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Nevada Nuclear Waste Storage Investigations Environmental Area Characterization Report

The MITRE Corporation
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NEVADA NUCLEAR WASTE STORAGE INVESTIGATIONS

ENVIRONMENTAL AREA CHARACTERIZATION REPORT

Compiled July 1982
by

The MITRE Corporation
Metrek Division
1820 Dolley Madison Boulevard
McLean, Virginia 22102

for

Sandia National Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87185

Under Sandia Contract: 52-1447

Sandia Project Leader
Sharla G. Bertram
Organization 6334

ABSTRACT

The Environmental Area Characterization Report describes the southwestern corner of the Nevada Test Site, Nye County, Nevada, a potential location for a geologic repository for high-level radioactive waste. The characterization summarizes reports supplied by Sandia National Laboratories, which cover the following topics: atmosphere, radiation background, hydrosphere, biosphere, energy and mineral resources, socioeconomics, and cultural resources. This report is one of a series of documents sponsored by the U.S. Department of Energy, Nevada Nuclear Waste Storage Investigations Project.

FOREWORD AND ACKNOWLEDGMENTS

The Department of Energy (DOE), in its National Waste Terminal Storage (NWTS) Program, has set objectives to develop a plan for the disposal of radioactive waste, to develop methods to isolate high-level wastes from the biosphere, and to identify appropriate sites for a geological repository and disposal facilities.

The Nevada Nuclear Waste Storage Investigations (NNWSI) are evaluating the suitability of the Department's Nevada Test Site (NTS) and vicinity in southern Nye County, Nevada, as a possible location for a geological repository. Weapons testing is the prime mission on the NTS. Waste isolation studies are therefore limited to the southwestern corner of the NTS and adjacent lands to the south and west. The Department of Energy's Nevada Operations Office is responsible for the NNWSI.

DOE is supported by technical assistance from Sandia National Laboratories (SNL) in conducting the NNWSI Environmental Area Characterization. Ms. Sharla G. Bertram of Sandia's NNWSI Overview Division provided overall coordination and direction to the environmental characterization studies. In support of the Sandia National Laboratories, The MITRE Corporation summarized and supplemented topical environmental information compiled by Nevada experts in the subject areas. These compilations are based on extensive literature and data searches covering southern Nevada and the southwestern NTS in particular.

We wish to acknowledge the technical input from the following scientists who contributed information to this report: Mr. Wayne G. Scoggins of Reynolds Electrical and Engineering Company, Inc., provided the data and the summary of onsite radiological conditions at the NTS. Dr. Gilbert D. Potter, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, provided the offsite radiological data and the summary of radiological background conditions. Dr. Lonnie C. Pippin and Donald L. Zerga of the Desert Research Institute, University of Nevada, provided the overview of cultural resources. Dr. John Bowen and Richard Egami of the Desert Research Institute provided an overview of atmospheric conditions, including meteorology and air quality data. Dr. James R. Firby of the Mackay School of Mines provided the data on paleontological resources. Dr. Thomas P. O'Farrell, Dr. William A. Rhoads (deceased), and Elizabeth Collins of EG&G, Energy Measurements Group (Santa Barbara Operations), provided the biologic overview and agricultural data. Ms. Elaine J. Bell and Dr. Lawrence T. Larson, consulting geologists, provided the characterization of energy and mineral resources. Dr. John Bird, of the University of Nevada at Las Vegas, provided a review of hydrology and water law in Nevada. Dr. Richard H. French, Dr. Atef Elzeftawy, and Bertrand Elliott, of the Desert Research Institute, provided data on hydrology and water resources.

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1.0 INTRODUCTION, ORIENTATION, AND SUMMARY

1.1 Purpose and Scope

The purpose of this report is to provide an environmental overview of the entire Nevada Nuclear Waste Storage Investigations (NNWSI) study area. This overview allows the Yucca Mountain location now being studied to be placed in the broader context of the surrounding area. It also provides a summary compilation of all the available literature on the area, thus serving as a planning basis for specific environmental baseline data collection at Yucca Mountain.

The scope of environmental studies summarized here includes a description of the hydrosphere, atmosphere, demographic, socioeconomic, and land use characteristics, as well as ecosystems of the NNWSI study area.

Site characterization studies will further narrow the scope of the investigation to a site or sites. The literature-based environmental area characterization will be followed by site-specific environmental baseline studies and an assessment of site characterization impacts. If the site is selected for a repository, additional data collection and analysis will be documented in an Environmental Impact Statement. The data collection and the assessment will be documented in baseline reports and in the environmental assessment for site characterization.

1.2 Location of Study Area

The Nevada Test Site (NTS) is located in southern Nye County, Nevada, about 65 miles (105 km) northwest of Las Vegas (Figure 1-1). It has an area of more than 900,000 acres (364,500 hectares) and varies from 25 to 35 miles (40 to 56 km) in width (east-west) and from 40 to 55 miles (64 to 88 km) in length (north-south). Part of the Basin and Range Province, the NTS consists of basins with relatively level floors called "flats", about 2500 feet (750 m) above mean sea level (MSL) surrounded by mountain ranges rising to 7500 feet (2300 m) above MSL; marked elevation changes occur over short distances. One of these ranges is Yucca Mountain, which rises to 5900 feet (1800 m) and is located just west of Jackass Flats. Other mountain ranges of the study area include the Shoshone Mountains, Skull Mountain, and the Specter Range to the south.

The NTS is surrounded on three sides by the Nellis Air Force Bombing Range (NAFBR), which provides a restricted zone that varies from 15 to 64 miles (25 to 105 km) wide between the NTS and land open to the public. Land adjacent to the southwestern corner of the NTS is public land, managed by the Bureau of Land Management (BLM). The study area includes a portion of the Amargosa Desert, and is crossed by U.S. highway 95. One small town, Lathrop Wells, is located just south of the NTS; the government town of Mercury is within the NTS boundary.

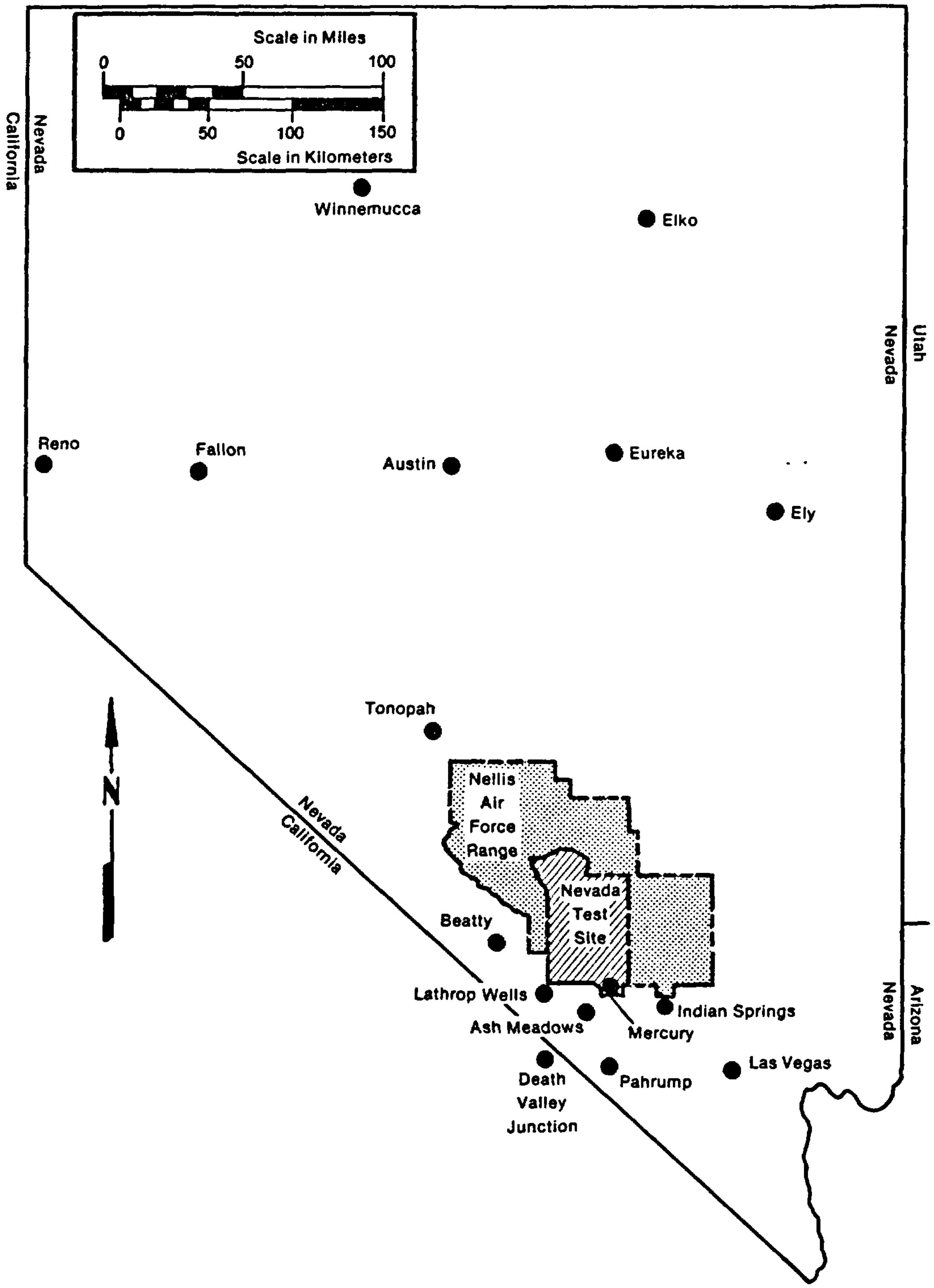

FIGURE 1-1
LOCATION OF THE NEVADA TEST SITE

The Nevada Nuclear Waste Storage Investigations (NNWSI) study area is defined by the 374-square-mile area (970 km^2) shown on Figure 1-2, which includes the southwestern NTS corner, plus adjacent public lands to the west and south. The NNWSI study area includes the Nevada Research and Development Area (NRDA) within the NTS. Contiguous to the NRDA, it includes the areas defined by extension of the northern border of the NRDA west to the western edge of the Topopah Spring Northwest 7.5-minute topographic quadrangle, south to the southwest corner of the Lathrop Wells 7.5-minute topographic quadrangle, then east to the point where the southward extension of the eastern boundary of the NNWSI meets the southern edge of the Specter Range 7.5-minute topographic quadrangle. The DOE has identified the southwestern corner of the NTS as an area suitable for investigation as a repository site, and has determined that use of this area is compatible with the weapons testing mission of the NTS. The Yucca Mountain area located just west of the NTS is generally considered to be favorable for a geologic repository, and field studies are ongoing in the vicinity of Yucca Mountain.

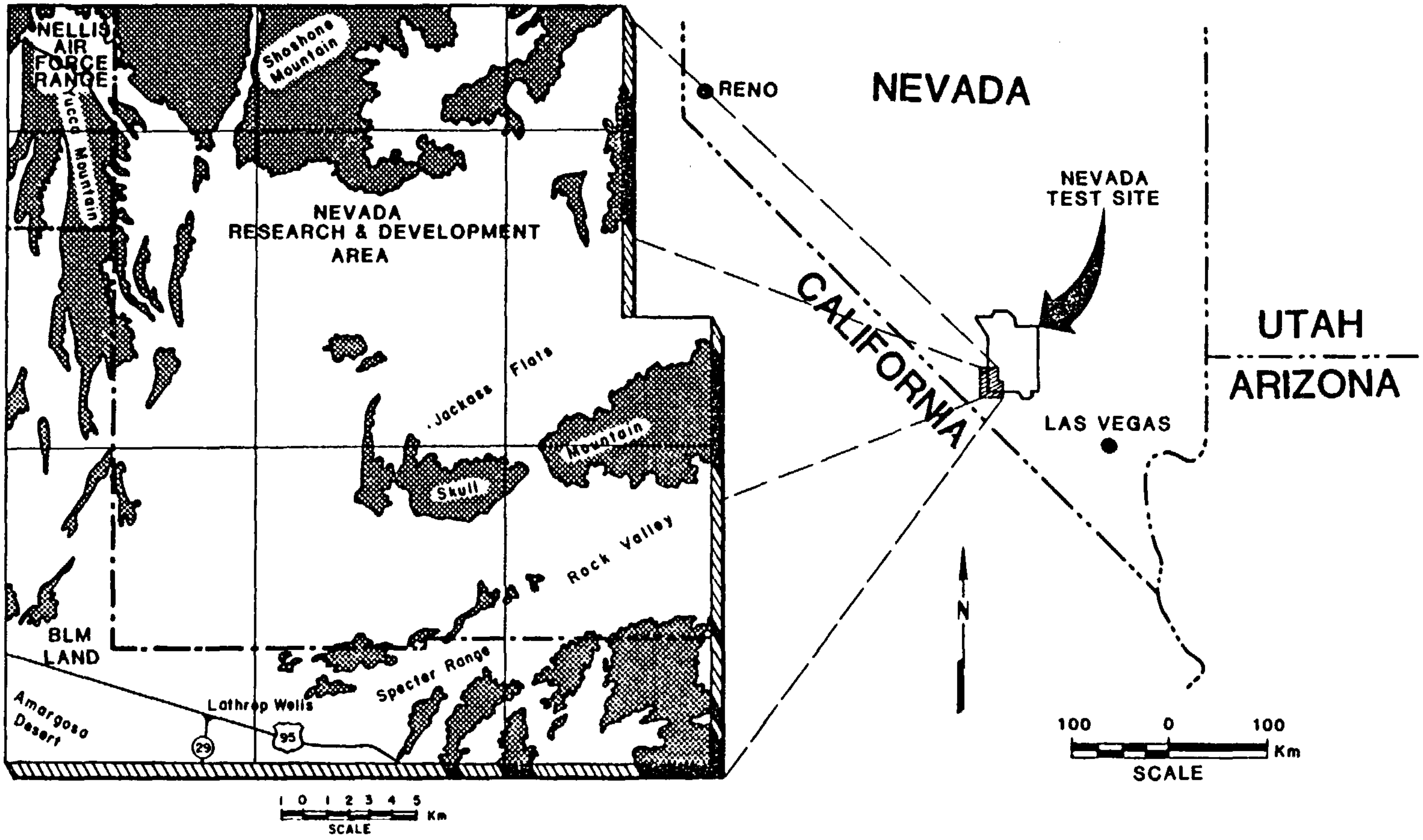

FIGURE 1-2
LOCATION OF THE NNWSI STUDY AREA

1.3 Summary Characterization

The climate of the NTS and surrounding area is highly variable, governed primarily by terrain and altitude. Generally, the climate is referred to as continental arid. Throughout the year, there is insufficient water to support the growth of common food crops without irrigation. According to Quiring (1968), the NTS average annual precipitation ranges from about 3.9 in (10 cm) at the lower elevations to around 9.8 in (25 cm) at the higher elevations. During the winter months, the mountains and high plateaus may be snow-covered for a period of several days or weeks. Snow is uncommon on the basin floors. Temperatures vary considerably with elevation, slope, and local air currents. The average daily high temperature at the lower altitudes is around 50°F (10°C) in January and 95°F (35°C) in July.

The wind direction at lower elevations has predominately diurnal oscillations with northerly winds at night and southerly winds during the day. Local terrain tends to control nocturanal winds while the general circulation prevails during the day. Local terrain differences and mountain influences may be significant in terms of local air dispersion characteristics.

The NTS lies in a portion of the Great Basin characterized by large, closed groundwater and surface water basins. Groundwater flows generally to the southwest and discharges are evident at Ash Meadows, Nevada, and Death Valley, California. Groundwater, because of its importance in repository site selection, is being studied by the USGS whose findings will be reported to DOE in a separate document. The water table ranges from less than 500 to approximate 2000 feet (150 to 610 m) deep in the study area. Few reliable estimates of groundwater flow velocity are available for the NTS region. The velocity of water in the aquifer beneath Yucca Flat (east of the study area) may range from 6 to 600 feet per year (2 to 180 m/yr); variation reflects the uncertainty of fracture porosity (Winograd and Thordarson, 1975). Much of the flow to wells is through local zones of fractured tuffaceous rocks and alluvium with higher than average hydraulic conductivity.

There are no large permanent surface water features in the study area. The largest major body of water close to the study area is Lake Mead, a man-made lake about 100 miles (160 km) to the southeast. In southern Nevada, small local reservoirs are used for irrigation and livestock watering. The many ephemeral stream beds or washes (e.g., Fortymile Wash and Topopah Wash) in the study area provide evidence of the occasional flash floods which occur after summer thunderstorms or rapid spring snow melt.

The Nevada Test Site is in an area of the Great Basin that has relatively low seismic activity for the Basin and Range Province and a low potential for volcanic eruptions. Current field and geophysical studies are concerned with characterizing structural features identified with past volcanic activity. The relationship between Quaternary strata of the basin fill deposits and erosional and depositional surfaces indicates that only very slight regional and local uplift and subsidence have occurred during the past few million years.

Limited mining was conducted in the area of the Nevada Test Site long before the land was withdrawn from the public domain. The mineral deposits are generally associated with intrusive granitic masses, and include gold, silver, other precious and base metals, and industrial material resources. Current geological exploration efforts in the southwestern part of the Nevada Test Site are directed to locations containing a potential candidate host rock, volcanic tuff. At present, studies are focusing on Yucca Mountain, which is underlain by at least 6000 feet (1800 m) of interbedded welded to nonwelded tuffs. No mineral deposits associated with the tuffs have been identified.

While there are still approximately 40 mines and mills in the general region of southern Nye County, it is predominantly a rural agricultural area, where grazing livestock are common, particularly to the northeast of the NAFBR. The area north of the NAFBR is also mid-latitude steppe, where the major agricultural activity is grazing of cattle and sheep. Minor agriculture is primarily the growing of alfalfa hay. Many of the residents grow fruits and vegetables. The areas east of the NAFBR, as well as some of the older river valleys, such as the Virgin River Valley and Moapa

Valley (over 150 miles to the east), support irrigation for small-scale but intensive farming of a variety of crops.

Other than agriculture, local business is limited to support of the U.S. Government facilities on the NTS and the NAFBR. There are small industrial plants in Henderson. The convention/tourist industry is primarily associated with the Las Vegas area.

Recreation, including camping, fishing, hunting, and offroad vehicle use, is a growing local industry, especially during the cooler montns. The Mojave desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada. The National Park Service estimates that the population within the Monument boundaries ranges from a minimum of 900 permanent residents to as many as 80,000 during "Death Valley Days" in November.

The permanent population density within the vicinity of the NTS is about 0.5 persons per square mile (1.3 per km^2). This low density is partially due to the presence of large government-owned properties such as the NTS. For comparison, the 48 contiguous states (1980 census) have a population density of approximately 11 persons per square mile (29 per km^2). Several small communities are located in the area, the largest being in the Pahrump Valley. This growing rural community, with an estimated population of about 3,600, is located about 45 miles (70 km) south-southwest of the

NTS. The Amargosa Farms area, which has a population of about 1,600, is located about 30 miles (50 km) southwest. The largest town in the near-offsite area is Beatty, which has a population of about 900, and is located approximately 20 miles (32 km) to the west. A low-level radioactive waste disposal site licensed by the State is located near Beatty.

To the east of Nye County lies Clark County and the city of Las Vegas, 65 miles (105 km) from Mercury. The Las Vegas Metropolitan Area includes the incorporated cities of North Las Vegas, Las Vegas, and Henderson and houses the majority of those employed on the NTS.

The surrounding ecosystems vary from mountain pinyon-juniper forest to the north, through a steppe-ecotone supporting sagebrush and blackbush with some bunch grasses, to the lower elevations and southern desert biome, which supports creosote bush-bursage and creosote bush-boxthorn-hopsage associations. The study area is on the northern boundary of the Mojave Desert and the southern boundary of the Great Basin Desert. These desert ecosystems are fragile and may take up to centuries to recover from severe disturbance.

There are 32 species of reptiles found in the study area, including the desert tortoise, which has the potential to be listed as a "threatened" species. The area supports 66 species of birds, including 27 permanent breeding residents. Of the 46 mammalian species in the study area, nearly half are rodents. Mule deer, wild horses, and burros range through the mountains and mid-elevations.

The hoofed mammals, together with eleven plant species and the desert tortoise are considered to be species which need further study. Research is in progress to determine the distribution and critical habitat of the desert tortoise. The desert endangered fishes, which live in very limited spring habitats south of the NTS (Ash Meadows and the Pahrump Valley), include the Devil's Hole pupfish, Warm Springs pupfish, and the Pahrump killifish.

2.0 NATURAL ENVIRONMENT OVERVIEW

2.1 Atmosphere

2.1.1 Climate

The present climate of the NTS and surrounding area is warm and dry, with most variations caused by altitude. The lower areas approach warm, arid desert conditions, with hot summers and mild winters; middle elevations are dry steppe and arid; while higher elevations may be either a moist steppe, with cooler temperatures and somewhat more precipitation, but still rather arid, to a cooler nearly boreal forest type of climate at high elevations. Wind tends to flow up and down slopes; temperature varies inversely with altitude, except for the daily minimums in closed basins; and precipitation varies directly with altitude.

Meteorological data has been collected on the NTS since 1956, from Class 1 weather stations at Yucca Flat and the Desert Rock Airport. A ten-year record (1962-1971) for Yucca flat, ten to 15 miles northeast of the NNWSI, is given on Table 2-1, with averages and extremes.* This area is known to be in a dry warm "banana belt" extending from Las Vegas to Reno. Yucca Flat has an average of 5.7 inches (14.5 cm) of precipitation annually, and 8.3 inches (21.1 cm) of snow, the latter from November through April. The

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*Yucca Flat was chosen as representative because inversion frequencies here are similar to those in Jackass Flats, although Yucca Flat is a closed basin and Jackass Flats is not. Site specific data on Yucca Mountain will be needed for dispersion modeling in complex terrain.

