 1.1-1. Areas within DoD excluded from siting consideration (Figures 1.3-1, 1.3-2 and 1.3-3) were studied in the detail necessary to determine the extent to which their environments may interact with the non-excluded siting area. No other areas were studied. Access to a specific investigative site may entail crossing an excluded area, but such activities should be limited in number and in scope, and will be fully studied, evaluated, and reported prior to execution. Excluded areas include:

1. DoD land with topographic grade greater than ten percent; and
2. Land within designated quantity-distance and major cultural exclusions.

The scope of the study included the following:

1. Collection of data from readily available literature sources in the detail necessary to describe the critical environmental systems in the siting areas;
2. Observations made during brief aerial and ground field reconnaissance of the siting areas;
3. Discussions with persons knowledgeable about the environmental systems in the areas;
4. Evaluation of the collected data, observations, and opinions;
5. Determination of the impacts of the recommended geotechnical field investigation discussed in Volume III on the environmental systems.




CULTURAL, QUANTITY-DISTANCE AND TOPOGRAPHIC GRADE EXCLUSION AREAS

MX SITING INVESTIGATION
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FIGURE 1.3-1

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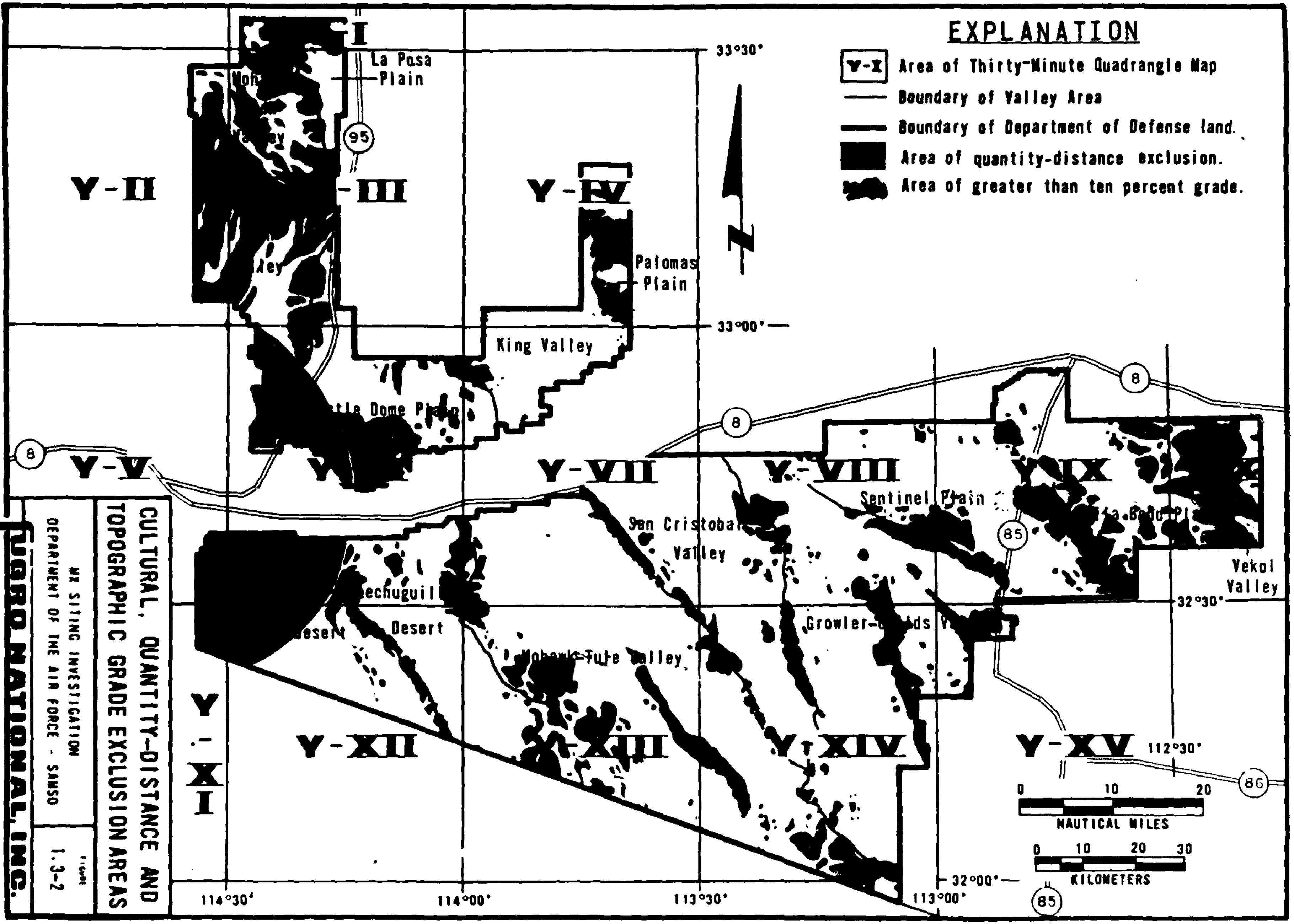


CULTURAL, QUANTITY-DISTANCE AND TOPOGRAPHIC GRADE EXCLUSION AREAS

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FIGURE 1.3-2

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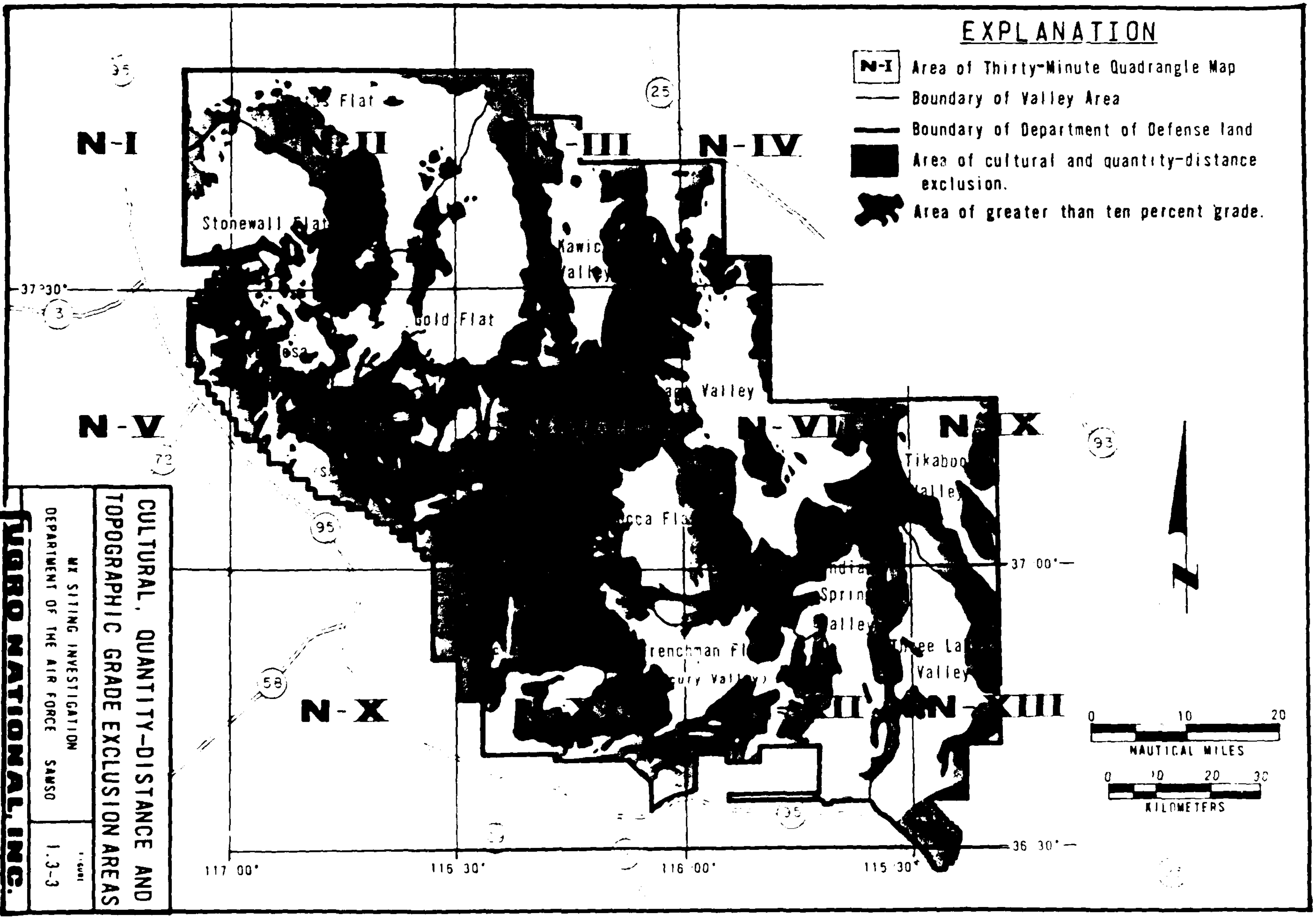


CULTURAL, QUANTITY-DISTANCE AND TOPOGRAPHIC GRADE EXCLUSION AREAS

MX SITING INVESTIGATION
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FIGURE 1.3-3

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## 1.4 DESCRIPTION OF PROPOSED ACTION

### 1.4.1 GENERAL

Detailed descriptions of the Phase I investigative techniques are not presented here. Volume III presents the more detailed description of actual field program. The field techniques can be summarized in terms of their characteristic activities which will result in environmental impact. The environmental impact of field programs will be directly related to the amount of surface area disturbed by the field technique and supportive programs. The activities which will result in ground surface disturbance (0.32 percent of the total available siting area) are off-road driving, clearing of roads for vehicles, drilling, and trenching. Assumptions about the extent of these activities which will be required for the field investigation are presented in the following sections. These assumptions are related to a 250 $nm^2$ unit-area of investigation with dimensions ten nm wide and 25 nm long.

### 1.4.2 SURFACE RECONNAISSANCE

In each 250 $nm^2$ of the available DoD siting area it is assumed that surface mapping, aerial photo control, and surveying will require off-road driving with a four-wheel drive vehicle over 250 nm of native ground leaving a disturbed zone ten feet wide.

### 1.4.3 Geophysical Techniques

In each 250 $nm^2$ of the available DoD siting area it is assumed that all reconnaissance geophysical techniques will require 250 nm off-road driving with four-wheel drive vehicles over native ground leaving a disturbed zone ten feet wide. In addition, explosive charges of 5 to 50 pounds may be used very near the surface or emplaced in shallow drill holes.

### 1.4.4 Drilling

It has been assumed that the following drilling activities will be conducted within each 250 $nm^2$ of available DoD siting area.

1. Three holes will be drilled to a depth of 1,000 feet with a rotary wash or air drill rig. A drill pad 100 feet square will be cleared for each hole: this area will not include pits for waste water and mud.
2. At one of the three holes a 60-hour multipurpose pump test will be conducted. As a result of this pump test it is expected that there will be a discharge of water of between 1,000,000 and 1,500,000 gallons. Saline water will be contained and fresh water will be fed to drainage channels.
3. Discharge of saline water as well as discharge of drilling mud during drilling will be contained in mud pits. The drilling mud and any salt accumulation will be disposed of in accordance with EPA regulations.

4. Twenty thousand gallons of water will be trucked in for the drilling of each hole.
5. Twenty-five nm of dozer road 20 feet wide with a minimum 6-inch cut will be required to gain access to the drilling site.

1.4.5 TRENCHING

For each 250 $nm^2$ of available DoD siting area, the following disturbance is assumed to be related to trenching:

1. Ten trenches 200 feet long, 25 feet deep, and three feet wide with a spoil pile on both sides will be dug by a truck-mounted backhoe.
2. Off road movement by tracked vehicles will total 100 nm. These vehicles will produce a 20-foot wide disturbed zone.

1.4.6 LABOR FORCE

It is estimated that a labor force to perform these investigations will consist of 20 to 30 people in the unit area. The sequence of investigation and the time schedule will determine the total labor force.

1.4.7 AVAILABLE AREA

Based on the criteria that suitable siting areas must have a topographic grade of ten percent or less and remain outside specified cultural exclusion areas, the following areas are available for geotechnical investigations:

WSMR/FBMR 1,964 $nm^2$

| | |
|---|---|
| YPG/LWBGR | 2,913 $nm^2$ |
| NBGR | 2,017 $nm^2$ |

Areas in which investigations will proceed are shown in white in Figures 1.3-1, 1.3-2 and 1.3-3.

The area disturbed by the recommended field investigation activities is shown in Table 1.4-1. The areas were determined by:

1. Calculating the number of 250 $nm^2$ of unit area in each DoD siting area,
2. Calculating the amount of disturbed area in square nautical miles and percent of each unit area, and
3. Totaling the area of disturbance ($nm^2$ and percent) for each siting area.

The values in Table 1.4-1 were determined in this manner. They show for example that 0.6 $nm^2$ will be disturbed in WSMR/FBMR for drilling and drilling related activities. This value represents 0.03 percent of the available area for siting.

TABLE 1.4-1

AREA DISTURBED BY RECOMMENDED
GEOTECHNICAL FIELD INVESTIGATION ACTIVITIES

| | DRILLING* | | SURFACE MAPPING, SURVEYING, GEOPHYSICAL TECHNIQUES** | | TRENCHING*** | | TOTALS | |
|---|---|---|---|---|---|---|---|---|
| | Subtotal ($nm^2$) | % of Available Area | Subtotal ($nm^2$) | % of Available Area | Subtotal ($nm^2$) | % of Available Area | Total $nm^2$ | % of Available Area |
| WSMR/FBMR (1964 $nm^2$) | 0.6 | 0.03 | 3.3 | 0.16 | 2.6 | 0.13 | 6.5 | 0.32 |
| YPG/LWBGR (2913 $nm^2$) | 1.0 | 0.03 | 4.9 | 0.16 | 4.0 | 0.13 | 9.9 | 0.32 |
| NBGR (2017 $nm^2$) | 0.6 | 0.03 | 3.3 | 0.16 | 2.6 | 0.13 | 6.5 | 0.32 |

*99% of disturbance due to dozer roads and pads.
**100% of disturbance due to off-road driving.
***99% of disturbance due to off-road driving.

# 2.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

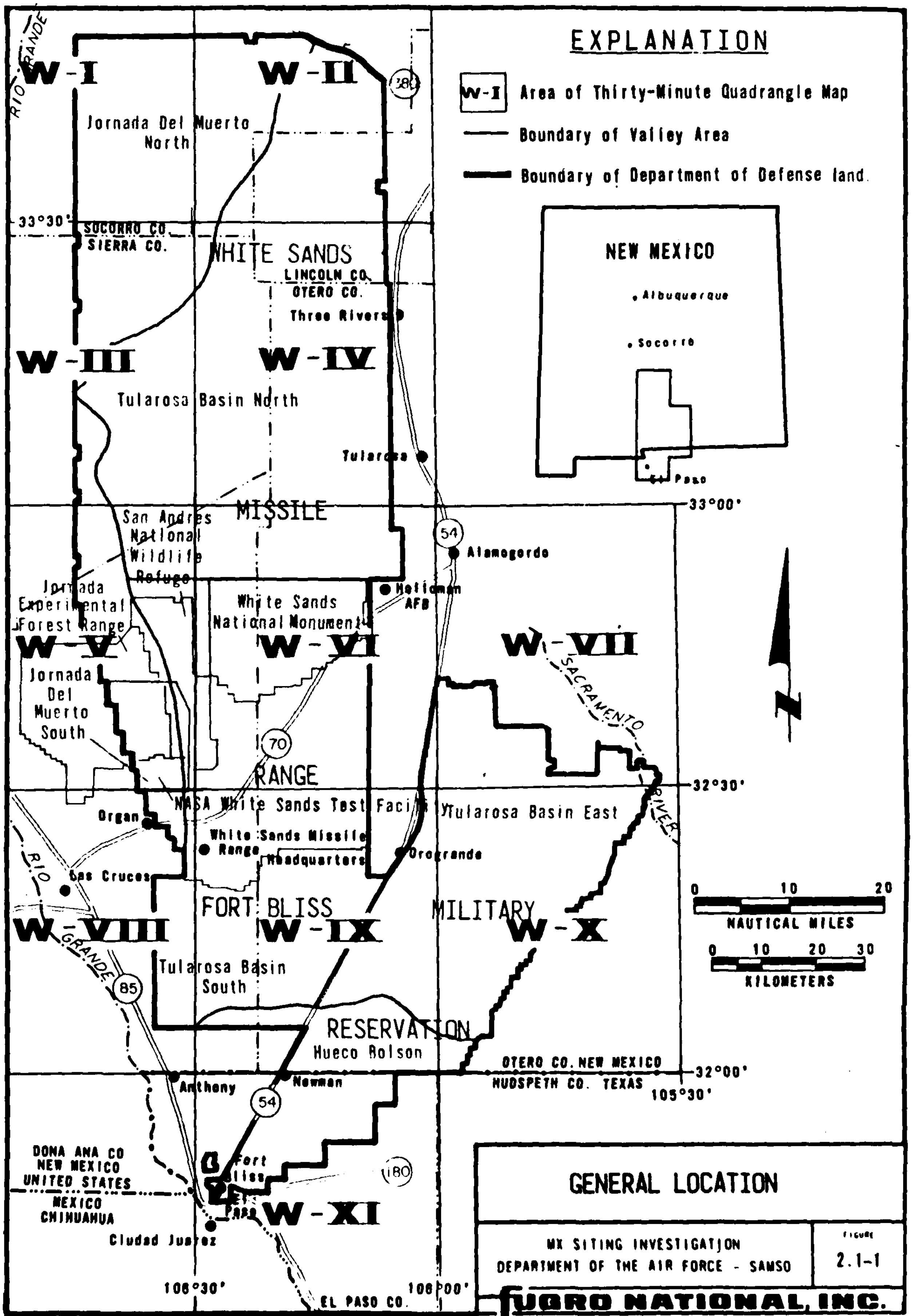
## 2.1 WSMR/FBMR

### 2.1.1 CURRENT LAND USE, LAND USE PLANS, POLICIES

The Department of the Army administers WSMR/FBMR and provides a missile range and test center for use by all branches of the U.S. military (WSMR) and a training area for missile, artillery and air defense units of the U.S. Army (FBMR). In addition to DoD controlled lands, other federal lands within WSMR/FBMR include: NASA White Sands Test Facility, White Sands National Monument, San Andres National Wildlife Refuge, and Jornada Experimental Range (Figure 2.1-1). Large segments of land within DoD boundaries are state and privately owned (Figure 2.1-2).

Public access through WSMR/FBMR is generally allowed along Highways 54,70 and New Mexico War Highway 11, although travel along Highway 11 is often restricted or controlled. Public travel off these main routes is restricted.

Special use areas within WSMR include White Sands National Monument and San Andres Wildlife Refuge which are excluded as areas for field work and testing activities. It is believed that short-range land use plans for those areas of WSMR/FBMR controlled unilaterally by the Department of the Army are to maintain current policies and controls to keep the facilities functioning at their present status. No details of long-range plans are known.

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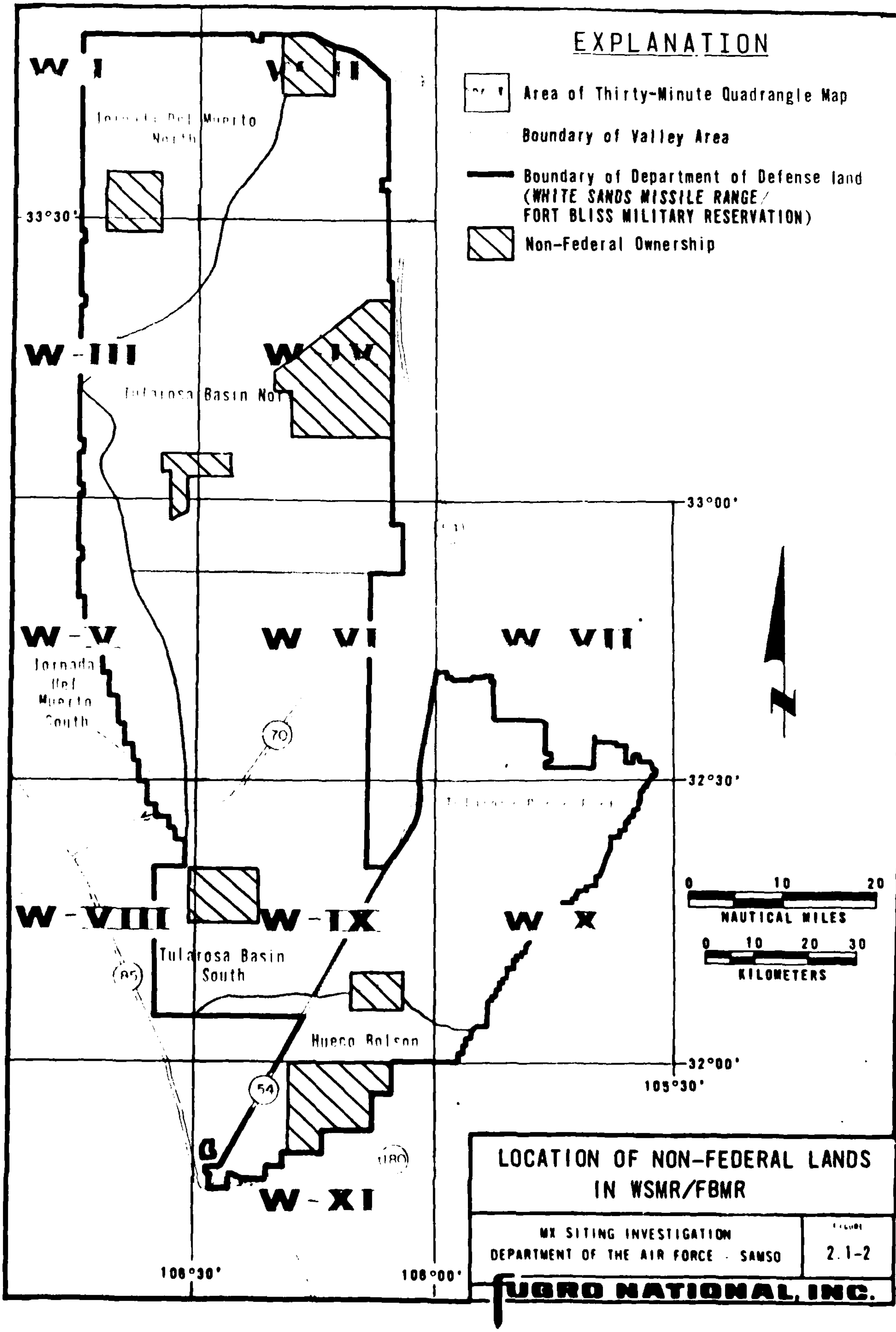


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## 2.1.2 SOCIOECONOMICS

WSMR/FBMR lies mainly within Otero and Dona Ana Counties, New Mexico, with lesser area in El Paso County, Texas, and Sierra, Socorro and Lincoln Counties, New Mexico. The principal cities in the area are shown in Table 2.1-1 with their populations (U.S. Census Bureau, 1970).

Principal employment activities of persons in the New Mexico counties are non-agricultural. Twenty-five percent to nearly 50 percent of this work force constitutes wage and salary earners working for the government (schools, colleges and federal, state, or local agencies). Approximately 10 to 15 percent are employed at some type of trade, while the remainder are divided among construction, manufacturing, transportation and utilities, insurance and real estate, mining services, and miscellaneous.

El Paso County has a varied employment situation and a more diverse economic development than is common in the state. Non-agricultural activities are greatly predominant over agricultural activities and a much wider range of employment disciplines is present within the non-agricultural category than is typical in New Mexico.

Cities or towns which would most likely serve as primary or secondary centers for mobilization of field related activities include: Las Cruces, El Paso, Alamogordo, Socorro, Tularosa, and Orogrande.

TABLE 2.1-1

POPULATIONS OF COMMUNITIES IN THE VICINITY OF WSMR/FBMR

| Population Center | Distance From Range Boundary (nautical miles) | 1970 Population |
|---|---|---|
| El Paso, Texas | 0 | 322,261 |
| Anthony, New Mexico | 4.8 | 1,728 |
| Las Cruces, New Mexico | 10.0 | 37,857 |
| Hatch, New Mexico | 22.6 | 867 |
| La Mesilla, New Mexico | 11.3 | 1,713 |
| University Park - Tortugas New Mexico | 10.4 | 4,165 |
| White Sands, New Mexico | 0 | 4,167 |
| Capitan, New Mexico | 26.1 | 439 |
| Carrizozo, New Mexico | 11.7 | 1,123 |
| Ruidoso, New Mexico | 21.3 | 2,216 |
| Ruidoso Downs, New Mexico | 25.7 | 702 |
| Alamogordo, New Mexico | 4.8 | 22,035 |
| Holoman, New Mexico | 0.9 | 8,001 |
| Cloudcroft, New Mexico | 16.1 | 525 |
| Tularosa, New Mexico | 3.9 | 2,851 |
| Truth or Consequences, New Mexico | 25.2 | 4,656 |
| Socorro, New Mexico | 16.1 | 4,687 |
| | Total | 420,993 |

Source: Bureau of Census, 1971c

## 2.1.3 CLIMATE

### 2.1.3.1 General

Climatic conditions within WSMR/FBMR are primarily a result of 1) its inland location, 2) its latitudinal position, and 3) the north-south alignment of the bordering mountain ranges. These factors combine to produce an arid to semi-arid climate, with greater precipitation in the mountain areas. Both the Tularosa Basin and Jornada del Muerto are characterized by hot summers, mild winters, and warm springs and autumns. Climatic conditions are assumed to be relatively similar throughout the siting area for similar elevations.

### 2.1.3.2. Precipitation

The low mean annual precipitation of WSMR/FBMR is controlled mainly by its inland location and the north-south trending mountain ranges, primarily the San Andres and Sacramento Ranges, within and adjacent to the siting area. Precipitation is generally in the form of rain, although light snowfall occurs in the valleys in winter. Average annual precipitation increases slightly (due to elevation) moving northward across the siting area (8.65 inches at El Paso and 9.10 inches at Bingham). Summer rains usually result from local thunderstorms, which occur on an average of 42 days, primarily from July to September. They result in intense rainfalls and may be accompanied by lightning, strong winds, dust storms, tornados and funnel clouds, or hail.

2.1.3.3 Wind

Wind direction is predominantly from the west, with mountain areas experiencing greater velocities than the valleys. Average annual velocities in the valleys range from 7.1 to 9.7 miles per hour (mph). Stronger winds occur in late winter and early spring, with maximum recorded wind gusts of 99 mph.

Funnel wind effects are common in late winter and throughout the spring months on the western side of Tularosa Basin; wind velocities are occasionally in excess of 70 mph.

2.1.3.4 Temperature

Daytime temperatures from mid-May to mid-September are usually between 90 and 100 degrees Farenheit ($^{O}$F), with night-time temperatures in the sixties. Day-time temperatures from November to mid-March average between 35 and 60$^{O}$F, dropping to near freezing at night. On the average, only one day per year remains below freezing all day. An average frost-free period of 180 days occurs from April to mid-October.

2.1.3.5 Relative Humidity and Evaporation

With an average of approximately 290 days (80 percent) of sunshine and an average relative humidity of 38 percent, evaporation is very high. Evaporation is approximately 85 to 90 inches per year, or roughly ten times the average annual precipitation.

2.1.3.6 Fog

Heavy fog can be expected up to six times a year from late autumn until early spring. Visibility may be reduced to less than 0.25 nm in the affected areas.

### 2.1.4 AIR QUALITY

Regional air quality throughout the siting area is good and generally free of significant levels of unnatural contaminants. Local variations may occur around the populated areas of El Paso and Alamogordo. Local strong winds and dust storms contribute seasonally to a natural, short term deterioration of air quality and visibility. Heavy fog, although not a common occurrence, may lower air quality and visibility.

Local, man-induced decreases in air quality may be caused by construction equipment operation, automobiles, missile or artillery firing and impact activities. These factors will contribute most near populated and travelled areas, but the overall effect should be minimal.

### 2.1.5 NOISE

Present noise levels within most of the siting area are high to low. The most common noises resulting from man's activities in these areas are from use of existing highways, railroad traffic, aircraft, missile and artillery testing, and military ground exercises (including offroad vehicles). These noises are generally intermittent and may be high to low. Some are local to the source and others affect fairly large areas.

The ambient noise level in the open basin areas is low. Natural sounds are generated by animals, wind (including moving brush), thunder and rain.

No base level noise data are known to exist for the specific WSMR/FBMR areas. Typical ambient noise levels in open desert areas may vary between approximately 25 and 60 dBA (Bureau of Reclamation, 1974). Levels up to 100 dBA may occur immediately adjacent to a major highway due to traffic, and sonic booms may cause levels of 150 dBA. Thunder may have a noise level of 120 to 130 dB. The public is known to complain at "impulse" levels of about 118 dBA (AFWL, 1974). Continuous ambient noise levels of 45 dBA and continuous levels of 65 dBA for periods of less than 8 hours are considered normally acceptable for human exposure based on HUD noise criteria.

### 2.1.6 AESTHETICS

The area can be evaluated in terms of the degree of naturalness of the setting, the degree of man-made alteration, dominant views, and types of distractions. The existing visual setting is typical of the closed valley, desert systems within the Basin and Range Physiographic Province. Intensity of military activities controls the relative amount of natural versus artificial scenery.

Most of the scenic value of the area lies in its naturalness, the combination of gentle and abrupt topography and the general undisturbed appearance of the desert terrain gained from view-points normally available to the public. In general, views from existing main highways through WSMR/FBMR are free of artificial elements such as structures, roads, and disturbances to the landscape (e.g., grading of surfaces or fences). However, both improved dirt roads and unimproved trails lead away from these highways, and near military facilities the visual impact of present human activities is apparent.

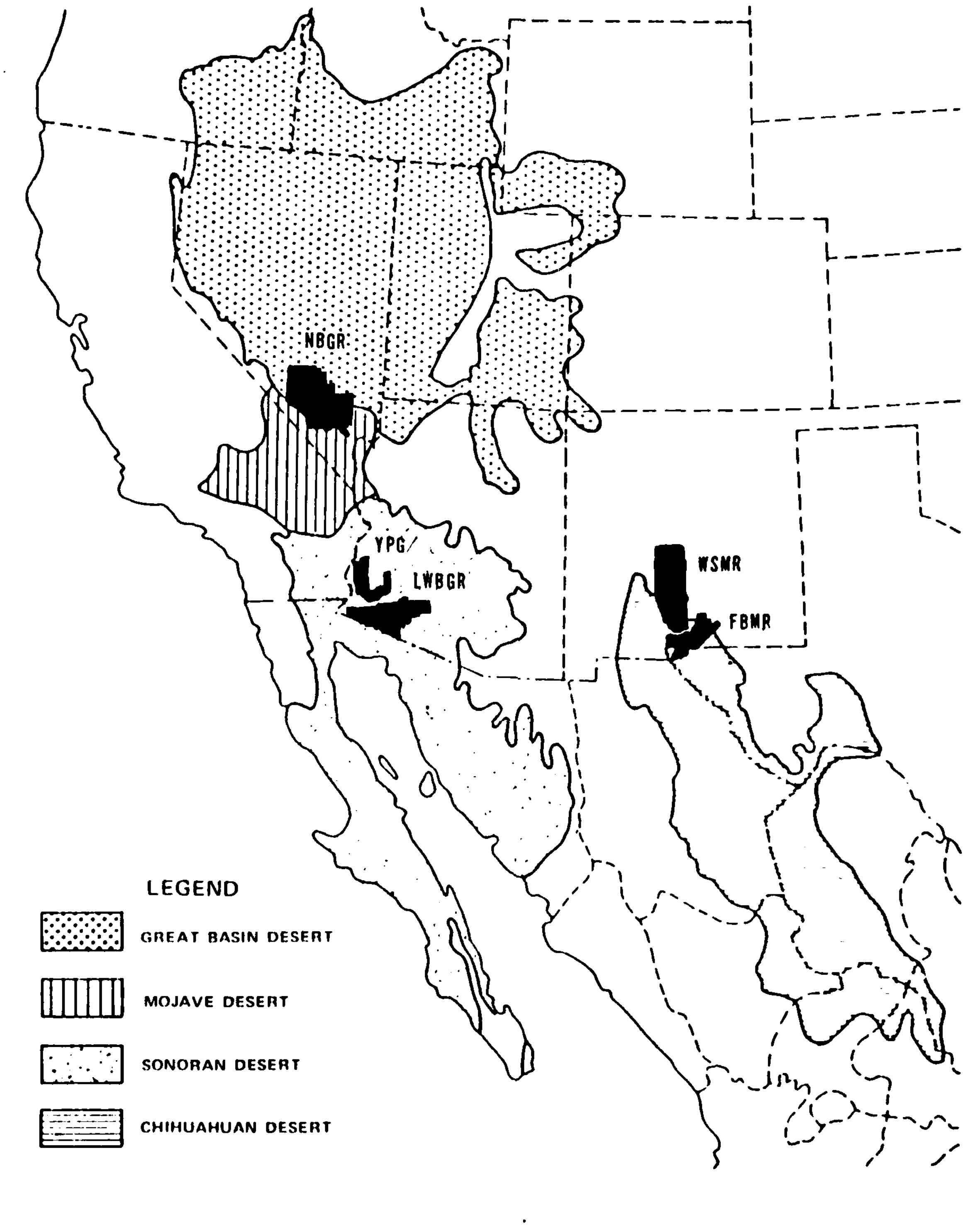
### 2.1.7 ECOLOGY

#### 2.1.7.1 General

The northern portions of WSMR/FBMR are situated in semi-arid grasslands characterized by grama (*Bouteloua* spp.), tobosa (*Hilaria* sp.), and dropseed (*Sporobolus* spp.) grasses. Much of the original vegetation at WSMR/FBMR was overgrazed 20 to 30 years ago by domestic animals resulting in the grama grass-lands being converted to mesquite grasslands.

The southern portions of the site are situated in the Chihuahuan Desert (Figure 2.1-3), and are dominated by creosote bush (*Larrea divaricata*).

A major characteristic feature of the environment of WSMR/FBMR is the general scarcity of rainfall throughout the area. Vegetation and wildlife have special structural, physiological, and behavioral adaptations which allow them to live in this arid environment (Hadley, 1973). Individual species of desert plants can be grouped into three separate categories based on




AFTER HASTINGS AND TURNER (1972); ORIGINALLY BASED ON SHREVE (1942)

| MAJOR DESERTS OF THE SOUTHWEST | |
|---|---|
| MX SITING INVESTIGATION<br>DEPARTMENT OF THE AIR FORCE - SAMSO | FIGURE<br>2.1-3 |

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Source: Jaeger, 1957

DATE: 31 OCTOBER 1975

their growth form in response to the general scarcity of water -- ephemeral annuals, succulent perennials, and non-succulent perennials.

An ephemeral annual (e.g., desert wildflower) is capable of completing its full life cycle -- germination, growth, flowering, seed production, and death -- in six to eight weeks. Seeds of desert plants lie dormant in the soil until sufficient soil moisture becomes available for germination and growth. Active growth following the rainy season is one of the principal physiological adaptations to water scarcity.

Succulent perennials have adapted to the desert environment through their ability to store water in stem tissues. These plants, of which the cacti are the best known, have the ability to accumulate and store water in excess of physiological needs during the rainy season.

Non-succulent perennials (e.g., phreatophytes -- plants dependent on groundwater, and other trees and shrubs) have a variety of adaptations to water scarcity. Some trees have deep root systems that provide a constant supply of water from year-round groundwater sources. The ocotillo, a drought-deciduous plant, reduces water loss by sprouting leaves only during the short rainy period. Other adaptations of non-succulent perennials include compact leaves that expose less surface to reflect light, and diffuse root systems.

Because of the hot, dry climate, most desert animals are crepuscular (active in the twilight) or nocturnal. During the heat of the day, these animals remain in shaded areas or underground. Consequently, edaphic (soil) conditions are very important to desert animals as well as plants.

Ecosystem factors are discussed in greater detail than other environmental considerations. This system will be most affected by the proposed action and the impact will be among the most difficult to mitigate. The following sections discuss general and Valley Specific (Figure 2.1-1) vegetation and wildlife characteristics for WSMR/FBMR. Threatened and endangered faunal and floral species are presented in Appendix B.

### 2.1.7.2 Vegetation

Vegetation on WSMR/FBMR has been divided into ten groups by Neher and Bailey (1974, in preparation). Table 2.1-2 is a listing of each vegetative group describing the morphological, soil, and plant association of each category.

From Table 2.1-2 it is evident that virtually all of the lowlands of WSMR/FBMR are in a low open shrub or grassland association. The ground coverage of most vegetative groups ranges between 10 and 30 percent.

Table 2.1-3 is a listing of the most common individual plant species that are found in the WSMR/FBMR. The table indicates the vegetative groups in which each species commonly occurs.