TABLE 2-1

CLIMATOLOGICAL SUMMARY FOR YUCCA FLAT

MONTH	TEMPERATURE (°F)							DEGREE DAYS (Base 65°)		PRECIPITATION (Inches)												RELATIVE HUMIDITY (%)				WIND (Speeds in mph) (a)					STATION PRESSURE (Inches)			(b)	AVERAGE NUMBER OF DAYS												
	AVERAGES			EXTREMES													SNOW					HOUR (Pacific Standard Time)							RESULTANT (Dir/Spd)						Sunrise to Sunset			PRECIPITATION						TEMPERATURE			
																																												Maximum		Minimum	
	DAILY MAXIMUM	DAILY MINIMUM	MONTHLY	HIGHEST	YEAR	LOWEST	YEAR	HEATING	COOLING	AVERAGE	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	GREATEST DAILY	YEAR	AVERAGE	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	04	10	16	22	AVERAGE SPEED	PEAK SPEED	YEAR	23-02 PST	11-14 PST	AVERAGES	HIGHEST	LOWEST	AVERAGE SKY COVER SUNRISE TO SUNSET	CLEAR	PARTLY CLOUDY	CLOUDY	.01 inch or more	.10 inch or more	.50 inch or more	1.00 inch or more	1.0 inch or more of snow	THUNDERSTORMS	90° F or more	32° F or less	32° F or less	0° F or less
JAN	52.1	20.8	36.5	73	1971	-2	1970	877	0	.53	4.02	1969	T	1971#	1.25	1969	0.9	4.3	1962	4.3	1962	67	49	35	60	6.6	58	1965	233/0.7	135/2.8	26.10	26.54	25.42	4.9	13	8	10	2	1	*	*	*	*	0	1	29	*
FEB	56.7	25.8	41.3	77	1963	5	1971#	662	0	.84	3.55	1969	T	1967#	1.16	1969	1.9	17.4	1969	6.2	1969	67	45	32	56	6.9	52	1967	275/1.1	118/2.7	26.05	26.42	25.56	5.0	11	8	9	3	2	*	*	1	0	0	*	23	0
MAR	60.9	27.7	44.3	87	1966	9	1969	634	0	.29	.60	1969	.02	1966	.38	1969	2.0	7.5	1969	4.5	1969	58	31	23	44	8.4	55	1971	240/1.8	186/1.5	25.99	26.43	25.48	4.8	12	9	10	3	1	0	0	1	1	0	0	24	0
APR	67.8	34.4	51.1	89	1962	13	1966	411	1	.45	2.57	1965	T	1962	1.08	1965	0.7	3.0	1964	3.0	1964	52	27	21	38	9.1	60+	1970#	250/2.2	198/5.1	25.96	26.39	25.50	4.5	13	9	8	3	1	*	*	*	1	0	0	12	0
MAY	78.9	43.5	61.2	97	1967	25	1967	147	38	.24	1.62	1971	T	1970#	.86	1971	0	T	1964	T	1964	46	22	17	31	8.3	60+	1967	260/1.5	179/7.2	25.94	26.39	25.47	4.3	14	11	6	2	1	*	0	0	1	4	0	2	0
JUN	87.6	49.9	68.8	107	1970	29	1971#	35	154	.21	1.13	1969	T	1971	.45	1969	0	0		0		39	19	14	26	7.9	60+	1967	272/1.9	185/8.2	25.92	26.20	25.56	3.0	19	7	4	2	1	0	0	0	2	14	0	*	0
JUL	96.1	57.0	76.6	107	1967	40	1964#	0	366	.52	1.34	1966	0	1963	.77	1969	0	0		0		40	20	15	28	7.5	55	1971	278/0.5	185/12.0	26.00	26.19	25.68	3.0	19	9	3	3	2	*	0	0	4	29	0	0	0
AUG	95.0	58.1	76.6	107	1970	39	1968	1	368	.34	1.04	1965	0	1962	.35	1971#	0	0		0		44	23	16	30	6.7	60+	1968	222/1.5	182/12.0	26.00	26.22	25.71	3.0	20	8	3	3	1	0	0	0	4	27	0	0	0
SEP	86.4	46.7	66.5	105	1971	25	1971	51	103	.68	2.38	1969	0	1968#	2.13	1969	0	0		0		43	21	17	32	7.0	52	1970	281/1.3	163/6.4	26.00	26.36	25.56	2.1	22	6	2	2	1	1	*	0	2	11	0	1	0
OCT	76.1	36.9	56.5	94	1964#	12	1971	266	9	.13	.45	1969	0	1967#	.42	1969	0	T	1971	T	1971	46	24	19	36	6.8	60	1971	286/1.3	138/3.7	26.06	26.40	25.52	2.9	20	7	4	1	1	0	0	0	*	2	0	9	0
NOV	61.8	27.6	44.7	82	1962	13	1966	602	0	.71	3.02	1965	0+	1962	1.10	1970	0.5	4.8	1964	2.3	1964	61	39	31	52	6.1	51	1970	234/1.2	152/4.1	26.08	26.58	25.64	4.8	13	7	10	3	2	*	*	*	*	0	0	23	0
DEC	50.7	19.9	35.3	70	1964	-14	1967	914	0	.79	2.66	1965	T	1969#	1.34	1965	2.3	9.9	1971	7.4	1971	68	50	41	64	6.6	53	1970	288/1.9	109/1.0	26.07	26.59	25.49	4.6	14	8	9	3	1	1	*	1	*	0	1	29	1
ANN	72.5	37.4	54.9	107	AUG 1970#	-14	DEC 1967	4600	1039	5.73	4.02	JAN 1969	0	SEP 1968#	2.13	SEP 1969	8.3	17.4	FEB 1969	7.4	DEC 1971	53	31	23	41	7.4	60+	APR 1970#	—	—	26.01	26.59	25.42	3.9	190	97	78	30	14	3	1	3	14	87	2	152	1

Source: Air Resources Laboratory, Las Vegas, NV. (Bowen and Egami, 1982).

* One or more occurrences during the period of record but average less than 0.5 day

\# Most recent of multiple occurrences

\+ Trace, an amount to small to measure

a) Average and peak speed are for the period starting with December 1964. The direction of the resultant wind are from a summary covering the period December 1964 through May 1969.

b) Sky cover is expressed in the range from 0 for no clouds to 10 when the sky is completely covered with clouds. Clear, partly cloudy and cloudy are defined as average daytime cloudiness of 0-3, 4-7 and 8-10 tenths, respectively.

annual temperature average ranges from 37.4°F (2.9°C) to 72.5°F (22.5°C) with extremes ranging from -14° to 107°F (-25 to 42°C) for the ten-year period shown for Yucca Flat. Winds are generally low, averaging 7.4 mph (12 km/hr), but high winds over 60 mph (96 km/hr) have been recorded in five different months.

2.1.2 Paleoclimatology

The climate within the last one million years has changed between glacial and interglacial periods. In Nevada, this change was from a moist, cool climate with pluvial lakes to a dry, warm climate during which the lakes disappeared. On the NTS, any surface water drainage from Jackass Flats may have been into Lake Manley (in Death Valley). Glaciers did not directly affect the NTS (Bowen and Egami, 1982). There is geological evidence that the northern Great Basin contained two large lakes and a number of smaller ones; however, in the southwestern NTS there were no known pluvial lakes.

Climatic changes influenced the vegetational character of the area. Ancient packrat middens (9000 to 13,000 years old) from the southern NTS indicate that the late Pleistocene juniper woodland once grew in areas now dominated by desert shrubs; this juniper community may have extended across the Las Vegas Valley. The desert vegetation did not reach its present character until about 2500 years ago (Spaulding, 1980).

Future climatic changes will probably be similar to those to the past, although human influences are uncertain at present. Various predictive schemes are not well enough developed to determine the effects of complicated interactions among natural and man-made forces.

2.1.3 Severe Weather

The most common type of weather which might be considered severe -- at least severe enough to limit population growth -- is the typical hot dry desert conditions of the summer, with high temperatures of up to 117°F (47°C). Other examples of severe weather which may occur in this area are high winds, tornadoes, flash floods, lightning and thunderstorms.

High winds are associated with winter Pacific storms and occassionally occur in southern Nevada. The fastest winds measured on the NTS range from 48 to 82 mph (77 to 132 km/hr), the latter being a 100-year wind. Gusts can be as high as 101 mph (163 km/hr) (Quiring, 1968). While tornadoes are rare, the southern part of Nevada has recorded four tornadoes, one water spout, and six funnel clouds. McDonald et al. (1975) have calculated a high wind (greater than 100 mph or 161 km/hr) probability of 1.0×10^{-3} and the probability for tornado winds at 5.9×10^{-7} per year.

The actual flooding potential is site-specific and is highest in the area of washes (See Section 2.3). Sudden spring snow melt in the mountains and summer thunderstorms may cause occasional flash flooding. Thunderstorms occur on 16 percent of the days in July and August, and 5 percent of the days annually. The greatest 24-hour precipitation, for example in Beatty, for a 10-year return and 100-year return, is 1.6 and 2.4 inches (4 and 6 cm), respectively (Thomas et al., 1970). In most cases, thunderstorm precipitation will fall within an hour (Bowen and Egami, 1982).

2.1.4 Air Quality

Air quality data are not available for the study area; therefore, a monitoring program is being designed to determine baseline conditions of criteria air pollutants.* Previously only the radioactive elements in the air have been measured.

Since the nearest man-made pollutants originate in Las Vegas, 65 miles (105 km) away, there are no significant sources of SO_2, NO_2, or CO on the NTS. The present air quality is probably very good. There may be high summer concentrations of O_3 and PM at times, since other remote southwestern locations have recorded high levels. The high PM would be from winds or "dust devils" raising particles; PM may be as high as 150 $\mu g/m^3$ (Bowen and Egami, 1981). The dust may also contribute to the hazy summer conditions with relatively low visibility; e.g., the visibility of the southern California desert in general ranges from 31 to 217 miles (50 to 350 km). The NTS is considerd to be a Class II area. Las Vegas has problems with nonattainment of air quality standards for PM and CO (Bowen and Egami, 1982).

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*sulfur dioxide(SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), photochemical oxidants measured as ozone (O^3), particulate matter (PM), and lead (Pb).

The ambient noise levels in the study area are probably in the range of 20 to 30 dBA. There are no significant sources of noise now known on the study area except for the occasional helicopter and jet overflights (these may be as loud as 70 to 117 dBA) on both the NTS and Nellis AFBR. Future impact studies may reveal sensitive native wildlife species which are potentially affected by noise, particularly the increased noise levels from construction equipment, although no noise-sensitive species are currently identified in the Yucca Mountain area.

2.1.5 Topographic Influences on Weather and Pollution

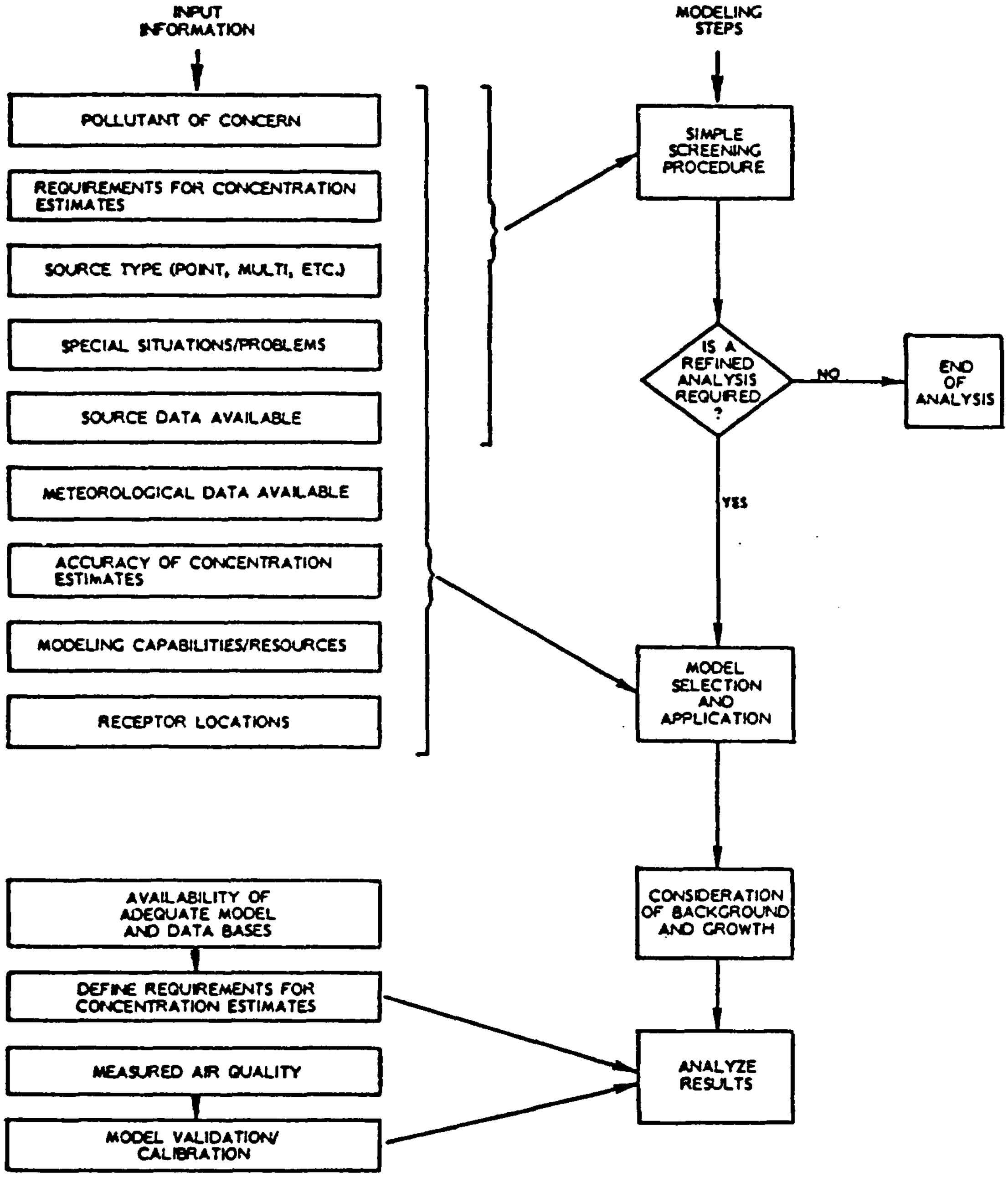
Topography influences dispersion of pollutants by changing dispersion parameters and by modifying winds and temperatures. Most terrain influence on meteorology is caused by differential heating or cooling. Air near the surface of a valley moves upslope as it is heated during the day and downslope at night as it cools. This local influence is more predominant at night when there is no insolation and the near surface motions can be decoupled from the upper air flow. The amount of local influence during the day dependes on the insolation, the strength of the upper flow, and the orientation of the terrain. In many situations, the synoptic flow and the local daytime flow reinforce each other, so that they become indistinguishable except for a possible slight direction shift. The terrain of a valley forces the winds along the axis of the valley; this causes most of the impacts from a pollution source to be along the axis as well. On higher exposed ridges or mountains, where the winds are less influenced by local effects, there is less change in speed and direction from day to night. There is also an altitude dependence of temperature. The lower elevations are warmer during the day but can be cooler at night than the higher elevations. The formation of an inversion in the valley causes poor dispersion during the night (Bowen and Egami, 1982).

Since the NTS terrain is complex and site specific meteorological and emissions data are not available yet, specific applications of a complex terrain model are premature at this time. Figure 2-1 illustrates the type of input one must have for model selection.

2.1.6 General Dispersion Conditions

Some actual dispersion data have been collected in conjunction with the various activities of the NTS. Studies of the motions of several constant volume ballons (tetroons) released from Yucca Flat over a three-day period revealed complicated vertical velocities over the NTS. Most of the tetroon flights were high above the terrain. Other research on the time rate of change of horizontal diffusion parameters associated with a nuclear debris cloud released from NTS may be applied to accidental airborne releases from a repository.

Of specific interest would be the data collected during the operation of the Nuclear Rocket Development Station (NRDS) in which downwind concentrations of radioactivity were measured at ground level at more than 62 miles (100 km) from the source. There is some evidence that for the slightly unstable conditions during the tests, the dispersion was close to that predicted by the Pasquill-Gifford dispersion parameters. The applicability of this diffusion work to the present situation is tenuous because most of the previous tests had plume rises greater than 3300 feet (1000 m). Any waste repository facility sources would be at or near ground level with little plume rise (Bowen and Egami, 1982). Plume rise would depend on temperature and vapor content of repository ventilation exhaust air.



Source: U.S. Environmental Protection Agency, 1980.

FIGURE 2-1
SELECTION AND APPLICATION OF AIR QUALITY MODELS

2.2 Background Radiation Description

The following sections provide descriptions of the background radiation levels found both onsite -- the southwestern corner of the NTS - and offsite. The offsite area of interest shown in Figure 2-2 includes the southwestern quadrant of an 80-km (50-mile) arc from Control Point 1 on the NTS. The towns of Beatty, Lathrop Wells, Ash Meadows, Pahrump, and Death Valley Junction are located within this arc.

Both onsite and offsite radiological monitoring programs have been ongoing for at least 30 years. Prior to 1954, an offsite surveillance program was conducted by the Los Alamos Scientific Laboratory and the U.S. Army. Since 1954, the U.S. Public Health Service and the U.S. Environmental Protection Agency have measured levels and trends in radioactivity in the environment. Since 1966, human surveillance programs, including individual dosimetry readings, have been conducted by the EPA's Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. Other media monitored by EPA include air, water, milk, and animals.

2.2.1 Offsite Radiation Background

The Environmental Monitoring Systems Laboratory conducts the Offsite Radiological Safety Program for the NTS and other sites designated by the Department of Energy (DOE) under an interagency agreement between DOE and EPA. Data presented in this section are those reported in 1980 from locations in the "Offsite Environmental Monitoring Report" (U.S. Environmental Protection Agency, 1981).

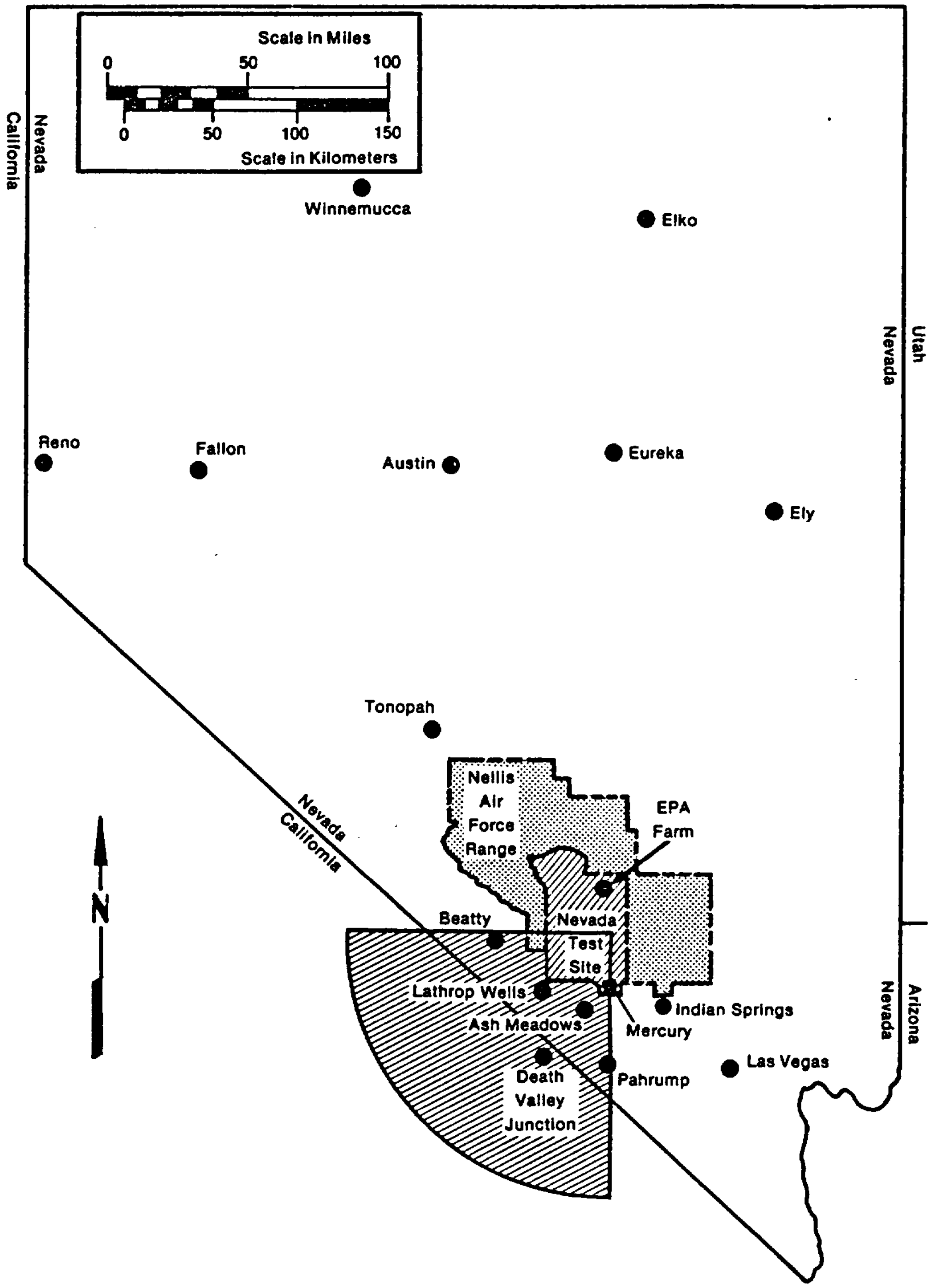


FIGURE 2-2
AREA DESCRIBED BY OFFSITE RADIOLOGICAL DATA

The Environmental Monitoring Systems Laboratory reports data from the following monitoring networks and programs which are established around the NTS:

- Air Surveillance Network
- Noble Gas and Tritium Surveillance Network
- Thermoluminescent Dosimetry (TLD) Network*
- Milk Surveillance Network
- Hydrological Monitoring Program
- Animal Investigation Program
- Human Surveillance Program

For information on sampling frequency, instrumentation, quality assurance, and more data from these monitoring programs, the reader should consult the U.S. Environmental Protection Agency (1981). The results reported herein are the 1980 data from EPA for locations within the offsite southwestern quadrant. Table 2-2 summarizes data from the first five networks listed above.

Offsite gamma radiation has been measured by a variety of methods, from the air, from a mobile NaI (Tl) detector used along Highway 95, and from the 78 stations of the Thermoluminescent Dosimetry (TLD) Network. In addition, 24 offsite residents each wore a dosimeter during 1980. Lantz (1980) reports the ambient gamma dose rate for the area south and west of the NTS to range from 4 to 20 μR/hr**. The mobile gamma detector results between Indian Springs and Beatty ranged up to 30 μR/hr, with the majority of

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*Initiated in 1971.

**μR is one millionth of a Roentgen; a Roentgen is a unit of energy defined for radiation protection purposes for people exposed to gamma radiation.

TABLE 2-2

OFFSITE SUMMARY OF 1980 EPA MONITORING NETWORKS

Network	Sample Location	Radioactivity Measured	Average Concentration (μCi/ml x 10^{-12})	Comment (a)
Air Surveillance	Beatty	Be - 7	0.14	less than 0.01% of guide
		Nb - 95	0.0038	
		Zr - 95	<0.001	
		Ru - 103	0.0037	
		I - 131	<0.001	
		Ce - 141	0.0018	
	Lathrop Wells	Be - 7	0.094	less than 0.01% of guide
		Nb - 95	0.0040	
		Zr - 95	<0.001	
		Ru - 103	0.0027	
		Te - 132	<0.001	
		Ce - 141	0.00010	
		U - 237	0.0012	
	Pahrump	Be - 7	0.19	less than 0.01% of guide
		Nb - 95	0.0015	
		Zr - 95	<0.001	
		Ru - 103	0.0013	
		Te - 132	<0.001	
		Ce - 141	<0.001	
		U - 237	<0.001	
Nobel Gas and Tritium	Beatty	Kr - 85	21	Xe and H_3 less than 0.01% of guide; Kr is 0.02% of guide
		Xe - 133	<3	
		H-3 (as HTO)	1.6	
	Lathrop Wells	Kr - 85	22	
		Xe - 133	<3	
		H-3 (as HTO)	2.5	

a) The average concentration is compared to DOE's Concentration Guide, which is given on Table 2-3.

TABLE 2-2 (CONTINUED)

OFFSITE SUMMARY OF 1980 EPA MONITORING NETWORKS

Network	Sample Location	Radioactivity Measured	Dose Rate (mrem/yr)	Comment (a)
Dosimetry (TLD)	Beatty[b]	gamma	95	56% of guide
	Lathrop Wells	gamma	95	56% of guide
	Spring Meadows	gamma	62	36% of guide
	Valley Crest	gamma	59	35% of guide
	Furnace Creek	gamma	65	38% of guide
	Pahrump	gamma	62	36% of guide
	Death Valley Junction	gamma	77	45% of guide

a) DOE guide is 170 m rem/yr for population in an uncontrolled area offsite.
b) Nuclear workers at Nuclear Engineering Co. near Beatty receive 120 mrem/yr.

TABLE 2-2 (CONCLUDED)

OFFSITE SUMMARY OF 1980 EPA MONITORING NETWORKS

Network	Sample Location (a)	Radioactivity Measured	Average Concentration ($\mu Ci/ml \times 10^{-9}$)	Comment (b)
Milk Surveillance	Pahrump	Sr - 89	<3	less than 0.97% of guide
	Oxborrow Ranch	Sr - 90	2.9	
Long-Term Hydrological	Ash Meadows	tritium	10	less than 0.01% of guide
	Crystal Pool	tritium	<10	
	Ash Meadows	tritium	70	
	Well 18 S	tritium	18	
	Ash Meadows	-		
	Well 17 S	tritium	<10	
	Ash Meadows	tritium	< 9	
	Fairbanks Spring	tritium	<10	
	Beatty City Well	tritium	<10	less than 0.01% of guide
	Beatty Well	tritium	12	
	Coffers Well	tritium	<10	
	Lathrop Wells	tritium	< 9	less than 0.01% of guide
	City Supply	tritium	<10	
	Pahrump/Calvada	tritium	<20	

Source: U. S. Environmental Protection Agency, 1981.

a) Locations selected within the 80-km arc, southwestern quandrant, offsite samples.
b) Concentration Guide is DOE's recommended exposure to sample of population in an uncontrolled area for offsite.

samples being less than 20 μR/hr. This rate is similar to Nevada background rates reported from 1975 to 1979 by Myrick et al. (1980). Table 2-2 shows the dose rate for 1980 from eight locations within the offsite area. Those rates ranged from 59 mrem/yr in Valley Crest to 95 mrem/yr at Beatty and Lathrop Wells. The DOE guideline for a population whole body dose in an uncontrolled area is 170 mrem/yr (19 μrem/hr).* Table 2-4 shows the average dose rates since the TLD Network was established in 1971. There has been a consistent downward trend in the average radiation dose rate with a gradual leveling off over the last few years. The trend shown by the TLD Network average is indicative of the trend exhibited by individual stations, suggesting that the elevated values in the early seventies may have been associated with international weapons test programs. Data for individual stations and resident data are tabulated in the EPA annual reports for specific years. During 1980, none of the residents' personal dosimeters showed any exposures in excess of background.

Table 2-2 also shows the radionuclides found in air samples taken at Beatty, Lathrop Wells, and Pahrump. Results are given for the average concentrations of Be-7, Nb-95, Zr-95, Ru-103, I-131, Te-132, Ce-141, and U-237 from the EPA Air Surveillance Program in 1980. DOE concentration guides are given on Table 2-3. The average concentration is given for each radionuclide; all averages are less than 0.01 percent of the applicable DOE concentration guide.

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*ERDA Chapter 0524 allowable whole body annual dose for population in uncontrolled area.

TABLE 2-3

DOE CONCENTRATION GUIDE

Network	Sampling Medium	Radio-Nuclide	CG* (μCi/ml)	Basis of Exposure
Air Surveillance Network	air	^{7}Be	1.1×10^{-8}	Suitable sample of the exposed population in uncontrolled area.
		^{95}Zr	3.3×10^{-10}	
		^{95}Nb	1.0×10^{-9}	
		^{99}Mo	2.3×10^{-9}	
		^{103}Ru	1.0×10^{-9}	
		^{131}I	3.3×10^{-11}	
		^{132}Te	1.3×10^{-9}	
		^{137}Cs	1.7×10^{-10}	
		^{140}Ba	3.3×10^{-10}	
		^{140}La	1.3×10^{-9}	
		^{141}Ce	1.7×10^{-9}	
		^{144}Ce	6.7×10^{-10}	
		^{239}Pu	3.3×10^{-13}	
Noble Gas and Tritium Surveillance Network, On-NTS	air	^{85}Kr	1.0×10^{-5}	Individual in controlled area.
		^{3}H	5.0×10^{-6}	
		^{133}Xe	1.0×10^{-5}	
		^{135}Xe	1.0×10^{-5}	
Noble Gas and Tritium Surveillance Network, On-NTS	air	^{85}Kr	1.0×10^{-7}	Suitable sample of the exposed population in uncontrolled area.
		^{3}H	6.7×10^{-8}	
		^{133}Xe	1.0×10^{-7}	
		^{135}Xe	1.0×10^{-7}	
Long-Term Hydrological Program	water	^{3}H	3.0×10^{-3}	Individual in a controlled or an uncontrolled area.
		^{89}Sr	3.0×10^{-6}	
		^{90}Sr	3.0×10^{-7}	
		^{137}Cs	2.0×10^{-5}	
		^{226}Ra	3.0×10^{-8}	
		^{234}U	3.0×10^{-5}	
		^{235}U	3.0×10^{-5}	
		^{238}U	4.0×10^{-5}	
		^{238}Pu	5.0×10^{-6}	
		^{239}Pu	5.0×10^{-6}	

* This table of concentration guides (CG's) is from the DOE Manual, Chapter 0524, "Standards for Radiation Protection." All values are annual average concentrations.

TABLE 2-4

TRENDS OF DOSIMETRY NETWORK DATA FOR THE YEARS 1971-1981

	Environmental Radiation Dose Rate (mrem/y)		
Year	Maximum	Minimum	Average
1971	250	102	160
1972	200	84	144
1973	180	80	123
1974	160	62	114
1975	140	51	94
1976	140	51	94
1977*	170	60	101
1978	150	50	95
1979	140	49	92
1980	140	51	90
1981	142	40	90

Source: U.S. Environmental Protection Agency, 1982.

*Mechanical readout problem in 1977.

The Noble Gas and Tritium Surveillance Network is used to measure airborne levels of krypton-85, xenon-133, and tritium. Data are shown in Table 2-2 for Beatty, Lathrop Wells, and Mercury; krypton-85 at all three sites is 0.02 percent of the DOE concentration guide (Table 2-3), while xenon-133 and tritium are less than 0.01 percent of the concentration guide.

The Air Surveillance Program also measures plutonium in the air; specifically, the 1980 results in Lathrop Wells indicated Pu-238 at less than 3×10^{-18} µCi/ml and Pu-239 at 10×10^{-18} µCi/ml, both less than 0.01 percent of the DOE concentration guide (U.S. Environmental Protection Agency, 1981).

Table 2-2 also shows the results of milk sampling for radiostrontium at the Oxborrow Ranch near Pahrump. Both Sr-89 and Sr-90 are less than 0.97 percent of the concentration guide.

The Long-Term Hydrological Monitoring Program samples wells, springs, and surface water at offsite locations near the NTS (Figure 2-3). Monthly and semi-annual samples are analyzed for gamma emitters and tritium. Table 2-2 shows the 1980 tritium levels for 14 samples taken in the NNWSI study area. The average concentration of tritium ranges from less than 9×10^{-9} µCi/ml to 70×10^{-9} µCi/ml in Ash Meadows. These averages are less than 0.01 percent of the DOE concentration guide (U.S. Environmental Protection Agency, 1981).

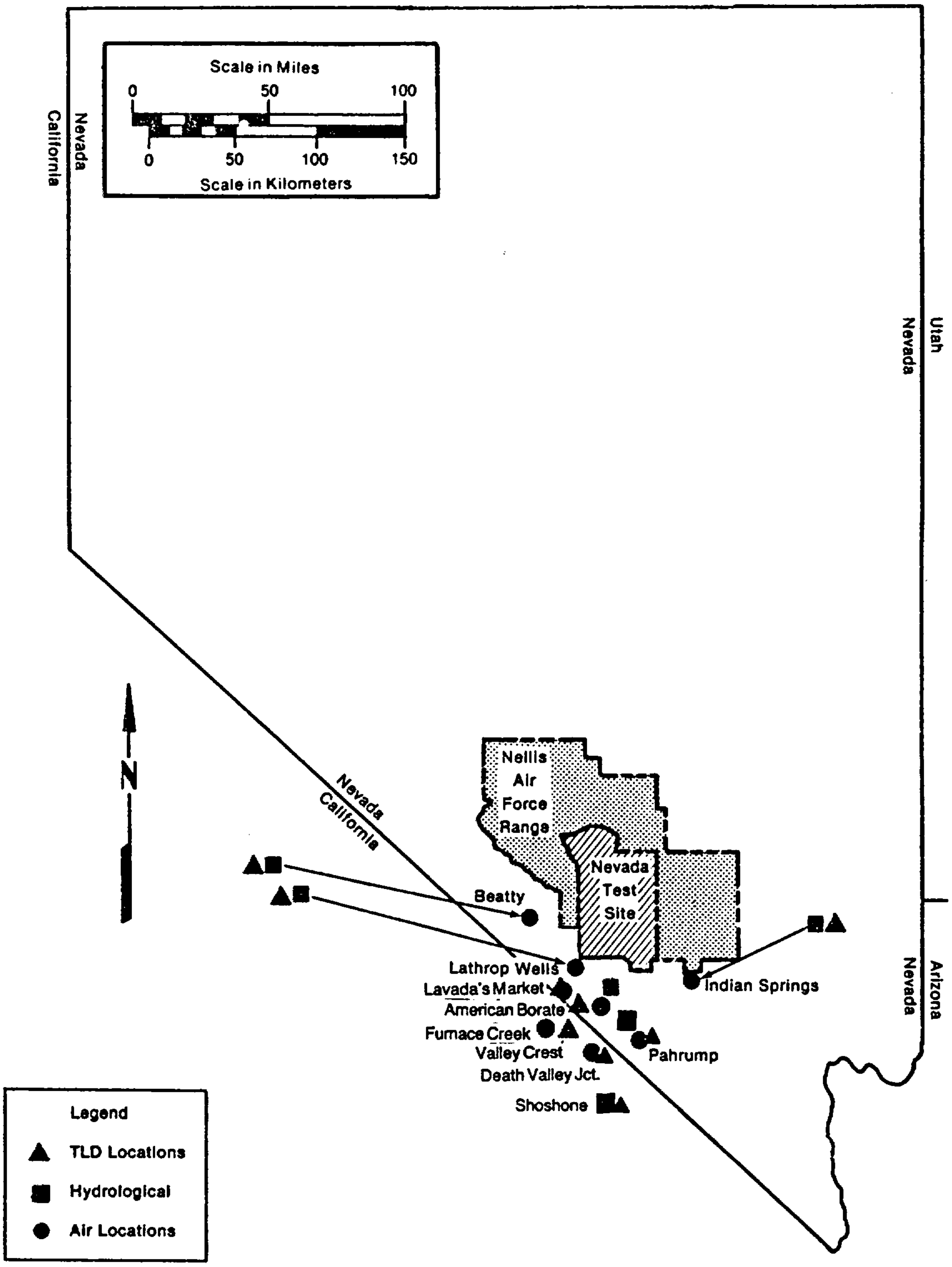

FIGURE 2-3
OFFSITE RADIOLOGICAL MONITORING STATIONS

The EPA also maintains an Offsite Human Surveillance Program, with a total sample of 652 whole-body counts and low energy radiation measurements from 45 individuals (offsite employees and families). Small amounts of cesium-137 were found in the population, but were similar to other regions of the U.S. (Patzer, 1981). No plutonium was detected. Tritium in urine averaged 5×10^{-7} µCi/ml, and varied seasonally (U.S. Environmental Protection Agency, 1981). There were no abnormal results reported from blood or thyroid testing. The only radioactivity detected in an offsite populated area was from xenon-133 and -135 at Lathrop Wells, with a calculated 11 µrem whole body dose.

2.2.2 Onsite Radiation Background

Scoggins (1982) provides results of the onsite NTS radiological surveys, including three aerial surveys, an Area 25 Radiation Survey, and the data from the Reynolds Electrical and Engineering Company environmental surveillance network. These sampling locations, which are shown in Figure 2-4, include the southwestern corner of the NTS.

The natural gamma background rate for the NNWSI ranges from 11 to 20 µR/hr at three feet above the ground (Lantz, 1980). Figure 2-4 shows the location of the E-MAD facilities and monitoring stations north of this area, which were cleaned to soil levels of less than 1×10^{-5} µCi/g. The general exposure rate in this area is presently in the range of 18 to 22 µR/hr (Scoggins, 1982).

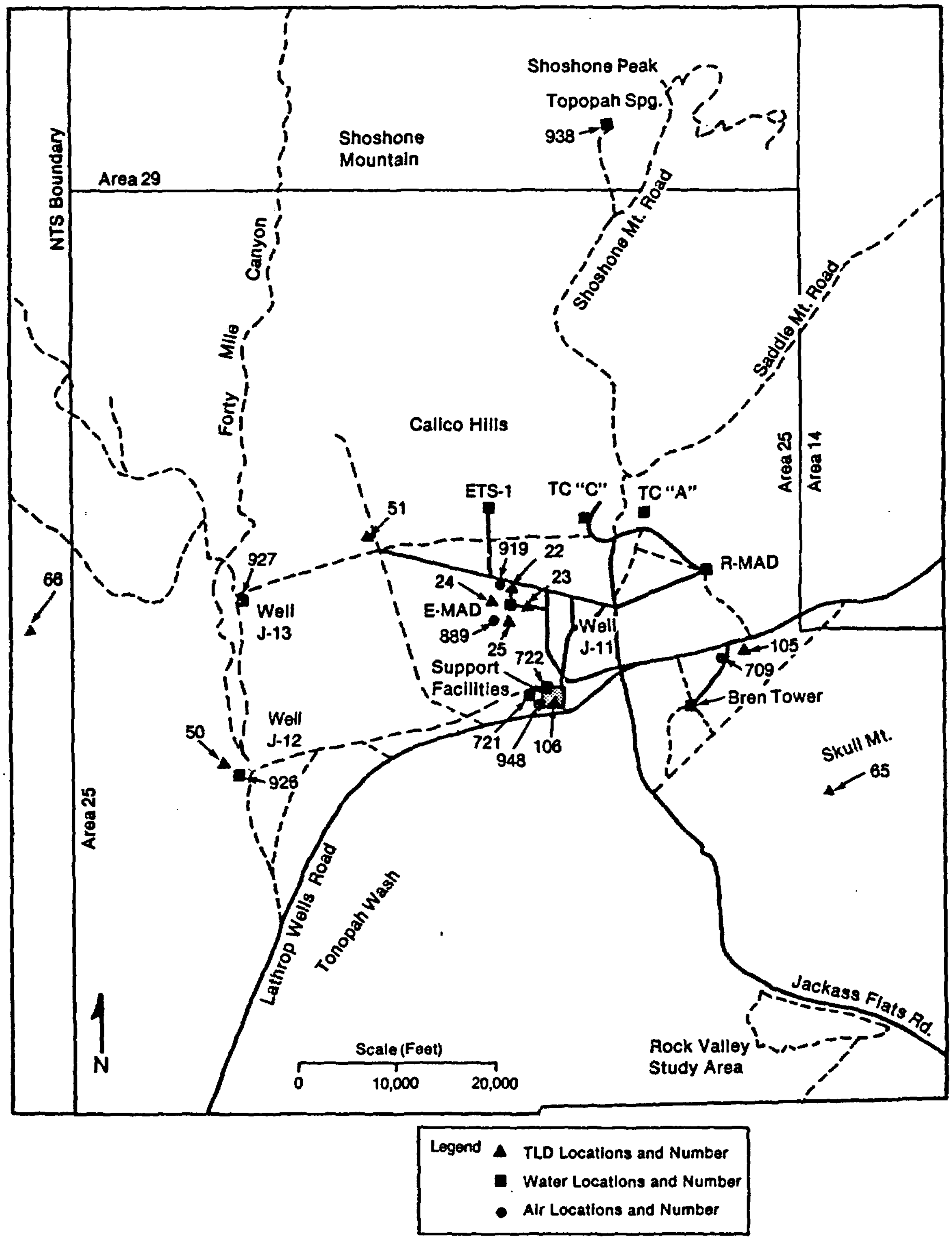

FIGURE 2-4
ONSITE RADIOLOGICAL MONITORING STATIONS

Table 2-5 presents the gamma monitoring results for 1979-1980 at nine locations onsite, as well as the Yucca and Fortymile locations offsite. These dose rates range from a low of 10 to 20 μrem/hr at Skull Mountain to a high of 30 to 40 μrem/hr north of the E-MAD (station 22 on Figure 2-4) at a pad contaminated during previous nuclear rocket development activities on the NTS.

Table 2-6 presents the air sampling data for gross beta and plutonium (Pu-239) at four onsite locations. Gross beta in air ranged from a high of 19.4×10^{-14} μCi/cc to a low of 1.4×10^{-14} μCi/cc of air. Normal background gross beta activity on the NTS (except when modified by foreign atmospheric testing) is approximately 2.0×10^{-14} μCi/cc (Scoggins, 1982).

Table 2-7 summarizes the six-year data on gross beta activity in water samples from the southwestern NTS. Tritium and plutonium-239 levels are generally below detection limits. The gross beta activity in water on the NTS are mainly from potassium-40 concentrations in water (Scoggins, 1982). In 1980, gross beta ranged between 4.6×10^{-9} μCi/ml at Well J-12 to 5.9×10^{-9} μCi/ml at Well J-11 and Topopah Springs.

TABLE 2-5

NTS ENVIRONMENTAL SURVEILLANCE GAMMA MONITORING RESULTS

Sample Location and Number	Dose Units	1979	1980
E-MAD NORTH 22	mrem/d μrem/h	0.71 30	0.97 40
E-MAD EAST 23	mrem/d μrem/h	0.31 13	0.34 14
E-MAD WEST 24	mrem/d μrem/h	0.33 14	0.35 15
E-MAD SOUTH 25	mrem/d μrem/h	0.34 14	0.33 14
24-4P 50	mrem/d μrem/h	0.33 14	0.38 16
27-7P 51	mrem/d μrem/h	0.44 14	0.37 15
SKULL MOUNTAIN 65	mrem/d μrem/h	0.24 10	0.29 12
WEST OF 40-MILE CANYON 66	mrem/d μrem/h	0.37 15	0.43 18
YUCCA MOUNTAIN 67	mrem/d μrem/h	0.38 16	0.44 18
HENRE SITE 105	mrem/d μrem/h	0.33 14	0.35 15
NRDS WAREHOUSE 106	mrem/d μrem/h	0.33 14	0.35 15

Source: Scoggins, 1982.

TABLE 2-6

NTS ENVIRONMENTAL SURVEILLLANCE AIR SAMPLE DATA[a]

Sample Location and Number	Type of Analysis	1975	1976	1977	1978	1979	1980
E-MAD SOUTH 889	Gross β (x10^{-14} μCi/cc) Pu-239 (x10^{-17} μCi/cc)	-- --	-- --	-- --	7.9 7.5	3.3 1.8	3.8 2.9
HENRE SITE 709	Gross β (x10^{-14} μCi/cc) Pu-239 (x10^{-17} μCi/cc)	11.9 3.3	2.5 1.4	19.4 7.0	10.7 6.3	3.5 2.3	3.7 3.7
E-MAD NORTH 919	Gross β (x10^{-14} μCi/cc) Pu-239 (x10^{-17} μCi/cc)	-- --	-- --	-- --	8.3 6.0	3.6 1.8	3.8 3.2
WAREHOUSE #1 948	Gross β (x10^{-14} μCi/cc) Pu-239 (x10^{-17} μCi/cc)	9.2 5.7	2.3 3.0	16.8 3.3	10.5 7.4	3.5 2.0	3.7 2.0

Source: Scoggins, 1982.

[a] Fluctuation attributed to foreign atmospheric testing.

TABLE 2-7

NTS ENVIRONMENTAL SURVEILLANCE
GROSS BETA IN WATER DATA ($\times 10^{-9}\ \mu$Ci/ml)

Sample Location and Number	1975	1976	1977	1978	1979	1980
WELL J-11 RES 721	--	--	--	--	5.0	5.9
SERVICE STATION 722	--	--	--	--	5.0	5.1
WELL J-12 926	4.4	--	5.6*	--	5.2	4.6
WELL J-13 927	6.2	5.6	6.7	5.3	5.1	5.3
TOPOPAH SPRINGS 938	17.6	13.7	14.6	6.3	6.3	5.9

Source: Scoggins, 1982.

*Average concentration for the entire period of 1976-1978.

2.3 Hydrosphere

2.3.1 Hydrological Knowledge and Data

This secton presents a brief description of the general hydrology of the study area including groundwater resources, hydrometeorology, and surface water resources. Field exploration and research of the hydrogeologic conditions in the NNWSI study area is being conducted by the U.S. Geological Survey as a major scientific effort for the repository site exploration.*

2.3.1.1 Groundwater. The hydrology of southern Nevada and the NTS is a natural system which is at present only partially understood. Geological and hydrological studies of the NTS have been in progress by the U.S. Geological Survey and various other organizations since 1957 when the first of a series of underground nuclear explosions were detonated. These studies have been undertaken to gain an understanding of the hydrology and subsurface geology of the area and to evaluate the potential for radionuclide contaminatin of groundwater in and near the Test Site. A wealth of information has been collected by the U.S. Geological Survey during these investigations and, therefore, this report only provides a brief summary of these historic results.

The geology of the NNWSI study area is complex, a characteristic shared by much of the Basin and Range province where this area is located. The geologic strata present consist of up to

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*Separate reports are being prepared by the U.S.G.S.

37,000 feet (11,300 m) of Paleozoic quartzites, shales, and carbonate rocks which were deformed during two compressional mountain building episodes in the Mesozoic Era (135 to 225 million years ago). These materials are overlain by several thousand feet of volcanic deposits, e.g., tuff, lava, and basalt, which are in turn overlain by accumulated alluvial deposits in most of the lower lying areas in the region. Yucca Mountain, for example, is underlain by approximately 6000 feet (1800 m) of interbedded, welded and non-welded, volcanic tuff materials whose thermal and chemical characteristics appear to be favorable for a geologic repository.