TABLE 2.1-2

PLANT COMMUNITIES OF WSMR/FBMR

| Plant Community | Indicator Plants: Common Name | Indicator Plants: Scientific Name | Geomorphic Associations and Habitats |
|---|---|---|---|
| 1. **Clay Grasslands** | Vine-mesquite<br>Sacaton<br>Tubosa<br>Fluffgrass<br>Burrograss<br><br>Chamiza | Panicum obtusum<br>Sporobolus wrightii<br>Hilaria mutica<br>Tridens pulchellus<br>Schleropogon brevi-<br>folius<br>Atriplex canescens | Floodplains and Lower Bajadas<br>Poorly drained clay and clay-loam soils |
| 2. **Salt Flats** | Alkali sacaton<br>Chamiza | Sporobolus airoides<br>Atriplex canescens | Alkali Flats<br>Slight to moderate saline soils. [illegible]ali flat margins |
| | Alkali sacaton<br>Iodine bush<br><br>Inland Saltgrass<br>Chamiza | Sporobolus airoides<br>Allenrolfea occident-<br>alis<br>Distichlis stricta<br>Atriplex canescens | Strong saline soils within alkali flats |
| 3. **Sand Grasslands** | Mesquite<br>Chamiza | Prosopis juliflora<br>Atriplex canescens | Dunes and Sandy Plains<br>Coppice dunes |
| | Giant dropseed<br>Mesa dropseed<br>Spike dropseed<br>Sand sagebrush | Sporobolus giganteus<br>Sporobolus flexuosus<br>Sporobolus contractus<br>Artemesia filifolia | Level to gently undulating deep sand |
| | Spike dropseed<br>Mesa dropseed<br>Tobosa grass<br>Black grama<br>Soaptree Yucca | Sporobolus contractus<br>Sporobolus flexuosus<br>Hilaria mutica<br>Bouteloua eriopoda<br>Yucca elata | Sandy plain of sandy loam soils |
| 4. **Gypsum Grasslands** | Rough Coldenia<br>Gypgrass<br>Torrey ephedra<br>Alkali sacaton<br>Lichens | Coldenia hispidissima<br>Sporibolus nealleyi<br>Ephedra torreyana<br>Sporobolus airoides | Sandy Plains and Dunes<br>Plains of shallow soil over gypsum |
| | Alkali sacaton<br>Chamiza<br>Torrey ephedra<br>Gyp grama | Sporobolus airoides<br>Atriplex canescens<br>Ephedra torreyana<br>Bouteloua breviseta | Plains of deeper soil |
| | Torrey ephedra<br>Chamiza<br>Rubber Rabbit-<br>brush<br>Indian ricegrass<br>Gyp gramma<br>Mesquite | Ephedra torreyana<br>Atriplex canescens<br>Chrysothamnus<br>nauseosus<br>Oryzopsis hymenoides<br>Bouteloua breviseta<br>Prosopis juliflora | Gypsum dunes |
| | Giant dropseed<br>Spike dropseed<br>[illegible] | Sporobolus giganteus<br>Sporobolus contractus<br>[illegible] | Between dunes on level surfaces |

| | | | |
|---|---|---|---|
| | Gyp grama | Bouteloua breviseta | |
| | Torrey ephedra<br>Chamiza<br>Rubber Rabbit-brush<br>Indian ricegrass<br>Gyp gramma<br>Mesquite | Ephedra torreyana<br>Atriplex canescens<br>Chrysothamnus nauseosus<br>Oryzopsis hymenoides<br>Bouteloua breviseta<br>Prosopis juliflora | Gypsum dunes |
| | Giant dropseed<br>Spike dropseed<br>Indian ricegrass<br>Rubber Rabbit-brush<br>Chamiza<br>Seepweed<br>Iodine bush | Sporobolus giganteus<br>Sporobolus contractus<br>Oryzopsis hymenoides<br>Chrysothamnus nauseosus<br>Atriplex canescens<br>Suaeda suffrutescens<br>Allenrolfea occidentalis | Between dunes on level surfaces |
| 5. **Footslope Grasslands** | Black grama<br>Blue grama<br>Bush muhly<br>Chamiza<br>Sand sagebrush<br>Soaptree Yucca<br>Broom snakeweed | Bouteloua eriopoda<br>Bouteloua gracilis<br>Muhlenbergia sp.<br>Atriplex canescens<br>Artemesia filiflora<br>Yucca elata<br>Gutierrezia sarothrae | **Alluvial fans and Bajadas**<br>**Gravelly and sandy loams** |
| 6. **Semidesert Shrubs** | Creosote bush<br>Mesquite<br>American tarbush<br>Mariola parthenium<br>Black grama | Larrea divaricata<br>Prosopis juliflora<br>Flourensia cernua<br>Parthenium incanum<br>Bouteloua eriopoda | Bajadas<br>**Gravelly limy soils** |
| 7. **Semidesert Hills and Rock Land** | Black grama<br>Creosote bush<br>Fluffgrass<br>Ocotillo<br>Mariola panthenium | Bouteloua eriopoda<br>Larrea divaricata<br>Tridens pulchellus<br>Fouquieria splendens<br>Parthenium incanum | **Lower Mountain Slopes**<br>**Below 6000 feet elevation; shallow soil** |
| 8. **Nonwooded Mountains** | Pinyon Pine<br>One-seed juniper<br>Grama grass<br>Algerita<br>Shrub live oak<br>Soaptree yucca<br>Mountain mahogany | Pinus edulis<br>Juniperus monosperma<br>Bouteloua sp.<br>Berberis trifoliolata<br>Quercus turbinella<br>Yucca elata<br>Cerocarpus montanus | **Lower Mountain Slopes**<br>**Above 6000 feet elevation in narrow valleys** |
| 9. **Pinyon-Juniper Woodlands** | Pinyon Pine<br>One-seed juniper<br>Metcalfe muhly<br>Pine muhly<br>Chihuahua love-grass<br>Side-oats grama<br>Mountain-mahogany<br>Soaptree yucca | Pinus edulis<br>Juniperus monosperma<br>Muhlenbergia metcalfei<br>Muhlenbergia dubia<br>Eragrostis erosa<br>Bouteloua curtipendula<br>Cercocarpus montanus<br>Yucca elata | **Mountains**<br>**Above 6000 feet on mountain slopes and narrow valleys** |
| 10. **Malpais** | Chamiza<br>Creosote bush<br>Black grama<br>Mariola parthenium<br>Alkali sacaton | Atriplex canescens<br>Larrea divaricata<br>Bouteloua eriopoda<br>Parthenium incanum<br>Sporobolus airoides | **Basalt Flows**<br>**Small pockets of soil** |

**Source: Neher and Bailey, in press, 1974.**

## TABLE 2.1-3

### COMMON PLANT ASSOCIATIONS OF WSMR/FBMR

| Common Plants | | Association | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Common Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| SHRUBS AND TREES | | | | | | | | | | | |
| Agave parryi | Agave; Century plant | | | | | | o | | o | | |
| Allenrolfea occidentalis | Picleweed, iodineush | | x | | x | o | | | | | |
| Artemesia filifolia | Sand sagebrush | | | x | | x | | | | | |
| Atriplex canescens | Chamiza; fourwing saltbrush | x | x | x | x | x | | | | | x |
| Berberis trifoliolata (Mahonia trifoliolata) | Algerita; laredo mahonia | | | | | | o | | x | | |
| Ceanothus greggii | Desert ceanothus | | | | | | | | o | | |
| Cercocarpus montanus | Mountain-mahogany | | | | | | | | x | x | |
| Chrysothamnus nauseosus | Rubber rabbitbrush | | | | x | x | | | | | |
| Coldenia hispidissima | Rough coldenia | | | | x | | | | o | | |
| Condalia spathulata | Knifeleaf condalia | | | | | | o | | | | |
| Dasylirion sp. | Sotol | | | | | | o | o | | o | |
| Ephedra torreyana | Torrey ephedra | | | | x | | | | | | |
| Ephedra trifura | Louisleaf ephedra; Mormon tea | | | o | | | | | | | |
| Eurotia lanata | Winterfat | | | o | | | | | | | |
| Flourensia cernua | American tarbush | | | | | | x | | | | |
| Fouquieria splendens | Ocotillo | | | | | o | o | x | | | |
| Garrya wrightii | Wright's silktassel | | | | | | | | o | | |
| Gutierrezia sarothrae | Broom snakeweed | | | | | x | | | | | |
| Juniperus monosperma | One-seed juniper | | | | | | | | x | x | |
| Larrea divaricata | Creosotebush | o | o | | | | x | x | | o | x |
| Nolina microcarpa | Sacahuista | | | | | | | | o | | |
| Opuntia imbricata | Cholla | | | | | | o | | o | | |
| Parthenium incanum | Mariola parthenium | | | | | | x | x | | o | x |
| Pinus edulis | Pinyon pine | | | | | | | | x | x | |
| Pinus ponderosa | Ponderosa pine | | | | | | | | o | | |
| Poliomintha incana | Hoary rosemarymint | | | | o | | | | | | |
| Prosopis juliflora | Mesquite; honey mesquite | | | x | x | | x | | | | |
| Quercus gambelii | Gambel oak | | | | | | | | o | | |
| Quercus turbinella | Shrub live oak | | | | | | | | x | | |
| Rhus trilobata | Sumac | | | | o | | | | | | |
| Yucca elata | Soaptree yucca | | | x | | x | | | x | x | |
| GRASSES AND FORBS | | | | | | | | | | | |
| Bouteloua breviseta | Gyp grama | | | | x | | | | | | |
| Bouteloua curtipendula | Side-oats grama | | | | | x | | | x | x | |
| Bouteloua eriopoda | Black grama | | | x | | x | x | x | x | o | x |
| Bouteloua gracilis | Blue grama | | | | | x | | | x | | |
| Distichlis stricta | Inland saltgrass | | x | | | | | | | | |

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Poliomintha incana** | **Hoary rosemarymint** | | | | | | | | | | |
| Prosopis juliflora | Mesquite; honey mesquite | | | x | x | | x | | | | |
| Quercus gambelii | Gambel oak | | | | | | | | o | | |
| Quercus turbinella | Shrub live oak | | | | | | | | x | | |
| Rhus trilobata | Sumac | | | | o | | | | | | |
| Yucca elata | Soaptree yucca | | | x | | x | | | x | x | |
| GRASSES AND FORBS | | | | | | | | | | | |
| Bouteloua breviseta | Gyp grama | | | | x | | | | | | |
| Bouteloua curtipendula | Side-oats grama | | | | | x | | | x | x | |
| Bouteloua eriopoda | Black grama | | | x | | x | x | x | x | o | x |
| Bouteloua gracilis | Blue grama | | | | | x | | | x | | |
| Distichlis stricta | Inland saltgrass | | x | | | | | | | | |
| Eragrostis erosa | Chihuahua lovegrass | | | | | | | | o | x | |
| Hilaria mutica | Tobosa | x | x | x | | | | | | | |
| Muhlenbergia dubia | Pine muhly | | | | | x | | | o | x | |
| Muhlenbergia metcalfei | Metcalfe muhly | | | | | x | | | o | x | |
| Oryzopsis hymeniodes | Indian ricegrass | | | | x | | | | | | |
| Panicum obtusum | Vine-mesquite | x | x | | | | | | | | |
| Schleropogon brevifolius | Burrograss | x | | | | | | | | | |
| Sporobolus airoides | Alkali sacaton | o | x | | x | | | | | | x |
| Sporobolus contractus | Spike dropseed | | | x | x | | | | | | |
| Sporobolus cryptandrus | Sand dropseed | | | o | | | | x | o | o | |
| Sporobolus flexuosus | Mesa dropseed | | | x | | | | | | | |
| Sporobolus giganteus | Giant dropseed | | | x | x | | | | | | |
| Sporobolus nealleyi | Gypgrass | | | | x | | | | | | |
| Sporobolus wrightii | Sacaton | x | | | | | | | | | |
| Suaeda suffrutescens | Seepweed | | o | | x | | | | | | |
| Tridens pulchellus | Fluffgrass | x | | | | | | x | | o | |

Note:
1. Clay grasslands
2. Salt flats
3. Sand grasslands
4. Gypsum grasslands
5. Footslope grasslands
6. Semidesert shrubs
7. Semidesert hills and rockland
8. Nonwooded mountains
9. Pinyon-Juniper Woodlands
10. Malpais

x = Dominant Plant
o = Common Plant

Source: Neher and Bailey, in press, 1974

## 2.1.7.3 Wildlife

### 2.1.7.3.1 General

Life zones are bands or groups of vegetation (and different animals inhabiting them) which change with latitude and/or altitude. The siting area is generally characteristic of the upper Sonoran life zone. The lower portion of this life-zone is in valley grasslands; the upper portion is taken up by woodland. Indicator species of animals for this life-zone include:

| | |
|---|---|
| Grasshopper Mouse | *Onychomys leucogaster* |
| White-throated Wood Rat | *Neotoma albigula* |

Table 2.1-4 is a list of the wildlife that are commonly found in the lowland portions of WSMR/FBMR, as well as their habitats, foods, and type of den or nesting area. It also indicates whether or not they are migratory. This list does not include such animals as bighorn sheep that are also found in the WSMR/FBMR, since they are found generally in the upland portions of the area and only venture occasionally into the lowlands (Bailey, 1931).

### 2.1.7.3.2 Endangered Wildlife Species

The only animal that is found on the 1974 "United States' List of Endangered Species", that may occur in the WSMR/FBMR is the American peregrine falcon (*Falco peregrinus*). Its habitat is open country and it feeds chiefly on birds, and rodents. It usually nests on a high ledge or cliff. The White Sands pupfish, *Cyprinodon tulorosae*, is listed as threatened by the state of New Mexico.

COMMON WILDLIFE OF WSMR/FBMR

| Common Name | Scientific Name | Habitat | Mig |
|---|---|---|---|
| Mourning Dove | Zenaidura macroura | Mesquite, grassland or desert | |
| Scaled Quail | Callipepla squamata | Grassland, brush | |
| Gambel's Quail | Lophortyx gambelii | Desert thickets, usually near water | |
| Sparrow Hawk | Falco sparverius | Open country, deserts | |
| Prarie Falcon | Falco mexicanus | Canyons, open mountains, plains, deserts | |
| Red-tailed Hawk | Buteo jamaicensis | Open country, woodlands, mountains, deserts | |
| Cooper's Hawk | Accipiter cooperii | Broken woodlands, canyons, river gorges | |
| Marsh Hawk | Circus cyaneus | Marshes, fields, prairies | |
| Western Kingbird | Tyrannus verticalis | Open country with scattered trees | |
| Horned Lark | Eremophila alpestris | Plains, deserts, sparse sage flats | |
| White-necked Raven | Corvus cryptoleucus | Arid country, plains, deserts | |
| Common Raven | Corvus corax | Mountains, deserts, canyons | |
| Black-throated Sparrow | Amphispiza bilineata | Arid brush, creosote bush deserts | |
| Ash-throated Flycatcher | Myiarchus cinerascens | Semidesert country, deserts, brush, mesquite | |
| Scott's Oriole | Icterus parisorum | Dry woods and scrub, yuccas, oaks, pinyons | |
| White-winged Dove | Zenaida asiatica | Mesquite groves, desert oases | |
| Grasshopper Mouse | Onychomys ssp. | Open grassy mesas | |
| Cactus Mouse | Peromyscus ssp. | Widespread (nocturnal) | |
| Bobcat | Lynx rufus baileyi | Rough and broken terrain (nocturnal) | |
| Free-tailed Bat | Tadarida brasiliensis | Plains, deserts (nocturnal) | |
| Spotted Ground Squirrel | Citellus spilosoma | Plains and mesas | |
| Hog-nosed Skunk | Conepatus mesoleucus | Washes and canyons in low desert valleys (nocturnal) | |
| Kangaroo Rat | Dipodomys ssp. | | |
| Pocket Mouse | Perognathus ssp. | Plains, deserts (nocturnal) | |
| Western Pocket Gopher | Thomomys ssp. | Widespread (subsurface) | |
| Rock Squirrel | Citellus variegatus | Rocky, hillsides, shrub-covered slopes | |
| Wood Rat | Neotoma ssp. | Plains, deserts, brush | |
| Gray Fox | Urocyon cinereoargenteus | Arid, open plains | |
| Kit Fox | Vulpes macrotis | Arid, open plains (nocturnal) | |
| Badger | Taxidea taxus | Prairie, plains, open forest | |
| Coyote | Canis latrans | Widespread | |
| Spotted Skunk | Spilogale gracilis | Plains and deserts (nocturnal) | |
| Black-tailed Jack Rabbit | Lepus californicus | Open or brushy areas | |
| Western Cottontail | Sylvilagus auduboni | Brushy areas | |
| Pronghorn Antelope | Antilocapra americana | Grassy or desert plains | |
| Striped Skunk | Mephitis mephitis | Any locality with sufficient ground cover | |
| Wild Horse | Equus caballus | Grass and rocky areas | |
| Mule Deer | Odocoileus hemionus | Foothills, upper plains | |

TABLE 2.1-4

| | Migration | Den or Nesting Area | Food |
|---|---|---|---|
| | Yes | Tree, shrub, cactus, or ground | Seeds, waste grain, fruits, insects |
| | No | Under bush | Insects, seeds, buds, berries |
| | No | On ground | Insects, seeds, buds, berries |
| | Yes | Tree, cliff, etc. | Birds, rodents, insects |
| | No | Cliff | Birds, rodents, insects |
| | Yes | Tree, cliff, etc. | Rats, mice, lizards |
| | Yes | Tree | Birds, small mammals |
| | Yes | Ground | Rodents, small birds |
| | Yes | Branch, pole, building | Flying insects |
| | Yes | Ground | Seeds, insects |
| | No | Tree, mesquite | Omnivorous |
| | No | Cliff or tree | Omnivorous |
| | Yes | Bush or cactus | Seeds, insects, small fruits |
| | Yes | Tree, mesquite, yucca | Flying insects |
| | Yes | Yucca, pinyon, small tree | Insects, small fruits, seeds waste grain |
| | Yes | Tree or thicket | Seeds, waste grain, fruits, berries |
| | No | Abandoned burrows | Insects, seeds, nuts |
| | No | Crevices, trees, etc. | Seeds, nuts, berries |
| | No | Cavity in rocks | Small mammals, rodents, birds |
| | Yes | Caves, crevices in cliffs | Fruits, flowers |
| ert | No | Burrow | Seeds, grains |
| | No | | Insects, birds, lizards |
| | No | Burrows | Seeds, grain and green foliage |
| | No | Burrow in sandy area | Chiefly seeds |
| ed | No | Burrow | Strictly vegetable (roots, tubers) |
| | No | Burrow | Seeds, nuts, grains, green vegetation |
| | No | Ground | Green vegetation, fruit, seeds, cacti |
| | No | Den in cliff, tree, ground | Small mammals, birds, fruit, berries |
| | No | Burrow in hillside, tree | Small mammals, birds, fruit, berries |
| | No | Burrow | Small mammals, birds, eggs |
| | No | Hole in rocks or bank | Small mammals, birds, snakes, fruit |
| | No | Rocks, hollow logs, burrow | Insects, birds, lizards |
| | No | Ground or under bush | Foliage, twigs, grasses |
| | No | | Foliage, twigs, grasses |
| | No | Low, brush covered areas | Grasses, weeds, cactus, greasewood |
| | No | Burrows, rock crevices | Small rodents, eggs, insects, fruits |
| | No | | Grasses |
| | Partial | | Foliage, twigs, grasses |

2.1.7.3.3 Wildlife Refuges

Thirty miles northeast of Las Cruces in the San Andres Mountains is the San Andres National Wildlife Refuge. It consists of approximately 67 $nm^2$ surrounded by DoD lands. Bighorn sheep are found within the Refuge, as well as mule deer, Gambel's quail, and scaled quail. Because it is situated within WSMR/FBMR, public access is controlled and only allowed by special arrangement during the annual deer hunting season.

2.1.7.4 Vegetation and Wildlife

2.1.7.4.1 General

Figure 2.1-1 depicts the location of the Valley sub-areas of WSMR/FBMR that are used in the following discussion. The boundaries of the Valleys are defined primarily by topographic and hydrologic divides with artificial boundaries (roads or DoD boundaries) assigned where necessary.

2.1.7.4.2 Jornada del Muerto North

The Jornada del Muerto North is a downwarped trough and encompasses the gently undulating sandy northwest corner of WSMR/FBMR. It is covered by a sparse hummocky vegetation composed of mesquite, scattered chamiza, widely scattered ephedra, sand sage, cacti, yucca, and various weeds and grasses. A herd of as many as 30 to 50 pronghorn antelope roams this area and takes refuge in the area of the volcanic field west of the WSMR/FBMR boundary (Fitzsimmon, 1955). Bats are also frequently seen in this area.

The alluvial fans on the northwest side of the San Andres Mountains, generally above 5,000 feet elevation, is an area of semi-desert shrubs composed of mesquite, creosote bush, and various weeds and grasses. The uplands of the Jornada del Muerto North are a pinyon-juniper woodland.

2.1.7.4.3 Tularosa Basin North

A low area of shrub-grassland, called Mockingbird Gap, separates Tularosa Basin North from Jornada del Muerto North. This grassland association continues south in a narrow strip along the eastern flank of the woodland area of the San Andres Mountains. Directly below this gap and to the northeast is a series of semi-desert hills with scattered creosote bush, scrub oak, and various weeds and grasses. South of this hilly area is an alluvial plain in a grassland association with scattered mesquite and creosote bush. Also in the northeastern Tularosa Basin North area is a basalt flow several nautical miles wide and over 35 nm long known as the Malpais. The Malpais is largely barren, except for pockets of soils in the rock in which sparse vegetation grows. At the southern edge of this lava flow is a spring of alkaline water, Malpais Spring, in which lives a cyprinodont minnow that is a relict fish (Jaeger, 1957). This minnow is rare due to its restricted distribution. Although it is not considered "endangered" by the Federal government due to its location in an area of restricted access, it is considered threatened by the State of New Mexico. Common wildlife includes lizards,quail, pocket mice, kangaroo rats, and wood-rats. This area is also the favorite habitat for the wild horses found in the WSMR/FBMR (Neher and Bailey, 1974, in preparation).

The Phillip Hills, immediately east of the Malpais, are sparsely vegetated with scattered grasses and shrubs. The southern edge of the Tularosa Basin North is a largely barren area of gypsum dunes and scattered playas such as Lumley Lake. The most common vegetation of this area is iodine bush.

2.1.7.4.4 Jornada del Muerto South

Along the western foot of the San Andres Mountains is a belt of grassland on the upper portion of the alluvial fans. This grassland is largely composed of blue and black grama.

Several dry washes, extending westward from the San Andres Mountains, dissect this grassland. Along these washes are found thickets of mesquite which provide suitable habitats for small desert mammals and birds.

2.1.7.4.5 Tularosa Basin South

The Tularosa Basin South is bordered on the west by the San Andres and Organ Mountains. Above 5,000 feet elevation, these mountains are covered by a pinyon-juniper woodland with some ponderosa pine at the uppermost elevations.

Within White Sands National Monument, the gypsum sand areas are generally barren with small scattered areas of vegetation dominated by iodine bush. South of the White Sands National Monument and below the woodlands of the eastern slopes of the San Andres and Organ mountains is an area of grassland with scattered mesquite. To the southeast of this area stretching beyond Highway 54 is a sandy area of mesquite, scattered chamiza and various weeds and grasses.

2.1.7.4.6 Tularosa Basin East

Within the Tularosa Basin East along Highway 54 is a sandy grassland association area with small dunes formed by sand drifting around mesquite plants. Chamiza is also commonly associated with the sand dunes.

Eastward, the Otero Mesa rises above the Tularosa Basin to the woodland areas of the Sacramento Mountains. Alluvial fans at the southwest base of the Sacramento Mountains are in a footslope grassland of grama grass.

2.1.7.4.7 Hueco Bolson

The small Hueco Bolson portion of WSMR/FBMR that lies outside the exclusion areas on the west side of the Hueco Mountains is an area of sandy grasslands with mesquite plants that have anchored small dunes. Dropseeds and sand sagebrush are abundant plants in this area.

## 2.1.8 GEOMORPHOLOGY AND TOPOGRAPHY

WSMR/FBMR lies within the Basin and Range Physiographic Province. The siting area lies principally within the Mexican Highland subprovince and extends eastward into the Sacramento subprovince.

Primary topographic features which typify this area are north-south trending mountain ranges and intervening alluvial basins, which encompass approximately 35 to 65 percent of the siting area, respectively. Principal basins within WSMR/FBMR include Jornada del Muerto, Tularosa Basin, and the Hueco Bolson. Elevations range from 3887 feet at Lake Lucero to 8958 feet at Salinas Peak in the central San Andres Mountains.

Typically closed basin conditions predominate with primary and secondary drainages terminating at playas in the central portions of the basins.

Secondary topographic features present within the basins include the following landforms (in order of decreasing abundance): 1) alluvial fans and bajadas, 2) playas, 3) sand dunes, 4) pediments, and 5) terraces. Two generations of alluvial fans are, in general, topographically distinct within WSMR/FBMR. These features flank the mountain ranges, extending toward the center of the basin, with the younger fans coalescing to form broad, gently sloping alluvial surfaces (bajadas). The alluvial fans and bajadas generally exhibit a topographic grade ranging from two to eight percent, with the lower values corresponding to the bajadas. In addition, small areas of greater than ten percent topographic grade occur on the older fans near the mountain fronts. The alluvial fans are moderately dissected, with the average number of drainages per nautical mile ranging from seven to 16, being greater on older fans. Incision is generally moderate ranging from six to 15 feet nearer the mountain fronts. Channels are typically flat-floored with steep to near-vertical channel walls.

Pediments are defined in WSMR/FBMR as surfaces of sediment transport with an implied shallow depth to rock. They are present along the eastern flank of the San Andres Mountains and the southwestern flank of the Sacramento Mountains. Topographic grade exhibited by the pediments generally ranges from eight to ten percent, but may exceed ten percent near the mountain fronts. The pediments are moderately to highly dissected, with an average of 11 to 19 drainages per nautical mile. Channels are moderately incised (16 to 20 feet), with typically near-vertical channel walls.

Active playas occur as single, large areas (e.g., Lake Lucero) and as small, isolated features (e.g., Lumley Lake) in the central portions of the basins. Alkali flats, mantled playa deposits, generally border the active playas and can be recognized by the presence of saltbush vegetation. Typically, both active playas and alkali flats exhibit topographic grades of less than two percent, and are slightly to moderately dissected with an average of five to eight drainages per nautical mile. Channels are shallow to moderately incised with steep channel walls.

The White Sands Dune Field, principally within White Sands National Monument, is the most significant accumulation of wind-blown sand in WSMR/FBMR. In addition, smaller dune and sheet sand deposits are present. These deposits include both stabilized and active dunes. Topographic grade in these areas is generally less than five percent; although locally it may greatly exceed ten percent. The wind-blown sand areas are highly dissected, and channels are shallow to moderately incised, with shallow slopes.

Terrace deposits of the Rio Grande have been recognized in southwestern WSMR within an area excluded from siting. Although their surface extent is quite limited, these deposits may be more extensive in the subsurface, buried beneath a mantle of younger alluvial fan material.

Undifferentiated alluvial deposits, those which do not possess a distinctive landform, encompass approximately 60 percent of the basin area. These deposits are transitional from the bajadas to the central basin features (alkali flats, playas and sand dunes). In general, the undifferentiated deposits are slightly to moderately dissected. Channels are shallow to moderately incised with steep to near-vertical channel walls.

Rock exposures, in addition to pediments, include mountain ranges, low-lying hills and isolated outcrops within the basins. Topographic grade in these areas generally exceeds ten percent: however, the latter two areas may exhibit less than ten percent grade. Two large basalt flows, the Tularosa Malpais and the

Jornada Malpais, occupy portions of WSMR, and generally exhibit a zero to five percent grade. These flows characteristically have very rough surfaces and are composed of multiple flow units which may be separated by elongate, and often large, voids.

## 2.1.9 GEOLOGY AND SOILS

### 2.1.9.1 General

The physiography of this region is controlled by and, therefore, strongly reflects the underlying structure. The major rock types are exposed in the uplifted fault block mountain ranges and include igneous, metamorphic, and sedimentary units. The intervening basins generally contain at least several hundred feet of relatively coarse-grained detritus, derived principally from the adjacent mountains, and lesser amounts of fine-grained material.

### 2.1.9.2 Stratigraphy

Rock units within WSMR/FBMR include crystalline igneous and metamorphic basement rock, competent volcanic, metamorphic and sedimentary bedrock, and volcanic flow rock which is restricted to geologically young, extrusive igneous (basaltic) rock in association with the basin-fill deposits. Table 2.1-5 lists the rock units and their respective rock types, ages and distribution within the siting area. The greatest areal extent of exposed rock units occurs in the mountains, with lesser amounts exposed in the pediments and isolated outcrops within the basin fill. Only two areas of volcanic flow rock are exposed in WSMR: The Tularosa and the Jornada Malpais.

TABLE 2.1-5

ROCK UNITS WITHIN WSMR/FBMR

| Category of Rock | Inclusive Rock Types | Ages | Distribution (areal predominance) |
| --- | --- | --- | --- |
| Basement Rock | Igneous: granitics | Precambrian | San Andres Mountains (eastern flank) |
| | Metamorphic: gneiss, schist and quartzite | | |
| Bedrock | Volcanic: pyroclastics and intrusives (andesite to rhyolite) | Tertiary | Northern San Andres Mountains |
| | Metamorphic: dolomite | Paleozoic and Mesozoic | San Andres Mountains |
| | Sedimentary: Limestone, sandstone, siltstone, shale and evaporites | Paleozoic and Mesozoic | San Andres Mountains |
| Volcanic Flow Rock | Igneous: flow rock (basaltic) | Quaternary | Northeastern WSMR |

Volcanic flow rock may occur in the subsurface within the basin fill.

Basin-fill deposits are primarily coarse-grained, with lesser amounts of fine-grained sediments, and have attained a maximum cumulative thickness of 8000 feet. These deposits are apparently a complex sequence of interbedded and intertonguing lacustrine and alluvial deposits. Sequences of bentonitic clays and silts with layers and veins of gypsum are dominant in the center of the basin, with alluvial gravels, sand and silt, that may be calichified, becoming dominant near the margins of the basins.

Soil distribution and nature of the surficial basin fill may be described in terms of coarse- and fine-grained deposits and the associated landforms. Coarse-grained deposits encompass 72 percent of the basin-fill area occupied by alluvial fans and bajadas, pediments and stream channels, in addition to the undifferentiated deposits. The average grain-size composition is 30 percent gravel, cobbles and boulders, 45 percent sand, 20 percent silt and 5 percent clay. Caliche may be present within these deposits; however, the degree of development varies with local conditions.

Wind-blown sand, whether present as sheet deposits or dunes, is composed of uniformly sized, loose dry sand (either quartz or gypsum). Minor amounts of clay and silt-size material may be present. These deposits encompass approximately eight percent of the basin-fill area.

The fine-grained deposits consist of 90 percent clay and silt-size material. These deposits are present in the alkali flats and playas and encompass approximately 20 percent of the basin-fill area.

Desert pavement, or lag gravel, is generally present on the surfaces of the older fans and pediments. The bajadas generally are covered by a discontinuous desert pavement. Desert varnish, a mineralized patina or coating, may be present in varying stages of development on the lag gravel. The wind-blown sand deposits and alkali flat and playa areas have fairly smooth surfaces typically composed of finer-grained material.

2.1.9.3 Structure

Two structural elements related to the Rio Grande Rift Zone encompass the siting area: the Tularosa Basin graben and the Jornada del Muerto syncline. The Tularosa Basin graben is a deep northwest-trending trough bounded by en echelon normal faults which separate the graben from the flanking uplifted mountain ranges (horsts).

The Jornada del Muerto syncline is a north-trending, gently folded basin that developed in association with normal faulting in the Rio Grande Rift Zone and along the western San Andres Mountains. This basin is relatively shallow (less than 500 feet) and, locally, the synclinal structure may be complicated by faulting.

Faults apparently offsetting Cenozoic alluvial fan deposits by as much as 50 feet are present along the eastern flank of the San Andres Mountains and the western flank of the Sacramento Mountains. Based on this evidence, these faults have been conservatively identified as capable of generating earthquakes. However, it should be noted that these features may have resulted from consolidation of the basin fill caused by leaching of soluble material rather than tectonic activity.

## 2.1.10 SEISMICITY

### 2.1.10.1 General

Based upon the nature of previous seismic activity within and adjacent to the siting area, the Rio Grande Rift Zone has been identified as the major source of seismicity that will influence WSMR/FBMR. This zone extends northward through central New Mexico, west of the siting area, and is characterized by low Richter magnitude (M less than 4) earthquakes. In addition, the capable faults identified within WSMR/FMBR may be a source of seismic activity.

Three non-nuclear seismic events have been located in southern WSMR/FBMR. Magnitudes of these events ranged from M 3.1 to 4.0.

### 2.1.10.2 Seismic Risk

Studies predicting the susceptibility of an area to relative levels of seismic intensity indicate that WSMR/FBMR has a maximum expected Modified Mercalli Intensity of V to VI, with the possibility of occasional higher levels (VII to IX) along the Rio Grande Rift Zone. Maximum levels of vibratory ground motion generated by activity within the Rift zone should not exceed 0.1 g (g being the acceleration due to gravity). However, should a large magnitude (M 7+) occur within the siting area associated with the capable faults, maximum ground shaking may be as great at 1.0 g.

Distant (exceeding 200 nm) earthquakes of M 5 to 7 and large magnitude (8+) teleseismic (distances greater than 540 nm) events may also affect the siting area. The most probable sources of distant earthquakes include: 1) the Jerome-Wasatch Zone in Arizona and Utah, 2) the northern and southern extensions of the Rio Grande Rift, and 3) an area of seismicity in north-central Nevada. Teleseismic events may be associated with the Aleutian and mid-American trenches.

The greatest potential for surface displacement due to faulting is along the capable faults bordering the San Andres and Sacramento Mountains. Vertical displacements of 1 to 10 feet could occur, associated with a large magnitude (7+) event.

### 2.1.11 SUBSIDENCE

Subsidence due to tectonism has not been reported with WSMR/FBMR. However, subsidence associated with leaching of soluble materials within the basin fill may be occuring in the southern and central Tularosa Basin.

## 2.1.12 HYDROLOGY AND WATER QUALITY

### 2.1.12.1 Surface Hydrology

#### 2.1.12.1.1 General

WSMR/FBMR lies within the Western Gulf of Mexico drainage basin. Drainage is typically a closed-basin system with surface drainage into a central basin playa.

#### 2.1.12.1.2 Perennial Systems

Five small lakes are located in the central portion of Tularosa Basin. These lakes are indicated on U.S. Geologic Survey topographic maps and may or may not be perennial.

There are no known perennial streams within the siting area with the possible exception of the headwater area of Salt Creek where groundwater discharged from springs may supply a small perennial flow. The Rio Grande is the only perennial drainage adjacent to the siting area.

Malpais Spring and a few of the Mound Springs in northern Tularosa Basin are the only known perennial springs.

#### 2.1.12.1.3 Ephemeral Systems

Ephemeral systems include drainages (streams and washes), playas, and natural reservoirs that intermittently contain water. The water supply for these systems is dependent upon rainstorm intensity and duration, and the runoff characteristic of the watershed.

Primary ephemeral drainages commonly occupy the central portion of a valley, or drain large watershed areas near the mountains, and have numerous secondary tributary drainages. In WSMR/FBMR, these include Salt Creek, Three Rivers and Rio Tularosa. Flooding, including flash flooding is common in these drainages, particularly following intense rainstorms.

The playas are located in the central portions of the basins and discharge groundwater and water received from direct percipitation and the ephemeral drainages.

Natural reservoirs are depressions formed in rock (rock tanks) that may be filled with sand (sand tanks), or are formed in fine-grained deposits (charcos). Water stored in these features may be supplied by direct precipitation and runoff, or by springs.

2.1.12.1.4 Water Quality

Surface water in these ephemeral systems varies from fresh to brine depending on the amount of total dissolved solids (TDS). In general, water in ephemeral drainages is fresh or slightly saline, with water in playas having very high TDS values. The principal contaminants are sulfates and bicarbonates.

2.1.12.2 Groundwater Hydrology

2.1.12.2.1 General

Two major groundwater regions encompass the siting area. The Tularosa Basin-Hueco Bolson region forms the larger groundwater basin, and the Jornada del Muerto region forms the smaller basin. In both regions, groundwater is known to occur in basin-fill, perched and rock aquifers.

Recharge is supplied by infiltration of surface runoff and direct precipitation and by underflow from bordering areas. Discharge occurs by evapotranspiration, by pumping through springs and playas, and by underflow to adjacent areas.