To help simplify the complex geology of the NTS, Winograd and Thordarson (1975) have grouped the numerous geologic formations and members into ten units of hydrologic significance in order of decreasing geologic age (Table 2-8). Six of these are geologic formations or structures that transmit water in sufficient quantities to supply water needs (aquifers), while the remainder are rock units with relatively low permeability that retards the flow of water (aquitards). As noted in Table 2-8, the geologic and hydraulic properties of the aquifers vary widely. The lower and upper carbonate aquifers and the welded tuff aquifer store and transmit groundwater chiefly through secondary openings along fractures. The bedded-tuff and the valley-fill aquifers store and transmit water chiefly through primary or interstitial openings. Of

TABLE 2-8

CHARACTERISTICS OF HYDROGEOLOGY UNITS IN THE VICINITY OF THE NNWSI STUDY AREA

Hydrologic Unit	Saturated Thickness feet (meters)	Depth to Static Water Level feet (meters)	Major Lithology	Water Bearing Characteristics[a]
Valley-fill aquifer	156 - 511 (48 - 156)	114 - 714 (35 - 218)	Alluvial fan, fluvial, fanglomerate, lakebed, & mudflow deposits	Coefficient of transmissibility ranges from 1,000 to 35,000 gpd per ft; saturated only beneath structurally deepest parts of Yucca Flat & Frenchman Flat.
Lava-flow aquifer	111 - 179 (34 - 55)	1039 (317)	Basalt and rhyolite flows	Water movement controlled by primary (cooling) and secondary fractures; estimated coefficient of transmissibility ranges from 500 to 10,000 gpd per ft; saturated only beneath east-central Jackass Flats.
Welded-tuff aquifer*	146 - 547 (45 - 167)	741 - 1507 (226 - 459)	Ash-flow tuff, non-welded to densely welded	Water movement controlled by primary and secondary joints; coefficient of transmissibility ranges from 100 to 100,000 gpd per ft; saturated only beneath structurally deepest parts of Yucca, Frenchman, and Jackass Flats.
Bedded-tuff aquifer	115 - 195 (35-60)	490 - 1569 (149 - 478)	Ash-fall tuff and	Coefficient of transmissibility ranges from 200 to 1,000 gpd per ft; saturated only beneath structurally deepest parts of Yucca Flat.

*Yucca Mountain is underlain by some saturated tuffs which are not of aquifer significance.

TABLE 2-8 (Continued)

CHARACTERISTICS OF HYDROGEOLOGIC UNITS IN THE VICINITY OF THE NNWSI STUDY AREA

Hydrologic Unit	Saturated Thickness feet (meters)	Depth to Static Water Level feet (meters)	Major Lithology	Water Bearing Characteristics[a]
Lava-flow aquitard	NA	NA	Lava-flow and interflow tuff and breccia; locally hydrothermally altered	Water movement controlled by poorly connected fractures; coefficient of transmissibility estimated less than 500 gpd per ft; contains minor perched water in foothills between Frenchman Flat and Jackass Flats.
Tuff aquitard	1000-1500(305-457)	NA	Ash-fall tuff, nonwelded to welded, rhyolite, sandstone, silstone, and claystone	Coefficient of transmissibility ranges from 100 to 200 gpd per ft; perches minor quantities of water beneath foothills flanking valleys; fully saturated only beneath structurally deepest parts of Yucca Flat, Frenchman Flat and Jackass Falts.
Upper carbonate aquifer	NA	NA	Limestone	Completely fractured aquifer, coefficient of transmissibility estimated in range from 1,000 to 100,000 gpd per ft. saturated only beneath western one-third of Yucca Flat.

TABLE 2-8 (Concluded)

CHARACTERISTICS OF HYDROGEOLOGIC UNITS IN THE VICINITY OF THE NNWSI STUDY AREA

Hydrologic Unit	Saturated Thickness feet (meters)	Depth to Static Water Level feet (meters)	Major Lithology	Water Bearing Characteristics[a]
Upper clastic aquitard	NA	NA	Argillite, quartzite conglomerate, limestone.	Completely fractured but nearly impermeable; coefficient of transmissibility estimated less than 500 gpd per ft; saturated only beneath western Yucca Flat and Jackass Flats.
Lower carbonate aquifer	110 - 872 (34 - 266)	737 - 2,055 (225 -626)	Limestone, dolomite, quartzite, claystone, and shale.	Complexly fractured aquifer which supplies major springs throughout easter Nevada; coefficient of transmissibility ranges from 1,000 to 1,000,000 gpd per ft; saturated much of this area.
Lower clastic aquitard	NA	NA	Quartzite, siltstone, sandstone, and dolomite.	Complexly fractured but nearly impermeable; supplies no major springs; coefficient of transmissibility less than 1,000 gpd per ft; saturated beneath most of study area.

Source: Winogard and Thordarson, 1975.

[a] Coefficient of transmissibility is a measure of the rate or flow of groundwater, at the prevailing temperature, through a vertical strip of aquifer one foot wide with a height equal to the saturated thickness of the aquifer and under a unit hydraulic gradient. The figures reported, in terms of gallons per day per foot (gpd per ft.) were calculated by the authors using available pumping test data in the NTS and vicinity.

[b] Data unavailable or not reported.

the six aquifers listed in Table 2-8, the lower carbonate and the valley-fill aquifers have been found to have the widest areal distribution and are the principal aquifers within the NTS area (Winograd and Thordarson, 1975).

Groundwater movement within the NTS has been classified as follows: (1) movement of perched water, (2) intrabasin movement of water, and (3) interbasin movement of water.

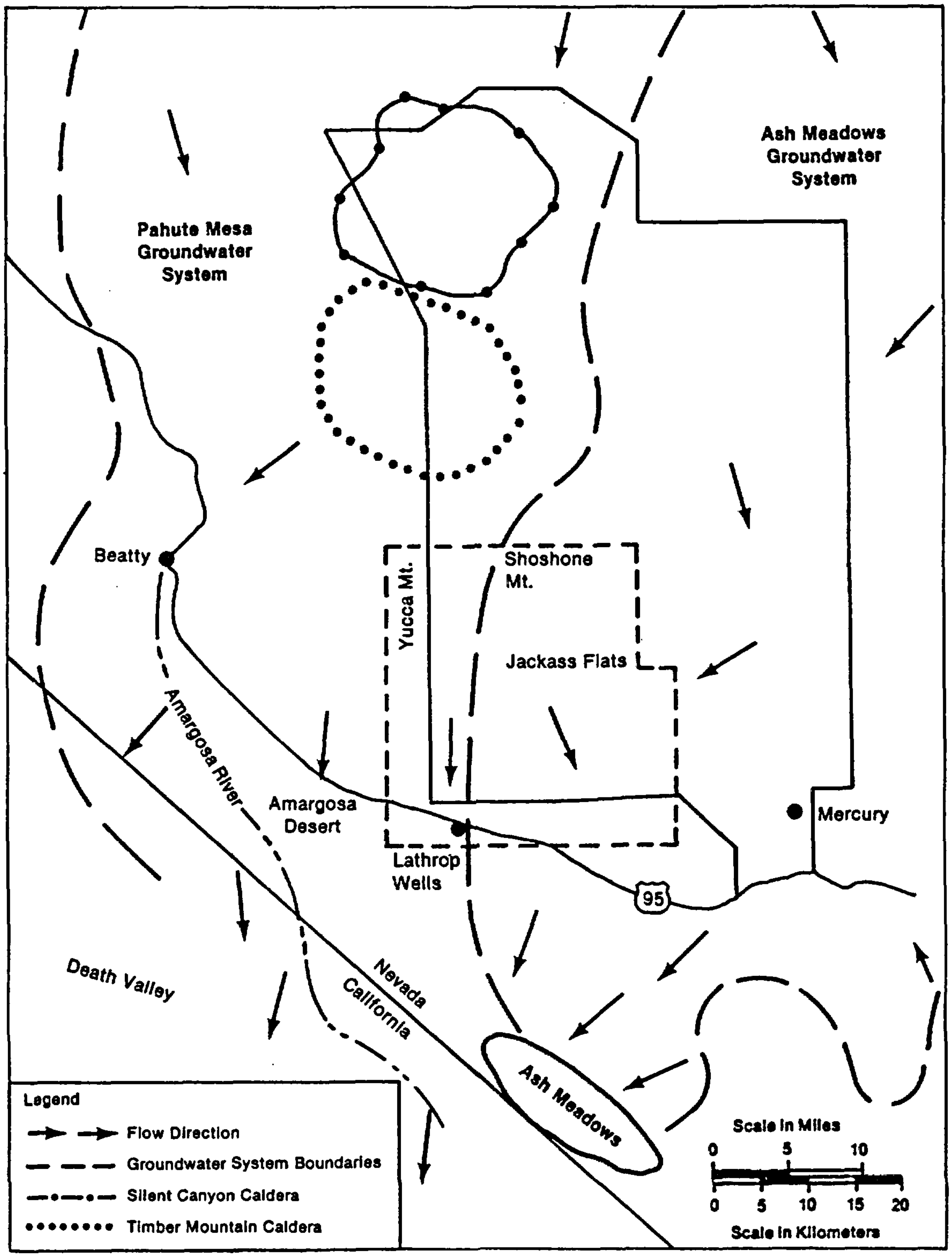
Perched groundwater at the NTS is believed to occur principally within the aquitards underlying ridges, namely within the tuff and lava-flow aquitard. According to Winograd and Thordarson (1975), the occurrence of perched water on the NTS can be summarized as follows:

- Perched water usually occurs at shallow depths (80-400 feet or 20-120 m) where tuff, lava flow, or granitic aquitards occur at or near the ground surface.
- When the aquitard is far below the ground surface, the perched water table is also deep (500-1400 feet or 150-430 m).
- When the top of the aquitard is at high altitude, the perched water table is also at a high altitude.
- Local precipitation apparently has no significant effect on the vertical position of the perched water table.

The movement of water between the aquifers and aquitards beneath a valley is termed intrabasin movement of groundwater. In Yucca Flat and Frenchman Flat, the movement of water is believed to be toward the lower carbonate aquifer. In the Indian Springs Valley and the Southern Amargosa Desert, this intrabasin movement has been reported to occur upward from the lower carbonate aquifer into the younger hydrogeologic units (Winograd and Thordarson, 1975).

Movement of groundwater over wide areas is also believed to occur in the study area principally because of the widespread occurrence of the lower carbonate aquifer beneath most of the valleys and ridges in the region. This regional movement of groundwater is termed interbasin, since it serves to integrate the several intermontane valleys in the area and appears not to be influenced by topographic features. Evidence for interbasin movement of groundwater at the NTS from hydraulic, geochemical, and isotopic studies appears strong.

It has been suggested that two major hydrologic systems, the Ash Meadows and Pahute Mesa groundwater basins as shown in Figure 2-5, underlie the NTS, although this hypothesis is still largely unproven. A revised hydrologic model under development by the U.S. Geological Survey is based on current studies for the NNWSI. It is possible that there is only a single, large regional groundwater basin. Few reliable estimates of groundwater flow velocity are available for the NTS region. Furthermore, the recharge areas of these flow systems are also poorly defined. Groundwater in the northwestern part of the NTS, or in the Pahute Mesa area, flows to the south and southwest into the Amargosa Desert and possibly as underflow to Death Valley. It is estimated that the groundwater beneath Specter Range (see Figure 1-2) on the NTS moves from north



Source: U.S. Environmental Protection Agency, 1981.

FIGURE 2-5
GROUNDWATER FLOW SYSTEMS

to south at a rate of 2 to 200 feet (0.6 to 60 m) per day. Carbon-14 analyses indicate that the lower velocity is nearer the true value (Winograd and Thordarson, 1975). Under Mercury Valley at the extreme southern part of the NTS, the eastern groundwater flow shifts southwestward towards the Ash Meadows Discharge area (Naff et al., 1974).

2.3.1.2 Hydrometeorology. Precipitation over the NNWSI study area and the rest of southern Nevada varies markedly with the season, and most precipitation falls during the winter and summer months. The amount of water precipitation is dependent on the tracks of major storms carried inland from the Pacific over the Sierra Nevada range. Consequently, there can be large variations in the amount of winter rainfall from year to year (Bowen and Egami, 1981). The summer precipitation, on the other hand, occurs as thunderstorms which can vary in intensity from one location to another and from one storm to the next.

There is an extensive system of rain gauges on the Nevada Test Site to measure precipitation; the locations of these gauges, some of which have been operating for as long as 20 years, are shown in Figure 2-6.

Studies of Southern Nevada precipitation by Quiring (1979) show that elevation is a major factor affecting differences in the amounts of precipitation at different locations within the NNWSI study area due to the amount of orographic lifting involved. Higher

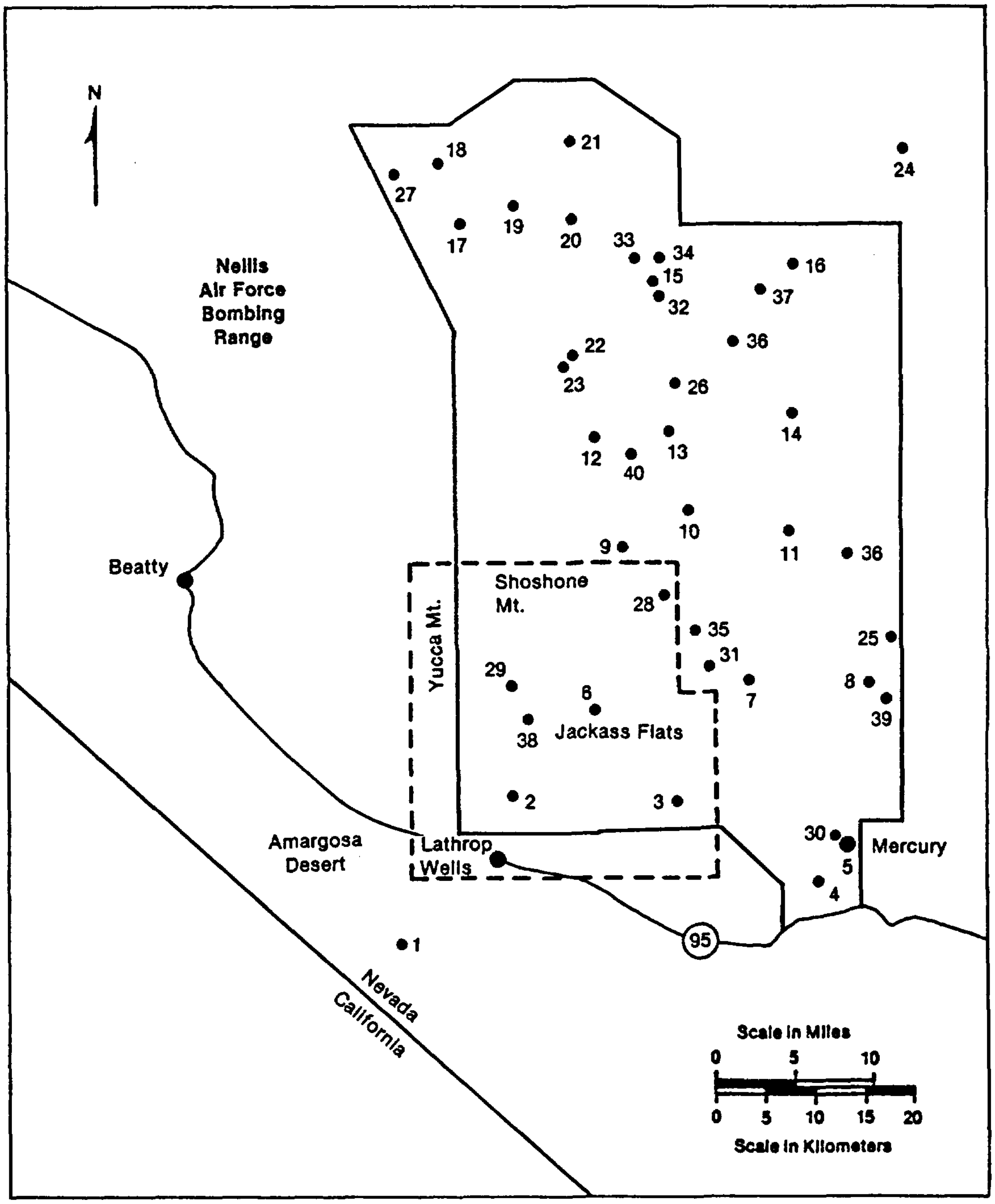


FIGURE 2-6
LOCATION OF NTS RAIN GAGES

terrain will cause more condensation in the clouds and thus more overall precipitation for those locations. As an example, Station 2 with an elevation of 2840 feet (865 m) has had an average annual precipitation of 3.6 inches (9.1 cm). Station 15 with an elevation of 7490 feet (2285 m) has averaged 12.2 inches (31 cm) per year. Quiring (1979) reported that elevation accounted for 95 percent of the variance in precipitation probability.

The large amount of precipitation that can occur during winter and summer storms can lead to flash flooding in low-lying portions of the study area. As with the normal amounts of precipitation these extreme values also have an altitude dependence. Thomas et al. (1970) has determined the greatest 24-hour precipitation for storms occuring at different frequencies at precipitation stations in Nevada. Table 2-9 presents data for selected stations in the vicinity of the NNWSI study area. As indicated by Bowen and Egami (1982), the Beatty results should be indicative of the lower elevations in the study area, with the Goldfield results being more representative of extremes in precipitation at the higher elevations. In most cases, thunderstorm precipitation will fall for much less than 24-hours duration, oftentimes in periods closer to an hour. The higher rainfall rates for these larger size storms, i.e., those occuring once in every 50 or 100 years, is much more typical of those resulting in flash floods in the study area.

TABLE 2-9

GREATEST 24-HOUR PRECIPITATION FOR STATIONS IN THE VICINITY OF NNWSI STUDY AREA

Station	Elevation (meters)	Inches of Rainfall From Storms Occurring at Different Frequencies[a] (years)					
		2	5	10	25	50	100
Las Vegas	659	0.84	1.33	1.65	2.07	2.39	2.69
Beatty	1010	0.88	1.29	1.57	1.91	2.17	2.43
Goldfield	1734	1.03	1.60	1.99	2.46	2.84	3.19

Source: Thomas et al., 1970.

[a] Greatest levels of precipitation associated with storms occurring at different yearly frequencies. A 100-year storm means the highest level of rainfall that, on the average, is likely to occur every 100 years, i.e., that has a 1 percent chance of occurring each year.

2.3.1.3 Surface Water. No large, perennial or intermittent streams are currently found in the vicinity of the study area, although the dry Amargosa River may be intermittent for a short reach near Beatty, Nevada. Surface water in the study area is confined mainly to discharges from the underlying aquifer, as are the major springs at Ash Meadows. Thirty springs emerge at Ash Meadows, including Devils Hole, in a ten-mile (16-km) stretch with an average annual aggregate discharge of about 17,100 acre-feet (21 million m^3). Some of these springs have greater than 15-foot (4.6-m) deep pools and range from a few feet to 30 feet (9 m) in diameter. Heat gradients, temperature of the water, and its chemical quality (ranging from 640 to 750 micromhos per cm at 25°C) suggest that the water emerging from these springs is derived from upward leakage from the lower carbonate aquifier (Winograd and Thordarson, 1975).

There have been few surface water studies on the runoff from flash flooding performed in the NTS area. To date only one such study has been completed. Christensen and Spahr (1980) have applied a multiple regression flood model to the Topopah Wash area on the eastern part of Jackass Flats. Data from 71 gauged watersheds were used to develop the regression equations shown in Table 2-10, although only 19 of these watersheds were located in arid southern Nevada and none are located in the study area. The primary variables in this model are drainage area of the watershed, elevation, and latitude.

TABLE 2-10

CHRISTENSEN AND SPAHR FLASH FLOOD MODEL

Frequency of Storm[a] (years)	Flow Equation	Range of Applicability
10	$Q^b = 392\ A^{0.66}\ E^{-1.02}\ L^{-0.33}$	$0.2 < A^c < 100$
25	$Q = 1810\ A^{0.61}\ E^{-1.14}\ L^{-0.70}$	$2 < E^d < 10$
50	$Q = 4860\ A^{0.58}\ E^{-1.21}\ L^{-0.94}$	$1 < L^e < 7$
100	$Q = 11900\ A^{0.55}\ E^{-1.28}\ L^{-1.16}$	

[a] A 100-year flood is one that is reasonably expected to strike once in a 100 years. There is a 1 percent chance that it might occur in any year, although a 100-year flood may occur two or three times within any 100-year period.

[b] Q is the quality of the flow, in cubic feet per second.

[c] A is the size of the drainage area, mi^2.

[d] E is mean basin altitude, in thousands of feet.

[e] L is latitude of basin minus 35°.

Source: Christensen and Spahr, 1980.

2.3.2 Water Supplies and Utilization

2.3.2.1 Municipal and Domestic Demands. In general, the small communities within the vicinity of the NNWSI study area currently do not have public water supply or waste water treatment plants. By and large, these communities are unincorporated and, thus, are governed by the appropriate county commissions. The primary communities in the study area are Indian Springs, Beatty, Mercury, Lathrop Wells, Death Valley Junction, and Pahrump. Figure 3-1 locates these communities relative to the NNWSI study area.

Table 2-11 summarizes data from French et al., (1981) who found that drinking water is supplied by domestic and municipal wells, and sewage treatment is by evaporation ponds and septic tanks for these communities. Most residents of farms, ranches, and single-family dwellings still obtain their domestic supplies of drinking water from private wells. The quantity and quality of water pumped from these wells is unknown. Likewise, these residents use individual septic tanks and disposal systems rather than a community-wide sewer system. There is a concern, therefore, that shallow wells are being polluted by septic contamination due to the high percolation rates of most soils in the region.

At the present time, the size of municipal and private utility systems in most communities in the study area appears adequate for current and future population levels, although it is doubtful that

TABLE 2-11

MUNICIPAL AND DOMESTIC WATER SUPPLY AND WASTE WATER TREATMENT SYSTEMS IN THE VICINITY OF THE NNWSI STUDY AREA

Community	Estimated Population	Source of Supply	Waste Water Disposal	Planned Water Supply and Waste Water Disposal Improvements	Potential Development In Area Requiring Additional Water Supplies and Waste Treatment Facilities
Indian Springs, Nevada	912	Municipal well capable of supplying 0.8 mgd[b] to 53 customers in addition approximately 80 domestic wells whose quantity is unknown.	Waste water from sewers discharged to evaporation ponds presently covering 7 acres.	An additional municipal water supply well.	State correctional facility south of community.
Beatty, Nevada	900	Two municipal wells supplying 250 customers; third well is source of water for industry.	Waste water from sewers discharged to evaporation ponds.	New well at Indian Spring, believed to be out-crop of regional carbonate acquifer.	Expansion of mine operations in local area.
Indian Springs Air Force Base, Nevada	500	Two wells supplying 0.2[b] mgd potable water for base.	Imhoff tank to separate solid wastes; solids pumped to sludge pits	No improvements planned.	No plans for expansion or closure of base.
Pahrump, Nevada	1,358	Most residents obtain water from domestic wells 70 feet deep.	Septic tanks	Expansion of service outside Calvada development.	Development of 100,000 lots sold in Pahrump Valley.
Ash Meadows, Nevada	2,235	N.A.[a]	N.A.	Expansion of service outside of Calvada development.	Development of 25,000 lots in planned community by 1997.
Lathrop Wells, Nevada	65	Residents obtain from domestic wells 320 feet deep.	Septic tanks	N.A.	No development is planned although employment levels at NTS can have definite effect.