2.1.12.2.2 Basin-fill Aquifers

Basin-fill aquifers may be subdivided into upper and lower zones based on water quality. Fresh water is generally confined to a wedge-shaped, coarse-grained zone of poorly consolidated deposits flanking the mountains. This zone tapers from a maximum of 2000 feet near the mountains to less than 100 feet near the central portion of the basin.

Beneath and extending basinward from the fresh water aquifer zone is a saline water aquifer zone. Overpumping of the freshwater zone may allow for saline groundwater encroachment.

Depth to groundwater decreases from approximately 350 feet in southern WSMR/FBMR and Jornada del Muerto to at the ground surface in northern Tularosa Basin near Salt Creek. Well yields, for various casing and pump sizes, range from less than one to 1300 gallons per minute.

2.1.12.2.3 Perched Aquifers

Caliche deposits and clay layers within the basin fill may produce local perched groundwater zones. Perched intervals have been encountered in the Tularosa Basin. Yields from these zones vary, depending on local conditions.

2.1.12.2.4 Rock Aquifers

Groundwater in rock aquifers is present in fractures within basement rock and bedrock. These aquifers occur at depths ranging from zero to 8000 feet, and supply only limited yields.

2.1.12.2.5 Water Quality

Chemical analyses of groundwater suggest a separation into fresh and saline based upon the TDS. The upper basin-fill aquifer zone contains fresh water, with TDS generally less than 800 mg/l.

An estimated 98 percent of the basin-fill aquifers contain sodium chloride brine water with TDS greater than 35,000 mg/l, and occurs both at depth and beneath the playa lakes in the central portions of the basins. A transitional zone of slightly to moderately saline water lies between the brine water and the upper fresh water zone. The slightly saline water contains predominantly calcium sulfate, while the moderately saline water contains the following:
sodium chloride, calcium chloride, sodium sulfate, calcium sulfate, and calcium magnesium sulfate.

The rock aquifers generally contain saline water beneath the basin areas. Where present near the surface, they may contaminate fresh water within the upper basin-fill aquifer zone.

## 2.1.13 HISTORY

From the 1530's until about 1599, the Spanish explored New Mexico and interacted with the natives, both peacefully and hostilely. Antiquities associated with this period of time relate mostly to the Indian and the pueblo communities. The official conquest of New Mexico took place during 1598 and 1599, and until the pueblo rebellion of 1680, the Spaniards held a tenuous position in the country, fearing that they might be expelled by the natives. Although the rebellion was successful in temporarily removing the Spanish conquerors, famine (1696) and successive defeats allowed the Spaniards to regain and maintain control of New Mexico until 1846. In this year the westward expansion of the United States engulfed New Mexico, which 66 years later became the 47th state of the Union.

Historic sites of Spanish and Indian culture are preserved as missions, pueblos, rock inscriptions, pottery sherds, and metal hardware. The Spanish sites are concentrated around major population centers or along major trails of exploration. The route of Cabeza de Baca (1536) passes through the southern portion of the FBMR complex (Hueco Bolson, Tularosa Basin East), just north of the Hueco and Franklin Mountains (Twitchell, 1963). Several expeditions passed through El Paso along the Rio Grande and may have included excursions into the siting area. No specific historic sites are known within the WSMR/FBMR complex.

American cultural influences began as early as 1806 with the Pike Expedition (Beck, 1963) and built rapidly with trappers and traders moving throughout the northern areas of what is now the state. Permanent physical features of this culture include the numerous army forts established in the early 1860's (e.g., Fort Bliss north of El Paso). Following the Civil War, New Mexico life was characterized by lawlessness and an abundance of "human refuse" (Beck, 1963) which contributed little to the lasting physical history of the area. Portions of the Indian population (Apaches, Navajos, Comanches) were constantly at war with settlers and the military. By the 1880's, campaigns to end the Indian hostilities had proven effective and marked the end of freedom of the Plains Indians.

Ranching (cattle and sheep), farming and mining became the prime sources of economic prosperity as the railroads brought settlers into the state in the early 1880's. These remain the principal sources of economic activity today.

Historic sites of the post Civil War era include the remains of mining towns, and scattered ruins of houses and equipment used by the settlers. No historically significant remnants of this period are known to exist within WSMR/FBMR.

## 2.1.14 ARCHAEOLOGY

Pre-historic inhabitants of New Mexico date back some 20,000 to 25,000 years (Alexander, 1966). Three distinct periods of aboriginal living are recorded: 1) the oldest is a hunting race which lived alongside animals now extinct (Twitchell, 1963), 2) the next developed as a hunting and gathering society using grinding tools to grind wild seed, and 3) the last were the semi-sedentary farmers who developed agriculture related tools and pottery to a high level (Alexander, 1966) and were present at the time of Spanish intervention. Periods (1) and (2) are characterized by pre-ceramic pottery, and group (3) is characterized by ceramic pottery.

Alexander (1966) groups the remains of the first two periods into the Paleo-Indian and Archaic Horizons of the pre-ceramic culture type. The sites related to the Paleo-Indian Horizon are dated as 10,000 to 25,000 years old and are usually buried beneath the present ground surface. Recognition of these sites most often comes either during excavation activities or in examination of natural exposures in stream washes. Cultural materials recovered include large animal bones, crude stone tools and stone chips.

The Archaic people must have had their origins with the Paleo-Indians but the link is unclear. The most common cultural material differences are the presence of stone metates and manos, a modern faunal association, and differences in projectile point size and shape. The Archaic

Horizon may have ended some 2,000 years ago. Archaic sites may be either camp or quarry sites. Camp sites are most commonly found in sandy areas (dunes or sheet sands) situated near a present or former source of water (stream, pond, river, lake). They can be recognized by the hearths, artifacts or tools exposed due to deflation of surrounding sand. These camp sites may or may not be located near rock outcrops which served as a source of materials for tools. Quarries are most commonly in the mountainous (rock) regions or along stream banks with outcroppings of cobbles and gravel (chert, quartz, etc.). Abundant "worked" rock fragments and stone chips characterize these areas.

Ceramic sites are distinguished by the presence of pottery (and sherds), more sophisticated and more permanent dwellings, and the relative youthfulness of the culture. This period is considered to have lasted from about the time of Christ until the 1530's when the first Spanish incursion occurred (Beck, 1963). The Mogollon and Anasazi cultures characterized this period in the southern and northern portions of New Mexico, respectively. Possibly the easiest distinction between these two cultures is the composition of their pottery. The Mogollon had brown paste, and the Anasazi had gray paste (Anderson, 1966).

Within both cultures there was a characteristic evolution of their dwellings, which developed in response to increasing agricultural activities and a less transient way of life.

The so-called pit house developed as a partially below ground structure with wooden poles supporting a brush and mud hemispherical roof. Floors are preserved of the roughly circular jacal, which was constructed of closely spaced, upright wooden poles, the interspaces being filled with adobe. Around 800 to 900 A.D., the above ground pueblos began to replace the pit house. Pueblos retained the pit (a ceremonial "Kiva") and were constructed as large, sometimes multistoried communal structures which became increasingly complex as the culture developed.

Topographically, the remains of these various structures age generally found on alluvial knolls and the first terraces above major floodplains, or when not adjacent to a perennial stream, they are on raised alluvial surfaces near washes which carried water during heavy rains. Pit houses are found on ridge crests and low hills in the valleys and are discernible as rounded depressions, indicated by changes in vegetation and topography. However, when the roof and support structures are present, they form a mound which supports a different vegetation.

Although Indian sites are not known specifically within WSMR/FBMR, they undoubtedly occur. According to Alexander (1966), the archaeology of the district encompassing WSMR/FBMR appears less diverse than surrounding areas; but due to the lack of archaeological research in the area, many diversities may exist.

## 2.1.15 PALEONTOLOGY

Remains of formerly living plants and animals are preserved in both rock units (in the mountainous areas) and in basin-fill deposits (in the valleys). Only fossiliferous basin-fill deposits are considered here due to the exclusion from siting considerations of areas with a topographic grade greater than ten percent (i.e., usually rock).

The bulk of the basin-fill materials within WSMR/FBMR (Tularosa, Jornada del Muerto basins and the Hueco bolson) has been defined, or suggested, to be part of the Santa Fe Group (Kottolowski and LeMone, 1969). These deposits range in age between Miocene and mid-Pleistocene and consist of alternating coarse- (sand and gravel) and fine- (clay and silt) grained facies. Areal distribution of the units within the group is not well known within the DoD land areas. Reported fossil occurrences have come from natural exposures west and southwest of WSMR/FBMR.

Although tilted in valleys to the west, it appears that the Santa Fe Group rocks within the Tularosa Basin are nearly horizontal and that only the upper limits of the Group are exposed. Within this upper sequence (in the Mesilla Valley to the west) a vertebrate fossil fauna including *Mammuthus*, *Cuviernius* (both mastadon or elephant-like), and *Equus* (ancestral horse) have been found (Ruhe, 1962; Gile and Hawley, 1966). The remains consist predominantly of tooth and jaw structures, and limb bone elements of mid-Pleistocene age that have been taken from the youngest sand and gravel unit of the Santa Fe Group (Kottolowski and LeMone, 1969).

Although not specifically reported from the Santa Fe Group, large portions of the entire skeletal remains of these larger animals are found. Potentially any of the Santa Fe Group deposits except the very coarsest, may yield similar fossils.

Metcalf (1969) has reported the presence of a mollusk (fresh water) fauna in the upper portion of these older basin-fill material from El Paso north along the west side of the San Andres Mountains. They are found predominantly in the finer deposits and, although not known to be present in WSMR/FBMR areas, may be in similar aged (correlative) deposits in the Tularosa Basin.

LeMone and Johnson (1969) describe an abundant and well developed early to middle Pleistocene fossil plant assemblage from upper Santa Fe Group deposits. Entraining sediments range between massive siliceous beds, that are locally jasperoidal, to calcareous silty sand. The fossil flora is opalized and is in an excellent state of preservation. Several genera and species (both new and old) have been described. The extent to which similar beds, and, therefore, similar fossils may be present in the Santa Fe Group within WSMR/FBMR is not known.

## 2.2 YPG/LWBGR

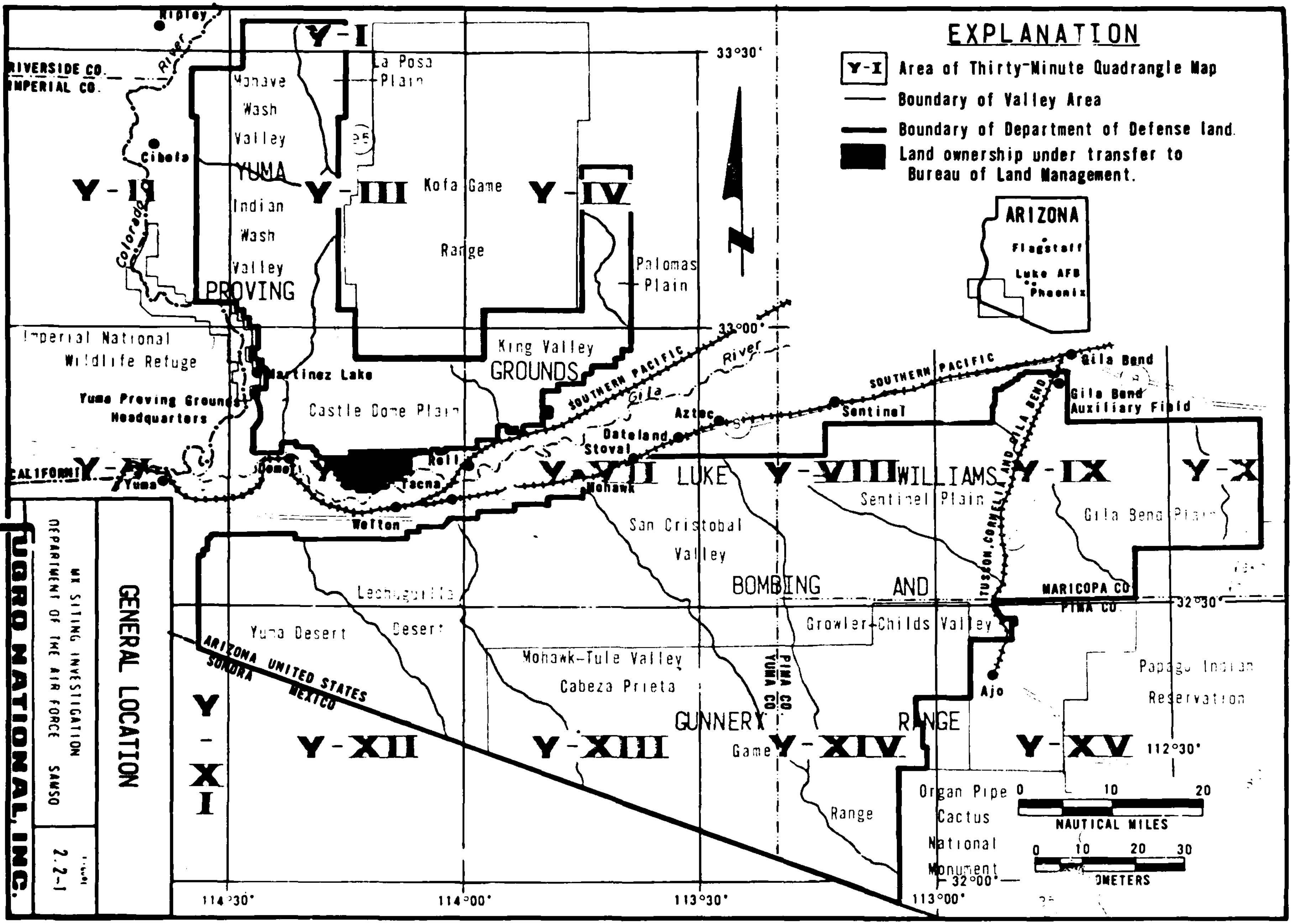
### 2.2.1 CURRENT LAND USE, PLANS, POLICIES AND CONTROLS

YPG and LWBGR are under the control of the Department of the Army and the Department of the Air Force, respectively. YPG, established in 1943, is the only U. S. military general purpose proving grounds located in desert terrain and provides facilities and technical services for the Signal Corps, Chemical Corps, Corps of Engineers and Ordinance Corps. Although public access is allowed along U. S. 95, the right to travel within YPG off this main highway is not within public domain. The Kofa Game Range and the Imperial Wildlife Refuge, together with YPG, comprise the Yuma Test Station; however, these two areas are excluded from field work and testing activities. (Figure 2.2-1).

Approximately 40 square nautical miles ($nm^2$) in the Muggins Mountains in southern YPG are under transfer to the Bureau of Land Management (BLM).

LWBGR, originally activated in 1941, remains under primary control of Luke Air Force Base (AFB), Litchfield Park (near Phoenix), with Gila Bend Auxiliary Field providing combat and facilities support for pilot training missions. The western sector is used by the U. S. Marine Corps Air Station, Yuma. The eastern sector is used by Luke AFB and also serves as a training area for NATO pilots of the Federal Republic of Germany. The only special use area designated within LWBGR is

DATE: 30 JUNE 1975




GENERAL LOCATION

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

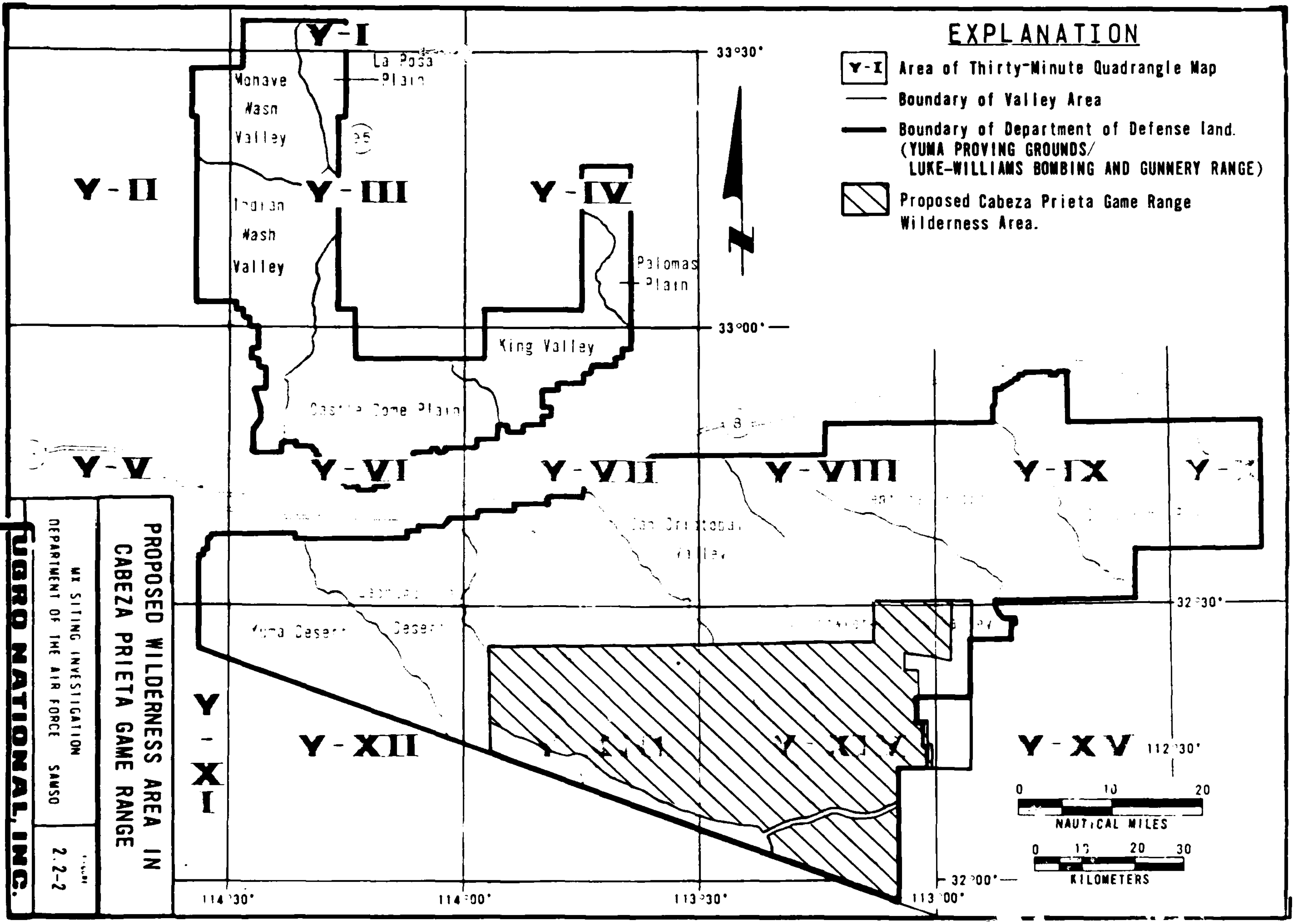
FIGURE 2.2-1

FUGRO NATIONAL, INC.

the Cabeza Prieta Game Range which is jointly administered with the U. S. Fish and Wildlife Service (U. S. Bureau of Sport Fisheries and Wildlife) in cooperation with the BLM.

Short-range land use plans for those areas under current Department of the Army control (YPG) include 1) the transfer of approximately 40 $nm^2$ in southern YPG to the BLM, 2) the development of North Cibola Range, a testing area proposed for La Posa Plain and 3) to maintain all other policies and controls to keep the facility functioning at its present status. It is believed that short-range land use plans for those areas under Department of the Air Force control (LWBGR) are to maintain current policies and controls to keep facilities functioning at their present status. To date, major portions of the Cabeza Prieta Game Range have been proposed for inclusion under the Federal Wilderness Act. (Figure 2.2-2). The proposal was submitted by the U. S. Fish and Wildlife Service with a request that Congressional action await completion of both aerial and ground surveys of the area by the U. S. Geological Survey. Both short- and long-range plans may be affected by future Congressional action on the status of the Cabeza Prieta Game Range. No details of long-range plans are known for either YPG or LWBGR, although considerations similar in magnitude to deployment of the MX land mobile system may have been made.

DATE: 30 JUNE 1975




PROPOSED WILDERNESS AREA IN CABEZA PRIETA GAME RANGE

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 2.2-2

FUGRO NATIONAL, INC.

## 2.2.2 SOCIOECONOMICS

YPG/LWBGR lies mainly within Yuma County, Arizona, with approximately one-third of LWBGR extending eastward into Maricopa and Pima Counties. The principal cities in the area are listed, with their respective populations, in Table 2.2-1 (U. S. Census Bureau, 1970).

Employment activities of persons in Arizona are almost equally divided between primary and secondary industrial categories (agriculture, manufacturing, construction, mining and power) and supplemental industries (retail and wholesale trade, financial, professional and non-professional services and public administration). These supplemental industries employ approximately two-thirds of the non-agricultural workforce. Approximately 20 percent of the non-agricultural workforce is in manufacturing. The aerospace and electronics industries dominate over food processing, textiles, construction and mining.

Agricultural activities are centered in irrigated areas such as the Salt and Gila River Valleys and the Yuma District. Principal crops include cotton, vegetables and citrus fruits, with livestock concentrated in feed lots. Near the large metropolitan areas, such as Phoenix and Tucson, urban growth is displacing agriculture and giving rise to urban horticulture (lawn grasses, palm trees, native and exotic plants for landscaping).

Cities or towns which would most likely serve as primary or

TABLE 2.2-1

POPULATIONS OF COMMUNITIES IN THE VICINITIES OF YPG/LWBGR

| Population Center | Distance From Range Boundary (nm) | 1970 Population |
|---|---|---|
| Yuma, Arizona | 6.5 | 29,007 |
| Blythe, California | 7.0 | 7,047 |
| Ajo, Arizona | 3.5 | 5,881 |
| West Yuma, Arizona | 7.8 | 5,552 |
| Yuma Station, Arizona | 5.2 | 3,460 |
| Somerton, Arizona | 7.8 | 2,225 |
| Gila Bend, Arizona | 2.2 | 1,795 |
| Yuma Proving Grounds, Arizona | 0 | 1.349 |
| Wellton, Arizona | 2.5 | 970 |
| Palo Verde, California | 7.2 | 610 |
| Quartzite, Arizona | 7.2 | 600 |
| Tacna, Arizona | 2.0 | 595 |
| Ehrenberg, Arizona | 3.9 | 400 |
| Roll, Arizona | 3.8 | 80 |
| Dateland, Arizona | 2.0 | 50 |
| Aztec, Arizona | 3.5 | 50 |
| Sentinel, Arizona | 2.0 | 35 |
| Martinez Lake, Arizona | 0.2 | 10 |
| Dome, Arizona | 1.7 | 10 |
| Cibola, Arizona | 3.9 | 10 |
| | Total | 59,736 |

Source: Bureau of the Census, 1975

or secondary centers for mobilization of field related activities include: Phoenix, Yuma, Gila Bend and Ajo.

## 2.2.3 CLIMATE

### 2.2.3.1 General

Climatic conditions within YPG/LWBGR are primarily a result of its inland location and latitudinal position. These two factors combine to produce an arid to semi-arid climate, characterized by hot summers, mild winters, relatively low humidity and long periods of aridity separated by thunderstorms yielding intense rainfalls. Climatic conditions throughout YPG/LWBGR are fairly uniform, with local variations due primarily to elevation differences.

### 2.2.3.2 Precipitation

The low mean annual precipitation of YPG/LWBGR is controlled by 1) the inland location, 2) the rain-shadow effect of the mountain ranges of the west coast and 3) the north-south trending mountain ranges within the area. Precipitation occurs principally in the months of July, August and September and December, January and February, and is generally in the form of rain, although traces of snow have been recorded. A general increase in the average annual rainfall due to increasing elevation is evident moving eastward across the siting area (3.48 inches at Yuma, 5.47 inches at Gila Bend and 8.86 inches at Ajo).

August is the month of heaviest rainfall, although approximately two-thirds of the total annual precipitation occurs during the winter. Summer rains usually result from local thunderstorms; while in winter, gentler rains over a large area are more common.

Thunderstorms in southwestern Arizona occur on an average of 15 days per year, primarily during July through September. They result in intense rainfalls (as much as 2.0 inches within 15 minutes; Anderson and Italia, 1970), and may be accompanied by lightning, strong winds, dust storms, tornados and funnel clouds, or hail.

2.2.3.3 Wind

In the eastern portion of the siting area, westerly winds predominate during the summer and easterly winds prevail during the remainder of the year; wind speeds average about ten miles per hour (mph). In the western portion, southerly winds predominate during the summer and northerly winds prevail during the remainder of the year; wind speeds average five to six mph. Maximum wind gusts of 50 to 60 mph are recorded in the valleys primarily during early spring.

2.2.3.4 Temperature

Daytime temperatures from mid-May to mid-September generally exceed 100 degrees Farenheit ($^{O}F$), with night-time temperatures usually in the sixties, but often remaining above 90$^{O}F$ during June, July and August. Summer soil temperatures may reach 140$^{O}F$ or greater, dropping to 80$^{O}F$ at night. Winters are mild with daytime temperatures averaging between 50 and 60$^{O}F$, dropping to the mid-thirties at night. A frost-free period of ten to eleven months is common, with frost usually occurring in December and January.

2.2.3.5 Relative Humidity and Evaporation

With an average of approximately 330 to 350 days (90 to 97 percent) of sunshine in the eastern and western portions of the area, respectively, and an average relative humidity of less than 35 percent, the evaporation rate is very high. Pan evaporation has been measured as 120 inches at YPG (Shepard and others, 1955), or roughly 25 times the average annual precipitation.

2.2.3.6 Fog

Fog may develop over the western portion of the area, particularly during December, January and February, when reversal of the normal winter wind pattern may draw warm, moist air in from the Gulf of California. The resulting fog may limit visibility to less than 1 nm for short durations (less than five hours).

2.2.3.7 Dust Storms

Strong winds (50 to 60 mph) that accompany thunderstorms and low pressure storm fronts passing through the area may pick up dust and sand, creating local dust storms that can limit visibility to zero in the affected area.

## 2.2.4 AIR QUALITY

Regional air quality throughout the siting area is very good and generally free of significant levels of unnatural contaminants. Local variations may occur adjacent to population centers (Yuma and Ajo). Strong winds and dust storms contribute to natural, short-term deterioration of air quality and visibility.

Local man-induced decreases in air quality may be caused by construction equipment operation, automotive traffic, military training missions, and agricultural activities. These factors will contribute most near populated and traveled areas, but the overall effect should be minimal.

## 2.2.5 NOISE

Present noise levels within most of the siting area are high to very low. The most common noises are a result of man's activities in these areas, including use of existing highways, railroad traffic, aircraft, missile and artillery testing, and military ground exercises (including off-road vehicles). These noises are generally intermittent and may be high to low. Some are local to the source and others affect fairly large areas.

The ambient noise level in the open basin areas is low. Natural sounds are generated by animals, wind (including moving brush), thunder and rain.

No base level noise data is known to exist for the specific YPG/LWBGR areas. Typically ambient noise levels in open desert areas may vary between approximately 25 and 60 dBA (Bureau of Reclamation, 1974). Levels up to 100 dBA may be appropriate immediately adjacent to a major highway due to traffic and sonic booms may cause levels of 150 dBA. Thunder may have a noise level of 120 to 130 dBA. The public is known to complain at "impulse" levels of about 118 dBA (Air Force Weapons Lab., 1974). Continuous ambient noise levels of 45 dBA and continuous levels of 65 dBA for periods not exceeding 8 hours are considered normally acceptable under HUD noise criteria.

### 2.2.6 AESTHETICS

The region can be evaluated in terms of its present visual impact, i.e., the degree of naturalness of the setting, the degree of manmade alteration, dominant views and types of distractions. The existing visual setting is typified by open-valley desert systems within the southern Basin and Range Physiographic Province. Intensity of military activities controls the relative amount of natural versus artificial scenery.

Most of the scenic value of the area lies in its naturalness, the combination of gentle and abrupt topography and the general undisturbed appearance of the desert terrain gained from viewpoints normally available to the public. In general, views from existing main highways through or adjacent to YPG/LWBGR are free from artificial elements such as structures, roads, and disturbances to the landscape (e.g., grading of surfaces or fences). However, both improved dirt and paved roads and unimproved trails lead away from these highways, and near military facilities the visual impact of human activities is apparent.

## 2.2.7 ECOLOGY

### 2.2.7.1 General

YPG/LWBGR lies within the Lower Colorado and Arizona Upland subdivisions of the Sonoran Desert vegetative communities of Arizona (Brown, 1973), and is characterized by dryness and seasonal temperature extremes.

The Sonoran Desert plains of both subdivisions are characterized by low, open stands of creosote bush (*Larrea divaricata*). However, the single outstanding characteristic which distinguishes the Sonoran Desert from other major deserts of North America is the presence of small drought-adapted (xerophytic) trees and arborescent cacti. These species are best developed in the Arizona Upland subdivision (Dunbier, 1968) and exhibit a great diversity of size and distribution. Figure 2.1-3 shows the general geographic location of the Sonoran Desert.

The most characteristic feature of the environment of YPG/LWBGR is the general scarcity of rainfall throughout the area. Vegetation and wildlife have special structural, physiological and behavioral adaptations which allow them to live in this arid environment (Hadley, 1973).

Individual species of desert plants can be grouped into three separate categories based on their growth form -- ephemeral annuals, succulent perennials, and non-succulent perennials.

An ephemeral annual (e.g., desert wildflower) is capable of completing its full life cycle -- germination, growth, flowering, seed production, and death -- in six to eight weeks. Seeds of desert wildflowers lie dormant in the soil awaiting sufficient soil moisture for germination and growth. Active growth following the rainy season is one of the principal physiological adaptions to water scarcity.

Succulent perennials (xerophytes) have adapted to the desert environment through their ability to store water in leafy tissues. This floral type, which includes the cacti, has the ability to accumulate and store water in excess of physiological needs during the rainy season.

Non-succulent perennials (e.g., phreatophytes -- plants dependent on groundwater, and other trees and shrubs) have a variety of adaptations to water scarcity. Some trees have deep root systems that provide a constant supply of water from year-round, near-surface groundwater sources. The ocotillo, a drought-deciduous plant, reduces water loss by sprouting leaves only during the short rainy period. For the remaining portion of the year, it appears lifeless. Otner adaptations of non-succulent perennials include compact leaves that expose less surface to water loss, white powder or hairs on the leaf surface to reflect light, and diffuse root systems.

Because of the hot, dry climate, most desert animals are crepuscular (active in the twilight) or nocturnal. During the heat of the day, these animals remain in shaded areas or underground. Consequently, edaphic (soil) conditions are very important to desert animals as well as plants.

Discussions of ecological aspects will predominate over other environmental factors considered. This is the system most susceptible to damage by the proposed action and the system for which impact is the most difficult to mitigate. The following sections discuss general and Valley Specific (Figure 2.2-1) vegetation and wildlife characteristics for the YPG/LWBGR area. Threatened and endangered faunal and floral species are presented in Appendix B.

### 2.2.7.2 Vegetation

Vegetation in YPG/LWBGR has been divided into four distinct plant communities:

1. Creosote Bush-Scrub
2. Palo verde-Saguaro
3. Desert Riparian
4. Freshwater Marsh

In general, the Creosote Bush-Scrub community is the most widely distributed of the vegetation types occurring in the intermontane valleys and plains.

The desert riparian community, which occurs along dry water-courses, and the freshwater marsh community, which occurs in the bottomlands of the Colorado River on the western boundary of the Yuma Proving Grounds, have limited distributions.

Table 2.2-2 summarizes the major plant communities and their geomorphic units and habitats within YPG/LWBGR.

The Creosote Bush-Scrub association in the lowlands is replaced by the Palo verde-Saguaro community on the rocky slopes of the mountain ranges or coarse-soiled slopes of the intermediate and higher elevation alluvial fans. Better drainage in these areas allows for the co-existence and proliferation of the small-leafed desert trees and shrubs and a variety of cacti. The Palo verde-Saguaro community is more prevalent in the eastern portion of the YPG/LWBGR due to more moisture resulting from increased orographic precipitation.

Table 2.2-3 lists the most common individual plant species found within YPG/LWBGR and their distribution among the various plant communities.

2.2.7.3 Wildlife

2.2.7.3.1 General

Life-zones are bands or groups of vegetation (and the animals inhabiting them) that vary with latitude and/or altitude. The siting area is generally characteristic of the Lower-Sonoran Life-zone, as indicated by the presence of the following fauna:

## TABLE 2.2-2

PLANT COMMUNITIES OF YPG/LWBGR

| Plant Community | Indicator Plants: Common Name | Indicator Plants: Scientific Name | Geomorphic Associations and Habitats |
|---|---|---|---|
| 1. Creosote Bush-Scrub | Creosote Bush<br>Bur-Sage<br>Pencil Cactus | Larrea divaricata<br>Franseria dumosa<br>Opuntia ramosissima | Intermontane Plains and<br>Lower Bajadas<br>Widespread |
| | Ratany<br>Ocotillo | Krameria rigida<br>Fouquieria splendens | Upper bajadas, hills |
| | Silver Cholla<br>Hedgehog Cactus | Opuntia echinocarpa<br>Echinocereus engelmannii | Upper bajadas |
| | Foothill Paloverde | Cercidium microphyllum | Margins of washes, upper bajadas |
| | Mesquite | Prosopis juliflora | Margins of washes, flood plains |
| | Burrobush | Hymenoclea monogyra | Margins of washes, sandy washes |
| | Box Thorn<br>Crucillo<br>Encelia | Lycium andersonii<br>Condalia lycioides<br>Encelia frutescens | Margins of washes |
| | Galleta Grass | Hilaria rigida | Sandy plains |
| | Saltbush | Atriplex canescens | Alkali flats |
| | Galleta Grass<br>Wild Buckwheat<br>Dyewood<br>Coldenia | Hilaria rigida<br>Eriogonum deserticola<br>Dalea emoryi<br>Coldenia palmeri | Dunes and sandy plains<br>Stabilized dunes |
| | Creosote Bush<br>Bur-Sage<br>Mormon Tea<br>Saltbush | Larrea divaricata<br>Franseria dumosa<br>Ephedra trifurca<br>Atriplex canescens | Moderately active dunes |
| | Lichens | Acarospora-Lecidia | Sandy plains |
| | Creosote Bush<br>Bur-Sage<br>Elephant Tree<br>Nightshade<br>Ocotillo<br>Foothill Paloverde<br>Ironwood<br>Saguaro | Larrea divaricata<br>Franseria dumosa<br>Bursera microphylla<br>Solanum hindsianum<br>Fouquieria splendens<br>Cercidium microphyllum<br>Olneya tesota<br>Cereus giganteus | Malpais fields<br>Local fields of basalt |
| 2. Paloverde-Saguaro | Creosote Bush<br>Silver Cholla | Larrea divaricata<br>Opuntia echinocarpa | Upper Bajadas<br>Dry slopes |
| | Ocotillo | Fouquieria splendens | Dry rocky slopes |
| | Saguaro Cactus | Cereus giganteus | Gravelly slopes |
| | Bur-Sage | Franseria dumosa | Well-drained soils |

| | | | |
|---|---|---|---|
| | Creosote Bush<br>Bur-Sage<br>Mormon Tea<br>Saltbush | Larrea divaricata<br>*Franseria* dumosa<br>Ephedra trifurca<br>Atriplex canescens | |
| | Lichens | Acarospora-Lecidia | *Sandy* plains |
| | Creosote Bush<br>Bur-Sage<br>Elephant Tree<br>Nightshade<br>Ocotillo<br>Foothill Paloverde<br>Ironwood<br>Saguaro | Larrea divaricata<br>Franseria dumosa<br>Bursera microphylla<br>*Solanum hindsianum*<br>Fouquieria splendens<br>Cercidium microphyllum<br>Olneya tesota<br>Cereus giganteus | Malpais fields<br>Local fields of basalt |
| 2. Paloverde-Saguaro | Creosote Bush<br>Silver Cholla | Larrea divaricata<br>Opuntia echinocarpa | Upper Bajadas<br>Dry slopes |
| | Ocotillo | *Fouquieria* splendens | Dry rocky slopes |
| | Saguaro Cactus | Cereus giganteus | Gravelly slopes |
| | Bur-Sage | Franseria dumosa | Well-drained soils |
| | Blue Paloverde<br>Ironwood<br>Mesquite<br>Foothill Paloverde | Cercidium floridum<br>Olneya tesota<br>Prosopis juliflora<br>*Cercidium microphyllum* | Near washes |
| 3. Desert Riparian | Desert Willow<br>Mesquite<br>Blue Paloverde<br>Ironwood | Salix bonplandiana<br>Prosopis juliflora<br>Cercidium floridum<br>Olneya tesota | Intermontane Plains and<br>Lower Bajadas<br>Large drainageways |
| | Smoke Tree | Dalea *spinosa* | Large drainageways and sandy washes |
| | Burrobrush<br>Broom Baccharis<br>Box Thorn | Hymenoclea Salsola<br>Baccharis sarothroides<br>Lycium andersonii | Small drainageways and sandy *washes* |
| 4. Freshwater Marsh | Salt Cedar<br>Saltbush<br>Pickleweed, Iodine bush<br>Arrowweed | Tamarix pentandra<br>Atriplex lentiformis<br>Allenrolfea occidentalis<br>Pulchea sericea | River Bottomland<br>Alkaline soils |

## TABLE 2.2-3

### COMMON PLANT ASSOCIATIONS OF YPG/LWBGR

| Common Plants | | Association | | | |
|---|---|---|---|---|---|
| Scientific Name | Common Name | 1 | 2 | 3 | 4 |
| SHRUBS AND TREES | | | | | |
| Acacia greggii | Cat's-claw acacia | | x | x | |
| Allenrolfea occidentalis | Pickleweed, Iodine bush | x | | | x |
| Atriplex canescens | Saltbush | x | | | |
| Atriplex lentiformis | Saltbush | x | | | x |
| Baccharis sarothroides | Broom Baccharis | | | x | |
| Bebbia juncea | Bebbia | x | | | |
| Calliandra eriophylla | False-mesquite | x | | | |
| Cercidium microphyllum and C. floridum | Palo verde | x | x | x | |
| Cereus giganteus | Saguaro | | x | | |
| Coldenia palmeryi | Coldenia | x | | | |
| Condalia lycoides | Crucillo | x | | | |
| Dalea emoryi | Dyewood | x | | | |
| Dalea spinosa | Smoke-tree | | | x | |
| Echinocactus sp. | Barrel cactus | | x | | |
| Echinocereus engelmannii | Hedgehog cactus | x | | | |
| Encelia farinosa | Brittle bush | x | x | | |
| Encelia frutescens | Brittle bush | x | | | |
| Ephedra spp. | Mormon tea | x | | | |
| Fouquieria splendens | Ocotillo | x | x | | |
| Franseria dumosa | Bur sage | x | x | | |
| Grayia spinosa | Hop-sage | x | | | |
| Hymenoclea sp. | Burrobrush | x | | | |
| Krameria grayia | Ratany | x | | | |
| Larrea divaricata | Creosote bush | x | x | | |
| Lycium andersonii | Boxthorn | x | x | x | |
| Olneya tesota | Ironwood | | x | x | |
| Opuntia basilaris | Beavertail cactus | x | x | | |
| Opuntia bigelovii | Bigelow's cholla | x | | | |
| Opuntia echinocarpa | Silver cholla | x | x | | |
| Opuntia ramosissima | Pencil cactus | x | | | |
| Opuntia versicolor | Staghorn cactus | | x | | |
| Prosopis juliflora | Mesquite | x | x | x | |
| Prosopis pubescens | Tornillo | x | | x | |
| Pulchea sericea | Arrowweed | x | | | x |
| Salix bonplandiana | Desert willow | | | x | x |
| Salix goodingii | Willow | | | | x |
| Simmondsea chinensis | Jojoba | | x | | |
| **Tamarix pentandra** | **Salt cedar** | | | | x |

| | | | | | |
|---|---|---|---|---|---|
| *Olneya tesota* | Ironwood | | x | x | |
| *Opuntia basilaris* | Beavertail cactus | x | x | | |
| *Opuntia bigelovii* | Bigelow's cholla | x | | | |
| *Opuntia echinocarpa* | Silver cholla | x | x | | |
| *Opuntia ramosissima* | Pencil cactus | x | | | |
| *Opuntia versicolor* | Staghorn cactus | | x | | |
| | | | | | |
| *Prosopis juliflora* | Mesquite | x | x | x | |
| *Prosopis pubescens* | Tornillo | x | | x | |
| *Pulchea sericea* | Arrowweed | x | | | x |
| | | | | | |
| *Salix bonplandiana* | Desert willow | | | x | x |
| *Salix gooddingii* | Willow | | | | x |
| *Simmondsea chinensis* | Jojoba | | x | | |
| | | | | | |
| *Tamarix pentandra* | Salt cedar | | | | x |
| | | | | | |
| GRASSES AND FORBES | | | | | |
| | | | | | |
| *Bouteloua* sp. | Grama grass | x | x | | |
| | | | | | |
| *Distichlis* sp. | Saltgrass | | | | x |
| | | | | | |
| *Eriogonum deserticola* | Wild buckwheat | x | | | |
| | | | | | |
| *Hilaria rigida* | Galleta grass | x | | | |
| *Hyptis emoryi* | Desert lavender | | x | | |
| | | | | | |
| *Phragmites communis* | Reed, common | | | | x |
| | | | | | |
| *Sarcostemma hirttellum* | Furastrum | x | | x | |
| *Scirpus validus* | Bulrush, great | | | | x |
| | | | | | |
| *Tridens pulchellus* | Desert fluffgrass | x | x | | |
| *Typha latifolia* | Cat-tail | | | | x |

***Note:*** 1. *Creosote Bush-Scrub*
2. Paloverde-Saguaro
3. Desert Riparian
4. Freshwater Marsh

***Sources:*** Shepard and others, 1955; Shreve and Wiggins, 1964; *Lowe and Brown*, 1973.

| | |
|---|---|
| Round-tailed ground squirrel | Citellus tereticaudus |
| Cactus mouse | Peromyscus eremicus |
| Desert pocket mouse | Perognathus penicillatus |

Table 2.2-4 lists the fauna commonly found in the lowland portion of YPG/LWBGR, as well as habitats, food, types of den or nesting area, and migration habits. Desert bighorn sheep and the desert chuckwalla are found in the mountain ranges. The desert kangaroo rat, desert pocket mouse, and numerous species of lizards and snakes, including the sidewinder rattlesnake, successfully occupy the open desert valleys.

2.2.7.3.2 Endangered and Threatened Wildlife

Faunal species found within the study area which are on the 1974 "United States List of Endangered Species" are:

| | |
|---|---|
| American peregrine falcon | Falco peregrinus anatum |
| Sonoran pronghorn antelope | Antilocapra americana sonoriensis |

The habitat of the American peregrine falcon is open country, and it has been reported to occasionally winter in the lower Colorado River Valley.

Along the southern edge of LWBGR between the Cabeza Prieta Mountains and Organ Pipe Cactus National Monument is a herd of about sixty pronghorn antelope that are the last remnant of the pale-haired race sonoriensis found in the United States. Since the establishment of the Cabeza Prieta Game Range for

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COMMON WILDLIFE OF YPG/LWBGR

| Common Name | Scientific Name | Habitat |
|---|---|---|
| Couch's Spadefoot | Scaphiopus couchi | Varied; ground dweller |
| Colorado River Toad | Bufo alvarius | Desert plain |
| Desert Tortoise | Gopherus agassizi | Rocky foothills |
| Gila Monster | Heloderma suspectum | Rocky foothills, upper bajadas, rocky canyons |
| Desert Iguana | Dipsosaurus dorsalis | Creosote bush scrub below 3300 feet elevation |
| Fringe-toed Lizard | Uma notata | Sandy areas and dunes |
| Gopher Snake | Pituophis melanoleucus | Widespread below 9000 feet |
| Western Diamondback Rattlesnake | Crotalus atrox | Widespread below 5300 feet |
| Sidewinder Rattlesnake | Crotalus cerastes | Widespread, but generally sandy soils |
| Red-tailed Hawk | Buteo jamaicensis | Widespread |
| Sparrow Hawk | Falco sparverius | Widespread |
| White-winged Dove | Zenaida asiatica | Brushy areas |
| Mourning Dove | Zenaidura macroura | Widespread |
| Roadrunner | Geococcyx californianus | Open country with scattered cover |
| Great Horned Owl | Bubo virginianus | Widespread |
| Gila Woodpecker | Centurus uropygialis | Desert washes, saguaros |
| Cactus Wren | Campylorhynchus brunneicapillus | Cactus, yucca, mesquite |
| Black-tailed Gnatcatcher | Polioptila melanura | Brush, dry washes, mesquite, paloverde |
| Lucy's Warbler | Vermivora luciae | Mesquite |
| Black-tailed Jack Rabbit | Lepus californicus | Widespread |
| Desert Cottontail | Sylvilagus audobonii | Bushy areas, below 6000 feet |
| Squirrels | Citellus sp. | Rocky and desert areas below 6000 feet |
| Round-tailed Ground Squirrel | Citellus tereticaudus | Wind-blown sand in Creosote bush-scrub below 3200 feet |
| Valley Pocket Gopher | *Thomomys* bottae | Widespread |
| Pocket Mice | Perognathus sp. | Desert plains from 500 to 5100 feet (nocturnal) |
| Desert Pocket Mouse | Perognathus pencillatus | Desert plains from 120 to 5200 feet (nocturnal) |
| Kangaroo Rat | Dipodomys sp. | Desert Plains from 120 to 5200 feet |
| Southern Grasshopper Mouse | Onychomys torridus | Desert plains from 120 to 5000 feet (nocturnal) |
| Cactus Mouse | Peromyscus eremicus | Desert plains from 120 to 6000 feet (nocturnal) |
| Desert Wood Rat | Neotoma lepida | Desert plains from 1100 to 6000 feet |
| Coyote | Canis latrans | Widespread from 120 to 9100 feet |
| Mearns' Coyote | Canis mearnsi | Vicinity of Tinajas Altas and Mohawk Mts. from 120 to 5000 feet |
| Kit Fox | Vulpes macrotis | Widespread from 120 to 6500 feet |
| Badger | Taxidea taxus | Widespread from 120 to 7000 feet |
| Spotted Skunk | Spilogale putorius | Dry watercourses from 120 to 7000 feet (nocturnal) |
| Striped Skunk | Mephitis mephitis | Dry watercourses from 300 to 9000 feet (nocturnal) |
| Bobcat | Lynx rufus | Widespread from 120 to 9300 feet |
| Javelina (Collared Pecary) | Tayassu tajacu | LWBGR: 1200 to 6000 feet |
| Mule Deer | Odocoileus hemionus | Brushy areas: 250 to 9000 feet |
| Prong-horned Antelope | Antilocapra americana | Desert plains |
| Bighorn Sheep | Ovis canadensis | High rocky mountain ranges |

TABLE 2.2-4

| Migration | Den or Nesting Area | Food |
|---|---|---|
| No | Intermittent pools | Insects |
| No | Intermittent pools | Insects |
| No | Hillside burrows, under rocks | Vegetarian |
| No | Rodent burrows, under rocks | Small rodents |
| No | Rodent burrows | Vegetation |
| No | Sand | Insects |
| No | Under rocks, logs | Small mammals, birds |
| No | Under rocks, logs, bushes | Small mammals |
| No | Rodent burrows, sand | Small mammals |
| Resident | Tree, cliff, etc. | Rats, mice, rabbits |
| Winter | Cavity in tree, sagauro | Birds, rodents, insects |
| Summer | Tree, thicket | Seeds, grain, fruits |
| Resident | Tree, shrub, cactus, ground | Seeds, grain, fruits |
| Resident | Bush, cactus, tree | Reptiles |
| Resident | Tree, cliff, ground | Rodents, birds, reptiles |
| Resident | Sagauro tree | Insects, fruit |
| Resident | Cactus or thorny bush | Insects, spiders |
| Resident | Low bush | Insects and larvae |
| Summer | Tree cavity | Insects |
| No | Ground depression or under bush | Vegetation |
| No | Ground | Grass, leaves, fallen fruit |
| No | Burrows | Seeds and fruits |
| No | Burrows | Seeds and fruits |
| No | Underground | Roots, underground growth |
| No | Burrows | Seeds |
| No | Burrows | Seeds |
| No | Burrows | Seeds and some grains |
| No | Burrows | Insects |
| No | Burrows | Seeds and grains |
| No | Ground | Green vegetation |
| No | Crevice or cave | Small mammals, birds, lizards, fruit, carrion |
| No | Crevice or cave | Small mammals, birds, lizards, fruit, carrion |
| No | Burrow | Desert rodents, insects |
| No | Burrow | Small mammals, rodents |
| No | Rocks, hollow logs, burrow | Mainly insects; occasionally small mammals, birds, eggs |
| No | Burrow | Insects, mice, small mammals |
| No | Cavity or cave in rocks | Small mammals, birds |
| No | | Omnivorous |
| Winter-Lowlands | Bushy areas | Grass, foliage |
| No | Bushy areas | Grasses, foliage |
| Occasional between Mountain Ranges | Rocky areas | Grasses, wildflowers |

their protection, their numbers have possibly stabilized in Arizona, but they are still rapidly decreasing in the Mexican portion of their range due to overshooting and poaching.

Also endangered, but found on the periphery of the study area is the Southern bald eagle (Haliaeetus leucocephalus leucocephalus). There have been records of the bald eagle wintering in the region (Lowe, 1964), but feeding characteristics of the species restrict its probable area of occurrence to the western margin of Yuma Proving Grounds in the lower Colorado River Valley.

Not considered to be an endangered species, but classified as "threatened wildlife" by the U. S. Fish and Wildlife Service is the prairie falcon (Falco maxicanus). This bird has been identified as a periodic resident and winter visitor to the study area (Lowe, 1964). It is wide-ranging among the habitats of the study area, nesting principally within bare niches in steep cliffs.

The status of the Gila monster (Heloderma suspectum) was listed as "undetermined" by the U. S. Fish and ife Service in 1973, and is protected by State law in A..zona. It is commonly found in the Lower Sonoran Lifezone in and around rocks on bajada slopes.

2.2.7.3.3 Wildlife Refuges

The Cabeza Prieta Game Range lies within the siting area and is located on the border of Arizona and Mexico in Yuma and Pima counties. The Range was established in 1939 to protect the desert bighorn sheep, but also provides habitat for the Sonoran pronghorn, the javelina or collared peccary, Gambel's quail, and white-winged dove. Unusual plants include the elephant tree, sinita cactus, Kearney sumac, and the Mexican jumping bean.

Its 1037 $nm^2$ are generally closed to the public because of its proximity to aerial bombing and gunnery ranges. Approximately (735 $nm^2$) (Figure 2.2-2) are designated for possible designation under the "Wilderness" classification of the Federal Wilderness Preservation System (Lower Colorado Region State-Federal Interagency Group, 1971).

The Imperial National Wildlife Refuge lies adjacent to the Yuma Proving Grounds on the southwest. Encompassing 51 $nm^2$ on the Colorado River the Refuge serves as a wintering area for many species of waterfowl.

The Kofa Game Range includes over 707 $nm^2$, roughly bounded on three sides by the Yuma Proving Grounds. The Range was established in 1939 to preserve and protect a sizeable habitat for the desert bighorn sheep, which now number approximately 250 (U. S. Fish and Wildlife Service, 1974). The area also supports a herd of desert mule deer (<u>Odocoileus hemionus</u>), in addition to populations of mountain lion

(<u>Felis concolor</u>), wild burro (<u>Equus assinus</u>) and collared peccary (<u>Tayassu tajacu</u>). Palm Canyon, in the west end of the Kofa Mountains, is the site of the only palms native to Arizona.

2.2.7.4 <u>Vegetation and Wildlife Summary by Valley</u>

2.2.7.4.1 <u>General</u>

Figure 2.2-1 depicts the locations of the Valley sub-areas of YPG/LWBGR that are used in the following discussion. The boundaries of the sub-areas are defined primarily by topographic and hydrologic divided with artificial boundaries (roads, DoD boundaries) assigned where necessary. Wildlife is typical of the Lower Sonoran zone and includes desert pocket mouse, lizards, desert iguana, rattlesnakes, coyotes and numerous species of birds in the valley areas with mule deer and bighorn sheep present in the mountains.

2.2.7.4.2 <u>La Posa Plain</u>

Ironwood, cat's claw and mesquite trees are present along the washes, with Saguaro cactus and creosote bush dominating inter-drainage areas. Density varies from 25 percent ground coverage along washes to 10 percent or less in open areas (U. S. Department of the Army, 1954).

2.2.7.4.3 <u>Mohave Wash Valley</u>

Along the various washes of this area grow small trees such as ironwood, palo verde, cat's claw, and mesquite, as well as Saguaro cactus and creosote bush. Density varies from 25 percent ground coverage in open growths of mesquite in wash bottoms to 10 percent ground coverage in the thin lines of trees along drainage channels (U. S. Department of the Army, 1954).

2.2.7.4.4 Indian Wash Valley

The gravelly plains are sparsely covered by galleta grass, creosote bush and ocotillo, with density ranging from 5 to 20 percent (U. S. Department of the Army, 1954) and are scattered in low bushes or clumps and hummocks. A fresh-water marsh plant community occurs along the Colorado River bottom-land areas on the southeastern boundary. Numerous species of waterfowl periodically reside in this habitat.

2.2.7.4.5 Castle Dome Plain

The composition and appearance of the vegetation of Castle Dome Plain is similar to communities in Indian Wash and King Valleys. The gravelly plains are sparsely covered by galleta grass, creosote bush and ocotillo to a density ranging from 5 to 15 percent (U. S. Department of the Army, 1954) and are scattered in low bushes or arranged in clumps or hummocks. Castle Dome Wash, the major drainage in the area, is lined with a mesquite bosque (desert riparian) vegetation. Areas of mesquite bosque provide habitat for numerous small mammals including rabbits, fox and skunks and rodents and a variety of birds including whitewing and mourning doves.

2.2.7.4.6 King Valley

The lower portion of King Valley has vegetation belonging to the Creosote Bush-Scrub association. Desert riparian vegetation is also prevalent along the numerous washes which dissect the valley. Large portions of the valley plain are made up of gravel surfaces on which sparse galleta grass (*Hilaria rigida*) and ocotillo (*Fouquieria splendens*) predominate.

2.2.7.4.7 Palomas Plain

The portion of the Palomas Plain within the Yuma Proving Grounds belongs to the Creosote Bush-Scrub association. Stands of creosote bush are taller and have heavier foliage than those in the intermontane valleys to the southwest. Numerous dry water courses lined with a desert riparian plant community dissect the Palomas Plain, providing habitat for numerous small mammals and birds.

2.2.7.4.8 Yuma Desert

Vegetation of the Yuma Desert is typical of all the intermontane valleys of the LWBGR siting area. The Creosote Bush-Scrub plant community is the predominant association consisting almost entirely of the creosote bush (*Larrea divaricata*) and bur-sage (*Franseria dumosa*). Sand dunes in the central and southern portion are largely devoid of vegetation. However, the sandy areas surrounding the dunes have vegetation typical of the creosote bush and bur-sage association, although generally lower and more open than the vegetation of the surrounding valley.

The alluvial fans along the flanks of the Gila Mountains have gravelly slopes that are covered with lichen and desert pavement that give the surface a black appearance. Cacti and larger shrubs belonging to the Palo verde-Saguaro association are found on the upper bajadas and slopes of the Gila and Tinajas Altas Mountains.

Wildlife of the Yuma Desert is typical of the Lower Sonoran Life-zone. Antelope ground squirrels, jackrabbits, deer mice, and coyotes are commonly found in the open desert, while kangaroo rats, pocket mice, and round-tailed ground squirrels are found in areas of fine sand and sparse vegetation. Mule deer, as well as bighorn sheep, are found on the plains below the Gila Mountains and are especially prevalent near the natural and man-made tanks in the Tinajas Altas Mountains.

2.2.7.4.9 Lechuguilla Desert

The Lechuguilla Desert has vegetation similar to the Yuma Desert. However, the basin-fill areas are much more dissected by large, dry, sand-filled washes. There is a linear aggregation of mesquite bosque along the dry watercourses of Coyote Wash that is generally composed of mesquite, palo verde, and desert ironwood. The mesquite bosque is the common habitat of numerous small mammals such as skunks, badgers, rabbits, and ring-tail cats.

2.2.7.4.10 Mohawk-Tule Valley

In general, the vegetation of the Mohawk-Tule Valley belongs to the Creosote Bush-Scrub association. However, there are numerous local variations to this dominant form of vegetation. The Pinacates volcanic field in the southern portion of Mohawk-Tule Valley is generally devoid of vegetation except for a malpais type vegetation which occurs in scattered communities on the surface and around the perimeter of the flow.

To the west of the Mohawk Mountains is an area of sand dunes that generally covered by sparse vegetation. The upper portions of the alluvial fans along the Mohawk Mountains are gravelly slopes that have been covered by lichen and desert pavement, giving the surface a black appearance. Large colonies of Kunze cholla cactus (*Opuntia kunzei*) are found in the Palo verde-Saguaro plant community on the upper alluvial slopes of the Mohawk Mountains.

Lower Sonoran life forms predominate in the Mohawk-Tule Valley with mule deer and Mearn's coyote particularly prevalent in the desert plains below the Mohawk Mountains.

2.2.7.4.11 San Cristobal Valley

Vegetation of the San Cristobal Valley is similar to the other intermontane valleys of the siting area with the Creosote Bush-Scrub plant community predominating. San Cristobal Wash, the major drainage in the valley, is lined with a mesquite bosque vegetation.

Open valley areas are inhabited by numerous small rodents, including the pocket mouse and desert kangaroo rats, and small mammals such as jack rabbits and coyotes. The mesquite bosque areas provide habitat for numerous small mammals such as skunks, rabbits and fox and numerous species of birds including whitewing and mourning doves. The upland areas typically provide habitat for javelina, mule deer, antelope and ground squirrels and desert bighorn sheep.

2.2.7.4.12 Growler-Childs Valley

Vegetation in the intermontane plains of Growler-Childs Valley belongs to the Creosote Bush-Scrub association. Growler Wash is lined by a mesquite bosque plant community. Because of the somewhat increased precipitation in the mountain ranges, the Palo verde-Saguaro plant community becomes more predominant. Organ pipe cactus (Cereus thurberi) is locally abundant in the Growler and Agua Dulce Mountains. Numerous small rodents, mammals and birds exist within these habitats.

2.2.7.4.13 Sentinel Plain

Vegetation in the Sentinel Plain belongs to the Creosote Bush-Scrub association. Alluvial fans on the northeastern side of the Crater Range have plant communities belonging to the Palo verde-Saguaro association. The Sentinel Volcanic

Field along the northernmost portions of the plain is characterized by only scattered communities of the Creosote Bush. Small rodents, mammals and birds are common to these habitats.

2.2.7.4.14 Gila Bend Plain

The Creosote Bush-Scrub plant community of the Gila Bend Plain is dissected by numerous dry watercourses. Sauceda Wash and Quilotosa Wash systems are lined by a desert riparian plant community of dense mesquite, palo verde, ironwood, and desert willows. Small rodents, mammals and birds occupy these habitats with bighorn sheep and javelina present in the mountain areas.

2.2.7.4.15 Vekol Valley

Vekol Valley has similar vegetation to that in the Gila Bend Plain. However, the Palo verde-Saguaro plant association occupies the gently sloping bajada surfaces. Numerous small mammals, rodents and birds exist within these habitats with larger mammals, such as javelina and bighorn sheep, in the mountains.

## 2.2.8 GEOMORPHOLOGY AND TOPOGRAPHY

YPG/LWBGR lies within the Basin and Range Physiographic Province. The entire siting area lies principally within the Sonoran Desert subprovince, with the exception of the Yuma Desert which lies in the Salton Trough subprovince.

Primary topographic features which typify this area are northwest-trending mountain ranges and intervening alluvial basins, which encompass approximately 25 and 75 percent of the siting area, respectively. Elevations range from 175 feet near Yuma Test Station Headquarters to 4084 feet in the Sand Tank Mountains in eastern LWBGR.

Unlike the major portion of the Basin and Range, this is an area of predominantly open-basin conditions. An integrated drainage system exists, with intermittent through-flowing drainage toward the Gila or Colorado River. Locally, drainage may flow southward toward Mexico or internally into small playas.

Secondary topographic features present within the basins include the following landforms (in order of decreasing abundance): 1) alluvial fans and bajadas, 2) pediments, 3) sand dunes, 4) terraces and 5) playas.

Alluvial fans are the most common landforms within the siting area, encompassing approximately 67 percent of the basin areas. Three generations of fans are topographically distinct in YPG, but exhibit only subtle topographic expression within LWBGR. These features flank the mountain ranges, extending toward the center of the basin, with the youngest fans coalescing to form broad, gently sloping alluvial surfaces (bajadas). In general, the alluvial fans and bajadas exhibit a topographic grade ranging from zero to five percent. In addition, small areas of five to ten and greater than ten percent topographic grade occur on the older fans, particularly near the mountain fronts. The alluvial fans are generally moderately dissected, with the average number of drainages per nautical mile ranging from eight to greater than 20, being greatest on the youngest fans. Average incision ranges from moderate (ten to 15 feet) on older fans to shallow (up to six feet) on younger fans and bajadas. Channels are typically flat-floored with gently sloping to near-vertical walls.

Pediments, planated rock surfaces, are most common in eastern LWBGR, but are also present along the Palomas Mountains in YPG and the Copper and Agua Dulce Mountains in LWBGR. Topographic grade exhibited by the pediments generally ranges from three to 3.5 percent, but may exceed ten percent near the mountain front. The pediments are moderately dissected, with an average of six to eight drainages per nautical mile. Depth of incision ranges from shallow to moderate, with typically near-vertical channel walls.

The Mohawk and Fortuna dunes and the Pinta Sands are the most significant accumulations of semi-stabilized wind-blown sand within YPG/LWBGR. Topographic grade in these areas is generally less than five percent; although locally it may greatly exceed ten percent. The wind-blown sand areas are only slightly dissected with less than five channels per nautical mile. Channels are shallowly incised (less than five feet) and have gently sloping walls.

Terrace deposits of the Gila and Colorado Rivers are present in the western portion of the siting area. Although their surface extent is quite limited, they may be more extensive beneath a mantle of alluvial fan deposits. Topographic grade exhibited by the terraces generally ranges from zero to two percent. The terraces are generally only slightly dissected (less than five channels per nautical mile) and shallowly incised (less than five feet). Channels are typically flat-floored with steep to near-vertical channel walls.

Playas, including Las Playas, Dos Playas and Pinta Playa, are generally located peripheral to the alluvial fans in central LWBGR. Typically, they have very limited geographic extent and exhibit topographic grades of less than one percent. The playas are only slightly dissected (less than five channels per nautical mile) and very shallowly incised (less than three feet). Channels are typically flat-floored with steep channel walls.

Rock exposures, in addition to pediments, include mountain ranges, low-lying hills and isolated outcrops within the basins. Topographic grade in these areas generally exceeds ten percent; however, the latter two areas may exhibit less than ten percent grade. Two large basalt flows, the Sentinel Flow and the Pinacates Volcanic Field, extend into LWBGR and generally exhibit a five to ten percent grade with limited areas of greater than ten percent.

## 2.2.9 GEOLOGY AND SOILS

### 2.2.9.1 General

The physiography of this region is controlled by and, therefore, strongly reflects the underlying structure. The major rock types are exposed in the uplifted fault block mountain ranges and include igneous, metamorphic and sedimentary units. The intervening basins generally contain at least several hundred feet of relatively coarse-grained detritus, derived principally from the adjacent mountains, and lesser amounts of fine-grained material.

### 2.2.9.2 Stratigraphy

Rock units within YPG/LWBGR include crystalline igneous and metamorphic basement rock, competent volcanic and sedimentary bedrock, and volcanic flow rock which is restricted to geologically young, extrusive igneous (basaltic) rock in association with the basin-fill deposits. Table 2.2-5 lists the rock units and their respective rock types, ages and distribution within the siting area. The greatest areal extent of exposed basement and sedimentary bedrock units occurs in the pediments. Volcanic bedrock and basement units are exposed in the mountains and as isolated outcrops within the basin-fill deposits. Only two areas of volcanic flow rock are exposed in LWBGR: the Sentinel Flow and the Pinacates Volcanic Field. Volcanic flow rock probably occurs in the subsurface within the basin-fill.

Basin-fill deposits are primarily coarse-grained, with lesser

TABLE 2.2-5

ROCK UNITS WITHIN YPG/LWBGR

| Category of Rock | Inclusive Rock Types | Ages | Distribution (areal predominance) |
|---|---|---|---|
| Basement Rock | Igneous: granitics<br>Metamorphic: gneiss and schist | Precambrian and Mesozoic | Southern YPG; western LWBGR; eastern LWBGR (pediments) |
| Bedrock | Volcanics: pyroclastics and flow rocks (rhyolite to andesite)<br>Sedimentary: sandstone, siltstone, conglomerate, limestone | Paleozoic through Tertiary-Quaternary | Northern YPG; central and eastern LWBGR |
| Volcanic Flow Rock | Igneous: flow rock (basaltic) | Tertiary-Quaternary and Quaternary | Central LWBGR |

amounts of fine-grained sediments, and have attained a maximum cumulative thickness of greater than 10,000 feet. These deposits have been subdivided into a lower, middle and upper unit (Air Force Weapons Lab, 1973).

The lower unit is a conglomeratic or fanglomeratic deposit of granitic, metamorphic and volcanic detritus that contains locally cemented (caliche) zones. This Tertiary (?) unit generally overlies rock and has limited surface exposure. Its maximum thickness is unknown.

The middle unit is composed of fine-grained alluvial material interbedded with lake-bed clays and silts, with minor lenses of sand and gravel and local gypsiferous beds. This unit apparently lacks surface exposure. Although the maximum thickness of this Tertiary-Quaternary unit is unknown, it probably does not exceed one or two thousand feet.

The upper unit consists primarily of coarse-grained gravels and sand with lesser amounts of fine-grained material. These Quaternary and Quaternary-Tertiary deposits extend from the surface to an unknown maximum depth.

Soil distribution and nature of the surficial basin fill may be described in terms of coarse- and fine-grained deposits and the associated landforms. Coarse-grained deposits encompass 98 percent of the basin-fill area occupied by alluvial fans and bajadas, pediments, terraces and stream channels. The average grain-size composition is 30 percent gravel, cobbles and boulders, 40 percent sand, 25 percent silt and five percent clay. Caliche may be present within these deposits; however, the degree of development varies with local conditions.

Wind-blown sand, whether present as sheet deposits or dunes, is composed of uniformly sized, loose dry sand. Minor amounts of clay and silt-size material may be present. These sand deposits encompass approximately one percent of the basin-fill area.

The fine-grained deposits consist of 90 percent clay and silt-size material. These deposits are present in the playas and encompass approximately one percent of the basin-fill area.

Desert pavement, or lag gravel consisting of gravel to cobble-size material, is generally present on the surfaces of the older fans and pediments. The youngest fans and bajadas generally are covered by a discontinuous desert pavement of pea-size gravel. Desert varnish, a mineralized patina or coating, may be present in varying stages of development on the lag gravel. The wind-blown sand deposits and playa areas have fairly smooth surfaces, typically composed of finer-grained material.

#### 2.2.9.3 Structure

YPG/LWBGR lies within two major structural provinces: the Gulf of California (Salton Trough) and the Basin and Range. The Gulf of California Structural Province is a complex, northwest-trending depression; the Salton Trough is the onland extension of this province. The portion of the Yuma Desert west of the Algodones fault occupies the northeast margin of this trough. Structurally, this area is characterized by a series of en echelon oblique-slip faults with depths of the basin generally increasing to the southwest.

The Basin and Range Structural Province encompasses most of YPG/LWBGR and is characterized by northwest trending horsts and grabens bounded by either simple or en echelon normal faults. On a regional scale, the grabens are deep structural basins with superimposed local variations.

Faults, offsetting late Cenozoic basin-fill deposits by as much as 60 feet, are present within eastern LWBGR and include the Algodones, Sheep Mountain and several unnamed faults bordering the Gila Mountains. Based on this evidence, these faults have been identified as capable of generating earthquakes. A low scarp (less than five feet) of unknown origin is present along portions of a lineation trending northwestward across San Cristobal Valley (LWBGR).

## 2.2.10 SEISMICITY

### 2.2.10.1 General

Based upon the nature of previous seismic activity within and adjacent to the siting area, three zones may be identified as potential sources of seismic activity that will influence YPG/LWBGR, including: 1) the Salton Trough, 2) Transition Zone and 3) Zone of Diffuse Seismicity.

The Salton Trough, which encompasses a portion of the Yuma Desert, is defined by numerous earthquakes of Richter magnitude (M) 6 to 7 and contains the San Andreas and Algodones faults. The Transition Zone trends north-northwest across Arizona and lies approximately 60 nm northeast of YPG/LWBGR. The Zone of Diffuse Seismicity is defined by random events of M 4 to 5 and encompasses most of the siting area. Four events (M 4.1 to 5.0) have been located within central LWBGR.

2.2.10.2 Seismic Risk

Studies predicting the susceptibility of an area to relative levels of seismic intensity indicate that nearly all of YPG/LWBGR has a maximum expected Modified Mercalli Intensity of V to VI, with a maximum expected seismic intensity of VII to IX in the Yuma Desert. Maximum levels of vibratory ground motion, generated by the three seismic zones affecting the siting area, may range from 0.2 to 1.0 g (g being the acceleration due to gravity).

Distant (exceeding 200 nm) earthquakes of M 5 to 7 and large magnitude (M 8+) teleseismic (distances greater than 540 nm) events may also affect the siting area. The most probable sources of distant earthquakes include: 1) the northern portion of the San Andreas fault zone, 2) the Agua Blanca fault in Mexico, 3) the Rio Grande Rift Zone in New Mexico and 4) an area of seismicity in north-central Nevada. Teleseismic events may be associated with the Aleutian and Mid-American trenches.

The greatest potential for surface displacement due to faulting is in western LWBGR along the Algodones, Sheep Mountain and other unnamed capable faults. Vertical displacements of 3 to 15 feet could occur, associated with a large magnitude (M 8+) event.

## 2.2.11 SUBSIDENCE

Subsidence due to tectonism has not been reported within YPG/LWBGR. However, the potential for subsidence due to withdrawal of fluids from the ground exists within the area depending on future lowering of groundwater levels. Subsidence due to groundwater decline has occurred in adjacent portions of southern Arizona where very large quantities of water have been withdrawn.

Surface expression as earth cracks or earth fissures has accompanied this subsidence. These fissures have reported lengths of seven nm and depths of 60 feet. Initially appearing as narrow cracks a few inches in width, they may be deepened and widened by erosion and gullying to a width of 20 feet. Tensional stresses associated with these earth cracks have produced splits in concrete roads and curbings.

## 2.2.12 HYDROLOGY AND WATER QUALITY

### 2.2.12.1 Surface Hydrology

#### 2.2.12.1.1 General

YPG/LWBGR lies within the Lower Colorado Hydrologic Basin. Unlike most of the Basin and Range Province where drainage is typically a closed-basin system draining into large playas, surface drainage within YPG/LWBGR is through-flowing to the Gila or Colorado Rivers with only very limited playa areas.

2.2.12.1.2 Perennial Systems

There are no known water bodies (lakes, rivers or streams) which contain water throughout the year within YPG/LWBGR. The Colorado and Gila Rivers are the only perennial drainages adjacent to the area.

Aqua Dulce Spring, in southeastern Mohawk-Tule Valley, is the only spring within the area. The slow rate of seepage of this spring provides water for wildlife in a man-made tank in the Cabeza Prieta Game Range.

2.2.12.1.3 Ephemeral Systems

Ephemeral systems include playas, drainages (streams and washes) and natural reservoirs that intermittently contain water. The water supply for these systems is dependent upon rainstorm intensity and duration, and the runoff characteristics of the watershed.

Primary ephemeral drainages commonly occupy the central portion of a valley or drain large watershed areas near the mountains, and have numerous secondary tributary drainages. Flooding, including flash flooding, is common in these drainages, particularly following intense rainstorms.

Natural reservoirs are depressions formed in rock (rock tanks) that may be filled with sand (sand tanks), or are formed in fine-grained deposits (charcos). Water stored in these features may be supplied by direct precipitation and runoff, or by springs.

2.2.12.1.4 Water Quality

Surface water in these ephemeral systems varies from fresh to moderately saline depending on the amount of total dissolved solids (TDS). Generally, the TDS are much greater than 500 milligrams per liter (mg/l) and may range as high as 7000 mg/l. The principal constituents include chlorides, sodium and bicarbonates. The major contaminants include boron, nitrates and fluoride, with the latter averaging three to four mg/l.

2.2.12.2 Groundwater Hydrology

2.2.12.3.1 General

Two major groundwater regions encompass the siting area. Groundwater flow in most of the northwest trending valleys is toward the Gila River, while in the western portion of YPG/LWBGR, groundwater flow is toward the Colorado River Valley. In both regions groundwater is known to occur in basin-fill, perched and rock aquifers.

Recharge is supplied by infiltration of surface runoff and direct precipitation and by underflow from bordering areas. Discharge occurs by evapotranspiration, by pumping and by underflow to the Gila and Colorado River Valleys.