TABLE 2-11 (Concluded)

MUNICIPAL AND DOMESTIC WATER SUPPLY AND WASTE WATER TREATMENT SYSTEMS IN THE VICINITY OF THE NNWSI STUDY AREA

Community	Estimated Population	Source of Supply	Waste Water Disposal	Planned Water Supply and Waste Water Disposal Improvements	Potential Development in Area Requiring Additional Water Supplies and Waste Treatment Facilities
Death Valley National Monument, California	800-2,000[c]	Three springs capable of supplying 1.9 mgd for	N.A.	No plans to expand service.	No plans of expansion in area.
Nevada Test Site: EPA Farm	3[d]	Bottled water for human consumption	Storage tank periodically emptied	N.A.	N.A.
Area 12 Camp	N.A.	One well supplying-0.8 mgd	N.A.	N.A.	N.A.
Area 6 Control Point	N.A.	Two wells supplying-0.2 mgd	N.A.	N.A.	N.A.
Area 3 Support Camp	N.A.	One well supplying-0.1 mgd	N.A.	N.A.	N.A.
Area 25, Jackass Flats, Yucca Mountain	N.A.	Two wells supplying-0.1 mgd	N.A.	N.A.	N.A.
Mercury, Nevada	300	Three municipal wells coupled with a distribution system; production averages	Waste water from sewers discharged to oxidation ponds.	No plans to expand service.	Water supply has been adequate for past expansions. of Nevada Test Site.
Death Valley Junction, California	N.A.	Municipal well coupled to distribution system; does not meet state drinking water standards.	Disposed in evaporation ponds.	N.A.	Restoration of opera house and establishment of hotel with daily population of 250 people projected.
Crystal, Nevada	20 families	Residents obtain people water from domestic wells 160 feet deep.	Septic tanks	N.A.	No development is planned in this area.
Johnnie, Nevada	1 family	N.A.	N.A.	N.A.	N.A.
Rhyolite, Nevada	2 families	Served by pipeline from water tank at new Beatty well at Indian Spring; other family uses bottled water.	Septic tanks	N.A.	N.A.

[a]N.A. = data not available
[b]mgd = million gallons per day
[c]Semi-permanent residents and visitors during the period from October through April
[d]Employees at farm only during weekday periods
Data extracted from French et al. (1981).

most systems could be expanded rapidly due to a sudden population influx. Rapid development could disrupt the present level of services in these communities. Several systems anticipate planned improvements over a number of years, i.e., new wells, water distribution and sewer lines, etc., to accomodate projected growth in the immediate vicinity of their communities. The primary problems which would be encountered are the location of additional potable water sources presumably from the lower carbonate aquifer and obtaining adequate development capital from the system revenue since many areas have large mobile home populations with few permanent dwellings.

The amount of potable water which will be required by proposed new developments planned for Pahrump and Ash Meadows is currently unknown, making the evaluation of the water and waste water systems difficult because of the rapid growth and development that is taking place. Table 2-12, however, offers a predicted water use based on subdivisions planned at this time. For example, a large community is currently being planned in the Ash Meadows area.* This community would include 13,000 acres (5263 hectares) of land for agriculture and recreation and 25,000 lots of varying size for single family dwellings, mobile homes, commercial buildings and industrial development. The developer anticipated selling all lots

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*Development has been halted by U.S. Fish and Wildlife Service emergency listing of two species of fish in May, 1982.

TABLE 2-12

EXIXTING AND POTENTIAL WATER USE IN NNWSI STUDY AREA

Location	Estimated Population 1980	Potential Increase in Housing Units	Potential Increase in Population Due to Future Development	Estimated Existing Water Use (mg/d)[d]	Potential Increase in Water Use Due to Future Development (mg/d)[e]
Indian Springs	912	-	-	0.6	-
Indian Springs Air Force Base	500	-	-	0.3	-
Beatty	900	-	-	0.6	-
Mercury	300	-	-	0.2	-
Pahrump	1,358[a]	100,000	210,000	0.9	144
Ash Meadows	2,235[b]	25,000	52,000	1.5	36
Johnnie	2	130[c]	273	0.001	0.2
Lathrop Wells	65	-	-	0.04	-
Crystal	42	-	-	0.03	-
Rhyolite	4	-	-	0.002	-
Totals	6,318	125,130	262,773	3.9	180.2

[a] Total includes population of town of Pahrump and Pahrump township.

[b] Total includes population of rural residents in the vicinity of Ash Meadows and Amargosa Farms areas.

[c] Two future subdivisions are planned - Johnnie Townsite (160 acres) and Forty - Bar Estates (100 acres). Lot sizes for these developments assumed to average approximately two acres in size.

[d] Maximum permissible water use in Southern Nye County, is 1800 gallons per day per residential unit or almost two acre feet per year; assume 2.1 residents per housing unit (see Table 3-1).

[e] Potential increase in water use if proposed land development takes place as planned and permissible water use per residential lot remains constant.

Data extracted from French et al. (1981).

by 1987; and based on a similar development in Pahrump, construction on an individual lot may commence ten years after the sale of the lot (approximately 1997). Currently, there is concern by the State of Nevada and the National Park Service that development of this project will endanger the groundwater levels at Devil's Hole, the home of the Devil's Hole pupfish.

2.3.2.2 Mineral Industry Demands. At the present time, the mineral industry consumes a rather insignificant amount of water for processing within the vicinity of the NNWSI study area, although this could change in response to the market values of the minerals, use of new extraction techniques, and the discovery of new deposits in the future. Many mines in the area, however, currently recycle process water after extraction of primary minerals, thereby reducing their overall consumptive water demand.

Current practices used in the mining of the extensive fluorspar deposits, located southeast of Beatty, require only minor quantities of water, which is presently trucked in from Beatty. While a gold mine that is being developed west of Crater Flats similarly utilizes water trucked in from Beatty, the quantities used at this site for mineral extraction are somewhat more significant, estimated to be in the range of some 24,000 gallons (90,000 liters) per day (French et al., 1981).

A gold mine in the proximity of Rhyolite purchases about 483,000 gallons (1,830,000 liters) of non-potable water per month from the Beatty Water and Sanitation District. This is in addition to the water supplied from its own well, which produces water at a rate of 40 gallons (150 liters) per minute. At the present time, this mine is in a development phase, and a sizable expansion in the number of employees and operations at the site is planned. Consequently, this mining operation could have a significant impact in the future on the population of nearby Beatty and on the water resources in the area (French et al., 1981).

Plans for expansion of the bentonite milling facilities near Lathrop Wells could also have similar impacts upon regional water resources. Currently, the plant draws its water supply from three wells having a total capacity of 485 gallons (1840 liters) per minute; water consumption for the plant is presently unknown. Future plans for this operation include expansion of the mill resulting in an average water consumption of some 500 gallons (1890 liters) per minute or 700,000 gallons (2,600,000 liters) per day, although this plan may be in conflict with current uses by the National Park Service, since the potential ore deposit prompting this expansion lies within the boundaries of Death Valley National Monument.

2.3.2.3 Agricultural Demands. The major agricultural areas in the vicinity of the NNWSI study area are located in the Amargos Desert (also known as the Amargosa Valley) and Pahrump Valley.

The Amargosa Valley is arid with low precipitation and humidity and high evapotranspiration rates; irrigation is required for any agricultural activity in this area. There is a large amount of potentially arable land in the Valley which could be developed for irrigated agriculture. However, there are special problems which would seriously affect full development of these lands. They incude gravelly and coarse-textured soils having low inherent fertility and low water holding capacity. The Valley is also subject to high intensity winds of prolonged duration that could be devastating to crops, especially seedlings. In light of these marginal soil and meteorological conditions, it does not appear that there will be significant growth in agricultural activities and demand for additional supplies of irrigation water within the Amargosa Valley (French et al., 1981). A well for a residential unit is legally limited to two acre-feet per year (1800 gal/well/day)*.

Likewise, agriculture in the Pahrump Valley depends heavily upon irrigation water because of the sparse rainfall during the growing season. Forty-six percent of the soils or 58,000 acres (23,000 hectares) of land in the valley are fairly well suited for agriculture, although only a small portion of this total could be irrigated due to a limited annual recoverable groundwater reservoir (estimated production is 47,600 acre-feet per year or 58,700,000 m^3/yr with 2 feet/year decline in the water table) which is the major water supply source in the Valley. The water level in most farm and ranch wells is shallow (few to several tens of feet) and is dropping at the rate of about two feet (0.6 m) per year in areas of concentrated pumpage.

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*Actual use in Pahrump Valley is 1670 gal/day or 1.9 acre feet/year/residential unit (Harrill, 1982).

During 1970, the State Engineer ordered that no more groundwater permits for irrigation be granted in the Pahrump Artesian Basin. At that time, appropriations had been certified to use 45,600 acre-feet (56,233,000 m^3) per year, and permits had been granted to develop another 45,400 acre-feet (55,998,000 m^3) per year. This could potentially lead to a legal demand of 91,000 acre-feet (112,231,000 m^3) per year from within the designated area of the Pahrump Artesian Basin. In recent years, the annual water pumpage from wells in the Valley has averaged about 40,000 acre-feet (49,320,000 m^3) per year (French et al., 1981).

Within the last ten years, real estate developers have purchased agricultural land from the local ranchers in the Valley for construction of single-family homes in subdivisions. As this residential construction continues, it is expected that Pahrump Valley agriculture will slowly decline, although water consumption will probably increase, since the water rights will be assumed by the developers. Existing domestic water use in the valley is estimated at 3.9 million gallons per day (Table 2-12). Full development of planned subdivisions could pose significant water supply problems for the area. As indicated in Table 2-12, the potential increase in water use due to these developments is estimated at 180 million gallons per day or approximately 201,600 acre-feet per year. The overdraft of groundwater in the Pahrump Artesian Basin could be severe since the State Engineer has currently only certified water use permits for 91,000 acre-feet (French et al., 1981).

2.4 Biosphere

2.4.1 Terrestrial Ecosystems

The NNWSI study area is located within an ecotone, an area where two types of desert ecosystems overlap; the area has characteristics of both, depending upon the elevation. The study area is located at the northern boundary of the Mojave Desert and the southern boundary of the Great Basin Desert. The Mojave is a warm, dry desert; the terrestrial ecosystem which occurs below 4000 feet (1200 m) on the NTS is typical of this system. The Great Basin Desert is cooler and wetter; the northern NTS and elevations above 5000 feet (1500 m) are typical of this system. The zone between the two (4000 to 5000 feet) is a transition zone with characteristic vegetation which extends in a broad east-west corridor generally across southern Nevada.

Five major vegetation associations are found in the study area. These are listed below as described by O'Farrell et al. (1981), and are indicated in Figure 2-7 in a simplified profile of the region.

Terrestrial Associations of the NNWSI Study Area

Common Name	Scientific Name	Elevation
Cresote bush-bursage	*Larrea-Ambrosia*	below 3500 ft (1100 m)
Cresote bush-boxthorn -hopsage	*Larrea-Lycium -Grayia*	3500-4000 ft (1100-1200 m)
Blackbrush	*Coleogyne*	4000-5000 ft (1200-1500 m)
Sagebrush	*Artemisia*	5000-6000 ft (1500-1800 m)
Sagebrush-pinyon -juniper	*Artemisia-Pinus -Juniperus*	6000 ft (1800 m) and above

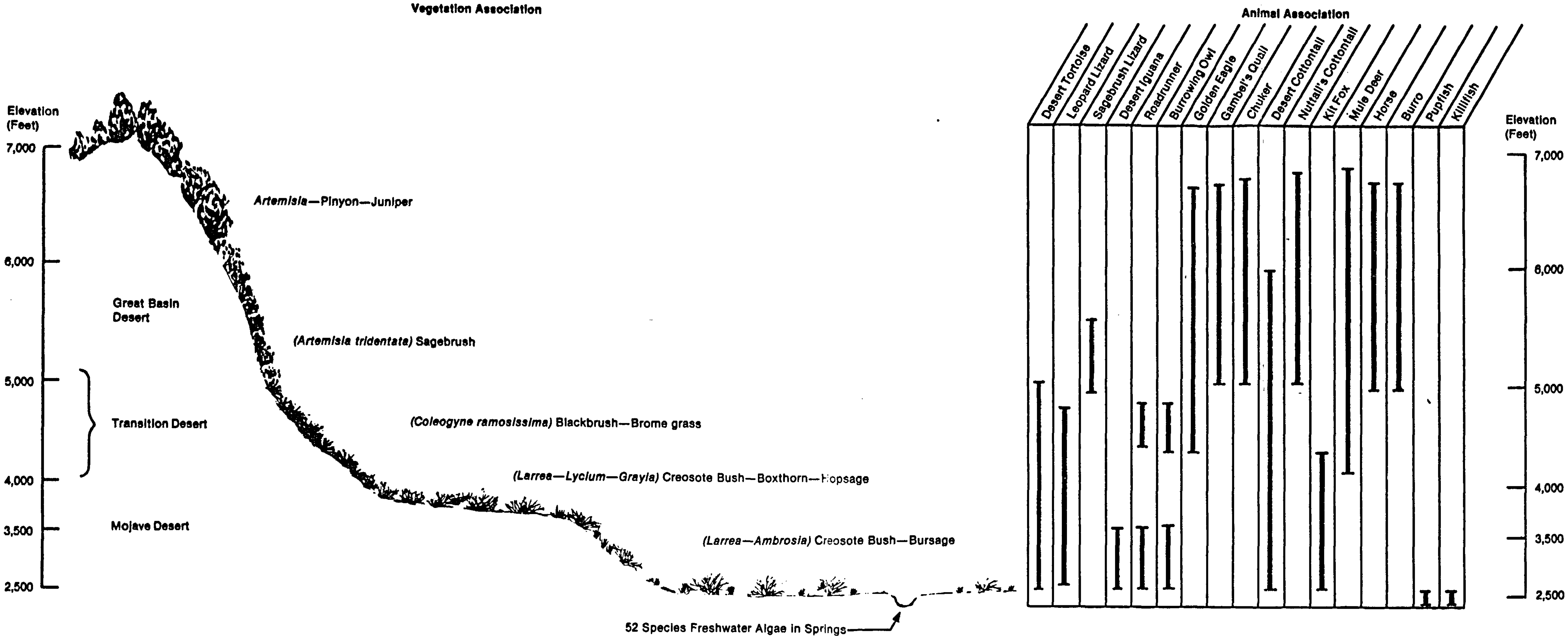

FIGURE 2-7
TERRESTRIAL ECOSYSTEMS PROFILE OF THE
NNWSI STUDY AREA

The highest elevations in the NNWSI study area are to the north in the Shoshone Mountains, ranging in the 6000 to 7000 feet (above 1800 m) zone and are dominated by pinyon pine and Utah juniper intermixed with sagebrush, forming open woodlands. Shrubs found in this association reflect the geologic diversity of substrates at these elevations and include the following:

Artemisia nova -- black sagebrush
Chrysothamnus nausiosus -- rubber rabbitbrush
C. viscidiflorus -- sticky-leaved rabbitbrush
Tetradymia canescens -- spineless horsebrush
Symphorocarpus longiflorus -- snowberry
Quercus gambelii -- Rocky Mountain oak

A juniper vegetation association may have been characteristic of the study area 9000 to 13,000 years ago (Wells and Jorgenson, 1964). Blackburn and Tueller (1970), however, report that black sagebrush was invaded first by juniper then pinyon pine. In the early 1920's, pinyon-juniper invasion was accelerated by overgrazing, fire suppression, and climatic changes. If the present sagebrush-pinyon-juniper community is disturbed, it is believed that recovery would be fairly rapid (years to decades) (Wallace et al., 1980), dependent upon moisture availability and a similar climate regime together with the presence of mature seed sources. Seedling recruitment would occur among dead scrubs or in cleared areas.

In the Shoshone Mountain woodlands, there may be free water which attracts the wintering and migrating mule deer (*Odocoileus hemionus*) (O'Farrell et al., 1981). Two other large ungulates, the feral "wild" horses (*Equus caballus*) and burros (*Equus asinus*) are also present in this ecosystem. Game birds, the chukar (*Alectoris graeca*) and Gambel's quail (*Lophortyx gambelii*), two cottontail species (*Sylvilagus audubonii* and *S. nuttallii*), and their predator the mountain lion (*Felis concolor*) are also found here. Of the 27 permanent breeding bird species on the study area, most inhabit the sagebrush-pinyon-juniper association.

At lower elevations (5000 to 6000 feet or 1500 to 1800 m), sagebrush becomes the more dominant vegetation. The sagebrush association is typical of Great Basin vegetation and is found in deeper soils, where precipitation is relatively high (8 in; 20 cm) and nighttime temperatures low. Great Basin vegetation is not summer deciduous, but may exhibit summer dormancy, which is broken when the rains begin in October and November. Two species of sagebrush are found with the following shrubs:

Chrysothamnus vicidiflorus -- sticky-leaved rabbitbrush
Ephedra viridis -- Mormon tea
Tetradymia glabrata -- little-leaf horsebrush
Eriogonum microthecum -- Great Basin buckwheat brush
Opuntia echinocarpa -- thorny-fruited cactus

Two cottontail species and the black-tailed jack rabbit (*Lepus californicus*) are common in sagebrush communities. Antelope squirrels (*Ammospermophilus leucurus*), pocket gophers and mice, kangaroo rats, and the sagebrush vole (*Lagurus curtatus*) are found throughout. Predators include hawks, golden eagle (*Aquila chrysaetos*), bobcat (*Lynx rufus*) and the coyote (*Canis latrans*)

(O'Farrell et al., 1981). Wild burros and horses are occasionally observed here; mule deer may be found at lower elevations during migration.

At lower elevations, the sagebrush gradually gives way to the dominant blackbrush (Coleogyne ramosissima), which is often mixed with the introduced brome grass (Bromus rubens). This typical transition desert is found on Yucca Mountain at 4000 to 5000 feet (1200 to 1500 m). The blackbrush association occurs on upper bajadas in shallow, sandy and gravelly soils with rock outcrops. While the blackbrush may occur in mid-elevations in pure stands of many square miles, the brome can dominate in disturbed or burned sites. Beatley (1969) reports the highest biomass productivity (753 kg/ha; 4100 lb/ac) in burned areas of southern Nevada. Other typical plants in the transition desert include:

Menodora spinescens -- spiny menodora
Ephedra nevadensis -- Nevada ephedra
Chrysothamnus terefifolius -- rabbitbrush
Yucca brevifolia -- Joshua tree
Yucca baccata -- yucca
Opuntia echinocarpa -- thorny-fruited cactus

The rodent diversity is greatest in the transition desert, because species of both deserts overlap ranges here. Two species of pocket mouse, two species of kangaroo rats, several mouse species, and perhaps the dark kangaroo mouse (Microdipodops megacephalus) are found in the blackbrush association. Larger mammals include the Audubon desert cottontail, black-tailed jack rabbit, badger, and striped skunk. The bobcat and coyote are the major predators.

Below 4000 feet (1200 m), the Mojave desert type ecosystem becomes dominant. The association of creosote bush-boxthorn-hopsage is characteristic of a narrow zone between 3500 to 4000 feet (1000 to 1200 m). Animal species remain about the same, but with a lower diversity. The dominant kangaroo rat is the Merriam's (*Dipodomys Merriami*). Additional species found at these lower elevations include the desert tortoise (*Gopherus agassizi*), the desert wood rat (*Neotoma lepida*) in rocky areas or with yucca, the kit fox (*Vulpes macrotis*), and the spotted skunk (*Spilogale gracilis*).

Below 3500 feet (1100 m), the creosote bush and bursage become codominant on soils which are loose and sandy. The cresote bush is tolerant of the low rainfall and high temperatures. This vegetation association prevails on the low-gradient bajadas at the foot of the volcanic mountain ranges. Typical of this ecosystem is that found in Rock Valley, an area studied as part of the International Biological Program. The association covers most of the lower flat areas of the NNWSI study area south to the lowest elevations of 2500 feet (750m) on the Amargosa Desert. The vegetation grouping with creosote bush (*Larrea tridentata*) is the most widespread and diversified, and consequently, the most stable vegetation, which represents a climax community (El-Ghonemy et al., 1980). If the creosote bush scrub association is disturbed, an optimistic recovery time may be 30 to 40 years; but, based on ages of creosote bush colonies, recovery time may range from 1500 to 3000 years (Vasek et al., 1975). Production of plant biomass is low, averaging 150 kg/ha (817 lb/ac) (Turner, 1976), with aboveground litter-fall ranging from 194 to 530 kg/ha (1060 to 2900 lb/ac) (Strojan et al., 1979). Below ground biomass is generally higher than the biomass above ground. Shrubs are dormant generally in the summer when they exhibit deciduousness.

While few animals are found in the harsh desert environment, those that survive to reproduce have adapted physiological and behavioral mechanisms to continue populations. For example, the ground squirrels (Spermophilus tereticaudus) and desert tortoise burrow underground to avoid extreme desert temperatures. Most animals are nocturnal to avoid the hot days. In dry years, only two bird species breed, the black-throated sparrow (Amphispiza bilineata) and the LeConte's thrasher (Toxostoma lecontei); the paucity of species is associated with the simple desert community of low productivity (Hill, 1980). Jack rabbits, pocket mice, kangaroo rats, cactus mice, coyotes, kit foxes, and spotted skunks are all found in the creosote bush-bursage association. The Mojave Desert communities support a large number of reptiles; 14 lizard species and 17 snake species (two poisonous) are found in the NNWSI study area. A complete listing of species found in the NNWSI study area is given in O'Farrell et al. (1981).

2.4.2 Species of Concern

In the area-to-location screening study, special definitions for "sensitive system" and "sensitive species" were developed. "Sensitive systems" were defined as those which: 1) are commercially or recreationally valuable, 2) support important species, or 3) are critical to the structure and function of an ecosystem. A species is important if a specific causal link can be identified between a potential repository and the species and if one or more of the following criteria apply: 1) the species is considerate be sensitive; 2) there may be secondary effects among species or species interrelationships; 3) the species is critical to the structure and function of the ecological system or is a biological indicator of radionuclides in the environment; or 4) the species is a potential nuisance.

"Sensitive species" were defined as taxa which are a) potentially threatened or potentially endangered, rare (likely to exist in small or dwindling numbers in one or a few populations), or infrequently encountered (thinly dispersed over the local area) so that government protection is under consideration, imminent, or in place; b) identifiably valuable for commercial or recreational purposes and therefore under governmental management; or c) of scientific or aesthetic value. In an attempt to make the area-to-location screening activity censervative in its environmental consideration the definitions were intentionally broad. However, "sensitive species" has a different and unique meaning to the U.S. Fish and Wildlife Service biologists concerned with implementation and enforcement of the Endangered Species Act of 1973. For purposes of this and any subsequent NNWSI documents the term "species of concern" will therefore be used instead of "sensitive species".

Species of concern were decided upon by consulting the lists of sensitive, rare, threatened and endangered species compiled by the U.S. Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM), and Nevada Divisions of Forestry and Wildlife, and the Northern Nevada Native Plant Society. No plant or animal on the NTS is currently listed by the FWS as a threatened or endangered species, or as an official candidate for such listing, although all eleven plants listed on Table 2-13 are under study (Federal Register, December 15, 1980). Two plants are likely to be listed, the funeral milk-vetch and the Mojave fishhook cactus, both found above 3500 feet (1100 m) elevations (O'Farrell et al., 1981).