2.2.12.2.2 Basin-Fill Aquifers

The deeper basin-fill, locally as much as 3000 feet thick consists of lenses of gravel, sand, clay and silt, and forms the major aquifer in YPG/LWBGR. The greatest and most consistent yields are obtained from a moderately cemented fanglomerate (lower alluvial unit?).

In general, depth to groundwater decreases with decreasing distance from the Colorado or Gila River Valley. Depths range from 50 to 100 feet in Mohave Wash Valley, marginal to the Colorado River, to greater than 1000 feet in La Posa Plain. Well yields, for various casing and pump sizes, range from less than one to 1100 gallons per minute.

Artesian conditions exist within a confined basin-fill aquifer in King Valley. This aquifer, confined by clay or "claystone" is below the static groundwater level.

2.2.12.2.3 Perched Aquifers

Caliche deposits and clay layers within the basin-fill may locally produce perched groundwater zones. Perched intervals have been recognized in La Posa Plain, King Valley and San Cristobal Valley. Yields from these zones vary depending on local conditions.

2.2.12.2.4 Rock Aquifers

Groundwater in rock aquifers is unconfined in fractures within the basement rocks and confined within bedrock strata (volcanic tuff). Yields from the basement fracture system are generally less than 500 gallons per day. Artesian conditions exist within the confined bedrock aquifer, with a recorded yield of greater than 350 gallons per minute.

2.2.12.2.5 Water Quality

Chemical analyses of groundwater suggest a separation into fresh and slightly saline based upon the TDS. Fresh water is obtained from the basin-fill and rock aquifers, with TDS ranging from 600 to 850 mg/l. Perched groundwater may be slightly saline, having 1000 to 1200 mg/l TDS. The primary contaminant is fluoride, which ranges from less than 1.0 mg/l in rock aquifers to 9.0 mg/l in basin-fill aquifers. Other contaminants may be present in small amounts and include iron, nitrate, boron and arsenic.

2.2.13 HISTORY

Indian supremacy was replaced by Spanish control during the 1500's. Exploration, exploitation and colonization of the area resulted in both peaceful and hostile interaction with the natives. During the 1600's, the Spanish developed the mission and the presidio (military garrison) system to maintain control of the region. Indian uprisings, including the Pima Revolt (1751), made Spanish rule tenuous during the 1700's and early 1800's. From 1820 to 1840, trappers and traders entered the region, initiating an American influence. Conflict with the United States culminated in the Mexican-American War beginning in 1846. In 1848 the Treaty of Guadalupe Hildago conceded Arizona territory north of the Gila River to the United States. The Gadsen Purchase (1853) completed U. S. acquisition of the Arizona territory which became the

48th state of the Union in 1912.

Historic sites of Spanish and Indian culture are preserved as missions, pueblos, rock inscriptions, pottery sherds and metal hardware. Sites are concentrated around major population centers or along major trails of exploration. The route of Fray Marcos de Niza (1540; Camino Del Diablo) passes through the southern portion of LWBGR (Cross, Shaw and Scheifele, 1960). No specific historic sites are known within YPG/LWBGR.

American cultural influence began in the 1820's with trappers and traders moving throughout the area for the next two decades. Exploratory expeditions of the 1850's induced only limited American settlement. However, with the discovery of gold in 1848, the American population increased, resulting in periodic Indian uprisings. With the Apache surrender in 1886, the last tribe was placed on a reservation.

Ranching (cattle and sheep) and mining (copper) were the prime economic stimulants of the 1880's and 1890's. With increasing population, there arose the mercantile stores (Goldwaters) in the early 1900's. These remain as major sources of economic activity today.

Historic sites of territorial Arizona include ghost towns and scattered ruins of early settlements. No significant sites are known within YPG/LWBGR.

## 2.2.14 ARCHAEOLOGY

The Cochise people, pre-historic inhabitants of Arizona, date back at least 11,000 years (Jennings, 1968) and probably greater than 22,000 years (Jay von Werlhof, oral communication, 1975). A primitive food gathering society, their existence is evidenced by camp sites and stone tools, including the prototype of the mano and metate. These people were ancestral to the Anasazi, Mogollon, Hohokam and Patayan cultures in Arizona.

The Anasazi and Mogollon cultures were centered in eastern Arizona, on the Colorado Plateau and in the southern mountain areas, respectively. The Hohokam culture developed in the desert area of southern Arizona, while the Patayan culture was centered in the Colorado River Valley in western Arizona. The latter two cultures encompassed the present-day DoD siting area (YPG/LWBGR) and, therefore, will be the principal subjects of the following discussion.

Three stages of development have been identified within these cultures (McGregor, 1941): (1) Archaic - primarily a hunting and gathering society living in caves or brush shelters, (2) Early Pueblo (Pithouse) - a semi-sedentary society that combined dry-land farming with hunting and gathering of food, and (3) Late Pueblo - a sedentary society utilizing irrigation farming. Period (1) is represented by un-fired (pre-ceramic) pottery while periods (2) and (3) are characterized by ceramic pottery.

Remains of the Archaic Cochise cultures (including San Dieguito, Armagosa, Playa), ranging from 2000 to 20,000 years before present, are exposed primarily by excavation or in natural exposures by gullying of stream washes (Pourade, 1966). Cultural materials include crude stone tools, projectile points, fire pits, animal kills, trails and sleeping circles (Jay von Werlhof, oral communication, 1975).

The Patayan culture has not been extensively investigated. Artifacts, including primitive tools such as manos and metates, scrapers, throwing sticks, bone implements, and pottery (McGregor, 1941), suggest development of the culture through the Archaic stage and into the Early Pueblo stage. Sites include mounds, rock shelters and sherd areas. Campsites include sherd areas in the plains and rock shelters in the mountains. Quarry sites are common along the Colorado River Terraces, which supplied cobbles and gravel (chert, basalt) for making tools, and are marked by abundant "worked" rock fragments.

The Hohokam culture began approximately 2000 years ago with progressive development through the Archaic (1 to 500 A.D.) and Early (500 to 1100 A.D.) and Late Pueblo (1100 to 1450 A.D.) stages, with an accompanying evolution of architectural style and farming methods. Archaic period remains include unfired pottery, stone palettes, stone tools and simple jewelry (Wormington, 1947). Food was obtained principally by hunting and gathering.

Increasing agricultural activity (dry-farming) allowed for a semi-sedentary life style and evolution of the pit house during the Early Pueblo stage. The pit house was a partially below ground structure with wooden poles supporting a brush and mud roof, evolving from a circular structure with a dome-shaped roof to a rectangular, flat-roofed structure. Artifacts of this stage include ceramic pottery, stone palettes, stone tools such as axes, spades, metates and manos, jewelry, basketry, ball courts, and sophisticated weapons such as the bow and arrow. Both camp and quarry sites exist.

During the Late Pueblo stage small homes evolved into compound villages, with aggregate populations supported by irrigated farming. Extensive evidence of this period has been discovered and includes ornate jewelry, distinctive red-on-buff ceramic pottery, clay and stone sculpture, weapons and tools, textiles, and an elaborate irrigation system. Casa Grande, a multi-storied structure located approximately 20 nm northeast of YPG/LWBGR, and the Snaketown site near Gila Bend are well preserved examples of the Late Pueblo Hohokam culture.

The Late Pueblo stage of the Hohokam culture was eclipsed approximately 1450 A.D.; however, the cause is unknown. The present day Pima and Papago Indians are presumed to have descended from the Hohokams (Cross, Shaw and Schiefele, 1960). However, there is little supportive factual evidence for this relationship.

Topographically, the remains of the Archaic and Early Pueblo stages of these cultures are generally found on alluvial knolls and terraces and on mountain slopes. Pit houses are found on ridge crests or low hills in the valleys and are often rounded depressions discernible by changes in vegetation as well as topography. Late Pueblo sites generally occupy open flat-land areas available for agriculture with a near-by water source.

Only two specific Indian sites are reported (Gladwin and Gladwin, 1929) as being within the boundaries of YPG/LWBGR; these are in southern Sentinel Plain. Four sites are also reported in Vekol Valley and may lie within the siting area. These sites include sherd areas, mounds, rock shelters and pictographs; all apparently representing Hohokam culture.

In addition, a rock shelter of unknown cultural origin was sighted during a brief aerial reconnaissance in the northern portion of Gila Bend Plain (LWBGR). Pictographs and stone rings are also present within YPG (H. F. Barnett, oral communication, 1975). Research is curently being conducted by the University of Arizona Geoscience Department to identify archeological sites within southwestern Arizona. Within the lower Colorado River Valley, the Archaic and Patayan cultural remains are being investigated (Jay von Werlhoff, oral communication, 1975).

### 2.2.15 PALEONTOLOGY

Remains of formerly living plants and animals are preserved in both rock units (in or adjacent to the mountains) and basin-fill deposits. The paucity of data on fossil locations may be due to several factors, including: 1) lack of detailed investigations in the area, and 2) absence of fossiliferous deposits due to non-deposition or erosion.

Fossils occur within rock units of Paleozoic (Pennsylvanian?) and Mesozoic (Cretaceous?) age. Crinoid fragments are present in small remnant outcrops of Paleozoic limestone in the southern Sand Tank Mountains and, near Ajo, marine fossils are present within a sequence of Mesozoic mudstone, limestone, shale and sandstone (Bryan, 1923, 1925).

Fossiliferous Tertiary rock units include a fanglomerate (Locomotive Fanglomerate; Gilluly, 1946) near Ajo and the Kinter Formation, fanglomerate and sequences of sandstone, shale and limestone, in the Muggins Mountains (Wilson, 1934). These deposits contain Miocene rhinoceros (Heindl, 1962) and camel (Lance and Wood, 1958; Lance, 1960) remains, respectively. A Pliocene marine deposit, composed of calcereous tufa, sands, silts, siltstone and coquina, contains worm-tube casts and abundant foaminifera and globigerinids (Metzger, 1968). This deposit, the Bouse Formation, is present in northwestern YPG in the vicinity of Gould Wash (Barnett, 1975, in press).

Known fossil occurrences within the basin-fill are restricted to the terrace deposits of the Colorado and Gila Rivers. Pleistocene age petrified wood is present within Colorado

River terrace deposits in the vicinity of Yuma Test Station Headquarters (Olmsted and others, 1973; Barnett, 1975, in press). Pleistocene *Equus* sp. (horse) and *Odocoileus* sp. (deer) bones are reported from Gila River terrace deposits less than one nm south of YPG, near Dome (Bryan, 1923).

## 2.3 NBGR

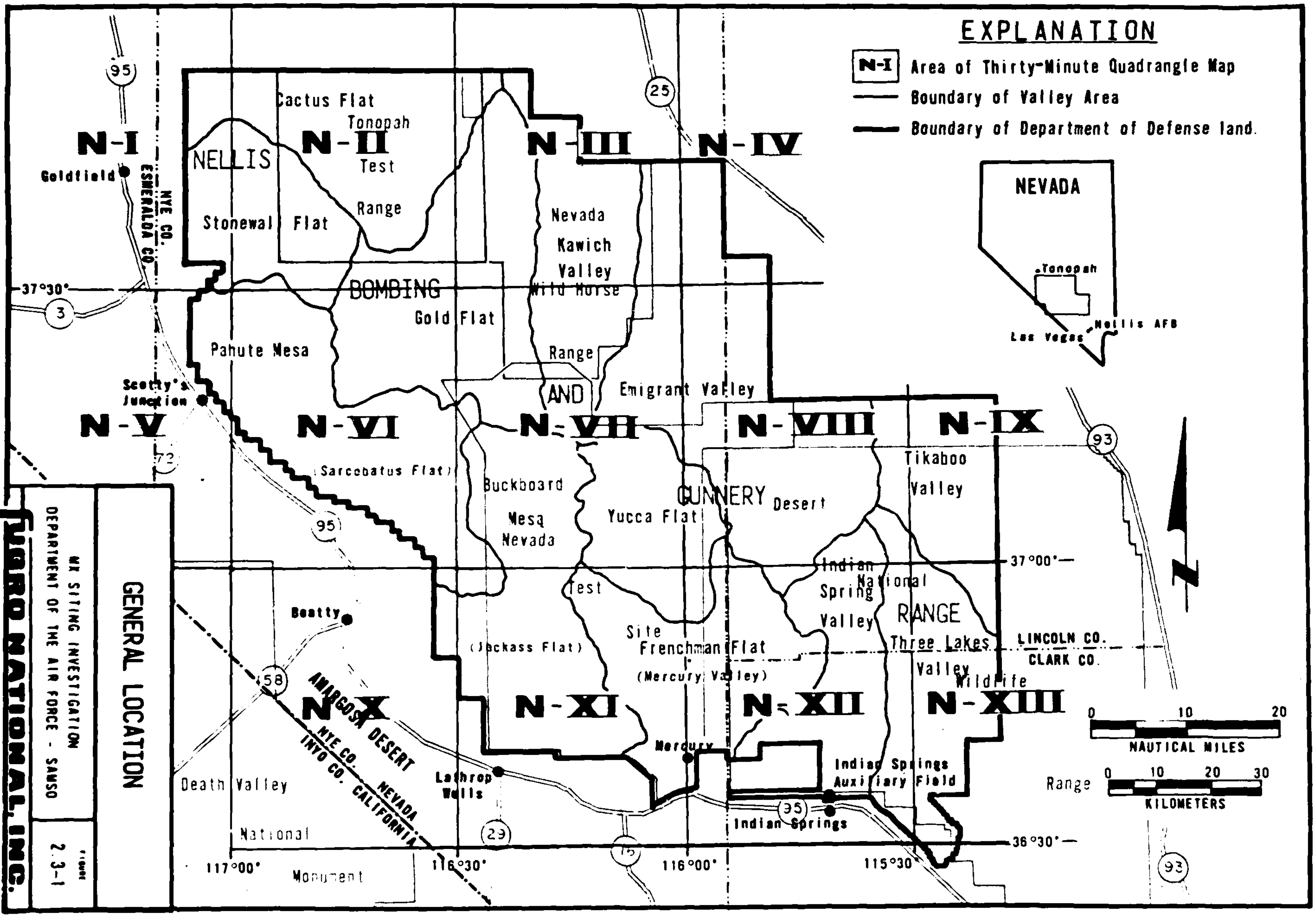
### 2.3.1 CURRENT LAND USE, LAND USE PLANS, POLICIES AND CONTROLS

NBGR is under control of the Department of the Air Force. The range was recently designated as a DoD range (V. Patterson, personal communication, 1975), and is presently available for use by all branches of the military. All roads leading into NBGR are restricted from use by the general public, except for limited access which is allowed into the Desert Wildlife Range in the eastern portion of NBGR in the northern portion (Kawich Valley). In addition to these two wildlife refuges, other special use areas include the Tonopah Test Range and the Nevada Test Site (Figure 2.3-1). None of these areas, to date, have been excluded from field work and testing activities.

NBGR has been administered by the Department of the Air Force since 1941, and serves as a training center for electronic warfare, and bombing and practice. Access is provided by Highway 95, south of the range, and Highways 6 and 25, north of the range.

Present short-range land use plans for NBGR are to maintain current policies and controls to keep the facilities functioning at their present status, with an increase of electronic warfare activities within the Tonopah Test Range (V. Patterson, personal communication, 1975). No details of long-range plans are known.

DATE: 30 JUNE 1975




GENERAL LOCATION

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 2.3-1

FUGRO NATIONAL, INC.

## 2.3.2 SOCIOECONOMICS

NBGR lies mainly within Nye County, with lesser area in Clark and Lincoln Counties, Nevada. The principal cities in the area are listed in Table 2.3-1, with their respective populations (U.S. Census Bureau, 1970).

The labor force in southern Nevada totalled approximately 108,000 in 1970. Of this group, about 87,000 (80%) were employed by private industry, about 16,000 (15%) were government employees, and about 5,000 were self-employed. Principal employment activities of this labor force were: service workers, (27%); clerical (17%); professional and technical (14%); craftsmen (13%); transportation workers (8%); laborers (4%); farm workers (1%) and private household workers (1%) U. S. Census Bureau, 1970).

Although tourism provides much of the employment for private industry, Tonopah, Goldfield and Beatty are also centers for limited mining activities (Albers and Stewart, 1972).

The cities, which would most likely serve as primary centers for mobilization of field-related activities, are Las Vegas and Tonopah. Indian Springs, Goldfield, Beatty and Lathrop Wells would provide secondary support. Mercury could supply additional support, if arrangements were made through the Nevada Operations Office, Energy Research and Development Administration, Las Vegas (Personal communication, J. W. Henderson, 1975).

TABLE 2.3-1

POPULATIONS OF COMMUNITIES IN THE VICINITY OF NBGR

| Population Center | Minimum Distance from Range Boundary (nm) | 1970 Population |
|---|---|---|
| Greater Las Vegas, Nevada | 26.1 | 291,143 |
| Henderson, Nevada | 39 | 16,410 |
| Tonopah, Nevada | 13.9 | 1,716 |
| Indian Springs, Nevada | 0 | 1,167 |
| Beatty, Nevada | 10 | 775 |
| Alamo, Nevada | 8 | 338 |
| Goldfield, Nevada | 7 | 240 |
| Hiko, Nevada | 16 | 40 |
| Warm Springs, Nevada | 18 | 35 |
| Lathrop Wells, Nevada | 2 | 30 |
| | Total | 311,894 |

Source: Bureau of the Census, 1971b.

## 2.3.3 CLIMATE

### 2.3.3.1 General

Climatic conditions, within NBGR, are primarily a result of its inland location and latitudinal position. These two factors combine to produce an arid-to semi-arid climate, characterized by hot summers, moderately cold winters, and mild, warm springs and autumns. Climatic conditions vary considerably throughout NBGR, with local variations due primarily to elevation differences.

### 2.3.3.2 Precipitation

NBGR has a low, mean annual precipitation because of 1) its inland location, 2) the rain-shadow effect of the Sierra Nevada Mountains, and 3) the north-south trending mountain ranges within the area. Precipitation occurs principally during the months of July and August, and November, December and January. It is generally in the form of rain, although traces of snow have been recorded in the valleys, and the higher mountains and upland valleys generally experience light snowfalls (less than one foot per year). Average annual precipitation decreases to the east due to the increasing rain-shadow effect of the mountain ranges within the siting area. Precipitation also increases with increasing elevation.

Summer precipitation usually consists of local thunderstorms. In winter, gentler rains occur over large areas commonly resulting from the passage of low-pressure systems.

Thunderstorms occur on an average of ten to fifteen days per year, primarily during June through September. Typically, these storms produce one to three inches of precipitation within a period of a few hours, and may be accompanied by lightning, strong winds, dust storms, tornados and funnel clouds or hail.

2.3.3.3 Wind

Westerly-to-northerly winds predominate over the area most of the year, with local wind directions determined by the local physiography. Average wind velocities range from less than one mile per hour (mph), in summer and autumn, to 20 mpy in winter and spring. Maximum wind speeds have been estimated at 75 to 80 mph.

2.3.3.4 Temperature

Daytime temperatures, from June to September, generally exceed 90$^{o}$degrees Farenheit ( F), with nighttime temperatures in the sixties, but often exceeding 70$^{o}$F. From October to March, daytime temperatures average between 35 and 60$^{o}$F, dropping to freezing or below at night. Temperatures below 0 F, rarely occur. A frost-free period of 130 to 200 days is common throughout the area from May through August.

2.3.3.5 Relative Humidity and Evaporation

Relative humidity ranges from ten to 30 percent in summer, and from 20 to 60 percent in winter. With an average of 290 to 319 days, (85 to 85 percent) of sunshine per year, annual evaporation has been estimated to range from 60 to 82 inches.

## 2.3.5 NOISE

Present noise levels, within the siting area vary from high to low. The most common noises, resulting from man's activities in these areas, are from use of existing highways, railroad traffic, aircraft, missile and artillery testing, and military ground exercises (including offroad vehicles). These noises are generally intermittent, and may be high to low. Some are local to the source and others affect fairly large areas.

The ambient noise level, in the open basin areas is low. Natural sounds are generated by animals, wind (including moving brush), thunder and rain.

No base level noise data is known to exist for the specific NBGR areas. Typically, ambient noise levels in open desert areas may vary between approximately 25 and 60 dBA (Bureau of Reclamation, 1974). Levels, up to 100 dBA, may occur immediately adjacent to a major highway due to traffic and sonic booms may cause levels up to 150 dBA. Thunder may have a noise level 120 to 130 dBA. The public is known to complain at "impulse" levels of about 118 dBA (AFWL, 1974). Continuous ambient noise levels of 45 dBA and continuous levels of 65 dBA for periods less than 8 hours are considered normally acceptable under HUD noise criteria.

## 2.3.6 AESTHETICS

The siting area can be evaluated in terms of its present visual impact, i.e., the degree of naturalness of the setting, the degree of man-made alteration, dominant views and types of distractions. The existing visual setting is typical of the closed valley desert systems within the Basin and Range Physiographic Province. Intensity of military activities controls the relative amount of natural, vs. artificial scenery.

Most of the scenic value of the area lies in its naturalness, the combination of gentle and abrupt topography and the general undistrubed appearance of the desert terrain gained from viewpoints normally available to the public. There are no main highways through NBGR.

2.3.7 ECOLOGY

2.3.7.1 General

NBGR is located where the Great Basin Desert meets the Mojave Desert and contains elements of both (Hastings and Turner, 1972). Dryness and diurnal and seasonal temperature extremes characterize the Sonoran Desert Province, whereas cold winters, hot summers and light precipitation, commonly in the form of winter snow, predominate in the Great Basin province. In general, southern NBGR (Jackass, Frenchman and southern Yucca Flat, Indian Spring and Three Lakes Valleys), is within the Mojave Desert, and northern NBGR (Stonewall, Cactus, Gold and northern Yucca Flat, Kawich, Emigrant and Tikaboo Valleys and Pahute and Buckboard Mesas) is within the Great Basin Desert (Figure 2.1-3). The Great Basin Desert is characterized by the presence of sagebrush (Artemesia ssp). Creosote bush (Larrea divaricata) are dominant plants in the Mojave Desert. Figure 2.1-3 depicts the general geographic location of the Great Basin, and Mojave Desert.

A major characteristic feature of the environment of NBGR is the general scarcity of rainfall throughout the area. Vegetation and wildlive have special structural physiological and behavioral adaptations which allow them to live in this arid environment (Hadley, 1973).

Individual species of desert plants can be grouped into three separate categories based on their growth form in response to the general scarcity of water -- ephemeral annuals, succulent perennials and non-succulent perennials.

An ephemeral annual (e.g., desert wildflower) is capable of completing its full life cycle -- germination, growth, flowering, seed production and death -- in six to eight weeks. Seeds of desert palnts lie dormant in the soil until sufficient soil moisture becomes available for germination and growth. Active growth, following the rainy season, is one of the principal physiological adaptations to water scarcity.

Succulent perennials have adapted to the desert environment through their ability to store water in stem tissues. These plants, of which the cacti are the best known, have the ability to accumulate and store water in excess of physiological needs during the rainy season.

Non-succulent perennials (e.g. phreatophytes -- plants dependent on groundwater and other trees and shrubs) have a variety of adaptations to water scarcity. Some trees have root systems that provide a constant supply of water from year-round groundwater sources. The ocotillo, a drought-deciduous plant, reduces water loss by sprouting leaves only during the short rainy period. Other adaptations of non-succulent perennials include compact leaves that expose less surface to water loss, white powder or hairs on the leaf surface to reflect light, and diffuse root systems.

Because of the hot, dry climate, most desert animals are crepuscular (active in the twilight) or nocuturnal. During the heat of the day, these animals remain in shaded areas, or underground. Consequently, edaphic (soil) conditions are very important to desert animals, as well as plants.

Ecosystem factors are discussed in greater detail than other environmental considerations. This system will be most susceptible to damage by the proposed action, and the impact will be among the most difficult to mitigate. The following sections discuss general and Valley Specific (Figure 2.3-1) vegetation and wildlife characteristics for NBGR. Threatened and endangered faunal and floral species are presented in Appendix B.

### 2.3.7.2 Vegetation

Vegetation of the Nellis Range has been divided into six plant communities (Allred and others, 1963).

1. Sagebrush Scrub
2. Shadscale Scrub
3. Creosote Bush Scrub
4. Alkali Sink
5. Pinyon-Juniper Woodland

6. Joshua Tree Woodland

Tables 2.3-2 and 2.3-3 list each plant community with indicator species, appearance, distribution, plant, climatic and landform associations. In general, the lowlands of NBGR are in a low, open-shrub association with creosote bush and bursage dominant in the Mojave Desert portion, and great Basin sagebrush dominant in the Great Basin portion. Pinyon-juniper woodland commonly occupy the pulands and mesa areas.

Table 2.3-4 lists the dominant plant species found on the NBGR, according to the plant communities in which they commonly occur.

Life-zones are bands or groups of vegetation (and the animals inhabiting them) that vary with latitude and/or altitude. Within NBGR, the Lower Sonoran Life Zone can be associated with the Mojave Desert portion, and the Upper Sonoran Life Zone can be associated with the Great Basin portion of the Range. In general, the relationships between life zones, plant communities and animal indicators is consistant within NBGR.

2.3.7.3 Wildlife

2.3.7.3.1 General

Hall (1946) recognized five separate faunal areas in Nevada, two of which encompass NBGR -- the Central Rocky Mountain faunal area correlates with the Upper Sonoran life zone, and the Lower Sonoran-Lahontan Lake Basin faunal area correlates with the Lower Sonoran life zone within NBGR. Table 2.3-5 lists the fauna commonly found within these two zones, as well as habitats,

## TABLE 2.3-2

PLANT COMMUNITIES OF NBGR

| Plant Community | Indicator Plants: Common Name | Indicator Plants: Scientific Name | Geomorphic Associations and Habitats |
|---|---|---|---|
| 1. Sagebrush Scrub | Great Basin Sagebrush | Artemesia tridentata | Alluvial Fans and Valleys 4000 to 7500 feet elevation; deep pervious soils |
| | Sagebrush | Artemesia arbuscula | |
| | Blackrush | Coleogyne ramosissima | |
| | Rabbit Bush | Chrysothamnus graveoleus | |
| | Saltbrush | Atriplex confertifolia | |
| | Saltbrush | Atriplex canescens | |
| | Cotton-Thorn | Tetradymia axillaris | |
| | Antelope Bush | Purshia tridentata | |
| | Antelope Bush | Purshia gladulosa | |
| 2. Shadscale Scrub | Hop-Sage | Grayia spinosa | Mesas and Flats 3000 to 6000 feet elevation; heavy soils, often with underlying hardpan |
| | Winterfat | Eurotia lanata | |
| | Green Molly | Kochia americana | |
| | Shadscale | Atriplex confertifolia | |
| | Budsage | Artemesia spinescens | |
| | Twin-Fruit | Menodora spinescens | |
| | Matchweed | Gutierrezia microcephala | |
| | Blackrush | Coleogyne ramosissima | |
| | Sagebrush | Salvia sp. | |
| 3. Creosote Bush-Scrub | Creosote Bush | Larrea divaricata | Alluvial Fans and Valleys Usually below 3500 feet; well-drained soils |
| | Bur-Sage | Franseria sp. | |
| | Indigo Bush | Dalea fremontii | |
| | Box-Thorn | Lycium andersonii | |
| | Cheese Bush | Hymenoclea salsola | |
| | Desert-Mallow | Sphaeralcea ambigua | |
| | Silver Cholla | Opuntia echinocarpa | |
| | Beaver Tail Cactus | Opuntia basilaris | |
| | Mesquite | Prosopis juliflora | |
| 4. Alkali Sink | Saltbrush | Atriplex polycarpa | Alkali Flats and Playas Usually below 4000 feet; poorly-drained soils |
| | Saltbrush | Atriplex confertifolia | |
| | Greasewood | Sarcobatus vermiculatus | |
| | Iodine Bush | Allenrolfea occidentalis | |
| | Seep-Wood | Suaeda torreyana | |
| | Red Sage | Kochia americana | |
| 5. Pinyon-Juniper Woodland | Pinyon Pine | Pinus monophylla | Mountain Range and Mesas 5000 to 8000 feet elevation; well-drained soils |
| | Juniper | Juniperus utahensis | |
| | Antelope Bush | Purshia glandulosa | |
| | Cowania | Cowania stansburiana | |
| | Apache Plume | Fallugia paradoxa | |
| | Mountain-Mahogany | Cercocarpus ledifolius | |
| | Mohave Yucca | Yucca schidigera | |
| | Ponderosa Pine | Pinus ponderosa | |
| 6. Joshua Tree Woodland | Joshua Tree | Yucca brevifolia | Mesa and Alluvial Slopes Usually 2500 to 4000 feet elevation; well-drained soils |
| | Juniper | Juniperus utahensis | |
| | Bladder-Sage | Salazaria mexicana | |
| | Box-Thorn | Lycium andersonii | |
| | Wild-Buckwheat | Eriogonum fasciculatum | |
| | Cotton-Thorn | Tetradymia axillaris | |

[illegible] and others, 1963; Munz and Keck, 1965; Beatley, 1969.

| | | | |
|---|---|---|---|
| **4. Alkali Sink** | **Saltbrush** | **Atriplex polycarpa** | **Alkali Flats and Playas** |
| | Saltbrush | Atriplex confertifolia | Usually below 4000 feet; poorly-drained soils |
| | Greasewood | Sarcobatus vermiculatus | |
| | Iodine Bush | Allenrolfea occidentalis | |
| | Seep-Wood | Suaeda torreyana | |
| | Red Sage | Kochia americana | |
| 5. Pinyon-Juniper Woodland | Pinyon Pine | Pinus monophylla | Mountain Range and Mesas 5000 to 8000 feet elevation; well-drained soils |
| | Juniper | Juniperus utahensis | |
| | Antelope Bush | Purshia glandulosa | |
| | Cowania | Cowania stansburiana | |
| | Apache Plume | Fallugia paradoxa | |
| | Mountain-Mahogany | Cercocarpus ledifolius | |
| | Mohave Yucca | Yucca schidigera | |
| | Ponderosa Pine | Pinus ponderosa | |
| 6. Joshua Tree Woodland | Joshua Tree | Yucca brevifolia | Mesa and Alluvial Slopes Usually 2500 to 4000 feet elevation; well-drained soils |
| | Juniper | Juniperus utahensis | |
| | Bladder-Sage | Salazaria mexicana | |
| | Box-Thorn | Lycium andersonii | |
| | Wild-Buckwheat | Eriogonum fasciculatum | |
| | Cotton-Thorn | Tetradymia axillaris | |

**Sources:** Allred and others, 1963; Munz and Keck, 1965; Beatley, 1969.

## TABLE 2.3-3

### TYPICAL CLIMATIC CONDITIONS AND APPEARANCE OF PLANT COMMUNITIES OF NBGR

| Plant Community | Climate | Appearance |
|---|---|---|
| 1. Sagebrush Scrub | Average precipitation 8 to 15 inches mostly as winter snow; mean summer maximum temperature 83° to 95° F, mean winter minimum 8° to 27° F. | Low silvery-gray shrubs 2 to 7 feet tall, interspersed with greener plants. |
| 2. Shadscale Scrub | Average rainfall 3 to 7 inches; mean summer maximum temperature 95° to 100° F, mean winter minimum 22° to 32° F. | Plants largely 1 to 1.5 feet tall, shallow-rooted, and covering large monotonous areas between Creosote Bush Scrub and Joshua Tree Woodland. |
| 3. Creosote Bush-Scrub | Average rainfall mostly 2 to 8 inches, some as summer showers; highly variable seasonal and diurnal temperatures, mean summer maximum 100° to 110°F, mean winter minimum 30° to 42° F. | Shrubs 2 to 10 feet tall, widely spaced, largely dormant between rainy periods. |
| 4. Alkali Sink | Average rainfall 1.5 to 7 inches; mean summer maximum 106° to 116° F, mean winter minimum 28° to 37° F. | Low scattered gray or fleshy halophytes where there is poor or no drainage, as about dry lakes. |
| 5. Pinyon-Juniper Woodland | Average precipitation 12 to 20 inches, with some snow and some summer showers; mean summer maximum 88° to 95°F, mean winter minimum 20° to 30° F. | Trees 10 to 30 feet tall, in open stands with shrubs between. |
| 6. Joshua Tree Woodland | Average rainfall about 6 to 15 inches, with summer showers; mean summer maximum 95° to 100°F, mean winter minimum 22° to 32° F. | Trees 10 to 30 feet high, scattered, with shurbs and herbs between. |

Sources: Allred and others, 1963; Munz and Keck, 1965; Beatley, 1969.

| | | |
|---|---|---|
| | minimum 28° to 37° F. | age, as about dry lakes. |
| 5. Pinyon-Juniper Woodland | Average precipitation 12 to 20 inches, with some snow and some summer showers; mean summer maximum 88° to 95°F, mean winter minimum 20° to 30° F. | Trees 10 to 30 feet tall, in open stands with shrubs between. |
| 6. Joshua Tree Woodland | Average rainfall about 6 to 15 inches, with summer showers; mean summer maximum 95° to 100°F, mean winter minimum 22° to 32° F. | Trees 10 to 30 feet high, scattered, with shurbs and herbs between. |

Sources: Allred and others, 1963; Munz and Keck, 1965; Beatley, 1969.