Three mammals, wild horses, burros, and mule deer and one reptile, the desert tortoise, constitute the animal species of concern in the study area. Two other species may be considered in the future, if they are found on the NTS. The spotted bat is protected as a rare species by the State of Nevada, and is therefore considered sensitive by the BLM. The dark kangaroo mouse, a species of limited range, probably reaches its southern distribution limit on the NTS (O'Farrell et al., 1981).

TABLE 2-13

TERRESTRIAL SPECIES OF CONCERN POTENTIALLY FOUND IN THE NNWSI STUDY AREA

Scientific Name	Common Name	Elevation (feet)	[a]Priority Group
PLANTS			
Astragalus funereus	Funeral milk-vetch	3500-6500	2
Sclerocactus polyancistrus	Mojave fishhook cactus	4500-7000	2
Lathyrus hitchcockianus	Mojave sweetpea	4500-6000	3
Arctomecon merriamii	Bear poppy	2500-4000	3
Phacelia beatleyae	Beatley's scorpion weed	4000-5000	3
Penstemon pahutensis	Pahute beardtongue	5000-7000	3
Camissionia megalantha	none	b	3/4
Trifolium andersonii	Beatley's five-leaf clover	5500-7500	4
Phacelia parishii	Parish's scorpion-weed	2500-3000	4
Gilia nyensis	Nye County gilia	2500-8000	4
Perityle megalocephala	none	3500-4500	4
ANIMALS			
Equus caballus	wild horse	>5000	c
E. asinus	burro	>5000	c
Odocoileus hemionus	mule deer	>6000	c
Gopherus agassizi	desert tortoise	<3500	1

a) 1 & 2 are likely to be listed as threatened or endangered; 3 probably will not be listed; 4 taxa under review by FWS.
b) Cane Springs and French Peak.
c) Protected by law.

The Nevada Division of Wildlife manages, through regulated hunting and trapping, designated game animals, game birds and fur-bearing animals. Game species include: mule deer, mountain lion, Audubon's cottontail, Nuttall's cottontail, chukar, and Gambel's quail; the fur-bearing animals include the bobcat and kit fox. Other species are given further protection by the State as "protected", "rare", or "endangered". Non-game birds protected by the State include all vultures, hawks, falcons, owls, pelicans, and the road runner. Other animals in various protected categories include the spotted bat, desert tortoise, Devil's Hole pupfish, Warm Springs pupfish, and the Pahrump killifish. The desert tortoise is under Notice of Review by the FWS, while the Meadows speckled dace and Ash Meadows Amargosa pupfish are protected by an emergency listing by FWS (Federal Register, May 10, 1982).

The bands of feral horses which range over parts of the NTS are most common on the northern mesas, in mountainous areas, and around springs where food and water can be obtained. Horses have been sighted at Cane Spring and undoubtedly inhabit the surrounding mountains. Horses may be found on either Yucca or Shoshone Mountains, especially in the vicinity of Topopah Spring (O'Farrell et al., 1981). While burros are not commonly observed on the NTS, they are present on Yucca Mountain. Large populations occur to the west in Death Valley and in the vicinity of Beatty. Individuals are occasionally observed near Cane and Topopah Springs.

Both animal species are protected from "capture, branding, harassment, or death" under the Wild Freeroaming Horse and Burro Act (Public Law 92-195) and are to be considered an "integral part of the natural system of the public lands." Habitats are not protected except in special ranges that are set aside as preserves (e.g., a portion of the Nellis Air Force Bombing Range).

Mule deer primarily inhabit the northern mesas and mountainous areas on the NTS but are occasionally observed at lower elevations. Mule deer on the NTS appear to summer at high elevations on the relatively mesic, northern mesas such as Pahute and Rainier mesas. Beginning in October, they move south or to lower elevations, wintering in areas such as Fortymile Canyon, Beatty Wash, Timber Mountain, Yucca Mountain, and Shoshone Mountain (O'Farrell et. al., 1981).

The desert tortoise is a Sonoran Desert species ranging as far north as southern Nevada and southwest Utah. Desert tortoises occur throughout the study area in the lower elevation creosote bush communities and in the higher (above 4000 ft) communities of the transition desert. Firm ground is required for construction of burrows; areas with deep, shifting sand are not suitable habitat. Surface activity begins near the beginning of April, when tortoises emerge from deep winter hibernation burrows to feed on annual plants. Dry grasses are consumed through May and June after other herbaceous annuals die out. From mid-June to mid-July tortoises estivate in burrows, emerging during thunderstorms to drink water caught in shallow basins. Activity peaks again in fall, when increased rainfall induces germination and tortoises emerge from estivation. By mid-November most animals enter hibernation (Nagy and Medica, 1977).

Little is known about the population dynamics of this species on the NTS; surveys to determine its density and distribution on the NTS are ongoing. Studies of a population in Rock Valley suggested tortoise densities there from 50 to 100/mi^2 (20 to 40/km^2). Tortoise densities are probably higher in Rock Valley than in Jackass Flats, because the vegetation is more diverse and dense and the soil is less sandy. Densities are lower south and west of the NTS, where tortoise densities are at most 10 to 50/mi^2 (4 to 20/km^2). These density estimates are relatively low when compared to other more southern desert tortoise populations (O'Farrell et al., 1981).

2.4.3 Agricultural Resources

Four areas in southern Nye County currently support a limited amount of agriculture. Three of these areas are located within 25 miles (40 km) of the NTS western or southern boundaries, and the Pahrump Valley is located 35 miles (56 km) south of the NTS. A mixture of public and private land holdings exist side-by-side in each of these four principal agricultural areas (see subsection 3.4).

Most of the agricultural acreage in southern Nye County is committed to cattle ranching on some 737,000 acres (300,000 hectares) of public domain land that is primarily located south of U.S. Highway 95 in five parcels. These unimproved public rangelands have been leased by the U.S. Bureau of Land Management (BLM) to livestock operators. Each lease is typically issued for a period of 10 years and requires a grazing fee. The number of livestock permitted on each lease and their period of grazing is annually specified by the BLM and is shown in Table 2-14. One animal unit month (AUM) represents the acreage required to support one adult cow or five sheep for one month; it is estimated that 800 pounds of dry forage are required for every AUM. The prescribed BLM allotment for each parcel, therefore, is a direct reflection of the sustained yield of productivity of the rangeland. The second column of Table 2-14 lists the total acreage in the lease. The third column lists both the AUM and the total cattle allotment, which has been calculated by dividing the total AUM's by 12; thus 675 cattle can be

TABLE 2-14

AGRICULTURAL RESOURCES LOCATED WITHIN WESTERN OR SOUTHERN BORDER OF THE NEVADA TEST SITE

AREAS SUPPORTING AGRICULTURE	ACTIVE GRAZING LEASES					PRIVATELY OWNED AGRICULTURAL LAND		
	LEASE NAME	ACREAGE	AUM/ CATTLE ALLOTMENT[a]	RANGE PRODUCTIVITY (ACRES/AUM)	VEGETATION	AGRICULTURAL CLASSIFICATION[b] OR CROPS	ACREAGE	COMMENTS
Within 25 miles of NTS:						1st class cultivated	10	Cattle ranching primary pursuit; most acres devoted to pasture or grazing land.
o Beatty/Oasis Valley						3rd class pasture	23	
						4th class pasture	95	
	Montezuma	426,000	8,100/675	52	Larrus-Ambrosia	1st class grazing	100	
	Razorback	71,000	1,334/112	52	Larrea-Lycium-Grayia		150	
						2nd class grazing	409	
					Coleogyne ramosissima		137	
						3rd class grazing	306	
o Amargosa Valley						1st class cultivated	500-649	Major principal farming in region and ranching area crop is alfalfa.
							25	
							174	
							40	
						2nd class cultivated	320	
							20	
						3rd class cultivated	650	
							640	
						4th class cultivated	58	
						2nd class pasture	4	
						1st class grazing	60	
							1,100	
						3rd class grazing	235	
							1,070	
							93	
						4th class grazing	40	
o Ash Meadows	Calvada	68,000	Not assigned by BLM		Larrea-Ambrosia	Irrigated pasture		Ranching abandoned in much of Ash Meadows after court-ordered injunction restricting pumping from wells.
	Mt. Sterling	163,000	1500/125	108		Alfalfa	720	
	Bowman	9,000	Not assigned by BLM			Sudan grass	240	
						Cotton	160	
Within 35 miles of NTS:								
o Pahrump Valley						Alfalfa	NA	Valley produces 95% of cotton produced in Nevada. Farmland gradually being sold and converted to housing.
						Cotton	NA	
						Sudan grass	NA	
						Small grains	NA	
						Fruits (apricots, peaches, plums)	NA	

[a] One Animal Unit Month (AUM) represents the acreage required to support one adult cow for one month, with an estimated 800 pounds of dry forage required for every AUM. Number is AUM ÷ 12 to get cattle allotment.

[b] Agricultural classification used for assessment of land, livestock, and merchandise stock by Nevada Tax Commission.

NA = Not Available.

Source: O'Farrell et al., 1981.

supported on 426,000 acres for a year. Range productivity (column four on Table 2-14) shows the total acres divided by AUMs; thus, it takes between 50 and 100 acres to produce the necessary forage for one AUM.

Lands near the southwestern NTS are primarily poor grade rangelands. As indicated in Table 2-14, two active leases in the Beatty areas, Montezuma and Razorback, represent approximately 497,000 acres (200,000 hectares). The AUM allotments issued for these parcels allow livestock operators to run a maximum of 112 and 675 head of cattle, respectively, on these leases each year. Range vegetation is predominantly Larrea-Ambrosia and Lycium-Grayia associations, with Coleogyne ramosissima integrating at higher elevations. Further to the southeast, in the Ash Meadows region, the range vegetation also consists of Larrea-Ambrosia, but exhibiting a much lower productivity. The Calvada lease is currently inactive and the Bowman lease is occasionally used in wet years (O' Farrell et al., 1981).

Privately-owned agricultural lands also exist in the vicinity of the NTS, although they are not extensive. Table 2-14 describes the distribution of agricultural resources within the four major agricultural areas.

- Beatty/Oasis Valley
- Amargosa Valley
- Ash Meadows
- Pahrump Valley

Nye County tax assessments recognize several types of agricultural land classifications (e.g., cultivated, pasture, and grazing lands, each class composed of subclasses determined by land productivity and the need for irrigation. Cultivated and pasture lands, for example, require some form of irrigation during the normal growing season, whereas private grazing lands are not irrigated (O'Farrell et al., 1981).

The Amargosa Valley sustains farming areas (approximately 3080 acres; 1247 hectares) within 25 miles (40 km) of the southwestern NTS boundaries. Alfalfa is a major crop grown on cultivated lands in the valley which are irrigated by wells in the Pahute Mesa groundwater system. While Ash Meadows and Pahrump Valley could support limited agriculture, no land is classified as crop or pasture land in the 1981 tax records. Two-thirds of Ash Meadows is held as public lands by BLM. Much of the private farm operations in Ash Meadows were cultailed in 1973 when a Federal Court decision required maintenance of a minimum water level in the Devil's Hole portion of the Death Valley National Monument, which is hydrologically connected to Ash Meadows wells, for the continued survival of the endangered Devil's Hole pupfish (O'Farrell et al., 1981).

2.4.4 Aquatic Ecosystems

In the desert ecosystem, temporary or seasonal water sources can occur, but do not last long enough to develop into distinct ecosystems. Examples are the flash floods in the Fortymile Canyon and temporary lakes created by rainfall runoff in Yucca and Frenchman playas, where waterfowl and shorebirds may gather. In the NNWSI study area, small temporary basins are created by the desert tortoise to catch summer thunderstorm waters for drinking. There are both seasonal and permanent springs in the study area.

Springs are rare and widely dispersed in the area, with eight known on the NTS, and approximately 30 in the Ash Meadows vicinity. Topopah, Cane, and Tippipah Springs are located on the eastern and northern periphery of the study area. O'Farrell et al. (1981) believe there is at least a temporary spring on Shoshone Mountain because of old tanks and pipes left there. Also, Gambel's quail and chukar gather there, indicating the presence of water.

Ash Meadows, although not within the NNWSI study area, is unique and may be hydrologically connected to it. Ash Meadows is at the southeastern end of the Amargosa Desert but discharges groundwater collected over several thousand square miles to the north and east (see Figure 2-5). Where a limestone aquifer collapses, depressions form small pools (e.g., Devil's Hole); these pools are interconnected with local wells. The spring discharge area is overgrown with a variety of phreatophytes: copper rush (*Juncus* *cooperi*), saltgrass (*Distichlis spicata*), saltbush (*Atriplex canescens*), saltcedar (*Tamarisk gallica*), arrow weed (*Pluchea sericea*), and fat-hen saltbush (*Atriplex hastata*) (Winograd and Thordarson, 1975). The Ash Meadows springs support three species of pupfish and unique plantlife, including nine sensitive endemic plants.

Listed below are those fishes which are protected by the U.S. Fish and Wildlife Service:

Protected Fish Species

Scientific Name	Common Name	Location	Status
Cyprinodon diabolis	Devil's Hole pupfish	Devil's Hole	endangered
C. nevadensis mionectes	Amargosa pupfish	Ash Meadows	emergency listing**
Rhinichthys osculus nevadensis	Meadows speckled dace	Ash Meadows	emergency listing**
C. nevadensis pectoralis	Warm Springs pupfish	Ash Meadows	endangered
Empetrichthys latos	Pahrump killifish*	Pahrump Valley	endangered

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*Became extirpated in 1975 from Manse Spring, but was reintroduced.

**Listed by Fish and Wildlife Service on May 10, 1982.

2.5 Energy and Mineral Resources

The following sections present a brief summary of the existing energy and mineral resources of the NNWSI study area and the vicinity within 9 miles (15 km) from the outside border of the NNWSI study area (see Figure 1-2). The general locations of energy and mineral resources within this area are shown in Figure 2-8.

2.5.1 Energy Resources

Energy resources known to exist within or near the NNWSI study area appear to be exclusively low-to-moderate temperature geothermal resources. No published information is available to suggest the presence of oil, natural gas, oil shale, or coal resources of any rank. Moreover, the geology of the study area and vicinity appears to be generally unfavorable for the finding of substantial supplies of oil or nautral gas at depth. Minor amounts of uranium have been reported immediately west and north of the study area in materials geologically similar to those located in the study vicinity. No mines or prospects for uranium or thorium currently exist within the NNWSI study area or 15-km vicinity (Bell and Larson, 1982).

The presence of the geothermal energy resource is indicated by hot springs immediately to the northwest and south of the study area and by 19 wells having water temperatures ranging from 70°F to 149°F (21 to 65°C) within the NNWSI study area and vicinity (Trexler et al., 1979; Garside and Schilling, 1979). For the most part, these wells have not been deliberately drilled to test the

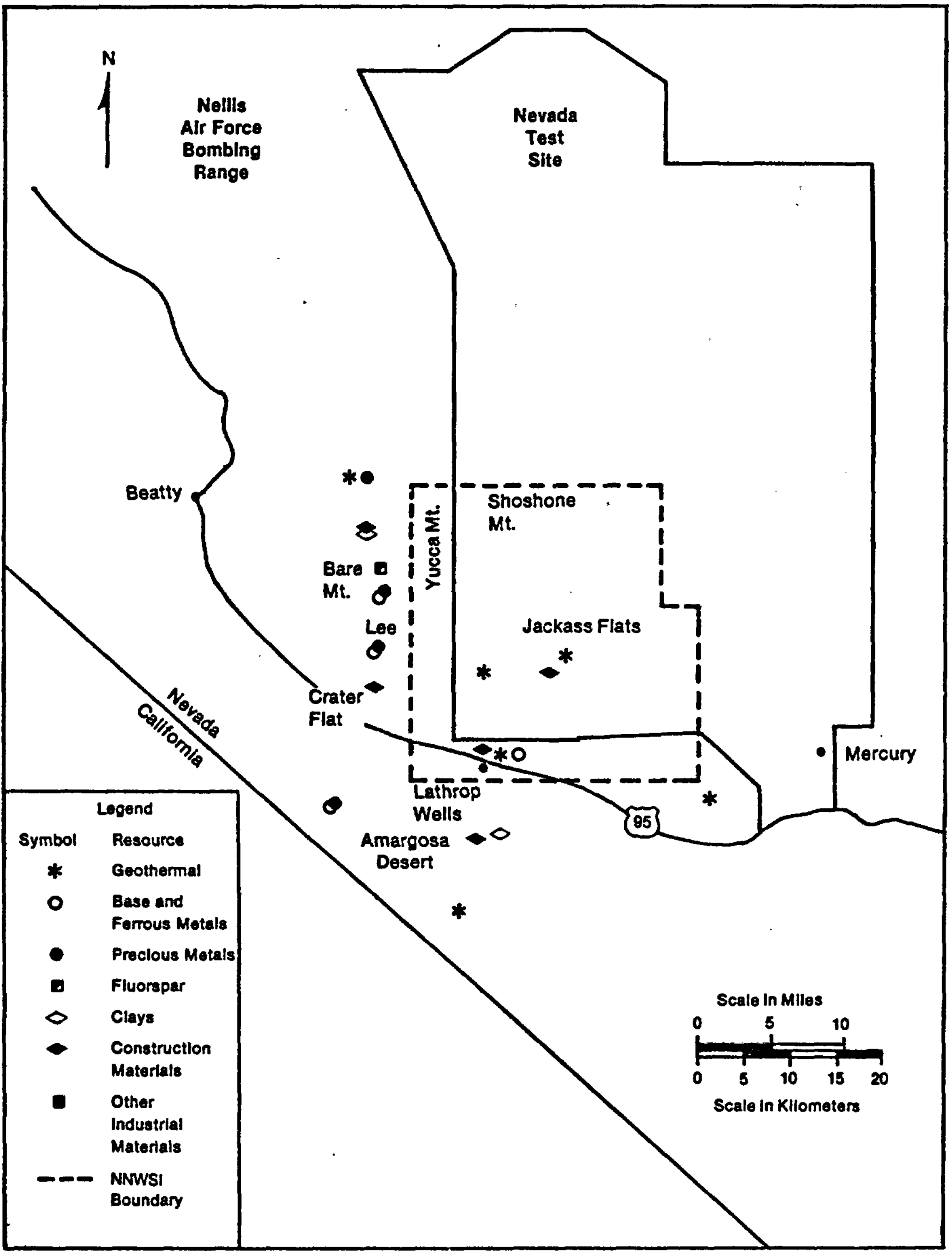


FIGURE 2-8
LOCATION OF MINERAL RESOURCES

geothermal potential of the region. Therefore, the areal extent, depths, and physical characteristics of commercial geothermal resources in or near the NNWSI study area remain undefined (Bell and Larson, 1982).

Garside and Schilling (1979) and Trexler et al. (1979) suggest that sufficient geological evidence exists, however, in or near the study area to indicate a potential for low-to-moderate temperature geothermal resources probably at depths of less than 0.6 miles (1 km). Commercial geothermal exploration efforts have yet to be undertaken in the vicinity of the study area, because better evidence of higher temperature geothermal systems appropriate for power generation purposes exist elsewhere in Nevada and California.

In summary, based on available information, Bell and Larson (1982) concluded that the NNWSI study area has only limited energy potential. Known uranium resources to the west on Bare Mountain do not appear to constitute highly attractive uranium exploration targets. In addition, no exploration has been conducted to determine the uranium content of Silent Canyon Caldera (see Figure 2-5).

2.5.2 Precious and Base Metals

The history of Nevada's mining industry centers around the mining of precious minerals such as gold and silver during the Comstock boom in the 1870's and the Tonopah-Goldfield boom in the early 1900's. From 1905 to 1910, prospecting activity from the

Bullfrog Mining District, west of the NNWSI study area, extended eastward through and beyond the Bare Mountain District into the NNWSI study vicinity. Exploration was primarily for precious metals, and although many discoveries resulted, they had very little recorded production. In the late 1970's, a new wave of exploration for precious metals started, due to the increase in the market prices of these minerals, and continues to date.

Large blocks of land are under five claims for the mining of precious and base metals in several mining districts both within and adjacent to the study vicinity on the west. Although exploration and claiming has been intense, the only discovery actively producing silver and gold ores in the vicinity of the study area is the Stirling (Panama) mine near Bare Mountain. No official announcement of production or reserves of this mine has been made by the company, although Bell and Larson (1982) have estimated the potential reserves of gold to be 30,000 ounces and silver to be 300 ounces, with the aggregate value of gold and silver production at the mine since early 1980 exceeding $1.8 million. Ore reserves at this property appear to be limited and the mine, while apparently profitable, is a relatively small producer on a national or international scale.

Deposits of precious and base metals within the area of interest include the Mine Mountain and Wahmonie Districts (Table 2-15). Information on the geology and status of mining operations

TABLE 2-15

STATUS OF MINING OPERATIONS FOR PRECIOUS AND BASE METALS IN THE VICINITY OF NNWSI

Mining District	Minerals	Status of Mining Operations		Type of Operations
Bare Mountain[a]	Gold	Active	4	Prospect pits
	Silver	Inactive	10	Open pits
	Mercury	Unknown[c]	10	Placer
	Lead			Underground tunnels and shafts
	Tungsten			
	Fluorspar			
Mine Mountain[a]	Silver	Active	-	Underground tunnels and shafts
	Lead	Inactive	1	
	Mercury	Unknown	-	
Wahmonie[a]	Gold	Active	-	Prospect pits
	Silver	Inactive	3	Underground shafts
	Copper	Unknown	-	
Lee[a]	Gold	Active	-	Prospect pits
	Copper	Inactive	1	Shallow diggings
	Tungsten	Unknown	1	Underground shafts
Yucca Flat[a]	Gold	Active	-	Shallow surface diggings
	Silver	Inactive	1	
	Lead	Unknown	-	Underground shafts
Amargosa Desert[b]	Tungsten	Active	-	Prospect pits
	Iron	Inactive	1	
		Unknown	-	
TOTAL	NA	Active	4	NA
		Inactive	17	
		Unknown	11	

Source: Bell and Larson, 1982.

[a] Mining district located within 15 km of the NNWSI study area.

[b] Mining district located within the NNWSI study area.

[c] Areas where information is unavailable or inadequate to characterize the status of mining operations.

of precious and base metals in these mining districts predates the withdrawal of the area from the public domain and cessation of mining more than 30 years ago. Furthermore, information on existing and past mining operations has almost always been considered proprietary by mine operators and generally not released to the public. At Mine Mountain, the literature suggests that early exploration was done at one location in 1928 where several underground tunnels and shafts were built. Cornwell (1972) reported that a sample from this site showed 10% lead, 0.5% mercury, and 0.07% silver. The Wahmonie District produced an unrecorded amount of gold and silver sometime between 1905 and 1910 and again in 1928. Geophysical work completed by the U.S. Geological Survey suggests that it might make an attractive precious metal exploration target were it available (Bell and Larson, 1982). A final area located in the Amargosa Desert Mining District within the study area may have potential for precious and base metal production. Limited geologic information on the district suggests that tungsten and iron ores may be prevalent, although no production has yet been recorded (Bell and Larson, 1982).