## TABLE 2.3-4

### COMMON PLANT ASSOCIATIONS OF NBGR

| Common Plants | | Association * | | | | |
|---|---|---|---|---|---|---|
| Scientific Name | Common Name | 1 | 2 | 3 | 4 | 5 |
| SHRUBS AND TREES | | | | | | |
| Allenrolfea occidentalis | Iodine Bush | | | x | | |
| Artemesia spinescens | Budsage | x | x | x | | |
| Artemesia tridentata | Sagebrush | | x | | x | x |
| Atriplex canescens | Saltbush | x | x | x | | x |
| Atriplex confertifolia | Shadscale | x | x | x | | x |
| Atriplex polycarpa | Saltbush | x | x | x | | x |
| Cercoarpus ledifolius | Mountain-mahogany | | | | x | x |
| Chrysothamnus nauseosus | Rabbit-brush | | | | | x |
| hrysothamnus viscidiflorus | Rabbit-brush | x | x | | x | x |
| Coleogyne ramosissima | Blackbush | x | x | | x | x |
| Cowania stansburgiana | Cowania | | | | x | |
| Dalea fremontii | Indigo bush | x | | | | |
| Ephedra ssp. | Mormon tea | | | | x | |
| Eurotia lanata | Winterfat | x | x | x | | |
| *Franseria dumosa* | *Bur-sage* | x | | | | |
| Grayia spinosa | Hop-sage | x | x | | | |
| Hymenoclea salsola | Cheese bush | x | x | | | |
| Juniperus osteosperma | Utah juniper | | | | x | |
| Kochia americana | Red sage | x | x | | | |
| Larrea divaricata | Creosote bush | x | x | | | |
| Lycium andersonii | Boxthorn | x | x | | | x |
| Lycium rickardii | Boxthorn | x | | | | |
| Menodora spinescens | Twin-fruit | x | x | | | |
| Opuntia basilaris | Beaver tail cactus | x | | | | |
| Opuntia echinocarpa | Silver cholla | x | | | | |
| Pinus monophylla | Pinyon pine | | | | x | |
| Prosopis juliflora | Mesquite | x | | | | |
| Purshia glandulosa | Antelope bush | | | | | x |
| Purshia tridentata | Antelope bush | | | | x | x |
| Quercus gambelii | Gambels oak | | | | x | |
| Salazaria mexicana | Bladder-sage | x | | | | |
| Sarcobatus vermiculatus | Greasewood | | | x | | |
| Spaeralcea ambigua | Desert-mallow | x | | | | |
| **Tetradymia glabrata** | **Cottonthorn** | x | | | | x |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Lycium rickardii** | **Boxthorn** | x | | | | |
| Menodora spinescens | Twin-fruit | x | x | | | |
| Opuntia basilaris | Beaver tail cactus | x | | | | |
| Opuntia echinocarpa | Silver cholla | x | | | | |
| Pinus monophylla | Pinyon pine | | | | x | |
| Prosopis juliflora | Mesquite | x | | | | |
| Purshia glandulosa | Antelope bush | | | | | x |
| Purshia tridentata | Antelope bush | | | | x | x |
| Quercus gambelii | Gambels oak | | | | x | |
| Salazaria mexicana | Bladder-sage | x | | | | |
| Sarcobatus vermiculatus | Greasewood | | | x | | |
| Spaeralcea ambigua | Desert-mallow | x | | | | |
| Tetradymia glabrata | Cottonthorn | x | | | | x |
| Tetradymia axillaris | Cottonthorn | x | x | | | |
| Yucca brevifolia | Joshua tree | x | x | | | |
| Yucca schidigera | Mohave yucca | x | | | | |
| GRASSES AND FORBS | | | | | | |
| Distichlis sp. | Saltgrass | | | x | | |
| Eriogonum fasciculatum | Wild buckwheat | x | x | | x | x |
| Fallugia paradoxa | Apache plume | | | | x | |
| Gutierrezia microcephala | Matchweed | x | x | | | |
| Suaeda torreyana | Seepweed | x | | x | | |

*Note:
1. Creosote Bush-Scrub
2. Shadscale Scrub
3. Alkali Sink
4. Pinyon-Juniper Woodland
5. Sagebrush-Scrub

**Sources:** Allred and others, 1963; Beatley, 1963

COMMON WILDLIFE OF NBGR

| Common Name | Scientific Name | Habitat |
|---|---|---|
| Desert Tortoise | Gopherus agassizi | Creosote bush scrub |
| Side Blotched Lizard | Uta stansburiana | Widespread |
| Shovel-Nosed Snake | Chionactis occipitalis | Creosote bush scrub shadscale scrub |
| Turkey Vulture | Cathartes aura | Widespread |
| Golden Eagle | Aquila chrysaetos | Widespread |
| Red-Tailed Hawk | Buteo jamaicensis | Widespread |
| Swainson's Hawk | Buteo swainsonii | Widespread |
| Prairie Falcon | Falco mexicanus | Creosote bush, shadscale and sagebrush scrub |
| Sparrow Hawk | Falco sparverius | Widespread |
| Chukar | Alectoris graeca | Pinyon-juniper woodland |
| Gambel's Quail | Lophortyx gambelli | Creosote bush, sagebrush, Pinyon-juniper woodland |
| Mourning Dove | Zenaidura macroura | Widespread |
| Burrowing Owl | Speotyto cunicularia | Creosote bush, shadscale, sagebrush scrub |
| Common Nighthawk | Chordeiles minor | Widespread |
| Ash-throated Flycatcher | Myiarchus cinerascens | Widespread |
| Horned Lark | Eremophilia alpestris | Widespread |
| Common Raven | Corvus corax | Widespread |
| Mokingbird | Mimus polyglottos | Widespread |
| Loggerhead Shrike | Lanius ludovicianus | Widespread |
| Black-throated Sparrow | Amphispiza bilineata | Widespread on lowlands |
| House Finch | Carpodacus mexicanus | Widespread |
| Black-tailed Jack Rabbit | Lepus californicus | Widespread |
| Desert Cottontail Rabbit | Sylvilagus audobonii | Widespread except alkali flats |
| White-tailed Antelope Ground Squirrel | Amnospermophilus leucurus | Widespread |
| Kangaroo Rat | Dipodomys sp. | Widespread in lowlands |
| Long-tailed Pocket Mouse | Perognathus formosus | Widespread |
| Canyon Mouse | Peromyscus crinitus | Widespread |
| Coyote | Canis latrans | Widespread |
| Kit Fox | Vulpes macrotis | Widespread (nocturnal) |
| Mule Deer | Odocoileus hemionus | Pinyon-juniper woodland |
| Bighorn Sheep | Ovis canadensis | High rocky mountain ranges |
| Pronghorn Antelope | Antilocapra americana | Lowlands |
| Wild Horse | Equus caballus | Grass and rocky areas |
| Merriam Shrew | Sorex merriami | Sagebrush scrub, pinyon-juniper woodland |
| Least Chipmunk | Eutamias dorsalis | Sagebrush scrub |
| Pallid Kangaroo Mouse | Microdipodops pallidus | Alkali sink and shadscale scrub (nocturnal) |
| Cactus Mouse | Peromyscus eremicus | Creosote bush scrub |

TABLE 2.3-5

| | Migration | Den or Nesting Area | Food |
|---|---|---|---|
| | No | | |
| | No | | |
| le | No | | |
| | No | Log, rocks, cliff hole ground | Carrion |
| | No | Tree, cliff, Joshua tree | Rats, mice, rabbits |
| | Yes | | Grasshoppers, insects |
| d | Yes | Bare niche of cliff | Rodents, birds, insects |
| | Yes | Cavity in isolated tree, cactus, cliff | Rodents, birds, insects |
| | No | Hollow under bush | Insects, seeds, buds, berries |
| inyon- | No | Ground | Insects, seeds, buds, berries |
| | Yes | Tree, shrub, cactus, ground | Seeds, grain, fruits, insects |
| | Yes | Rodent burrow | Rodents, birds, reptiles, large insects |
| | Yes | Bare ground | Nocturnal insects |
| | Yes | Hole in tree, mesquite, yucca | Flying insects |
| | Yes | Grass-lined depression on ground | Seeds, insects |
| | No | Cliff or tree | Omnivorous |
| | Yes | Bush or dense tree | Insects, fruits |
| | Yes | Bush or tree | Insects, lizards, mice, small birds |
| | No | Bush or cactus | Seeds, insects, small fruits |
| | No | Bush, tree, cactus, building | Seeds, insects, small fruits |
| | No | Depression in dust or under bush | Herbs and shrubs |
| ats | No | Ground | Grass, leaves, fallen fruit |
| | No | Burrow | Seeds, grains, green vegetation |
| | No | Burrow | Seeds and some grains |
| | No | Burrow | Seeds |
| | No | Under rocks | Seeds, grains, small nuts, dry vegetable food |
| | No | Natural crevices or caves | Rabbits, ground squirrels, gophers, mice, kangaroo rats |
| | No | Burrow | Desert rodents and insects |
| | Partial | | Huckleberry, salal, blackberry, bitterbrush, snowbrush |
| | Partial | | Grass, tender plants, wildflowers |
| | Partial | | Sagebrush, grasses, desert plants |
| | No | | Grasses |
| iper | No | Burrow | Insects and larva |
| | No | Burrow | Insects and seeds |
| crub | No | Burrow | Seeds |
| | No | Rotting log, among rocks, burrow | Seeds, fruits |

food, types of den or nesting areas, and migration habits.

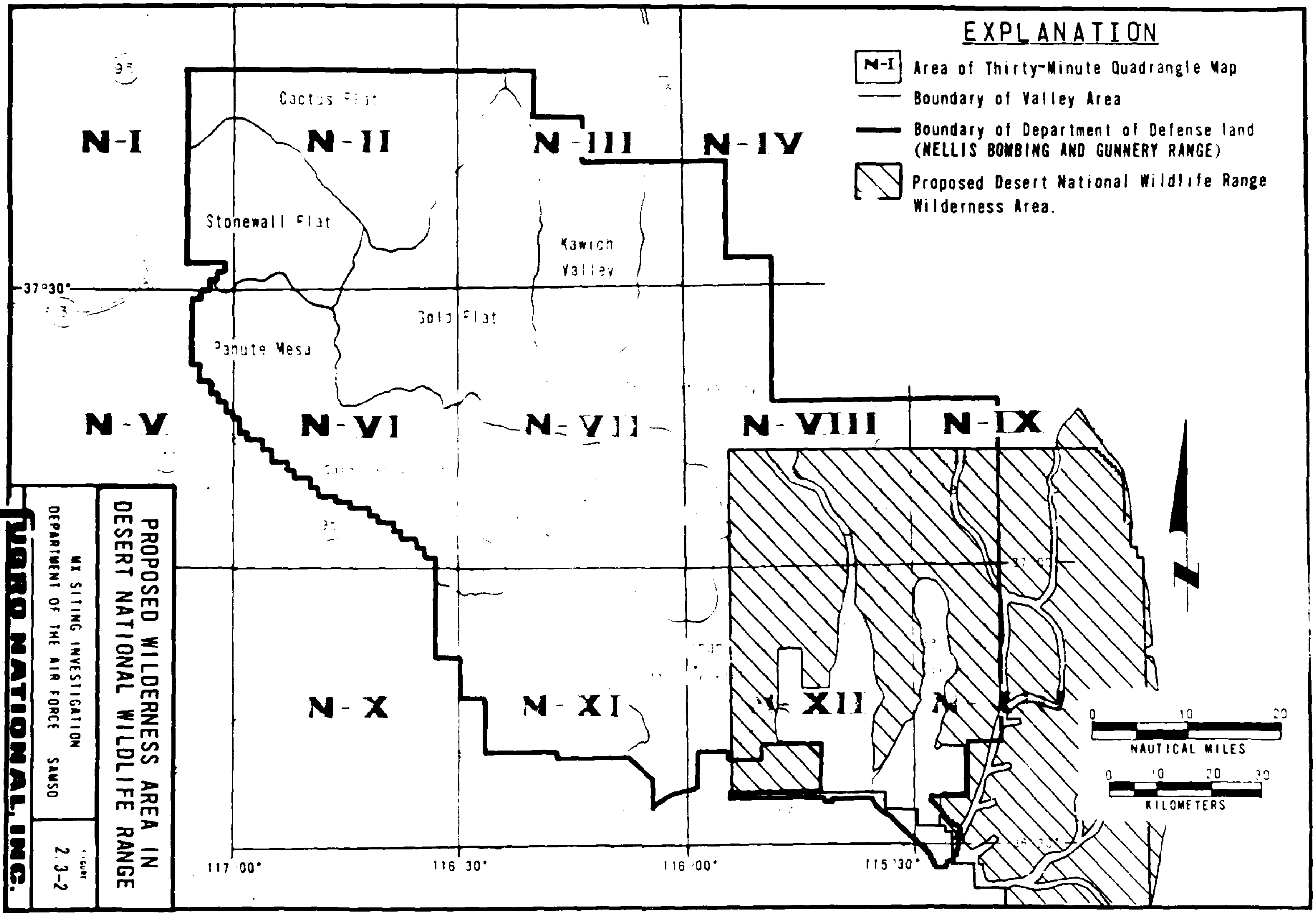
### 2.3.7.3.2 Endangered and Threatened Wildlife

The only animal on the 1975 "United States list of Endangered Species" that may occur within the Nellis Range is the American peregrine falcon (*Falco peregrinus anatum*). Its habitat is open country, and it feeds largely on birds, and rodents. It may use the Nellis Range as a winter feeding area.

### 2.3.7.3.3 Wildlife Refuges

Along the southeastern portion of the NBGR and extending to within 14 miles of Las Vegas, is the Desert National Wildlife Range (Figure 2.3-2). This area, of over 2000 $nm^2$, is the largest refuge in the United States outside Alaska. The waterless and desolate rocky ranges, which jut up from the low desert plains, provide ideal conditions for the existence of the desert bighorn sheep. The largest federally-protected herd of bighorn sheep is present within this range. Significant populations of mule deer, Gambel's quail, mourning doves, and the desert pronghorn antelope, are also found in the Range. An area of 805 $nm^2$ of the Desert National Wildlife Refuge has been designated for inclusion into the National Wilderness Preservation System. In addition, one nm presently controlled by the Department of Defense, will be reviewed for wilderness classification when the area is no longer in use by the military.

Occupying part of the northern portion of NBGR is the Nevada Wild Horse Range, administered by the U.S. Bureau of Land Management (BLM). This area has been set up for the protection of the




PROPOSED WILDERNESS AREA IN DESERT NATIONAL WILDLIFE RANGE

FIGURE 2.3-2

North American mustang (Equus caballus), and public access into the area is limited.

2.3.7.4 Vegetation and Wildlife: Summary by Valley

2.3.7.4.1 General

Figure 2.3-1, depicts the locations of the Valley subareas of NBGR that are used in the following discussion. The boundaries of the subareas are defined primarily by topographic and hydrologic divides, with artificial boundaries (roads, DoD boundaries) assigned where necessary.

2.3.7.4.2 Stonewall Flat

Specific ecological information, regarding plant and animal communities within Stonewall Flat is limited. In general, plant communities in the lowlands belong to the Sagebrush Scrub association. The area surrounding Mud Lake and the smaller playas of Stonewall Flat contain typical Alkali Sink vegetation associations.

2.3.7.4.3 Cactus Flat

Little is known of the plant and animal communities within Cactus Flat. The lower elevations of the basin belong to the Alkali Sink vegetation association dominated by the saltbush plant. The more well-drained soils of the area are covered by the Shadscale Scrub plant community.

2.3.7.4.4 Gold Flat

Vegetation common to the playas of Gold Flat include those species belonging to the Alkali Sink plant community. The southern edge of the playa is characterized by greasewood, rabbitbrush, and four-winged saltbush. Other portions of the valley are characterized by plant species within the Shadscale Scrub plant community. The Life-zone of Gold Flat is Upper Sonoran. Pronghorn antelope are known to inhabit the sagebrush plains of this area.

2.3.7.4.5 Kawich Valley

Playa area in Kawich Valley are characterized by the Alkali Sink plant community. Plant communities belonging to the Shadscale Scrub association predominate in valley areas north and south of the playa. Vegetation types belonging to the Sagebrush Scrub association occur on the gently sloping alluvial areas along the flanks of the playa and in the numerous washes. The upper portions of the alluvial fans contain Mormon tea (*Ephedra nevadensis*) and hopsage (*Grayia spinosa*).

The Upper Sonoran Life-zone characterizes wildlife in the Kawich Valley. A herd of approximately 20 pronghorn antelope is reported to graze in the Valley. Kawich Valley is also within the Nevada Wild Horse Range where the North American mustang (*Equus caballus*) is allowed to graze under the protection of the Bureau of Land Management.

2.3.7.4.6 Emigrant Valley

Emigrant Valley is ecologically similar to Kawich Valley. The playa is an Alkali Sink plant community of very sparse vegetation. The remaining portion of the valley bottom and bordering alluvial areas has plant communities belonging to the Shadscale Scrub association, merging into Sagebrush Scrub above 5,000 feet elevation.

The Belted Range forms Emigrant Valley's northwestern boundary and is abundantly wooded with pinyon-juniper on the lower slopes and mesas, merging into cedars and firs at the higher elevations. Chukar partridges are the abundant wildlife form in the Belted Range.

2.3.7.4.7 Pahute Mesa (Sarcobatus Flat)

Vegetation of Pahute Mesa is fairly dense and is typical of the Pinyon-Juniper Woodland association. Common trees include pinyon pine, Utah juniper, and Gambel's oak. Great Basin sagebrush is the predominant understory occurring along along with Mormon tea, rabbitbrush, antelope brush, and mountain mahogany.

The more alkaline soils of the lower elevations on the western side of Pahute Mesa (Sarcobatus Flat) are dominated by greasewood (*Sarcobatus vermiculatus*).

The mule deer and chukar partridge are the most common game species on Pahute Mesa. Golden eagles are known to inhabit the higher crags surrounding Pahute Mesa.

2.3.7.4.8 Buckboard Mesa (Jackass Flat)

Vegetation of Buckboard Mesa is a Sagebrush Scrub. It is dominated by an association of two species of sagebrush, *Artemesia tridentata* and *A. arbuscula.*

Jackass Flats and Rock Valley have plant communities belonging to the Creosote Bush Scrub association, although there are some areas dominated by box-thorn (Lycium andersonii) in Rock Valley. A Joshua Tree Woodland is present on the northern and eastern slopes of Jackass Flats and merges into a Pinyon-Juniper Woodland on Shoshone Mountain.

2.3.7.4.9 Yucca Flat

A Shadscale Scrub plant community occupies much of Yucca Flat. Yucca Lake is an Alkali Sink community, bounded by Joshua Tree Woodlands, particularly on the southwest and southeast. Ranier Mesa is in Pinyon-Juniper Woodland while cotton-thorn (Tetradymia glabrata) is very common in Plutonium Valley.

2.3.7.4.10 Frenchman Flat (Mercury Valley)

Vegetation in Frenchman Flat is typical of the Mojave Desert, generally belonging to the Creosote Bush Scrub association at the lower elevations. Frenchman Lake is characterized by a very sparse Alkali Sink plant community. The alluvial fans southeast of Frenchman Lake are covered with creosote bush (Larrea divaricata) and box-thorn (Lycium rickardii). Black bush (Coleogyne ramosissima) is common on the alluvial fans of northern Frenchman Flat, as well as along Mercury Ridge, the Spotted Range, and Mine Mountain. Joshua Tree Woodlands are common in northwestern Frenchman Flat, but only occasional Joshua trees (Yucca brevifolia) are found in the southern portion.

2.3.7.4.11 Indian Spring Valley

Vegetation in Indian Spring Valley is a Creosote Bush-Scrub association. The Pintwater Range forms the western boundary of the area and is generally free of vegetation.

2.3.7.4.12 Three Lakes Valley

Information is sparse regarding the nature of the ecosystems present within Three Lakes Valley. In general, its vegetation is typical of the Mojave Desert subprovince and is in a Creosote Bush Scrub association.

2.3.7.4.13 Tikaboo Valley

Information on vegetation and wildlife of the Tikaboo Valley area is limited. The southern portion of the valley and the Desert Range on the west are sparse and dry.

The southern portion of the Tikaboo Valley and the Desert Range are part of the Desert National Wildlife Range established for the protection of the desert bighorn sheep, which are found in the isolated rocky areas of the mountain ranges.

## 2.3.8 GEOMORPHOLOGY AND TOPOGRAPHY

NBGR lies within the Great Basin section of the Basin and Range Physiographic Province.

Primary topographic features which typify this area are north-trending mountain ranges and intervening alluvial basins, which encompass approximately 65 and 35 percent of the siting area, respectively. Elevations range from 2700 feet in Jackass Flat, southwestern NBGR, to 8202 feet at Belted Peak in northwestern NBGR.

Closed basin conditions predominate with primary and secondary drainages terminating in playas in the central portion of the basins. Through-flowing drainage conditions are present in Pahute and Buckboard Mesa where drainage flows southward, external to NBGR.

Secondary topographic features present within the basins include the following landforms (in order of decreasing abundance): 1) alluvial fans and bajadas, 2) pediments, 3) playas, 4) terraces and 5) sand dunes.

Alluvial fans are the most common landforms within the siting area, encompassing approximately 75 percent of the basin area. Three generations of fans can be identified; however, topographic and geomorphic expression of these fans ranges from distinct to subtle. These features flank the mountain ranges, extending toward the center of the basin, with the youngest fans coalescing to form broad, gently sloping alluvial surfaces (bajadas). In general, the older two generations of fans exhibit a topographic grade ranging from four to nine percent; bajada surfaces typically have less than five percent topographic grade. In addition, small areas of greater than ten percent topographic grade occur near the mountain fronts. The alluvial fans are moderately dissected, with the average number of drainages per nautical mile ranging from eight to twenty. Average incision ranges from moderate (ten feet) or older fans to shallow (three feet) on bajadas. Channels are typically flat-floored with steep to near vertical walls.

Pediments, planated rock shelves, are well developed in eastern NBGR, but are also present along mountain flanks in other portions of the siting area. Topographic grade exhibited by the pediments generally ranges from eight to ten percent, and may exceed ten percent near the mountain front. The pediments are moderately dissected, with an average of ten to 15 drainages per nautical mile. Depth of incision is moderate with typically near-vertical channel walls.

Active playas occur as simple, large areas (e.g. Frenchman Playa) and as small, isolated features in the central portions of the basins. Inactive mantled playa deposits generally border the active playas. These areas typically exhibit topographic grades of less than three percent and are slightly dissected with an average of one to five drainages per nautical mile. Channels are very shallowly incised with steep channel walls.

No significant areas of wind-blown sand occur within NBGR. These deposits generally are present as small, thin sheet sands with poorly developed dunes. Topographic grade in these areas is generally less than five percent; although locally it may exceed ten percent. The wind-blown sand areas are typically slightly dissected and shallowly incised.

Terraces within NBGR are low beach ridges representing former playa lake levels. They commonly are only five to 15 feet above the valley floor. Typically, they have limited geographic extent and exhibit topographic grades of three to seven percent. The terraces are slightly dissected and shallowly incised.

Rock exposures, in addition to pediments, include mountain ranges, low-lying hills and isolated outcrops within the basins. Topographic grade in these areas generally exceeds ten percent; however, the latter two areas may exhibit less than ten percent grade. Basalt flows, of limited areal extent, are present in southern and western NBGR and generally exhibit a less than ten percent topographic grade.

## 2.3.9 GEOLOGY AND SOILS

### 2.3.9.1 General

The physiography of this region is controlled by and, therefore strongly reflects the underlying structure. The major rock types are exposed in the uplifted fault block mountain ranges and include igneous, metamorphic and sedimentary units. The intervening basins generally contain at least several hundred feet of relatively coarse-grained detritus derived principally from the adjacent mountains, and lesser amounts of fine-grained material.

### 2.3.9.2 Stratigraphy

Rock units within NBGR include crystalline igneous and metamorphic basement rock, competent volcanic, metamorphic and sedimentary bedrock, and volcanic flow rock which is restricted to geologically young, extrusive igneous (basaltic) rock in association with the basin-fill deposits. Table 2.3-6 lists the rock units and their respective rock types, ages and distribution within the siting area. The greatest areal extent of exposed rock units occurs in the mountains, with lesser amounts exposed in the pediments and isolated outcrops within the basin fill. Small areas of volcanic flow rock occur primarily in Pahute Mesa. Volcanic flow rock probably occurs in the subsurface within the basin fill.

Basin-fill deposits are primarily coarse-grained, with lesser amounts of fine-grained sediments and have attained a maximum cumulative thickness of greater than 4500 feet. These deposits are apparently a complex sequence of coarse- and fine-

TABLE 2.3-6

ROCK UNITS WITHIN NBGR

| Category of Rock | Inclusive Rock Types | Ages | Distribution (areal predominance) |
|---|---|---|---|
| Basement Rock | Igneous: granitics | Precambrian | Southern NBGR |
| | Metamorphic gneiss, schist, quartzite | | |
| Bedrock | Volcanic: pyroclastics and flow rocks (rhyolite to basalt) | Tertiary | All mountain ranges and pediments |
| | Sedimentary: limestone, sandstone, and shale | Paleozoic an Mesozoic | Central and south-east NBGR |
| | Metamorphic: dolomite and quartzite | | Southeast NBGR |
| Volcanic Flow Rock | Igneous: flow rock (basaltic) | Tertiary and Quaternary | Pahute Mesa |

grained sediments with both gradational and abrupt lateral and vertical changes in grain size. Sediments are of alluvial and lacustrine origin. In general, particle size distribution grades from an abundance of boulders, cobbles and gravel, near the mountain front to clay, silt and fine sand near the central portion of the valley. These deposits may be calichified.

Soil distribution and nature of the surficial basin fill may be described in terms of coarse-and fine-grained deposits and the associated landform. Coarse-grained deposits encompass 90 percent of the basin-fill area occupied by alluvial fans and bajadas, pediments, and stream channels. The average grain-size composition is 40 percent gravel, cobbles and boulders, 40 percent sand, 15 percent silt and five percent clay. Caliche may be present within these deposits; however, the degree of development varies with local conditions.

Wind-blown sand, whether as sheet deposits or dunes, is composed of approximately 70 percent sand and 30 percent silt and clay. These deposits encompass less than one percent of the basin-fill area.

The fine-grained deposits consist of 90 percent clay and silt-size material. These deposits are present in the playas and in the mantled playa deposits beneath a thin (five feet or less) cover of coarse-grained deposits.

Desert pavement, or lag gravel consisting of gravel to cobble-size material, is generally present on the surfaces of the older fans and pediments. The bajadas are covered by a discontinuous desert pavement. Desert varnish, a mineralized patina or coating, may be present in varying stages of development on the lag gravel. The wind-blown sand deposits and playa areas have fairly smooth surfaces typically composed of finer-grained material.

2.3.9.3 Structure

NBGR lies within the Great Basin section of the Basin and Range Structural Province, and is characterized by north-trending horsts and grabens bounded by either simple or en echelon normal faults. On a regional scale, the grabens are deep structural basins with superimposed local variations.

Tertiary volcano-tectonic activity within this province produced the following associated structures: calderas, grabens, domes and elevated blocks. Calderas and other colcanic subsidence structure centers are located near Stonewall Flat, Pahute Mesa, Buckboard Mesa and Kawich Range.

Faults offsetting late Cenozoic basin-fill deposits by as much as 75 feet, are present in portions of NBGR. Based on this evidence, several faults have been identified as capable of generating earthquakes. The most prominent of these faults is Yucca fault, that since 1969 has displayed vertical movement in association with underground nuclear explosions within the Nevada Test Site.

## 2.3.10 SEISMICITY

### 2.3.10.1 General

Based upon the nature of previous seismic activity within and adjacent to the siting area, the following seismo-tectonic elements have been identified as potential sources of seismic activity that may affect NBGR: 1) Walker Lane Las Vegas Valley shear zone, 2) Death Valley Furnace Creek fault zone, 3) Jerome-Wasatch structural zone, 4) Owens Valley fault zone, 5) Northern Nevada seismic zone, and 6) capable faults including Yucca fault, within NBGR. Of these, the Owens Valley and Death Valley-Furnace Creek fault zone are most significant, in addition to man-made underground nuclear tests. Numerous seismic events of Richter magnitude (M) less than 5.0 have been located within NBGR, with a maximum recorded event of M 6.3 induced by an underground nuclear test.

### 2.3.10.2 Seismic Risk

Studies predicting the susceptibility of an area to relative levels of seismic intensity indicate that NBGR has a maximum expected Modified Mercalli Intensity of VI to VIII. Maximum levels of vibratory ground motion, generated by the six seismo-tectonic elements affecting the seismic area, may range from 0.2 to 1.0g (g being the acceleration due to gravity).

Distant (exceeding 200 nm) earthquakes of M 5 to 7 and large magnitude (M 8+) teleseismic (distances greater than 540 nm) events may also affect the siting area. The most probable sources of distant earthquakes include: 1) the northern Nevada seismic zone, 2) the San Andreas shear zone and 3) the Jerome-Wasatch structural zone. Teleseismic events may be associated with the Aleutian and Mid-American trenches.

The greatest potential for surface displacement due to faulting lies along the capable faults within the NBGR. Vertical displacements of three feet could occur, associated with an event of M 6+.

### 2.3.11 SUBSIDENCE

A potential for subsidence due to withdrawal of groundwater exists. Subsidence due to groundwater decline has occurred in adjacent portions of Nevada where large quantities of water have been withdrawn. Surface expression as earth cracks or earth fissures has accompanied this subsidence. These fissures have reported lengths of 350 feet and widths of two feet accompanying a cumulative subsidence of 3.4 feet.

### 2.3.12 HYDROLOGY AND WATER QUALITY

#### 2.3.12.1 Surface Hydrology

##### 2.3.12.1.1 General

NBGR lies principally within the Pacific Southwest Hydrologic Basin, with the southeastern portion of the area (Indian Spring and Three Lakes Valleys) being part of the Lower Colorado Hydrologic Basin. Surface drainage within NBGR is typical of the Great Basin with drainage into central playas.

2.3.12.1.2 Perennial Systems

There are no known water bodies (lakes, rivers or streams) which contain water throughout the year with NBGR.

Several springs at Indian Springs have perennial flow rates ranging from less than one to greater than 400 gallons per minute (gpm).

2.3.12.1.3 Ephemeral Systems

Ephemeral systems include playas and drainages (streams and washes) that intermittently contain water. The water supply for these systems is dependent upon rainstorm intensity and duration, and the runoff characteristics of the watershed.

Primary ephemeral drainages commonly occupy the central portion of a valley or drain large watershed areas near the mountains, and have numerous secondary tributary drainages. Flooding, including flash floods, are common in these drainages, particularly following intense rainstorms.

Playas are located in the central portions of the basins, and they discharge water received from direct precipitation into the ephemeral drainages.

2.3.12.1.4 Water Quality

Surface water in these systems varies from fresh to saline depending on the amount of total dissolved solids (TDS). In general, most runoff from springs or streams can be considered fresh (i.e., TDS less than 1000 mg/l). The principal constituents include bicarbonate, silica, calcium and sodium.

The major contaminants include fluoride, nitrate and boron. In general, water in playas will be saline (TDS greater than 1000 mg/l) with salinity increasing with duration of water occupancy within the playa.

2.3.12.2 Groundwater Hydrology

2.3.12.2.1 General

Three regional groundwater systems encompass the siting area. The Ash Meadows hydrologic system encompasses the eastern half of NBGR. The Pahute Mesa groundwater system trends north-south and encompasses Kawich Valley, Gold Flat, Buckboard Mesa and eastern Pahute Mesa. The Sarcobatus Flat groundwater system encompasses Staonewall Flat, western Pahute Mesa and Cactus Flat. Because the first two flow systems converge in the Armagosa Desert south of NBGR, they may actually be parts of a larger regional groundwater system. In all three systems groundwater is known to occur in basin-fill, perched and rock aquifers.

Recharge is supplied by infiltration of surface runoff and direct precipitation and by underflow from bordering areas. Discharge occurs by evapotranspiration, by pumping, through springs, and by underflow to adjacent areas.

2.3.12.2.2 Basin-fill Aquifers

Groundwater is found in the deeper basin fill in all basins in NBGR, except Pahute and Buckboard Mesas, where the basin fill is unsaturated. These coarse-grained deposits are of variable thickness, generally less than several hundred feet, and may be only locally saturated.

In general, depth to groundwater increases southward from approximately 100 feet near Mud Lake to greater than 1700 feet in Yucca and Frenchman Flats. Well yields, for various casing and pump sizes, range from less than ten to 360 gallons per minute.

2.3.12.2.3 Perched Aquifers

Caliche deposits, clay layers and interbedded volcanic tuffs within the basin fill may produce local perched groundwater zones. Perched intervals have been recognized in Yucca Flat, Frenchman Flat, and Jackass Flat. Yields from these zones vary depending on local conditions.

2.3.12.2.4 Rock Aquifers

Groundwater in rock aquifers is present within both volcanic and sedimentary units. Volcanic rock aquifers include welded and bedded tuffs and volcanic flows of basalt and rhyolite. Sedimentary rock aquifers include a lower and upper carbonate fracture systems. These rock aquifers are the principal sources of groundwater within NBGR, with yield ranging from 20 to greater than 800 gallons per minute.

2.3.12.2.5 Water Quality

Chemical analyses of groundwater indicate that all groundwater within NBGR is fresh, having less than 1000 TDS. Sodium is the primary constituent, with lesser amounts of silica, calcium, potassium and bicarbonate. Traces of sulfate, chloride, fluoride, nitrate and selenium may be present.

## 2.3.13 HISTORY

The Spanish conducted several exploratory expeditions during the late 1700's, establishing trails such as the Old Spanish Trail, but expressing little interest in the region. The first Americans, trappers and traders, entered the region during the early 1800's. The small numbers of white men entering the area posed little threat to the Indian tribes, who remained peaceful.

Emigration of American settlers during the 1840's was spurred by the discovery of gold in California in 1849 and later by the discovery of gold in Nevada in 1850. Mining camps sprang up, with the first towns settled by the Mormons. Increasing population resulted in conflict with the Indians, starting in 1860 with the Pyramid Lake Indian War (Elliot, 1973) and continuing for more than a decade.

Even after statehood in 1864, Nevada's history may be traced with the discovery and development of mining. Gold, silver and copper, the Comstock Lode, Pahranagat Mines and Tonopah-Goldfield Boom, Virginia City, Gold Hill and Las Vegas identify major expansive periods of mining and growth of Nevada. The completion of the railroads in 1881 also marked the beginning of large-scale ranching within the state.

Today, mining and ranching, in addition to legalized gambling and tourism, provide the main sources of economic activity.

Historic sites include ghost towns, early Mormon settlements such as Genoa Fort (1851) and scattered ruins of early mining camps. No significant sites are definitely known within NBGR.

## 2.3.14 ARCHAEOLOGY

Pre-historic inhabitants of southern Nevada date back at least 12,000 years (Jennings, 1968). Three periods may be distinguished: 1) Archaic - primarily hunting and gathering societies living in caves or brush shelters, 2) early Pueblo (Pithouse) - a semi-sedentary society that combined farming with hunting and gathering, and 3) Late Pueblo - a sedentary society using irrigation farming. Period (1) is pre-ceramic, while periods (2) and (3) are ceramic.

The Desert Archaic cultures (including San Dieguito, Armagosa and Basketmaker) are known primarily from remains in caves and excavations, such as Gypsum and Etna Caves (Harrington, 1933; Jennings, 1968) near Las Vegas and the Tule Springs Site (Pourade, 1966; Elliott, 1973) northwest of Las Vegas near the Sheep Range. Artifacts include textiles, stick figures, tools of bone, wood and stone, weapons, bones of Pleistocene elephants, camels, horses and sloth. These primitive cultures spanned at least a 10,000 year period prior to the influx of the Anasazi culture from neighboring Arizona and Utah.

A more complete record is known for the Anasazi period in southern Nevada than for the Desert Archaic cultures.

Evolution through the Early Pueblo stage (approximately 300 B.C. to 700 A.D.) is marked by development of the pithouse from a partially below ground circular structure with wooden poles supporting a dome-shaped roof to one having masonry walls of adobe and rock. Artifacts include petroglyphs, stone weapons and tools, pottery, and mining (salt) tools. During the late Pueblo stage (700 to 1100 A.D.), adobe pueblos evolved into complex cities, such as "Pueblo Grande" ("Lost City") northeast of Las Vegas (now under Lake Mead) and "Mesa House" near Overton (Harrington, Hayden and Schellbach, 1930). This stage of the Anasazi culture is marked by irrigation farming of corn, beans, squash and cotton, salt mining, domesticated animals (dogs), pottery, textiles, petroglyphs and stone weapons and tools (Hulse, 1969; Elliott, 1973). The Anasazi apparently abandoned this area around 1150 A.D., however, the reasons are presently unknown.

Soon after 1200 A.D., the Paiutes, a semi-nomadic culture, entered this region and were present when the first white men arrived.

Topographically, the ramains of the Desert Archaic and Early Pueblo cultures are generally found on alluvial knolls and terraces and on mountain slopes, particularly near sources of water. Pit houses are found on ridge crests or low hills in the valleys and are now rounded depressions discernible by changes in vegetation as well as topography.

Late Pueblo sites generally occupy open flat-land areas available for agriculture with a near-by water source.

Only one specific Indian site is reported (Pourade, 1966) as being within the boundaries of NBGR, this is at Quartz Spring in the northwest end of the Pintwater Range. This site includes scattered camps and stone circles; all apparently representing the Desert Archaic cultures.

### 2.3.15 PALEONTOLOGY

Remains of formerly living plants and animals are preserved in both rock units (in or adjacent to the mountains) and basin-fill deposits.

Fossils occur within rock units of Paleozoic and Mesozoic age. Contained primarily within siltstone and limestone, the fossils reflect a complex marine fauna including graptolytes, brachipods, ammonites, pelecypods and corals (Ekren and others, 1971; Albers and Stewart, 1972). The most distinctive fossils are the Cambrian trilobites which include several olenellid species.

Fossils occurring within rock units of Tertiary age include fossil wood fragments (conifers) and vertebrate bone fragments of camels and fish of late Miocene age (Ekren and others, 1971). These fossils are exposed in conglomerate and sandstone deposits near Mount Helen.

Basin-fill deposits contain faunal remains of Blancan and Quaternary age. Fossil bones of horse, camel, elephant, bison, sheep, and deer are found within exposures of the Las Vegas formation (primarily clay and silt) in Pahrump Valley (Longwell and others, 1965). Fossil remains of early man may also be present in these same deposits, based on associations of animal bones and early man artifacts in the nearby Tule Springs area (Elliott, 1973).

The distribution and extent of these deposits within NBGR is not well known due to a lack of detailed paleontologic investigations.

## 3.0 RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS, POLICIES, AND CONTROLS FOR THE AFFECTED AREA

As discussed in Section 2.0, the principal uses of the sit areas are military in nature. Some of these uses may be temporarily interrupted by the geotechnical field investigations. Field investigations may be scheduled to cause minimal interference with existing uses. Because of the short-range effect of the recommended field investigations, there will be no direct interference with long-term plans for the areas.

There is land in the YPG/LWBGR and NBGR siting areas which is of significance under the Wilderness Act of 3 September 1964 (Public Law 88-577). This act declares that it is the policy of Congress to secure for the American people, of both present and future generations, the benefits of an enduring resource of wilderness. The purpose of this action is to assure that an increasing population, accompanied by expanding settlements and growing mechanization, does not occupy and modify all U.S. areas. The act established a National Wilderness Preservation System to be composed of federally owned areas designated by Congress as wilderness areas. These areas are to be administered for future use and enjoyment by the American people, and are to be left unimpaired as wilderness areas. Within NBGR the Desert National Wildlife Range and in YPG/LWBGR, the Cabeza Prieta Game Range have been considered for designation as wilderness areas. There is reason to believe that Congressional action may be taken to officially designate these ranges as wilderness areas. These areas in which the geotechnical field investigations may take place are of significant ecological value for scientific and recreational uses, and as potential wilderness areas. The area not included in wilderness areas was not designated as such because of existing roads in the area or considerable use by the military. Field investigation programs conducted in the proposed wilderness areas may jeopardize their status as future wilderness areas. Each phase conducted in these areas may progressively jeopardize their present status.