There are several geologically promising areas for precious and base metals production within and adjoining the vicinity extending outward from the borders of the NNWSI study area. On the basis of widespread and vigorous exploration activity along the western edge of the study area from Bare Mountain southward to the Lee District

(Figure 2-8), evidence suggests some potential for the development of limited gold, silver, tungsten, lead, mercury, and fluorspar mining operations. In the northwest corner of the Bare Mountain District, for example, claims have been staked over a large number of presumably precious metal veins related to various tuffs and other volcanics of the Timber Mountain Caldera. In addition, fluorite mineralization is widespread throughout the entire Bare Mountain District, although the largest deposit in terms of production (Crowel Mine) is west of the study vicinity. Recent mining of fluorspar within this area has taken place at the Mary and Diamond Queen mines using the open pit method of production. Aggregate production is relatively small, estimated to be less than 90,000 tons (81,700 tonnes) (Bell and Larson, 1982).

The limited production of gold, silver, fluorspar, mercury, and other associated minerals along the extreme western edge of the study vicinity from past and present operations suggests that increased production appears most likely to be from small-scale operations similar to the Stirling mine. Furthermore, the impact of development and production of resources in this area would be minor with regard to national, international, or even regional production (Bell and Larson, 1982).

2.5.3 Industrial Material Resources

A large variety of industrial minerals and construction materials are present within the vicinity of the study area. These include different types of clays (montmorillonite, kaolin, and halloysite); construction materials such as sand, gravel, and volcanic cinders; and miscellaneous industrial materials such as ceramic silica, travertine, zeolite, and alunite.

Sand and gravel pits are ubiquitous throughout the entire area and appear to have been sited in several mining districts (Table 2-16) on the basis of localized need for gravel and cinders used as a road base construction medium. Although a substantial sand and gravel resource base exists within the study area, there appears to be nothing unique or critical about this base since similar resources exist in many if not all of the valleys and range front pediments that surround the NNWSI study area.

Clay resources in the vicinity of the NNWSI study area are dominately montmorillonitic (bentonite) with lesser and economically unimportant kaolinite and halloysite deposits. Montmorillonitic clays are used in industrial applications such as drilling muds, bleaching and decoloring agents, insecticide and fungicide carriers, and general purpose filler materials. Although detailed information on the geologic character, size, and actual production of such deposits is lacking in the study area, it is known that several montmorillonitic prospects and occurrences exist in the Bare

TABLE 2-16

STATUS OF MINING OPERATIONS FOR CONSTRUCTION MATERIALS, CLAYS, OTHER INDUSTRIAL MATERIALS IN THE VICINITY OF NNWSI

Mining District	Minerals	Status of Mining Operations		Type of Operations
Jackass Flat[b]	Gravel	Active	-	Open pit
		Inactive	-	
		Unknown[c]	2	
Wahmonie[a]	Alunite	Active	-	Unknown[c]
		Inactive	-	
		Unknown	1	
Lathrop Wells[b]	Gravel	Active	1	Open pit with crusher and screens; single bench
		Inactive	-	
		Unknown	4	
Amargosa Desert[b]	Gravel	Active	2	Prospect pit
	Montmorillonite	Inactive	4	Open pit
	Travertine	Unknown	14	Underground shafts
Bare Mountain[a]	Montmorillonite	Active	-	Prospect pit
	Halloysite	Inactive	3	Open pit
	Kaolin	Unknown	7	
	Ceramic silica			
	Perlite			
	Zeolite			
Yucca Mountain[b]	Gravel	Active	-	Open pit
		Inactive	-	
		Unknown	1	
Syncline Ridge[a]	Gravel	Active	-	Open pit
		Inactive	-	
		Unknown	1	
Crater Flat[b]	Pumice	Active	1	Open pit
	Cinder	Inactive	-	
		Unknown	2	
Yucca Flat[a]	Gravel	Active	-	Open pit
		Inactive	-	
		Unknown	10	

Source: Bell and Larson, 1981.

[a] Mining district located within 15 km of the NNWSI study area.

[b] Mining district located within the NNWSI study area.

[c] Areas where information is unavailable or inadequate to characterize the status of mining

Mountain and Amargosa Desert Districts (Table 2-16) similar to those in the Ash Meadows District further to the south. While these clay resources are substantial and thus of commercial interest, they are probably not critical to regional or national demands since abundant bentonite reserves exist elsewhere.

Deposits of volcanic cinder, perlite, and pumice, located in the Crater Flat and Bare Mountain Mining Districts, are similarly not unique resources when viewed from the perspective of the southern Nevada/California region. Therefore, the importance of these resources is considered minimal. These resources are used in the construction industry for light weight aggregate, in concrete blocks, and for road base and decorative stone. The Cind-r-lite deposit, located north of Highway 95 about 5 miles (8 km) west northwest of Lathrop Wells, is an active commercial operation using open pit methods of production (Bell and Larson, 1982).

Alunite has been reported in the Wahmonie Mining District, but limited information is available on the quality and extent of this occurrence. Since the entire Wahmonie District is within the NTS, this potential resource is unlikely to be developed due to its location.

3.0 HUMAN ENVIRONMENT OVERVIEW

3.1 Introduction

This section provides a broad overview of the social, economic, and cultural resource characteristics of southern Nye County and Clark County, including the Las Vegas metropolitan area, 65 miles (105 km) from the NTS. The population areas serving the southwestern NTS include Amargosa Valley, Beatty, Lathrop Wells, and Pahrump Valley in Nye County and Indian Springs and Las Vegas in Clark County. Prehistoric and historic cultural resources in the NNWSI study area are also described.

3.2 Demography and Settlement Patterns

Both southern Nye County and Clark County have doubled in population since the 1970 census. Tables 3-1 and 3-2 summarize population characteristics of the region from the 1980 census. In Nye County in 1980, the population density was about 0.5 persons per square mile (1.3 per km^2). The estimated average population density for Nevada in 1980 was 1.1 persons per square mile (2.8 per km^2).

Surrounding the NTS, the human settlement pattern is predominantly rural. The largest town near the NTS is Beatty, approximately 20 miles (32 km) west of the NTS. There are approximately 3500 people in Beatty Township; about 900 are in the town itself. The Beatty Township is the fastest growing area in Nye County, up 392 percent since 1970 (U.S. Department of Commerce, 1981a).

TABLE 3-1

SOUTHERN NYE COUNTY: SOCIOECONOMIC CHARACTERISTICS

Township	Total Housing Units	Median Value ($)	1980 Census Population Categories					Total Population*
			White	Black	Indian	Spanish	Other	
Beatty	1,658	-[a]	3,353	31	47	273	93	3,524
Pahrump	596	-	1,274	12	26	76	46	1,358
Totals	2,254	35,600	4,627	43	73	349	139	4,882

Source: U.S. Department of Commerce, 1981a.

*Spanish may be any race and are not counted separately in arriving at the totals indicated in the last column.

[a] Not available

TABLE 3-2

CLARK COUNTY SOCIOECONOMIC CHARACTERISTICS

Township	Total Housing Units	Median Value $	1980 Census Population Categories					Total Population*
			White	Black	Indian	Spanish	Other	
Boulder City	4,025	69,200	9,372	31	48	326	67	9,590
Bunkerville	149	-	447	-	7	46	38	492
Goodsprings	276	-	779	171	22	31	51	1,003
Henderson	8,882	-	22,471	574	263	2,197	1,026	24,334
Las Vegas	150,980	-	305,057	26,536	1,833	25,106	17,085	350,511
Logan	307	-	1,033	-	1	87	53	1,087
Mesquite	302	-	888	-	3	58	31	922
Moapa	199	-	434	-	194	188	74	702
Nelson	4,320	-	9,831	35	50	339	143	10,059
N. Las Vegas	23,682	-	46,818	18,748	642	6,802	4,126	70,334
Overton	725	-	1,649	-	18	116	85	1,752
Searchlight	401	-	614	-	4	8	2	620
Totals	194,248	67,800	399,393	46,095	3,085	35,324	22,761	471,406

Source: U.S. Department of Commerce, 1981a.

*Spanish may be any race and are not counted separately in arriving at the totals in the last column.

[a]Not available

The Pahrump Valley, another growing area with a population of about 1360, is located about 45 miles (70 km) south of the NTS CP-1. The Amargosa Farms area, which has a population of about 1600, is located about 30 miles (50 km) southwest of CP-1.

Other small settlements in southern Nye County (shown on Figure 3-1) include Lathorp Wells (65 people), Ash Meadows (600 people), and Mercury (300 people). Southern Nye County (including Beatty and Pahrump Townships) has a total population of 4900, which is about 53 percent of the entire county.

The population of Clark County is much larger and urban. Of the total 462,000 population, 52 percent live in the incorporated areas of Boulder City, Henderson, Las Vegas, and North Las Vegas. Table 3-3 shows the population characteristics of these incorporated urban areas of Clark County. Las Vegas is the largest township in Clark County.

The population center nearest the NNWSI in Clark County is the Indian Springs area, which is adjacent to the Indian Springs Air Force Base. Settlement here includes on-base housing for military personnel, as well as off-base housing. Indian Springs has a population of 900 people off-base and 500 on-base. Some residents of Indian Springs commute to Las Vegas.

3.3 Economy of the Region

Industry within the southern Nye and Clark County area includes approximately 40 active mines and mills, two oil fields at Trap

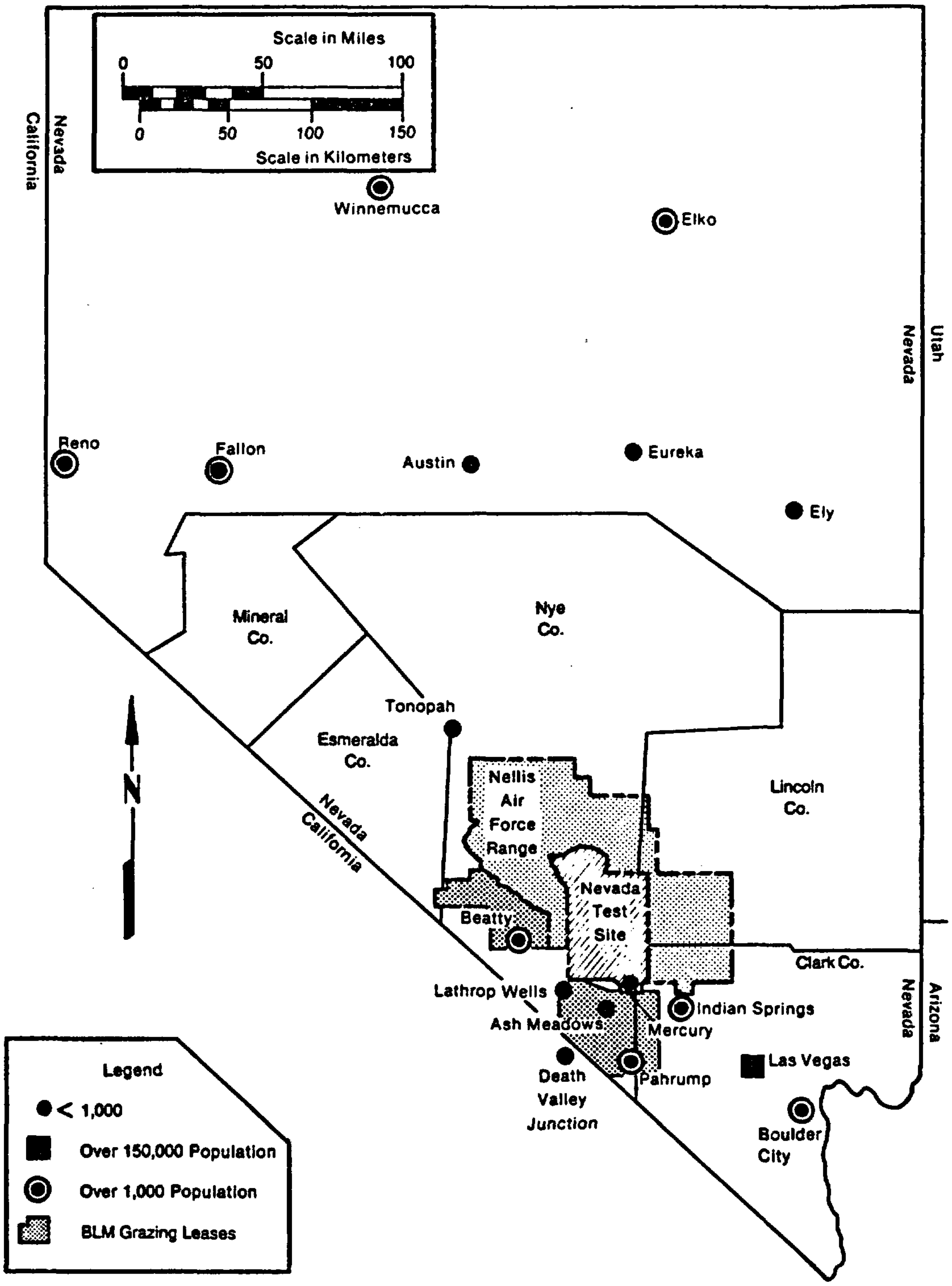


FIGURE 3-1
POPULATION CENTERS SURROUNDING NTS

TABLE 3-3

INCORPORATED PLACES OF CLARK COUNTY, NEVADA: SOCIOECONOMIC CHARACTERISTICS

City	Total Housing Units	Median Value ($)	Census Population Categories					Total Population*
			White	Black	Indian	Spanish	Other	
Boulder City	4,025	69,200	9,372	31	48	326	139	9,590
Henderson	8,889	61,100	22,491	580	263	2,197	1,029	24,363
Las Vegas	67,133	65,500	134,330	21,054	1,050	12,787	8,240	164,674
North Las Vegas	14,123	46,500	23,588	16,115	374	4,826	2,662	42,739
Totals:	94,170	NA	189,781	37,780	1,735	20,136	12,070	241,366

Source: U.S. Department of Commerce, 1981a.

*Spanish may be any race and are not counted separately in arriving at the totals in the last column.

Springs and Eagle Springs, and several industrial plants in Henderson, Nevada. The number of employees of these operations may vary from one person at several of the small mines to several hundred workers for the oil fields north of the NTS and the industrial plants in Henderson. Most of the individual mining operations involve less than ten workers per mine; however, a few operations employ 100 to 250 workers. Tourism in Las Vegas, recreation, agriculture, and the military, as well as the NTS operations, employ the remainder of the work force. The permanent residents of the Las Vegas area are largely in the city of Las Vegas, where many NTS employees live. The tourist and convention business supports the largest number of employees. North Las Vegas and Henderson are the second and third to Las Vegas in size of populations. The employment statistics are shown in Table 3-4, with estimated incomes given for a projected base year of 1982. The numbers of service personnel are also given for both Clark and Nye Counties.

In the metropolitan Las Vegas area, there are 2.56 people per housing unit. Housing costs average between $46,500 in North Las Vegas to a high of $65,500 in Las Vegas (U.S. Department of Commerce, 1981a). North Las Vegas has lower per capita income and has a 45 percent minority population.

In comparison, the residents of southern Nye County have lower incomes, are rural and ranching oriented, or are employed in mines,

TABLE 3-4

SOCIOECONOMIC BASELINE CHARACTERISTICS FOR NYE AND CLARK COUNTIES, NEVADA

Population[a]	
Nye County	9,048
Lincoln County	4,076
Clark County	463,087

Employment[b]	Nye	Clark
Population Baseline (1982)	10,000	485,433
Labor Force	3,220	233,979
Available Resident Labor Force	32	11,231
Unemployed	129	18,251
Service Personnel Facilities[b]		
Physicians	15	728
Nurses	44	2,185
Dentists	5	257
Mental Health Persons	2	131
Hospital Beds	40	1,942
Teachers	118	5,739
Law Enforcement	20	971
Firemen	16	801
School Enrollment[b]		
K - 12th Grade	2,600	126,265

Annual Income Average[b]	Nye and Clark
Construction	$39,000
Assembly/Mft.	$25,000
Military	$11,400 - 25,800
Civilian Personnel	$19,700
Indians	<$ 5,000

[a] U. S. Department of Commerce, 1981a

[b] Henningson, Durham, and Richardson, 1980

at the NTS or Nellis Air Force Range, or work in Beatty. People also commute to Las Vegas from Pahrump, which contains most of the higher incomes and home values. In southern Nye County, there are 2.1 people per housing unit, and the median house is valued at $35,600. One reason for the lower home value is the presence of a large number of mobile homes.

3.4 Land Use

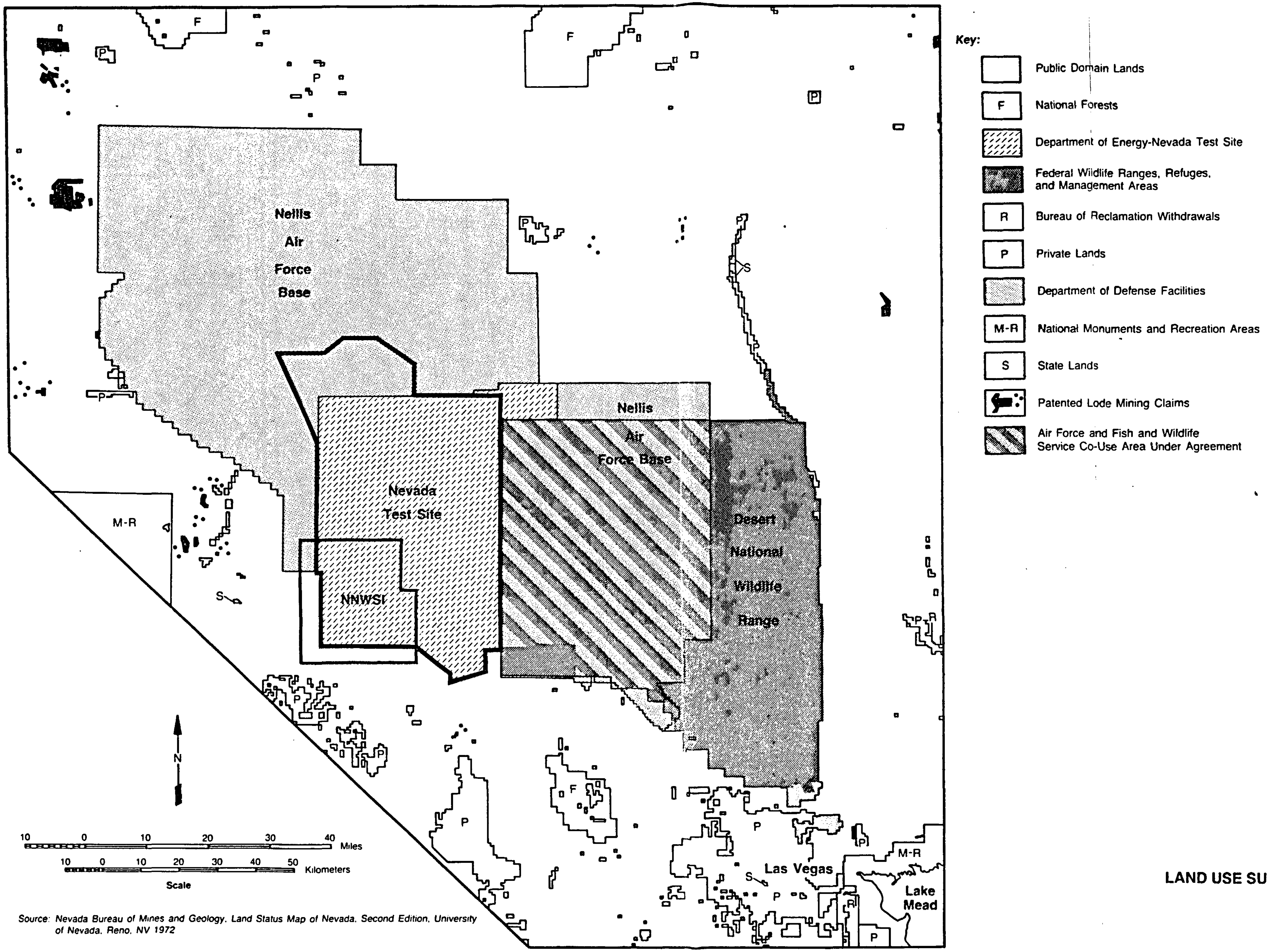
Land use surrounding the southwestern NTS area shows a wide variety of uses, such as farming, mining, grazing, camping, fishing, and hunting. The area north of the NAFBR is mid-latitude steppe, where the major agricultural activity is grazing of cattle and sheep. Minor agriculture, primarily the growing of alfalfa hay, is found in this portion of the State. Many of the residents grow or have access to locally grown fruits and vegetables. Livestock grazing is a common land use particularly to the northeast, as well as on public lands south and west of the NTS. Dairy farms are rather limited, with most of the dairy industry north of Lake Meade in Clark County.

Many recreational areas, in all directions around the NTS and the NAFBR, are used for such activities as hunting, fishing, and camping. In general, the camping and fishing sites to the northwest, north, and northeast of the NAFBR are utilized throughout the year except for the winter months. Camping and fishing locations to the southeast, south, and southwest of NTS are utilized throughout the year. The Desert National Wildlife Range is a joint use area of the Air Force and the Fish and Wildlife Service (Figure 3-2).

The Mojave Desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada about 35 miles (56 km) from Mercury. The National Park Service estimates that the population within the Monument boundaries ranges from a minimum of 900 permanent residents during the summer months to as many as 35,000 tourists per day during the major holiday periods in the winter months, and as many as 80,000 during "Death Valley Days" in the month of November. In addition, Toiyabe National Forest and skiing area in the Spring Mountains is located southeast of the NTS near Las Vegas and is a major recreation area.

Most private and commercial development is concentrated in the Las Vegas metropolitan area, which includes the incorporated areas previously described. Private lands are scarce in the immediate area around the NTS and are located within the following towns and valleys:

- Amargosa Valley - 1500 acres (600 hectares)
- Beatty - limited acreage along Highways 95 and 58
- Indian Springs - limited acreage along Highway 95
- Lathrop Wells - limited acreage at intersection of Highways 95 and 29
- Pahrump Valley - planned community development



Source: Nevada Bureau of Mines and Geology. Land Status Map of Nevada. Second Edition. University of Nevada, Reno, NV 1972

FIGURE 3-2
LAND USE SURROUNDING STUDY AREA

- Ash Meadows - planned subdivision; approximately 13,000 acres (5300 hectares) of private lands are available
- Oasis Valley - unknown acreage

Future subdivisions are planned in Ash Meadows and the Pahrump Valley. The largest planned subdivision is called Calvada Lakes in Ash Meadows (Sections 28, 33, 34 and T17S R50E, and Section 3 in T18S R50E); also planned in Ash Meadows are Johnnie Townsite, about 160 acres (65 hectares) (Section 36 T17S R52E and Section 1, T18S R52E) and Forty Bar Estates, about 100 acres (40 hectares) (Sections 7 and 8 in T17S R52E). The largest subdivision in Pahrump Valley is planned near the center of the valley around the old Pahrump Ranch (O'Farrell et al., 1981). Other large parcels of former farmlands in the valley have been purchased for future subdivision.

3.4.1 Transportation

In the immediate area surrounding the NNWSI study area, transportation is limited; a major Highway, U.S. 95, connects Beatty to Las Vegas, passing through Lathrop Wells and Indian Springs. State Highway 373 provides southbound access to Death Valley from Lathrop Wells. State Highway 160 serves the Pahrump Valley and accesses both U.S. 95 near Mercury and Interstate 15 south of Las Vegas, and State Highway 372 is westbound out of Pahrump.