# 4.0 PROBABLE ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

## 4.1 SOCIOECONOMIC IMPACT

The recommended geotechnical field surveys involve labor forces of 20 to 30 people per unit area and require few services from the population centers in the vicinity of the siting areas. Short term effects, which may be economically significant to very small towns, may occur. However, the larger towns will be used for the base of operations and impacts on these communities are anticipated to be minor. The use of local labor will be small, with no significant effect. The combined socioeconomic effects would be beneficial.

The socioeconomic impact of the short term use of small quantities (on the order of 100,000 gallons per unit area of investigation) of groundwater for dust control, drilling and revegetation will, overall, be insignificant. Even so, the use of any quantity of groundwater from existing sources of supply is socioeconomically significant in the arid Southwest. Any extended competitive groundwater use, as in later investigation phases, may eventually have a proportionately greater impact on the local areas.

## 4.2 IMPACT ON CLIMATE

Geotechnical field investigations (all phases) will have no impact on the climate of the siting areas.

## 4.3 IMPACT ON AIR QUALITY

### 4.3.1 VEHICULAR EMISSIONS

Vehicles and equipment involved in field investigations (all phases) which may produce gaseous emissions include four-wheel drive vehicles for transportation of personnel and materials, trucks for transportation of materials and water, caterpillars and loaders for road grading, drill rigs for drilling and borings, backhoes for excavating trenches, and generators to supply electricity for deep resistivity surveys. The amount of equipment or number of vehicles in use at any one time is expected to cause insignificant changes in air quality.

### 4.3.2 DUST

Dust conditions in arid environments such as those encountered at the siting areas are more severe than in other areas of the United States due to the action of wind over dry, fine ground soils.

There will be increases in airborne dust due to movement of vehicles transporting equipment and personnel to investigation areas, and due to earth movement involved in grading and trenching. It is expected that increases in dust due to vehicular movement or equipment useage in all phases will be insignificant. Dust mitigation techniques, such as watering, will be utilized in areas of more concentrated vehicular movement where more significant amounts of dust may be raised.

## 4.4 NOISE IMPACT

The impact of noise is a function of the presence of people who might be affected. Because of the restricted access and the relative remoteness of the siting areas, it is not expected that noise impact on people will be significant. Of greater interest is the effect of noise on wildlife in the siting areas.

According to the EPA (1974), noise produces the same general types of effects on animals as it does on humans, namely: hearing loss, masking of communications, behavioral and non-auditory physiological effects. The most observable effects of noise on wild animals seem to be behavioral. Clearly, noise of sufficient intensity or noise of aversive character can disrupt normal patterns of animal existence.

Any effects normally expected would be somewhat lessened by the current military uses of the siting areas. It is expected that fauna at the areas will be somewhat accustomed to irregular occurrences of noise levels higher than natural background.

Noise will result from the vehicle and equipment usage described in Section 4.3. Because of the limited amount of vehicle or equipment usage at any one time (during all phases) and the lack of concentration of these sources, it is expected that noise impacts will be minimal.

## 4.5 AESTHETIC IMPACT

Aesthetic impacts will result from the surface disturbance caused during field investigations. Surface disturbance in a desert area is not readily ameliorated due to the difficulty of revegetation and the potential for soil discoloration (Section 4.6). It is expected that surface disturbance of the small total affected area will be apparent for decades after the geotechnical surveys are complete, even though revegetation with native plants will be attempted. The level of disturbance varies with the type of investigative technique. Driving over virgin area to perform field mapping will have less of an impact compared with drilling and trenching.

## 4.6 IMPACT ON ECOLOGY

### 4.6.1 GENERAL

The major ecological impact will be caused by road construction and vehicular traffic over desert areas. There will also be land disturbance due to the drilling and trenching and the human activities involved in these tasks.

### 4.6.2 ROAD CONSTRUCTION AND VEHICULAR ACTIVITY

Vehicular use in the areas investigated will have the greatest adverse effect on the environment. Vegetation and wildlife habitat will be destroyed or damaged along new roads and vehicle pathways. Approximately 0.3 percent of the available area to be investigated will be disturbed by off-road driving during Phase I.

Approximately 0.03 percent of available investigation area will be cleared for new roads in Phase I related field activities. Individuals of some wildlife species will be killed as a result of traffic through these areas. It is unlikely that this loss will result in any long term reduction in population levels.

### 4.6.3 INVESTIGATION PRACTICES

#### 4.6.3.1 General

Human activities and machine noise associated with drilling, mapping, surveying, and trenching will disturb wildlife and may alter the distributional pattern of some species. However, these areas are used as bombing and gunnery ranges and wildlife may be accustomed to disturbance. Of principal concern is the endangered race of pronghorn antelope on the Arizona site. This animal is very shy, occurs in very small numbers, and is restricted in the United States to a very limited habitat range. The small field investigation work force is anticipated to have little effect on on this animal.

4.6.3.2 Trenching

Compared to road construction and use, trench excavation will have a minor ecological impact. The digging of trenches and stockpiling of soil will result in a loss of small amounts of vegetation and may kill a few small animals. Depressions remaining following subsidence of the backfilled trench areas may collect some runoff and create favorable situations for revegetation and for some animal species.

4.6.3.3 Drilling

Water and mud from mud tanks may temporarily affect near-surface conditions if it spills onto the ground and dries into a mud cake or changes the chemical quality of water infiltrating the soil. Any flora or fauna in this area may be affected. This impact is expected to be very localized and of minor significance.

## 4.7 IMPACT ON GEOLOGY

The major impact on geology will be an increase in erosion potential due to the surface disturbance caused during field investigations. The increased erosion potential arise from the changed nature of soils affected and from the difficulty in revegetating these areas in the arid Southwest environment. Because of the relatively small surface area disturbance and the availability of engineering methods to control erosion due to surface disturbance it is expected that increases in the erosion potential will not be significant. Alluvial fan areas covered by desert pavement may be particularly susceptible to erosion following disturbance.

## 4.8 IMPACT ON HYDROLOGY

### 4.8.1 SURFACE HYDROLOGY

There is a potential for some change in normal drainage patterns due to the surface disturbance, such as road building or impoundment construction during field investigations. Because of the limited amount of surface disturbance which will be required, it is expected that any change in drainage patterns will be insignificant and corrected naturally following the next thunderstorm.

Water discharged during pump testing will be allowed to flow in existing drainage channels if it is fresh; this will have no significant impact due to the short-term occurrences. Saline water must be impounded and allowed to infiltrate. Maximum pumpage (500 gallons per minute) for 56 hours would produce 1,000,000 to 1,500,000 gallons of water. An impoundment structure would be necessary to contain this discharge. An area of natural terrain approximately 300 feet by 300 feet, surrounded by a three-foot high berm would be disturbed. Following the test, the berm will be leveled to the original grade.

### 4.8.2 GROUNDWATER HYDROLOGY

Impacts on groundwater hydrology will occur due to the use of groundwater for drilling, dust control, and water well pump tests. Additional water use may be required for revegetation of disturbed soil. The amount of groundwater depletion will be insignificant and may infiltrate back into the groundwater aquifer.

Drilling additives (e.g., barite, muds and chemicals) may seep into the groundwater system during drilling. These additives are normally biodegradeable and will not be detrimental to the environment. In order to drill a 1000 foot deep boring, it is estimated that 20,000 gallons of water will be required. Some of the 20,000 gallons of water used for drilling will infiltrate back into the groundwater system. Some of the 1,000,000 to 1,500,000 gallons of water discharged at each pump test will infiltrate back into the groundwater system. This infiltration may temporarily affect groundwater tables by raising shallow or perched groundwater levels or changing chemical quality.

## 4.9 IMPACT ON HISTORICAL, ARCHAEOLOGICAL, PALEONTOLOGICAL RESOURCES

There is a potential for destruction of historical, archaeological or paleontological resources during surface disturbance for field investigations, particularly road building, pad grading, and trenching operations. It is expected that any effect could be minimized to a great degree through site specific field work by trained historians, archaeologists and paleontologists prior to, or coincident with, field investigations.

## 5.0 PROBABLE ADVERSE IMPACTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSED ACTION BE IMPLEMENTED

Impacts which cannot be avoided during the geotechnical field investigations in local areas include:

a) Destruction or alteration of terrestrial ecological habitats;

b) Degradation of the aesthetic quality;

c) Increase in erosion potential;

d) Consumption of groundwater;

e) Deterioration of air quality; and,

f) Increase noise levels.

Section 4.0 contains a more complete description of these potential impacts.

## 6.0 PROBABLE BENEFICIAL EFFECTS SHOULD THE PROPOSED ACTION BE IMPLEMENTED

Geologic and engineering information obtained for this study will not only satisfy the design requirements of the MX system, but will also add a great deal to the understanding of geotechnical conditions within the Basin and Range Province. Some additional information will be collected in the areas of history, archaeology, paleontology, and ecology. This information may lead to a better understanding of historic and prehistoric activity in the Southwest, as well as a better understanding of habitat distribution and associations throughout the region.

## 7.0 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG TERM PRODUCTIVITY

Field investigations will destroy the long term productivity of some ecological habitats (Sections 3.0 and 4.6). This destruction of habitat is not expected to have a long term impact on the productivity over the region because of the small area used during the field exploration program.

## 8.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES THAT WILL BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

The relatively small surface area affected by the field investigation and the small quantities of groundwater may result in some irreversible and irretrievable commitments. These are:

a) Destruction or alteration of terrestrial ecological habitats;

b) Degradation of the aesthetic quality; and

c) Consumption of groundwater.

Section 4.0 contains a more complete description of these potential impacts.

## 9.0 POTENTIAL MITIGATING MEASURES

There are some steps that can be taken to minimize the impact of the geotechnical field investigations. These include the following:

1. Restrict to a minimum the number of roads constructed to excavation areas and off-road (cross-country) vehicular traffic. Use existing roads and trails wherever possible. Route roads to correspond to existing access routes and those anticipated in future site development.

2. Route roads so as to cross as few major drainage channels and to avoid as much vegetation, particularly cacti, as possible.

3. Select excavation of sites to avoid the larger perennial vegetation, e.g., saguaro cacti.

4. Avoid as much as possible areas of special ecological importance, such as established research areas, pronghorn antelope ranges, and natural springs and water holes.

5. Stockpile top soil and preserve both the seed source and the physical and chemical soil properties of a suitable substrate for natural vegetation when excavating trenches.

6. Backfill and compact trenches and replace the topsoil after investigations are complete. Leave trenches to revegetate naturally.

7. Survey, by professional archaeologists, proposed layouts for roads and investigation sites to minimize the probability of destroying archaeological resources.

8. Revegetate drill pads and roads to their near-natural state.

9. Use helicopter-borne exploration equipment and personnel where possible to reduce the dependence upon roads and/or off-road vehicles for access to study areas.

## 10.0 DETAILS OF UNRESOLVED WORK

Literature surveys specific to the areas considered suitable for MX deployment and field reconnaissance should be conducted to allow accurate vegetational mapping of the potential investigation areas. This will assist in the establishment of ecological exclusion areas for field personnel.

Literature surveys specific to the potential investigation areas and field reconnaissance should be conducted by historians, archaeologists, and paleontologists to determine areas which should be avoided based on these considerations.

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This report assesses the potential environmental impacts for field activities proposed in the recommended geotechnical field investigation program for three DoD areas -- WSMR/FBMR, YPG/LWBGR, and NBGR. The report relates only to activities of significant impact as outlined in Volume III of Recommended Geotechnical Field investigations, and is intended to serve as a source document for environmental statements made prior to specific field tasks within DoD lands.

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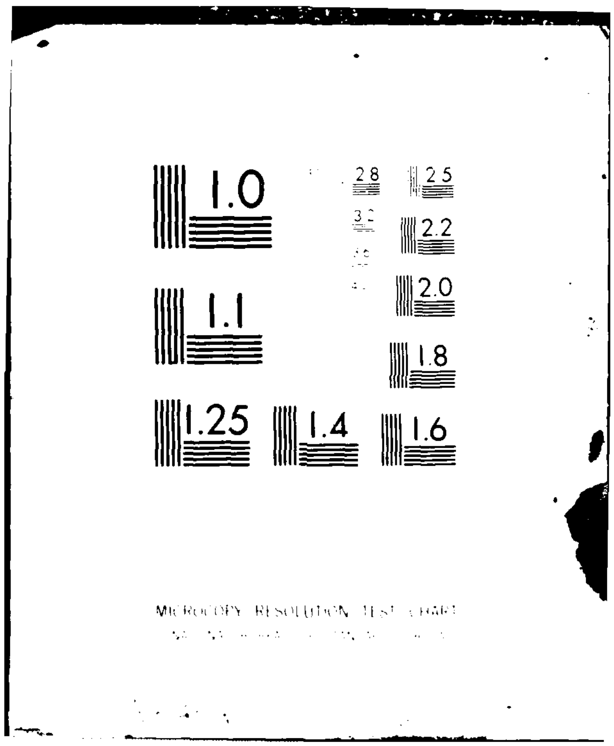
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MICROCOPY RESOLUTION TEST CHART

# APPENDIX A

# REFERENCES

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# APPENDIX B

# ENDANGERED AND THREATENED FLORA AND FAUNA

ENDANGERED AND THREATENED FLORA AND FAUNA

Floral species listed below are included in the Federal Register and are based on a Smithsonian Institution report entitled "Report on Endangered and Threatened Plant Species of the United States" prepared in accordance with Section 12 of the Endangered Species Act of 1973 (Public Law 93-205). The plant species listed are currently being considered for addition to the list of Threatened and Endangered Species of the United States.

Faunal species listed below are presented in the now out-of-date 1973 edition of Threatened Wildlife of the United States (USDI, Bureau of Sport Fisheries and Wildlife, Resources Publication 14). Both the fauna and flora listed are state-wide and include many species which would not be expected at the site due to lack of suitable habitat.

FLORA

STATE LISTS OF ENDANGERED AND THREATENED FLORAL SPECIES OF THE CONTINENTAL UNITED STATES

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| ARIZONA | ENDANGERED | ANACARDIACEAE | RHUS KEARNEYI |
| ARIZONA | ENDANGERED | APOCYNACEAE | AMSONIA KEARNEYANA |
| ARIZONA | ENDANGERED | ASTERACEAE | ERIGERON ERIOPHYLLUS |
| ARIZONA | ENDANGERED | ASTERACEAE | ERIGERON KUSCHEI |
| ARIZONA | ENDANGERED | ASTERACEAE | ERIGERON RELIGIOSUS |
| ARIZONA | ENDANGERED | ASTERACEAE | GALINSOGA SEMICALVA VAR. PERCALVA |
| ARIZONA | ENDANGERED | ASTERACEAE | HAPLOPAPPUS SALICINUS |
| ARIZONA | ENDANGERED | ASTERACEAE | MACHAERANTHERA ARIZONICA |
| ARIZONA | ENDANGERED | ASTERACEAE | PECTIS RUSBYI |
| ARIZONA | ENDANGERED | ASTERACEAE | PERITYLE GILENSIS VAR. SALENSIS |
| ARIZONA | ENDANGERED | ASTERACEAE | PLUMMERA AMBIGENS |
| ARIZONA | ENDANGERED | ASTERACEAE | SENECIO FRANCISCANUS |
| ARIZONA | ENDANGERED | ASTERACEAE | STEPHANOMERIA SCHOTTII |
| ARIZONA | ENDANGERED | BERBERIDACEAE | BERBERIS HARRISONIANA |
| ARIZONA | ENDANGERED | BORAGINACEAE | CRYPTANTHA ATWOODII |
| ARIZONA | ENDANGERED | BRASSICACEAE | DRABA ASPRELLA VAR. ASPRELLA |
| ARIZONA | ENDANGERED | BRASSICACEAE | DRABA ASPRELLA VAR. KAIBABENSIS |
| ARIZONA | ENDANGERED | BRASSICACEAE | SISYMBRIUM KEARNEYI |
| ARIZONA | ENDANGERED | BRASSICACEAE | STREPTANTHUS LEMMONII |
| ARIZONA | ENDANGERED | CACTACEAE | ECHINOCACTUS HORIZONTHALONIUS VAR. NICHOLII |
| ARIZONA | ENDANGERED | CACTACEAE | ECHINOCEREUS TRIGLOCHIDIATUS VAR. ARIZONICUS |
| ARIZONA | ENDANGERED | CACTACEAE | OPUNTIA BASILARIS VAR. TRELEASEI |
| ARIZONA | ENDANGERED | CACTACEAE | PEDIOCACTUS BRADYI |
| ARIZONA | ENDANGERED | CACTACEAE | PEDIOCACTUS PEEBLESIANUS VAR. PEEBLESIANUS |
| ARIZONA | ENDANGERED | CACTACEAE | PEDIOCACTUS SILERI |
| ARIZONA | ENDANGERED | CARYOPHYLLACEAE | SILENE RECTIRAMEA |
| ARIZONA | ENDANGERED | CHENOPODIACEAE | ATRIPLEX GRIFFITHSII |
| ARIZONA | ENDANGERED | CONVOLVULACEAE | IPOMOEA EGREGIA |
| ARIZONA | ENDANGERED | CONVOLVULACEAE | IPOMOEA LEMMONI |
| ARIZONA | ENDANGERED | CRASSULACEAE | ECHEVERIA COLLOMAE |
| ARIZONA | ENDANGERED | CRASSULACEAE | ECHEVERIA RUSBYI |
| ARIZONA | ENDANGERED | CYPERACEAE | CAREX SPECUICOLA |
| ARIZONA | ENDANGERED | FABACEAE | ASTRAGALUS BEATHII |
| ARIZONA | ENDANGERED | FABACEAE | ASTRAGALUS CREMNOPHYLAX |
| ARIZONA | ENDANGERED | FABACEAE | ASTRAGALUS LENTIGINOSUS VAR. MARICOPAE |
| ARIZONA | ENDANGERED | FABACEAE | ASTRAGALUS XIPHOIDES |
| ARIZONA | ENDANGERED | FABACEAE | SOPHORA FORMOSA |
| ARIZONA | ENDANGERED | HYDROPHYLLACEAE | PHACELIA FILIFORMIS |
| ARIZONA | ENDANGERED | HYDROPHYLLACEAE | PHACELIA WELSHII |
| ARIZONA | ENDANGERED | LILIACEAE | AGAVE ARIZONICA |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| ARIZONA | ENDANGERED | LILIACEAE | AGAVE MCKELVEYANA |
| ARIZONA | ENDANGERED | LILIACEAE | AGAVE SCHOTTII VAR. TRELEASEI |
| ARIZONA | ENDANGERED | LOASACEAE | MENTZELIA NITENS VAR. LEPTOCAULIS |
| ARIZONA | ENDANGERED | MALVACEAE | SPHAERALCEA FENDLERI VAR. ALBESCENS |
| ARIZONA | ENDANGERED | NYCTAGINACEAE | ALLIONIA CRISTATA |
| ARIZONA | ENDANGERED | OLEACEAE | FRAXINUS GOODDINGII |
| ARIZONA | ENDANGERED | ONAGRACEAE | CAMISSONIA SPECUICOLA SSP. SPECUICOLA |
| ARIZONA | ENDANGERED | PAPAVERACEAE | ARCTOMECON HUMILIS |
| ARIZONA | ENDANGERED | POACEAE | SPOROBOLUS PATENS |
| ARIZONA | ENDANGERED | POLYGONACEAE | ERIOGONUM CAPILLARE |
| ARIZONA | ENDANGERED | POLYGONACEAE | ERIOGONUM DARROVII |
| ARIZONA | ENDANGERED | POLYGONACEAE | ERIOGONUM MORTONIANUM |
| ARIZONA | ENDANGERED | POLYGONACEAE | ERIOGONUM THOMPSONAE VAR. ATWOODII |
| ARIZONA | ENDANGERED | POLYGONACEAE | ERIOGONUM ZIONIS VAR. COCCINEUM |
| ARIZONA | ENDANGERED | POLYGONACEAE | RUMEX ORTHONEURUS |
| ARIZONA | ENDANGERED | PRIMULACEAE | PRIMULA HUNNEWELLII |
| ARIZONA | ENDANGERED | RANUNCULACEAE | RANUNCULUS INAMOENUS VAR. SUBAFFINIS |
| ARIZONA | ENDANGERED | ROSACEAE | COWANIA SUBINTEGRA |
| ARIZONA | ENDANGERED | RUBIACEAE | GALIUM COLLOMAE |
| ARIZONA | ENDANGERED | SCROPHULARIACEAE | CASTILLEJA CRUENTA |
| ARIZONA | ENDANGERED | SCROPHULARIACEAE | LIMOSELLA PUBIFLORA |
| ARIZONA | ENDANGERED | SCROPHULARIACEAE | PENSTEMON CLUTEI |
| ARIZONA | ENDANGERED | SCROPHULARIACEAE | PENSTEMON DISCOLOR |
| ARIZONA | ENDANGERED | SOLANACEAE | MARGARANTHUS LEMMONII |
| ARIZONA | THREATENED | APIACEAE | CYMOPTERUS NEWBERRYI |
| ARIZONA | THREATENED | APOCYNACEAE | AMSONIA PALMERI |
| ARIZONA | THREATENED | APOCYNACEAE | AMSONIA PEEBLESII |
| ARIZONA | THREATENED | ASCLEPIADACEAE | ASCLEPIAS CUTLERI |
| ARIZONA | THREATENED | ASTERACEAE | ASTER LEMMONII |
| ARIZONA | THREATENED | ASTERACEAE | ENCELIA FRUTESCENS VAR. RESINOSA |
| ARIZONA | THREATENED | ASTERACEAE | ERIGERON ARIZONICUS |
| ARIZONA | THREATENED | ASTERACEAE | ERIGERON LEMMONII |
| ARIZONA | THREATENED | ASTERACEAE | ERIGERON LOBATUS |
| ARIZONA | THREATENED | ASTERACEAE | ERIGERON PRINGLEI |
| ARIZONA | THREATENED | ASTERACEAE | GUTIERREZIA LINOIDES |
| ARIZONA | THREATENED | ASTERACEAE | HAPLOPAPPUS SCOPULORUM |
| ARIZONA | THREATENED | ASTERACEAE | HELENIUM ARIZONICUM |
| ARIZONA | THREATENED | ASTERACEAE | HYMENOXYS QUINQUESQUAMATA |
| ARIZONA | THREATENED | ASTERACEAE | HYMENOXYS SUBINTEGRA |
| ARIZONA | THREATENED | ASTERACEAE | MACHAERANTHERA MUCRONATA |
| ARIZONA | THREATENED | ASTERACEAE | PERITYLE COCHISENSIS |
| ARIZONA | THREATENED | ASTERACEAE | PERITYLE LEMMONII |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| ARIZONA | THREATENED | ASTERACEAE | PERITYLE SAXICOLA |
| ARIZONA | THREATENED | ASTERACEAE | PLUMMERA FLORIDUNDA |
| ARIZONA | THREATENED | ASTERACEAE | SENECIO CARDAMINE |
| ARIZONA | THREATENED | ASTERACEAE | TAGETES LEMMONII |
| ARIZONA | THREATENED | BORAGINACEAE | CRYPTANTHA SEMIGLABRA |
| ARIZONA | THREATENED | BRASSICACEAE | ARABIS GRACILIPES |
| ARIZONA | THREATENED | BRASSICACEAE | DRABA ASPRELLA VAR. STELLIGERA |
| ARIZONA | THREATENED | BRASSICACEAE | LESQUERELLA GOODDINGII |
| ARIZONA | THREATENED | CACTACEAE | CORYPHANTHA RECURVATA |
| ARIZONA | THREATENED | CACTACEAE | CORYPHANTHA SCHEERI VAR. ROBUSTISPINA |
| ARIZONA | THREATENED | CACTACEAE | CORYPHANTHA VIVIPARA VAR. ALVERSONII |
| ARIZONA | THREATENED | CACTACEAE | CORYPHANTHA VIVIPARA VAR. ROSEA |
| ARIZONA | THREATENED | CACTACEAE | ECHINOCEREUS LEDINGII |
| ARIZONA | THREATENED | CACTACEAE | FEROCACTUS ACANTHODES VAR. EASTWOODIAE |
| ARIZONA | THREATENED | CACTACEAE | MAMMILLARIA ORESTERA |
| ARIZONA | THREATENED | CACTACEAE | MAMMILLARIA THORNBERI |
| ARIZONA | THREATENED | CACTACEAE | NEOLLOYDIA ERECTOCENTRA VAR. ACUNENSIS |
| ARIZONA | THREATENED | CACTACEAE | NEOLLOYDIA ERECTOCENTRA VAR. ERECTOCENTRA |
| ARIZONA | THREATENED | CACTACEAE | OPUNTIA BASILARIS VAR. LONGIAREOLATA |
| ARIZONA | THREATENED | CACTACEAE | OPUNTIA PHAEACANTHA VAR. FLAVISPINA |
| ARIZONA | THREATENED | CACTACEAE | OPUNTIA PHAEACANTHA VAR. MOJAVENSIS |
| ARIZONA | THREATENED | CACTACEAE | OPUNTIA PHAEACANTHA VAR. SUPERBOSPINA |
| ARIZONA | THREATENED | CACTACEAE | OPUNTIA WHIPPLEI VAR. MULTIGENICULATA |
| ARIZONA | THREATENED | CACTACEAE | PEDIOCACTUS PAPYRACANTHUS |
| ARIZONA | THREATENED | CACTACEAE | PEDIOCACTUS PARADINEI |
| ARIZONA | THREATENED | CACTACEAE | PEDIOCACTUS PEEBLESIANUS VAR. FICKEISENIAE |
| ARIZONA | THREATENED | CACTACEAE | SCLEROCACTUS SPINOSIOR |
| ARIZONA | THREATENED | CAPPARIDACEAE | CLEOME MULTICAULIS |
| ARIZONA | THREATENED | CROSSOSOMATACEAE | CROSSOSOMA PARVIFLORUM |
| ARIZONA | THREATENED | EUPHORBIACEAE | MANIHOT DAVISIAE |
| ARIZONA | THREATENED | FABACEAE | ASTRAGALUS AMPULLARIUS |
| ARIZONA | THREATENED | FABACEAE | ASTRAGALUS DESPERATUS VAR. CONSPECTUS |
| ARIZONA | THREATENED | FABACEAE | ASTRAGALUS ENSIFORMIS |
| ARIZONA | THREATENED | FABACEAE | ASTRAGALUS GEYERI VAR. TRIQUETRUS |
| ARIZONA | THREATENED | FABACEAE | ASTRAGALUS LANCEARIUS |
| ARIZONA | THREATENED | FABACEAE | ASTRAGALUS LENTIGINOSUS VAR. AMBIGUUS |
| ARIZONA | THREATENED | FABACEAE | ASTRAGALUS STRIATIFLORUS |
| ARIZONA | THREATENED | FABACEAE | ASTRAGALUS TITANOPHILUS |
| ARIZONA | THREATENED | FABACEAE | ASTRAGALUS TROGLODYTUS |
| ARIZONA | THREATENED | FABACEAE | ERRAZURIZIA ROTUNDATA |
| ARIZONA | THREATENED | FABACEAE | LUPINUS CUTLERI |
| ARIZONA | THREATENED | FABACEAE | PETERIA THOMPSONIAE |
| ARIZONA | THREATENED | FABACEAE | PSORALEA EPIPSILA |
| ARIZONA | THREATENED | FABACEAE | SOPHORA ARIZONICA |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| ARIZONA | THREATENED | HYDROPHYLLACEAE | NAMA RETRORSUM |
| ARIZONA | THREATENED | HYDROPHYLLACEAE | PHACELIA CEPHALOTES |
| ARIZONA | THREATENED | HYDROPHYLLACEAE | PHACELIA CONSTANCEI |
| ARIZONA | THREATENED | HYDROPHYLLACEAE | PHACELIA HOWELLIANA |
| ARIZONA | THREATENED | HYDROPHYLLACEAE | PHACELIA RAFAELENSIS |
| ARIZONA | THREATENED | HYDROPHYLLACEAE | PHACELIA SERRATA |
| ARIZONA | THREATENED | ISOETACEAE | ISOETES BOLANDERI VAR. PYGMAEA |
| ARIZONA | THREATENED | LILIACEAE | AGAVE UTAHENSIS VAR. KAIBABENSIS |
| ARIZONA | THREATENED | LILIACEAE | ALLIUM GOODDINGII |
| ARIZONA | THREATENED | LILIACEAE | TRITELEIA LEMMONAE |
| ARIZONA | THREATENED | LORANTHACEAE | ARCEUTHOBIUM APACHENSE |
| ARIZONA | THREATENED | OLEACEAE | FRAXINUS ANOMALA VAR. LOWELLII |
| ARIZONA | THREATENED | OLEACEAE | FRAXINUS CUSPIDATA VAR. MACROPETALA |
| ARIZONA | THREATENED | ONAGRACEAE | CAMISSONIA CONFERTIFLORA |
| ARIZONA | THREATENED | ONAGRACEAE | CAMISSONIA EXILIS |
| ARIZONA | THREATENED | ONAGRACEAE | CAMISSONIA PARRYI |
| ARIZONA | THREATENED | ONAGRACEAE | CAMISSONIA SPECUICOLA SSP. HESPERIA |
| ARIZONA | THREATENED | PAPAVERACEAE | ARGEMONE ARIZONICA |
| ARIZONA | THREATENED | PLUMBAGINACEAE | LIMONIUM LIMBATUM |
| ARIZONA | THREATENED | POACEAE | PUCCINELLIA PARISHII |
| ARIZONA | THREATENED | POLEMONIACEAE | PHLOX CLUTEANA |
| ARIZONA | THREATENED | POLEMONIACEAE | PHLOX JONESII |
| ARIZONA | THREATENED | POLYGALACEAE | POLYGALA PILIOPHORA |
| ARIZONA | THREATENED | POLYGONACEAE | ERIOGONUM APACHENSE |
| ARIZONA | THREATENED | POLYGONACEAE | ERIOGONUM DENSUM |
| ARIZONA | THREATENED | POLYGONACEAE | ERIOGONUM HOFFMANNII VAR. SUBRACEMOSUM |
| ARIZONA | THREATENED | POLYGONACEAE | ERIOGONUM OVALIFOLIUM VAR. VINEUM |
| ARIZONA | THREATENED | POLYGONACEAE | ERIOGONUM RIPLEYI |
| ARIZONA | THREATENED | POLYGONACEAE | ERIOGONUM THOMPSONAE VAR. THOMPSONAE |
| ARIZONA | THREATENED | POLYPODIACEAE | CHEILANTHES PRINGLEI |
| ARIZONA | THREATENED | POLYPODIACEAE | CHEILANTHES PYRAMIDALIS VAR. ARIZONICA |
| ARIZONA | THREATENED | POLYPODIACEAE | NOTHOLAENA LEMMONII |
| ARIZONA | THREATENED | PRIMULACEAE | PRIMULA SPECUICOLA |
| ARIZONA | THREATENED | RANUNCULACEAE | AQUILEGIA DESERTORUM |
| ARIZONA | THREATENED | RANUNCULACEAE | CIMICIFUGA ARIZONICA |
| ARIZONA | THREATENED | RANUNCULACEAE | CLEMATIS HIRSUTISSIMA VAR. ARIZONICA |
| ARIZONA | THREATENED | ROSACEAE | POTENTILLA MULTIFOLIOLATA |
| ARIZONA | THREATENED | ROSACEAE | ROSA STELLATA |
| ARIZONA | THREATENED | ROSACEAE | VAUQUELINIA PAUCIFLORA |
| ARIZONA | THREATENED | RUTACEAE | CHOISYA ARIZONICA |
| ARIZONA | THREATENED | RUTACEAE | CHOISYA MOLLIS |
| ARIZONA | THREATENED | SCROPHULARIACEAE | CASTILLEJA KAIBABENSIS |
| ARIZONA | THREATENED | SCROPHULARIACEAE | PENSTEMON BICOLOR SSP. ROSEUS |
| ARIZONA | THREATENED | SCROPHULARIACEAE | PENSTEMON VIRGATUS SSP. PSEUDOPUTUS |

| STATE | STATUS | FAMILY | SPECIES |
| --- | --- | --- | --- |
| NEVADA | ENDANGERED | APIACEAE | CYMOPTERUS NIVALIS |
| NEVADA | ENDANGERED | ASCLEPIADACEAE | ASCLEPIAS EASTWOODIANA |
| NEVADA | ENDANGERED | ASTERACEAE | CIRSIUM CLOKEYI |
| NEVADA | ENDANGERED | ASTERACEAE | MACHAERANTHERA LEUCANTHEMIFOLIA |
| NEVADA | ENDANGERED | ASTERACEAE | TANACETUM COMPACTUM |
| NEVADA | ENDANGERED | BRASSICACEAE | DRABA ARIDA |
| NEVADA | ENDANGERED | BRASSICACEAE | DRABA PAUCIFRUCTA |
| NEVADA | ENDANGERED | EUPHORBIACEAE | CROTON WIGGINSII |
| NEVADA | ENDANGERED | EUPHORBIACEAE | DITAXIS DIVERSIFLORA |
| NEVADA | ENDANGERED | FABACEAE | ASTRAGALUS BEATLEYAE |
| NEVADA | ENDANGERED | FABACEAE | ASTRAGALUS CALYCOSUS VAR. MONOPHYLLIDIUS |
| NEVADA | ENDANGERED | FABACEAE | ASTRAGALUS NYENSIS |
| NEVADA | ENDANGERED | FABACEAE | ASTRAGALUS PHOENIX |
| NEVADA | ENDANGERED | FABACEAE | ASTRAGALUS PORRECTUS |
| NEVADA | ENDANGERED | FABACEAE | ASTRAGALUS ROBBINSII VAR. OCCIDENTALIS |
| NEVADA | ENDANGERED | FABACEAE | ASTRAGALUS SERENOI VAR. SORDESCENS |
| NEVADA | ENDANGERED | FABACEAE | ASTRAGALUS UNCIALIS |
| NEVADA | ENDANGERED | FABACEAE | LATHYRUS HITCHCOCKIANUS |
| NEVADA | ENDANGERED | FABACEAE | TRIFOLIUM ANDERSONII SSP. BEATLEYAE |
| NEVADA | ENDANGERED | FABACEAE | TRIFOLIUM LEMMONII |
| NEVADA | ENDANGERED | GENTIANACEAE | CENTAURIUM NAMOPHILUM |
| NEVADA | ENDANGERED | GENTIANACEAE | FRASERA GYPSICOLA |
| NEVADA | ENDANGERED | GENTIANACEAE | FRASERA PAHUTENSIS |
| NEVADA | ENDANGERED | GERANIACEAE | GERANIUM TOQUIMENSE |
| NEVADA | ENDANGERED | HYDROPHYLLACEAE | PHACELIA BEATLEYAE |
| NEVADA | ENDANGERED | LOASACEAE | MENTZELIA LEUCOPHYLLA |
| NEVADA | ENDANGERED | NYCTAGINACEAE | MIRABILIS PUDICA |
| NEVADA | ENDANGERED | ONAGRACEAE | CAMISSONIA MEGALANTHA |
| NEVADA | ENDANGERED | ONAGRACEAE | CAMISSONIA NEVADENSIS |
| NEVADA | ENDANGERED | POLYGONACEAE | ERIOGONUM ANEMOPHILUM |
| NEVADA | ENDANGERED | POLYGONACEAE | ERIOGONUM ARGOPHYLLUM |
| NEVADA | ENDANGERED | PRIMULACEAE | PRIMULA CAPILLARIS |
| NEVADA | ENDANGERED | PRIMULACEAE | PRIMULA NEVADENSIS |
| NEVADA | ENDANGERED | ROSACEAE | IVESIA CRYPTOCAULIS |
| NEVADA | ENDANGERED | ROSACEAE | IVESIA EREMICA |
| NEVADA | ENDANGERED | SCROPHULARIACEAE | CASTILLEJA SALSUGINOSA |
| NEVADA | ENDANGERED | SCROPHULARIACEAE | PENSTEMON DECURVUS |
| NEVADA | ENDANGERED | SCROPHULARIACEAE | PENSTEMON KECKII |
| NEVADA | ENDANGERED | SCROPHULARIACEAE | PENSTEMON NANUS |
| NEVADA | ENDANGERED | SCROPHULARIACEAE | PENSTEMON NYEENSIS |
| NEVADA | ENDANGERED | SCROPHULARIACEAE | PENSTEMON PAHUTENSIS |
| NEVADA | ENDANGERED | SCROPHULARIACEAE | PENSTEMON RUBICUNDUS |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| NEVADA | ENDANGERED | SCROPHULARIACEAE | SYNTHYRIS RANUNCULINA |
| NEVADA | THREATENED | APIACEAE | ANGELICA SCABRIDA |
| NEVADA | THREATENED | APIACEAE | CYMOPTERUS BASALTICUS |
| NEVADA | THREATENED | ASTERACEAE | ANTENNARIA SOLICEPS |
| NEVADA | THREATENED | ASTERACEAE | ENCELIOPSIS NUDICAULIS VAR. CORRUGATA |
| NEVADA | THREATENED | ASTERACEAE | ERIGERON OVINUS |
| NEVADA | THREATENED | ASTERACEAE | ERIGERON UNCIALIS VAR. CONJUGANS |
| NEVADA | THREATENED | ASTERACEAE | GRINDELIA FRAXINO-PRATENSIS |
| NEVADA | THREATENED | ASTERACEAE | HAPLOPAPPUS BRICKELLIOIDES |
| NEVADA | THREATENED | ASTERACEAE | HAPLOPAPPUS CANUS |
| NEVADA | THREATENED | ASTERACEAE | HAPLOPAPPUS EXIMIUS |
| NEVADA | THREATENED | ASTERACEAE | MACHAERANTHERA AMMOPHILA |
| NEVADA | THREATENED | ASTERACEAE | MACHAERANTHERA GRINDELIOIDES VAR. DEPRESSA |
| NEVADA | THREATENED | ASTERACEAE | PERITYLE MEGALOCEPHALA VAR. INTRICATA |
| NEVADA | THREATENED | ASTERACEAE | SENECIO LYNCEUS VAR. LEUCOREUS |
| NEVADA | THREATENED | ASTERACEAE | TOWNSENDIA JONESII VAR. TUMULOSA |
| NEVADA | THREATENED | BORAGINACEAE | CRYPTANTHA COMPACTA |
| NEVADA | THREATENED | BORAGINACEAE | CRYPTANTHA HOFFMANNII |
| NEVADA | THREATENED | BORAGINACEAE | CRYPTANTHA INTERRUPTA |
| NEVADA | THREATENED | BORAGINACEAE | CRYPTANTHA TUMULOSA |
| NEVADA | THREATENED | BRASSICACEAE | ARABIS SHOCKLEYI |
| NEVADA | THREATENED | BRASSICACEAE | DRABA ASTEROPHORA VAR. ASTEROPHORA |
| NEVADA | THREATENED | BRASSICACEAE | DRABA CRASSIFOLIA VAR. NEVADENSIS |
| NEVADA | THREATENED | BRASSICACEAE | DRABA DOUGLASII |
| NEVADA | THREATENED | BRASSICACEAE | DRABA JAEGERI |
| NEVADA | THREATENED | BRASSICACEAE | DRABA STENOLOBA VAR. RAMOSA |
| NEVADA | THREATENED | BRASSICACEAE | LEPIDIUM NANUM |
| NEVADA | THREATENED | BRASSICACEAE | LESQUERELLA HITCHCOCKII |
| NEVADA | THREATENED | BRASSICACEAE | RORIPPA SUBUMBELLATA |
| NEVADA | THREATENED | CACTACEAE | CORYPHANTHA VIVIPARA VAR. ROSEA |
| NEVADA | THREATENED | CACTACEAE | OPUNTIA WHIPPLEI VAR. MULTIGENICULATA |
| NEVADA | THREATENED | CACTACEAE | SCLEROCACTUS PUBISPINUS |
| NEVADA | THREATENED | CARYOPHYLLACEAE | ARENARIA KINGII VAR. ROSEA |
| NEVADA | THREATENED | CARYOPHYLLACEAE | ARENARIA STENOMERES |
| NEVADA | THREATENED | CARYOPHYLLACEAE | SILENE CLOKEYI |
| NEVADA | THREATENED | CARYOPHYLLACEAE | SILENE SCAPOSA VAR. LOBATA |
| NEVADA | THREATENED | EPHEDRACEAE | EPHEDRA FUNEREA |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS AEQUALIS |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS ALVORDENSIS |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS CALLITHRIX |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS CONVALLARIUS VAR. FINITIMUS |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS FUNEREUS |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS GEYERI VAR. TRIQUETRUS |

| STATE | STATUS | FAMILY | SPECIES |
| --- | --- | --- | --- |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS LENTIGINOSUS VAR. LATUS |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS MUSIMONUM |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS OOPHORUS VAR. CLOKEYANUS |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS OOPHORUS VAR. LONCHOCALYX |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS PSEUDIODANTHUS |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS PTEROCARPUS |
| NEVADA | THREATENED | FABACEAE | ASTRAGALUS TOQUIMANUS |
| NEVADA | THREATENED | FABACEAE | DALEA KINGII |
| NEVADA | THREATENED | FABACEAE | LUPINUS HOLMGRENANUS |
| NEVADA | THREATENED | FABACEAE | LUPINUS MONTIGENUS |
| NEVADA | THREATENED | HYDROPHYLLACEAE | PHACELIA ANELSONII |
| NEVADA | THREATENED | HYDROPHYLLACEAE | PHACELIA GLABERRIMA |
| NEVADA | THREATENED | HYDROPHYLLACEAE | PHACELIA [illegible] |
| NEVADA | THREATENED | ISOETACEAE | ISOETES BOLANDERI VAR. PYGMAEA |
| NEVADA | THREATENED | LILIACEAE | AGAVE UTAHENSIS VAR. NEVADENSIS |
| NEVADA | THREATENED | LILIACEAE | AGAVE UTAHENSIS VAR. EBORISPINA |
| NEVADA | THREATENED | LILIACEAE | CALOCHORTUS STRIATUS |
| NEVADA | THREATENED | NYCTAGINACEAE | ADRONIA ORBICULATA |
| NEVADA | THREATENED | OLEACEAE | FRAXINUS CUSPIDATA VAR. MACROPETALA |
| NEVADA | THREATENED | ONAGRACEAE | EPILOBIUM NEVADENSE |
| NEVADA | THREATENED | PAPAVERACEAE | ARCTOMECON MERRIAMII |
| NEVADA | THREATENED | POLEMONIACEAE | GILIA NYENSIS |
| NEVADA | THREATENED | POLEMONIACEAE | GILIA RIPLEYI |
| NEVADA | THREATENED | POLEMONIACEAE | LINANTHUS ARENICOLA |
| NEVADA | THREATENED | POLEMONIACEAE | PHLOX GLADIFORMIS |
| NEVADA | THREATENED | POLEMONIACEAE | POLEMONIUM NEVADENSE |
| NEVADA | THREATENED | POLYGONACEAE | ERIOGONUM BIFURCATUM |
| NEVADA | THREATENED | POLYGONACEAE | ERIOGONUM CONCINNUM |
| NEVADA | THREATENED | POLYGONACEAE | ERIOGONUM EREMICUM |
| NEVADA | THREATENED | POLYGONACEAE | ERIOGONUM HOLMGRENII |
| NEVADA | THREATENED | POLYGONACEAE | ERIOGONUM OVALIFOLIUM VAR. CALLESTRINUM |
| NEVADA | THREATENED | POLYGONACEAE | ERIOGONUM RUBRICAULE |
| NEVADA | THREATENED | PORTULACACEAE | LEWISIA MAGUIREI |
| NEVADA | THREATENED | SCROPHULARIACEAE | CASTILLEJA LINOIDES |
| NEVADA | THREATENED | SCROPHULARIACEAE | CORDYLANTHUS TECOPENSIS |
| NEVADA | THREATENED | SCROPHULARIACEAE | PENSTEMON ARENARIUS |
| NEVADA | THREATENED | SCROPHULARIACEAE | PENSTEMON BICOLOR SSP. BICOLOR |
| NEVADA | THREATENED | SCROPHULARIACEAE | PENSTEMON BICOLOR SSP. ROSEUS |
| NEVADA | THREATENED | SCROPHULARIACEAE | PENSTEMON MODESTUS |
| NEVADA | THREATENED | SCROPHULARIACEAE | PENSTEMON PUDICUS |
| NEVADA | THREATENED | SCROPHULARIACEAE | PENSTEMON THOMPSONIAC SSP. JAEGERI |
| NEVADA | THREATENED | VIOLACEAE | VIOLA CHARLESTONENSIS |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| NEW MEXICO | ENDANGERED | ASTERACEAE | ERIGERON RHIZOMATUS |
| NEW MEXICO | ENDANGERED | ASTERACEAE | HELIANTHUS LACINIATUS SSP. CRENATUS |
| NEW MEXICO | ENDANGERED | ASTERACEAE | HELIANTHUS PARADOXUS |
| NEW MEXICO | ENDANGERED | BRASSICACEAE | LESQUERELLA AUREA |
| NEW MEXICO | ENDANGERED | BRASSICACEAE | LESQUERELLA VALIDA |
| NEW MEXICO | ENDANGERED | CACTACEAE | ECHINOCEREUS LLOYDII |
| NEW MEXICO | ENDANGERED | CACTACEAE | PEDIOCACTUS KNOWLTONII |
| NEW MEXICO | ENDANGERED | CARYOPHYLLACEAE | SILENE PLANKII |
| NEW MEXICO | ENDANGERED | FABACEAE | ASTRAGALUS CASTETTERI |
| NEW MEXICO | ENDANGERED | FABACEAE | ASTRAGALUS SILICEUS |
| NEW MEXICO | ENDANGERED | FABACEAE | PETALOSTEMUM SCARIOSUM |
| NEW MEXICO | ENDANGERED | PAPAVERACEAE | ARGEMONE PLEIACANTHA SSP. PINNATISECTA |
| NEW MEXICO | ENDANGERED | POLYGALACEAE | POLYGALA RIMULICOLA |
| NEW MEXICO | ENDANGERED | POLYGONACEAE | ERIOGONUM GYPSOPHILUM |
| NEW MEXICO | ENDANGERED | RANUNCULACEAE | AQUILEGIA CHAPLINEI |
| NEW MEXICO | THREATENED | APIACEAE | ALETES FILIFOLIUS |
| NEW MEXICO | THREATENED | ASTERACEAE | CHAETOPAPPA HERSHEYI |
| NEW MEXICO | THREATENED | ASTERACEAE | LAPHAMIA CERNUA |
| NEW MEXICO | THREATENED | ASTERACEAE | PERITYLE LEMMONII |
| NEW MEXICO | THREATENED | ASTERACEAE | PERITYLE STAUROPHYLLA |
| NEW MEXICO | THREATENED | ASTERACEAE | SENECIO CARDAMINE |
| NEW MEXICO | THREATENED | ASTERACEAE | SENECIO QUAEREUS |
| NEW MEXICO | THREATENED | BRASSICACEAE | DRABA MOGOLLONICA |
| NEW MEXICO | THREATENED | BRASSICACEAE | LESQUERELLA GOODDINGII |
| NEW MEXICO | THREATENED | CACTACEAE | CORYPHANTHA SNEEDII VAR. LEEI |
| NEW MEXICO | THREATENED | CACTACEAE | CORYPHANTHA SNEEDII VAR. SNEEDII |
| NEW MEXICO | THREATENED | CACTACEAE | PEDIOCACTUS PAPYRACANTHUS |
| NEW MEXICO | THREATENED | CACTACEAE | SCLEROCACTUS MESAE-VERDAE |
| NEW MEXICO | THREATENED | CAPPARIDACEAE | CLEOME MULTICAULIS |
| NEW MEXICO | THREATENED | FABACEAE | ASTRAGALUS ACCUMBENS |
| NEW MEXICO | THREATENED | FABACEAE | ASTRAGALUS ALTUS |
| NEW MEXICO | THREATENED | FABACEAE | ASTRAGALUS PUNICEUS VAR. GERTRUDIS |
| NEW MEXICO | THREATENED | FUMARIACEAE | CORYDALIS CASEANA SSP. CASEANA |
| NEW MEXICO | THREATENED | HYDROPHYLLACEAE | PHACELIA INTEGRIFOLIA VAR. TEXANA |
| NEW MEXICO | THREATENED | LILIACEAE | ALLIUM GOODDINGII |
| NEW MEXICO | THREATENED | ONAGRACEAE | OENOTHERA ORGANENSIS |
| NEW MEXICO | THREATENED | PLUMBAGINACEAE | LIMONIUM LIMBATUM |
| NEW MEXICO | THREATENED | POACEAE | PUCCINELLIA PARISHII |
| NEW MEXICO | THREATENED | POLYGONACEAE | ERIOGONUM DENSUM |
| NEW MEXICO | THREATENED | POLYPODIACEAE | NOTHOLAENA LEMMONII |
| NEW MEXICO | THREATENED | ROSACEAE | ROSA STELLATA |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| TEXAS | ENDANGERED | ASCLEPIADACEAE | MATELEA EDWARDSENSIS |
| TEXAS | ENDANGERED | ASCLEPIADACEAE | MATELEA TEXENSIS |
| TEXAS | ENDANGERED | ASTERACEAE | AMBROSIA CHEIRANTHIFOLIA |
| TEXAS | ENDANGERED | ASTERACEAE | BRICKELLIA VIEJENSIS |
| TEXAS | ENDANGERED | ASTERACEAE | COREOPSIS INTERMEDIA |
| TEXAS | ENDANGERED | ASTERACEAE | COREOPSIS TRIPTERIS VAR. SUBRHOMBOIDEA |
| TEXAS | ENDANGERED | ASTERACEAE | DYSSODIA TEPHROLEUCA |
| TEXAS | ENDANGERED | ASTERACEAE | ERIGERON GEISERI VAR. CALCICOLA |
| TEXAS | ENDANGERED | ASTERACEAE | GRINDELIA OOLEPIS |
| TEXAS | ENDANGERED | ASTERACEAE | HELIANTHUS PARADOXUS |
| TEXAS | ENDANGERED | ASTERACEAE | MACHAERANTHERA AUREA |
| TEXAS | ENDANGERED | ASTERACEAE | PERITYLE BISETOSA VAR. BISETOSA |
| TEXAS | ENDANGERED | ASTERACEAE | PERITYLE BISETOSA VAR. SCALARIS |
| TEXAS | ENDANGERED | ASTERACEAE | PERITYLE CINEREA |
| TEXAS | ENDANGERED | ASTERACEAE | PERITYLE LINDHEIMERI VAR. HALIMIFOLIA |
| TEXAS | ENDANGERED | ASTERACEAE | PERITYLE PARRYI |
| TEXAS | ENDANGERED | ASTERACEAE | PERITYLE VITREOMONTANA |
| TEXAS | ENDANGERED | ASTERACEAE | SOLIDAGO LINDHEIMERIANA |
| TEXAS | ENDANGERED | ASTERACEAE | VIGUIERA LUDENS |
| TEXAS | ENDANGERED | BRASSICACEAE | LEAVENWORTHIA AUREA |
| TEXAS | ENDANGERED | BRASSICACEAE | LESQUERELLA VALIDA |
| TEXAS | ENDANGERED | BRASSICACEAE | SELENIA JONESII |
| TEXAS | ENDANGERED | BRASSICACEAE | STREPTANTHUS SPARSIFLORUS |
| TEXAS | ENDANGERED | BRASSICACEAE | THELYPODIUM TEXANUM |
| TEXAS | ENDANGERED | CACTACEAE | ANCISTROCACTUS TOBUSCHII |
| TEXAS | ENDANGERED | CACTACEAE | CORYPHANTHA MINIMA |
| TEXAS | ENDANGERED | CACTACEAE | CORYPHANTHA RAMILLOSA |
| TEXAS | ENDANGERED | CACTACEAE | CORYPHANTHA STROBILIFORMIS VAR. DURISPINA |
| TEXAS | ENDANGERED | CACTACEAE | ECHINOCEREUS CHLORANTHUS VAR. NEOCAPILLUS |
| TEXAS | ENDANGERED | CACTACEAE | ECHINOCEREUS LLOYDII |
| TEXAS | ENDANGERED | CACTACEAE | ECHINOCEREUS REICHENBACHII VAR. ALBERTII |
| TEXAS | ENDANGERED | CACTACEAE | ECHINOCEREUS VIRIDIFLORUS VAR. DAVISII |
| TEXAS | ENDANGERED | CACTACEAE | NEOLLOYDIA GAUTII |
| TEXAS | ENDANGERED | CACTACEAE | NEOLLOYDIA MARIPOSENSIS |
| TEXAS | ENDANGERED | CARYOPHYLLACEAE | CERASTIUM CLAWSONII |
| TEXAS | ENDANGERED | CARYOPHYLLACEAE | PARONYCHIA CONGESTA |
| TEXAS | ENDANGERED | CARYOPHYLLACEAE | PARONYCHIA MACCARTII |
| TEXAS | ENDANGERED | CARYOPHYLLACEAE | SILENE PLANKII |
| TEXAS | ENDANGERED | CHENOPODIACEAE | ATRIPLEX KLEBERGORUM |
| TEXAS | ENDANGERED | CHENOPODIACEAE | SUAEDA DURIPES |
| TEXAS | ENDANGERED | CRASSULACEAE | SEDUM TEXANUM |
| TEXAS | ENDANGERED | CYPERACEAE | ELEOCHARIS CYLINDRICA |
| TEXAS | ENDANGERED | ERIOCAULACEAE | ERIOCAULON KORNICKIANUM |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| TEXAS | ENDANGERED | EUPHORBIACEAE | ANDRACHNE ARIDA |
| TEXAS | ENDANGERED | EUPHORBIACEAE | ARGYTHAMNIA APHOROIDES |
| TEXAS | ENDANGERED | EUPHORBIACEAE | ARGYTHAMNIA ARGYRAEA |
| TEXAS | ENDANGERED | EUPHORBIACEAE | EUPHORBIA FENDLERI VAR. TRILIGULATA |
| TEXAS | ENDANGERED | EUPHORBIACEAE | EUPHORBIA GOLONDRINA |
| TEXAS | ENDANGERED | EUPHORBIACEAE | MANIHOT WALKERAE |
| TEXAS | ENDANGERED | EUPHORBIACEAE | PHYLLANTHUS ERICOIDES |
| TEXAS | ENDANGERED | FABACEAE | ACACIA EMORYANA |
| TEXAS | ENDANGERED | FABACEAE | BRONGNIARTIA MINUTIFOLIA |
| TEXAS | ENDANGERED | FABACEAE | CALLIANDRA BIFLORA |
| TEXAS | ENDANGERED | FABACEAE | GENISTIDIUM DUMOSUM |
| TEXAS | ENDANGERED | FABACEAE | HOFFMANNSEGGIA TENELLA |
| TEXAS | ENDANGERED | FABACEAE | PETALOSTEMUM REVERCHONII |
| TEXAS | ENDANGERED | FABACEAE | PETALOSTEMUM SABINALE |
| TEXAS | ENDANGERED | FAGACEAE | QUERCUS GRACILIFORMIS |
| TEXAS | ENDANGERED | FAGACEAE | QUERCUS HINCKLEYI |
| TEXAS | ENDANGERED | FAGACEAE | QUERCUS TARDIFOLIA |
| TEXAS | ENDANGERED | FRANKENIACEAE | FRANKENIA JOHNSTONII |
| TEXAS | ENDANGERED | GENTIANACEAE | BARTONIA TEXANA |
| TEXAS | ENDANGERED | HYDROPHYLLACEAE | PHACELIA PALLIDA |
| TEXAS | ENDANGERED | ISOETACEAE | ISOETES LITHOPHYLLA |
| TEXAS | ENDANGERED | LAMIACEAE | BRAZORIA PULCHERRIMA |
| TEXAS | ENDANGERED | LAMIACEAE | PHYSOSTEGIA CORRELLII |
| TEXAS | ENDANGERED | LILIACEAE | POLIANTHES RUNYONII |
| TEXAS | ENDANGERED | MALVACEAE | CALLIRHOE SCABRIUSCULA |
| TEXAS | ENDANGERED | MALVACEAE | GAYA VIOLACEA |
| TEXAS | ENDANGERED | MALVACEAE | HIBISCUS DASYCALYX |
| TEXAS | ENDANGERED | POACEAE | MUHLENBERGIA VILLOSA |
| TEXAS | ENDANGERED | POACEAE | POA INVOLUTA |
| TEXAS | ENDANGERED | POACEAE | ZIZANIA TEXANA |
| TEXAS | ENDANGERED | POLEMONIACEAE | PHLOX NIVALIS SSP. TEXENSIS |
| TEXAS | ENDANGERED | POLEMONIACEAE | POLEMONIUM PAUCIFLORUM SSP. HINCKLEYI |
| TEXAS | ENDANGERED | POLYGALACEAE | POLYGALA MARAVILLASENSIS |
| TEXAS | ENDANGERED | POLYGALACEAE | POLYGALA RIMULICOLA |
| TEXAS | ENDANGERED | POLYGONACEAE | ERIOGONUM NEALLEYI |
| TEXAS | ENDANGERED | POLYGONACEAE | ERIOGONUM SUFFRUTICOSUM |
| TEXAS | ENDANGERED | POLYGONACEAE | POLYGONELLA PARKSII |
| TEXAS | ENDANGERED | POLYGONACEAE | POLYGONUM TEXENSE |
| TEXAS | ENDANGERED | POTAMOGETONACEAE | POTAMOGETON CLYSTOCARPUS |
| TEXAS | ENDANGERED | RANUNCULACEAE | ANEMONE EDWARDSIANA VAR. EDWARDSIANA |
| TEXAS | ENDANGERED | RANUNCULACEAE | ANEMONE EDWARDSIANA VAR. PETRAEA |
| TEXAS | ENDANGERED | RANUNCULACEAE | AQUILEGIA CHAPLINEI |
| TEXAS | ENDANGERED | RANUNCULACEAE | AQUILEGIA HINCKLEYANA |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| TEXAS | ENDANGERED | RANUNCULACEAE | RANUNCULUS FASCICULARIS VAR. CUNEIFORMIS |
| TEXAS | ENDANGERED | RHAMNACEAE | COLUBRINA STRICTA |
| TEXAS | ENDANGERED | RHAMNACEAE | CONDALIA HOOKERI VAR. EDWARDSIANA |
| TEXAS | ENDANGERED | RUTACEAE | ZANTHOXYLUM PARVUM |
| TEXAS | ENDANGERED | SALICACEAE | POPULUS HINCKLEYANA |
| TEXAS | ENDANGERED | SCROPHULARIACEAE | CASTILLEJA CILIATA |
| TEXAS | ENDANGERED | STYRACACEAE | STYRAX PLATANIFOLIA VAR. STELLATA |
| TEXAS | ENDANGERED | STYRACACEAE | STYRAX TEXANA |
| TEXAS | ENDANGERED | URTICACEAE | URTICA CHAMAEDRYOIDES VAR. RUNYONII |
| TEXAS | THREATENED | ACANTHACEAE | DYSCHORISTE CRENULATA |
| TEXAS | THREATENED | ACANTHACEAE | JUSTICIA RUNYONII |
| TEXAS | THREATENED | ACANTHACEAE | JUSTICIA WARNOCKII |
| TEXAS | THREATENED | ACANTHACEAE | JUSTICIA WRIGHTII |
| TEXAS | THREATENED | ACANTHACEAE | RUELLIA DRUMMONDIANA |
| TEXAS | THREATENED | ACANTHACEAE | STENANDRIUM FASCICULARIS |
| TEXAS | THREATENED | ACERACEAE | ACER GRANDIDENTATUM VAR. SINUOSUM |
| TEXAS | THREATENED | APIACEAE | ALETES FILIFOLIUS |
| TEXAS | THREATENED | APIACEAE | EURYTAENIA HINCKLEYI |
| TEXAS | THREATENED | APOCYNACEAE | AMSONIA GLABERRIMA |
| TEXAS | THREATENED | APOCYNACEAE | AMSONIA REPENS |
| TEXAS | THREATENED | APOCYNACEAE | AMSONIA THARPII |
| TEXAS | THREATENED | ASCLEPIADACEAE | MATELEA BREVICORONATA |
| TEXAS | THREATENED | ASTERACEAE | ASTER SCABRICAULIS |
| TEXAS | THREATENED | ASTERACEAE | ASTRANTHIUM ROBUSTUM |
| TEXAS | THREATENED | ASTERACEAE | BAHIA BIGELOVII |
| TEXAS | THREATENED | ASTERACEAE | BRICKELLIA BRACHYPHYLLA VAR. HINCKLEYI |
| TEXAS | THREATENED | ASTERACEAE | BRICKELLIA BRACHYPHYLLA VAR. TERLINGUENSIS |
| TEXAS | THREATENED | ASTERACEAE | BRICKELLIA DENTATA |
| TEXAS | THREATENED | ASTERACEAE | BRICKELLIA LEPTOPHYLLA |
| TEXAS | THREATENED | ASTERACEAE | BRICKELLIA SHINERI |
| TEXAS | THREATENED | ASTERACEAE | CHAETOPAPPA HERSHEYI |
| TEXAS | THREATENED | ASTERACEAE | CIRSIUM TURNERI |
| TEXAS | THREATENED | ASTERACEAE | ERIGERON BIGELOVII |
| TEXAS | THREATENED | ASTERACEAE | HELIANTHUS PRAECOX SSP. HIRTUS |
| TEXAS | THREATENED | ASTERACEAE | LIATRIS CYMOSA |
| TEXAS | THREATENED | ASTERACEAE | LIATRIS TENUIS |
| TEXAS | THREATENED | ASTERACEAE | PERITYLE WARNOCKII |
| TEXAS | THREATENED | ASTERACEAE | POROPHYLLUM GREGGII |
| TEXAS | THREATENED | ASTERACEAE | SENECIO WARNOCKII |
| TEXAS | THREATENED | ASTERACEAE | SOLIDAGO MOLLIS VAR. ANGUSTATA |
| TEXAS | THREATENED | BERBERIDACEAE | BERBERIS SWASEYI |
| TEXAS | THREATENED | BETULACEAE | OSTRYA CHISOSENSIS |
| TEXAS | THREATENED | BORAGINACEAE | CRYPTANTHA CRASSIPES |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| TEXAS | THREATENED | BORAGINACEAE | ONOSMODIUM HELLERI |
| TEXAS | THREATENED | BRASSICACEAE | ARABIS PETIOLARIS |
| TEXAS | THREATENED | BRASSICACEAE | LESQUERELLA ANGUSTIFOLIA |
| TEXAS | THREATENED | BRASSICACEAE | LESQUERELLA MCVAUGHIANA |
| TEXAS | THREATENED | BRASSICACEAE | LESQUERELLA THAMNOPHILA |
| TEXAS | THREATENED | BRASSICACEAE | STREPTANTHUS BRACTEATUS |
| TEXAS | THREATENED | BRASSICACEAE | STREPTANTHUS CARINATUS |
| TEXAS | THREATENED | BRASSICACEAE | STREPTANTHUS CUTLERI |
| TEXAS | THREATENED | CACTACEAE | CORYPHANTHA DASYACANTHA VAR. VARICOLOR |
| TEXAS | THREATENED | CACTACEAE | CORYPHANTHA DUNCANII |
| TEXAS | THREATENED | CACTACEAE | CORYPHANTHA HESTERI |
| TEXAS | THREATENED | CACTACEAE | CORYPHANTHA SNEEDII VAR. SNEEDII |
| TEXAS | THREATENED | CACTACEAE | CORYPHANTHA SULCATA VAR. NICKELSIAE |
| TEXAS | THREATENED | CACTACEAE | ECHINOCEREUS REICHENBACHII VAR. CHISOSENSIS |
| TEXAS | THREATENED | CACTACEAE | ECHINOCEREUS REICHENBACHII VAR. FITCHII |
| TEXAS | THREATENED | CACTACEAE | ECHINOCEREUS VIRIDIFLORUS VAR. CORRELLII |
| TEXAS | THREATENED | CACTACEAE | EPITHELANTHA BOKEI |
| TEXAS | THREATENED | CACTACEAE | NEOLLOYDIA WARNOCKII |
| TEXAS | THREATENED | CACTACEAE | OPUNTIA ARENARIA |
| TEXAS | THREATENED | CACTACEAE | OPUNTIA IMBRICATA VAR. ARGENTEA |
| TEXAS | THREATENED | CACTACEAE | THELOCACTUS BICOLOR VAR. FLAVIDISPINUS |
| TEXAS | THREATENED | CAMPANULACEAE | CAMPANULA REVERCHONII |
| TEXAS | THREATENED | CAPPARIDACEAE | CLEOME MULTICAULIS |
| TEXAS | THREATENED | CAPRIFOLIACEAE | SYMPHORICARPOS GUADALUPENSIS |
| TEXAS | THREATENED | CARYOPHYLLACEAE | PARONYCHIA CHORIZANTHOIDES |
| TEXAS | THREATENED | CARYOPHYLLACEAE | PARONYCHIA DRUMMONDII SSP. PARVIFLORA |
| TEXAS | THREATENED | CARYOPHYLLACEAE | PARONYCHIA NUDATA |
| TEXAS | THREATENED | CARYOPHYLLACEAE | PARONYCHIA VIRGINICA VAR. PARKSII |
| TEXAS | THREATENED | CARYOPHYLLACEAE | PARONYCHIA WILKINSONII |
| TEXAS | THREATENED | COCHLOSPERMACEAE | AMOREUXIA WRIGHTII |
| TEXAS | THREATENED | COMMELINACEAE | TRADESCANTIA EDWARDSIANA |
| TEXAS | THREATENED | COMMELINACEAE | TRADESCANTIA WRIGHTII |
| TEXAS | THREATENED | CONVOLVULACEAE | IPOMOEA CARDIOPHYLLA |
| TEXAS | THREATENED | CRASSULACEAE | SEDUM ROBERTSIANUM |
| TEXAS | THREATENED | CUCURBITACEAE | CUCURBITA TEXANA |
| TEXAS | THREATENED | CYPERACEAE | CYPERUS ONEROSUS |
| TEXAS | THREATENED | CYPERACEAE | ELEOCHARIS AUSTROTEXANA |
| TEXAS | THREATENED | EUPHORBIACEAE | EUPHORBIA INNOCUA |
| TEXAS | THREATENED | EUPHORBIACEAE | EUPHORBIA JEJUNA |
| TEXAS | THREATENED | EUPHORBIACEAE | EUPHORBIA PERENNANS |
| TEXAS | THREATENED | EUPHORBIACEAE | EUPHORBIA ROEMERIANA |
| TEXAS | THREATENED | EUPHORBIACEAE | EUPHORBIA STRICTIOR |
| TEXAS | THREATENED | EUPHORBIACEAE | TRAGIA NIGRICANS |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| TEXAS | THREATENED | FABACEAE | AMORPHA TEXANA |
| TEXAS | THREATENED | FABACEAE | ASTRAGALUS MOLLISSIMUS VAR. MARCIDUS |
| TEXAS | THREATENED | FABACEAE | CAESALPINIA BRACHYCARPA |
| TEXAS | THREATENED | FABACEAE | CAESALPINIA DRUMMONDII |
| TEXAS | THREATENED | FABACEAE | COURSETIA AXILLARIS |
| TEXAS | THREATENED | FABACEAE | DESMODIUM LINDHEIMERI |
| TEXAS | THREATENED | FABACEAE | SOPHORA GYPSOPHILA VAR. GUADALUPENSIS |
| TEXAS | THREATENED | HYDROPHYLLACEAE | NAMA XYLOPODUM |
| TEXAS | THREATENED | HYDROPHYLLACEAE | PHACELIA INTEGRIFOLIA VAR. TEXANA |
| TEXAS | THREATENED | LAMIACEAE | HEDEOMA APICULATUM |
| TEXAS | THREATENED | LAMIACEAE | PHYSOSTEGIA MICRANTHA |
| TEXAS | THREATENED | LAMIACEAE | SALVIA PENSTEMONOIDES |
| TEXAS | THREATENED | LILIACEAE | AGAVE CHISOENSIS |
| TEXAS | THREATENED | LILIACEAE | ALLIUM PERDULCE VAR. SPERRYI |
| TEXAS | THREATENED | LILIACEAE | ANTHERICUM CHANDLERI |
| TEXAS | THREATENED | LILIACEAE | POLIANTHES MACULOSA |
| TEXAS | THREATENED | LILIACEAE | TRILLIUM TEXANUM |
| TEXAS | THREATENED | LOGANIACEAE | SPIGELIA TEXANA |
| TEXAS | THREATENED | LYTHRACEAE | HEIMIA LONGIPES |
| TEXAS | THREATENED | LYTHRACEAE | LYTHRUM OVALIFOLIUM |
| TEXAS | THREATENED | MALVACEAE | ABUTILON MARSHII |
| TEXAS | THREATENED | MELASTOMATACEAE | RHEXIA SALICIFOLIA |
| TEXAS | THREATENED | NYCTAGINACEAE | ACLEISANTHES CRASSIFOLIA |
| TEXAS | THREATENED | ORCHIDACEAE | HEXALECTRIS GRANDIFLORA |
| TEXAS | THREATENED | ORCHIDACEAE | HEXALECTRIS NITIDA |
| TEXAS | THREATENED | ORCHIDACEAE | HEXALECTRIS REVOLUTA |
| TEXAS | THREATENED | ORCHIDACEAE | PLATANTHERA FLAVA |
| TEXAS | THREATENED | ORCHIDACEAE | PLATANTHERA INTEGRA |
| TEXAS | THREATENED | PEDALIACEAE | PROBOSCIDEA SABULOSA |
| TEXAS | THREATENED | PLUMBAGINACEAE | LIMONIUM LIMBATUM |
| TEXAS | THREATENED | POACEAE | BOTHRIOCHLOA EXARISTATA |
| TEXAS | THREATENED | POACEAE | BROMUS TEXENSIS |
| TEXAS | THREATENED | POACEAE | CHLORIS TEXENSIS |
| TEXAS | THREATENED | POACEAE | FESTUCA LIGULATA |
| TEXAS | THREATENED | POACEAE | WILLKOMMIA TEXANA |
| TEXAS | THREATENED | POLYGONACEAE | ERIOGONUM CORRELLII |
| TEXAS | THREATENED | POLYGONACEAE | POLYGONUM STRIATULUM |
| TEXAS | THREATENED | POLYGONACEAE | RUMEX SPIRALIS |
| TEXAS | THREATENED | POLYPODIACEAE | NOTHOLAENA SCHAFFNERI VAR. NEALLEYI |
| TEXAS | THREATENED | RANUNCULACEAE | THALICTRUM DEBILE |
| TEXAS | THREATENED | ROSACEAE | CRATAEGUS BERBERIFOLIA |
| TEXAS | THREATENED | ROSACEAE | CRATAEGUS STENOSEPALA |

| STATE | STATUS | FAMILY | SPECIES |
|---|---|---|---|
| TEXAS | THREATENED | ROSACEAE | CRATAEGUS SUTHERLANDENSIS |
| TEXAS | THREATENED | ROSACEAE | CRATAEGUS WARNERI |
| TEXAS | THREATENED | ROSACEAE | PRUNUS HAVARDII |
| TEXAS | THREATENED | ROSACEAE | PRUNUS MINUTIFLORA |
| TEXAS | THREATENED | ROSACEAE | PRUNUS MURRAYANA |
| TEXAS | THREATENED | ROSACEAE | PRUNUS TEXANA |
| TEXAS | THREATENED | ROSACEAE | ROSA STELLATA |
| TEXAS | THREATENED | ROSACEAE | RUBUS DUPLARIS |
| TEXAS | THREATENED | RUBIACEAE | GALIUM CORRELLII |
| TEXAS | THREATENED | SAXIFRAGACEAE | PHILADELPHUS ERNESTII |
| TEXAS | THREATENED | SAXIFRAGACEAE | PHILADELPHUS TEXENSIS VAR. TEXENSIS |
| TEXAS | THREATENED | SCROPHULARIACEAE | CASTILLEJA ELONGATA |
| TEXAS | THREATENED | SOLANACEAE | LYCIUM BERBERIOIDES |
| TEXAS | THREATENED | SOLANACEAE | LYCIUM TEXANUM |
| TEXAS | THREATENED | STYRACACEAE | STYRAX YOUNGAE |

FAUNA

| | |
|---|---|
| Arizona | Arizona (Apache) trout |
| | Humpback chub |
| | Colorado squawfish |
| | Mexican duck |
| | Southern Bald eagle |
| | American peregrine falcon |
| | Masked bobwhite |
| | Yuma clapper rail |
| | Sonoran pronghorn antelope |
| Nevada | Lahontan cutthroat trout |
| | Pahranagat bonytail |
| | Moapa dace |
| | Cui-ui |
| | Devil's Hole pupfish |
| | Warm Spring pupfish |
| | Pahrump killifish |
| | American peregrine falcon |
| New Mexico | Gila trout |
| | Mexican duck |
| | Southern bald eagle |
| | American peregrine falcon |
| Texas | Comanche Springs pupfish |
| | Clear Creek gambusia |
| | Pecos gambusia |
| | Fountain darter |
| | American alligator |
| | Texas blind salamander |
| | Houston toad |
| | Eastern brown pelican |
| | Mexican duck |
| | Southern bald eagle |
| | Attwater's prairie chicken |
| | Whooping crane |
| | Eskimo curlew |
| | American ivory-billed woodpecker |
| | Red wolf |
| | Black-footed ferret |