Clark County and the Metropolitan Las Vegas Area, more specifically, are served by Interstate 15, U.S. Highways 93 and 95. In addition, there are various highways, county roads and streets and a network of residential streets as well as high volume traffic arteries. At the present time (1982) Las Vegas is served by the Union Pacific Railroad and AmTrack; however, there is some question as to whether or not the AmTrack service will be continued.

There is presently only one small section of railroad track on the NTS, in the central portion of the NRDA. This railroad and paved and unpaved roads on the NTS are shown on Figure 3-3.

Air service into the study area is limited to contractor aircraft, government helicopters, and U.S. Air Force planes. There are landing fields (Yucca Lake and Pahute Strip) on the NTS, and at Indian Springs AFB and Nellis AFB. Nellis AFB airport, under Air Force control, is 61 miles (98 km) to the east and handles 64,000 flights per year. Just south of Mercury on the NTS is the Desert Rock Air Strip which is under DOE control (Figure 3-3). Small landing strips for private planes are located south of Beatty, at Lathrop Wells, and in Pahrump. In Clark County, there are two large commercial and public airports. The North Las Vegas Airport, located 53 miles (85 km) to the southeast of the NTS, handles 170,000 flights per year. The largest airport in the region, McCarran International, located 59 miles (95 km) to the southeast of the NTS, handles 265,000 commercial operations per year (U.S. Energy Research and Development Administration, 1977).

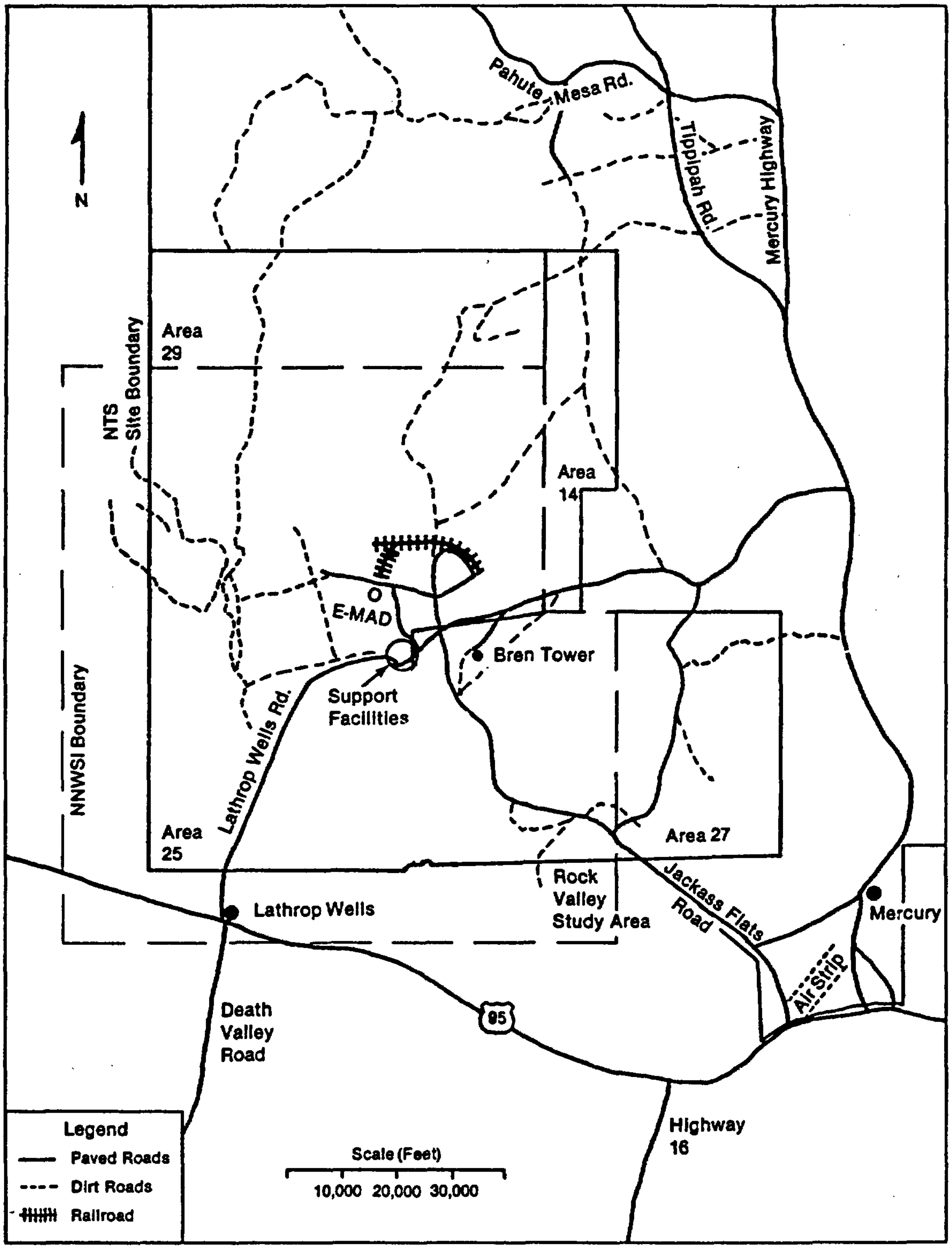


FIGURE 3-3
ROADS OF THE NTS

3.4.2 Public Land

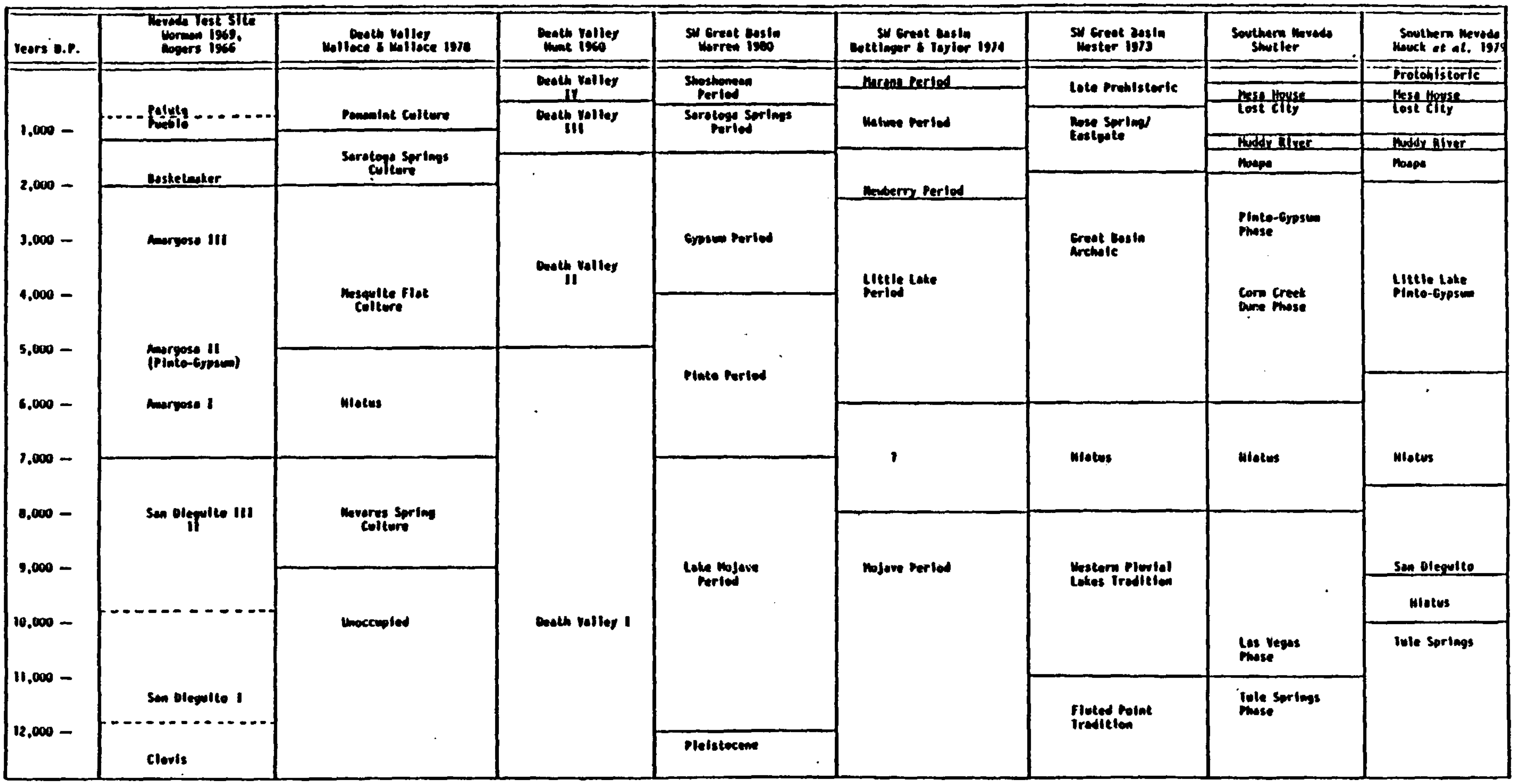
The majority of the lands in the region are public lands, administered by either the Bureau of Land Management under the multiple-use principle, by the U.S. Air Force as the Nellis AFBR, or by the U.S. Department of Energy for the Nevada Test Site. The NTS is more than 900,000 acres (364,500 hectares) and is surrounded on three sides by hundreds of thousands of acres managed or used by the U.S. Air Force. The remainder are BLM Federal lands (primarily south of Highway 95, east of Highway 373 to the Clark County line, west of the Nellis AFBR to Beatty, and north and west of Beatty to the Esmeralda County line). About 737,000 acres (298,000 hectares) are leased to private ranchers; however, no leases are adjacent to the NTS. The Federal government owns 87 percent of Nye County (O'Farrell et. al., 1981). The Desert National Wildlife Range to the east of the NTS, located in Lincoln and Clark Counties, is a million and a half acre refuge Federally controlled.

3.5 Cultural Resources

It is believed that Paleoindian hunters first entered the NNWSI study area around 13,000 years ago. Within the Las Vegas Valley, late Pleistocene and Holocene sediments contain artifacts made by these ancient peoples. Pippin and Zerga (1981) trace the settlement of the region using projectile points as "index fossils" of various cultures since 12,000 B.C.

The establishment of a cultural chronology in the area is basic for understanding its prehistory and for evaluating the significance of cultural resources located therein. The chronological sequence of cultural events in and around the study area is poorly known, and scholars disagree about the character and temporal placement of cultural phases as shown by Pippin and Zerga (1981) on Figure 3-4. Prehistoric populations making "Clovis-like" and "Great Basin Stemmed" projectile points may have inhabited the region as early as 10,000 to 13,000 years ago, but their societies and relationships to each other and to those of outside regions are not known. Although undoubtedly younger than the "Clovis" and "Great Basin Stemmed" cultural materials, the "Pinto", "Humboldt" and/or "Little Lake" cultural assemblages are also poorly defined and dated (Pippin and Zerga, 1981).

With the exception of horticulturalists around the Muddy and Virgin River areas, the prehistoric peoples who inhabited southern Nevada relied on hunting and gathering. Nonetheless, there may have been significant cultural changes in resource exploitation strategies, settlement patterns, interaction spheres, and social structure. The semi-permanent habitation and multi-component sites in the study area may contain evidence of subsistence changes as well as artifact assemblages and distributions reflecting changes in technology, cultural influence and community structure. In other cases, the evidence of such changes and their causes may be preserved in the archaeological remnants of numerous specialized activity areas marked by isolated artifacts.



Source: Compiled by Pippin and Zerga, 1981.

FIGURE 3-4
VARIOUS CULTURAL CHRONOLOGIES PROPOSED FOR THE PREHISTORY OF SOUTHERN NEVADA AND ADJACENT CALIFORNIA

When the first Euroamerican explorers and immigrants entered southern Nevada, they encountered widely scattered groups of primitive hunters and gatherers who spoke different dialects of closely related Uto-Aztecan languages. These peoples usually called themselves the "Numas", but are now commonly referred to as Southern Paiute and Shoshone (Fowler and Fowler, 1971). These peoples were subsistence groups whose demographic patterns were determined by availability of food and water supplies, and fuel during the winter. It is also believed that Pueblo and Paiute peoples frequented the area of Fortymile Canyon, via the Timber Mountain Divide - Cat Canyon road (Pippin and Zerga, 1981). Here are found rockshelters, roasting pits, and rock art known as petroglyphs.* In the region to the east, the Virgin River - Moapa Valley area, pit houses, pueblos and stratified dry caves are also recorded.

The first Euroamerican habitation is recorded near Cane Spring, with a stone block in a fireplace inscribed in 1847. The first documented emigrants who passed through the study area in 1849 were California-bound, but it is possible that Mormons may have been in this region in the winter of 1846-1847 (Pippin and Zerga, 1981). The route between Utah and California, with a branch through Fortymile Canyon in the NNWSI study area, became known as the "Old Emigrant Trail."

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*There are nine known petroglyphs in Nye County; the oldest date to 5,000-3,000 B.C. and are associated with hunters and game drives.

Studies of the various routes followed by the Jayhawkers, Brier, and Manly-Bennett parties provide a baseline to the historic development of transportation networks through the study area and their importance in the exploration, mining and ranching histories of southern Nevada. Hence, the Old Emigrant Trail became a major mail and freight route with relay stations, camp sites, abandoned wagons, and settlements along its path, which opened the area to newcomers (Pippin and Zerga, 1981). Studies of these transportation networks may provide information on the development of this region, and how this development may have impacted the regions' natural and cultural environments.

The history of Nevada is intimately linked with the history of mining. However, the vast majority of the literature documenting this history has been oriented toward those already well known mining camps that became major towns, such as Rhyolite, Tonopah, and Goldfield. Even for these major centers, historical documentation is biased and contradictory (Pippin and Zerga, 1981). In the case of tent camps, such as Wahmonie, and isolated prospects, such as those around the Calico Hills, information is scant, based on stray fragments of data usually in the form of claim names or statements from courthouse records, newspaper files and other documents. The lure of mineral wealth attracted people to the study area. The earliest records are of galena ore mining in 1869 in the northwest corner of the study area. During the period between 1870 and 1900, an economic depression occurred, and no mining activity is known, except for borax in Death Valley, about 30 miles (48 km) west of the study area (Pippin and Zerga, 1981).

In 1900, rich silver deposits were discovered in southwestern Nevada. This led to the formation of the Tonopah Mining District, the largest producer of siliceous silver-gold ore in the U.S., with 50 new mining districts quickly established in Nye County. From 1902 to 1904, both gold and silver strikes brought a rush of people to the region (Pippin and Zerga, 1981). The Bullfrog Hills area, 20 miles (30 km) northwest of the study area became the largest gold producing district in Southern Nye County. In 1928, high grade silver-gold ore discoveries at Wahmonie brought a population of over 1000* and a supporting "town" of stores, saloons, and a post office. Concomitant with the mining development, the regional network of roads and railroads built up.

As the miners dispersed in the region, some left for other states, but some stayed to open the early ranches which ranged cattle on open lands. Several hundred cattle were ranged at Cane, Topopah, Whiterock and Tippipah Springs for a number of years prior to the Federal land withdrawal. Furthermore, a Frenchman named NaQuinta, the supposed namesake of Frenchman Flat, also ranched in this region prior to 1951. Topopah Spring is also the site of a

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*These mines closed after one year.

former ranch. Wild horse hunters used Whiterock Spring, near the northern boundary of the Nevada Test Site, as a ranch headquarters from where they drove their captured horses to Las Vegas (Pippin and Zerga, 1981).

3.5.1 Prehistoric and Historic Resources

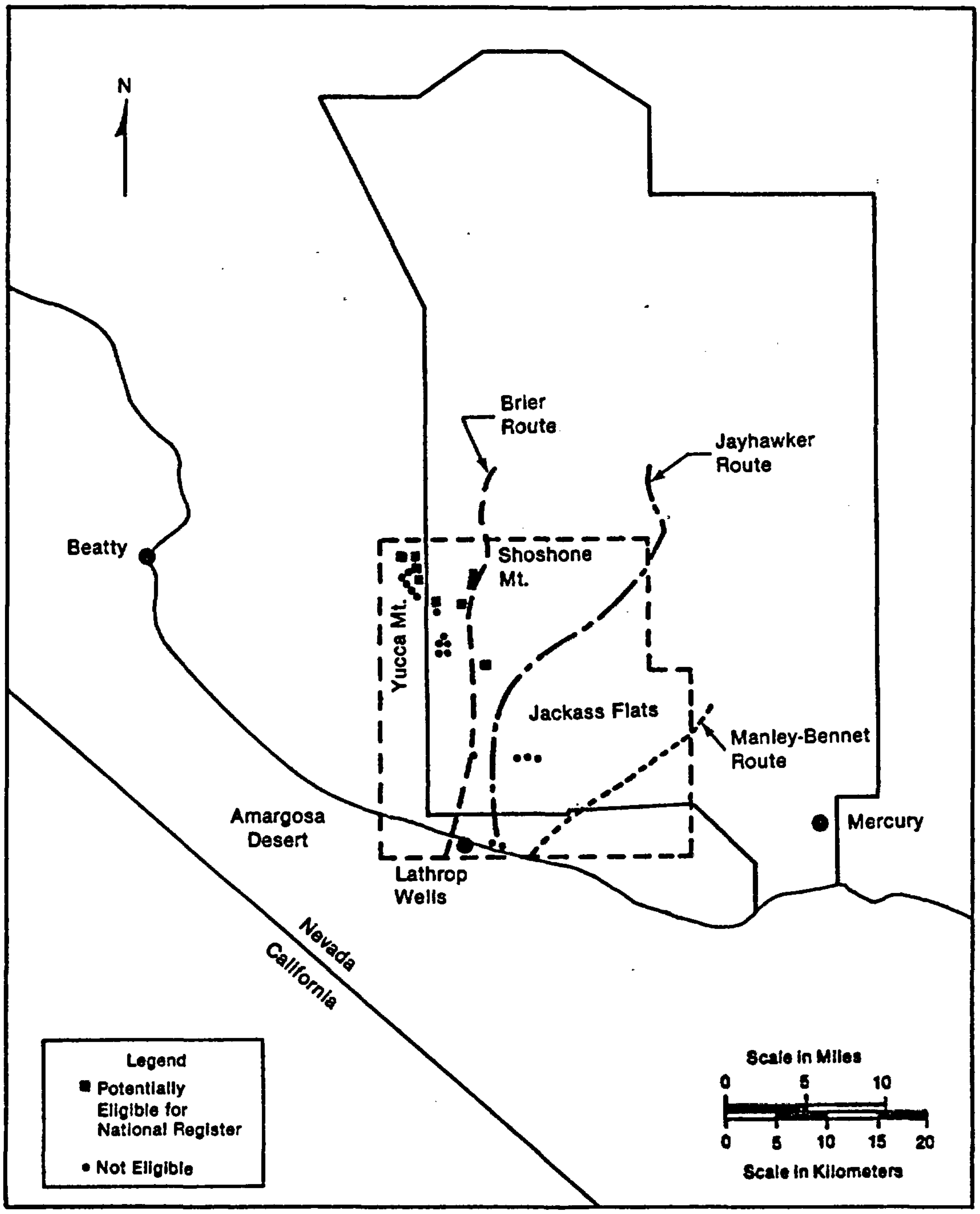
Locations of prehistoric cultural resources are determined by the habits and settlement patterns of the cultures. Pippin and Zerga (1981) report 26 prehistoric archaeological sites recorded in the study area, and these are shown in Figure 3-5. These prehistoric resources are classified by the following site types:

- residential bases (1)
- field camps (4)
- workshops (4)
- knapping stations (1)
- quarries (1)
- isolates (14)
- tinajitas (potholes) (1)

The idealized site types represent localities with a theorized settlement and subsistence system characteristic of most collecting societies whether they be hunters, gatherers or both (Binford, 1980). Consequently, this classification scheme provides a means of ordering the archaeological record and a framework for the scientific evaluation of the significance of each previously known archaeological site.

The historic resources (shown in Figure 3-5) also include the three branches of the Old Emigrant Trail which passed through the NTS prior to 1847:

- Brier Route
- Jayhawker Route
- Manley-Bennett Route



Source: Pippin and Zerga, 1981.

FIGURE 3-5
KNOWN CULTURAL RESOURCES OF THE AREA

The earliest permanent record of Euroamerican presence is a stone block inscribed "R.J. Bryor, 1847." Other historic sites include 21 known prospects and mines from the late 1800's and early 1900's and the site of the mining town of Wahmonie, north of Skull Mountain.

3.5.2 Significance of the Cultural Resources

Pippin and Zerga (1981) indicate that some of the prehistoric sites are of value, and these cultural resources in the study area are grouped into three classes: (1) sites with potential for nomination to the National Register, (2) sites not eligible for nomination, and (3) sites where eligibility is indeterminate.

Cultural resources listed in the National Register of Historic Places are protected under Section 106 of the National Historic Preservation Act of 1966 (Public Law 89-665). The Old Emigrant Trail was listed in 1980 in the Federal Register (45FR54:17505) as a significant historic resource eligible for nomination in the National Register because of its importance during the early exploration and settlement of Nevada and California. Because the three separate routes of the Emigrant Trail through the study area are an integral part of the Trail's importance, they are to be included under this listing, although they have not been examined for associated archaeological remains (Pippin and Zerga, 1981).

Furthermore, Pippin and Zerga (1981) indicate that ten cultural resource sites in the project area appear to have a potential to yield significant information important for the understanding of sourthern Nevada prehistory, and therefore may be eligible for nomination to the National Register. These cultural resources may be grouped into two categories: archaeological sites whose eligibility lies with their significance as individual entities and archaeological sites whose eligibility rests not so much with their individual characteristics, but rather with their patterning on the landscape and their relationships with other archaeological sites.

Three archaeological sites may be eligible for nomination to the National Register as individual entities. Based on their geological context and material culture content, all three sites appear to have a good potential to yield new and significant data.

Seven archaeological sites appear to represent specialized activity areas such as field camps or workshops, and further research is necessary to determine their eligibility. These sites are shown in Figure 3-5. Although their full meaning and significance may not yet be known, 15 of the previously recorded archaeological sites in the study area need not be considered for nomination to the National Register (Pippin and Zerga, 1981).

The NNWSI study area has not been systematically examined* for cultural resources. Limited preconstruction and area familiarization surveys in the area have discovered several archaeological sites there, but these surveys have covered less than

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*archaeological reconnaisance was begun on Yucca Mountain in mid-1982.

0.01 percent of the total land area, and survey locations have not been determined by archaeological sampling. It is important to emphasize, therefore, that the known cultural resources represent only a very small and unrepresentative fraction of the prehistoric and historic archaeological records of the study area (Pippin and Zerga, 1981).

3.6 Paleontological Resources

Firby (1981) conducted an extensive literature survey and collection survey of the paleontological resources of the southwestern NTS, including the fossiliferous strata--primarily early to middle Paleozoic marine carbonates and fine grained clastics. Firby's list of 19 locations on the Annotated Paleontological Locality Register is included in a separate topical report to DOE. Paleozoic fossils of marine invertebrates, including mollusks, gastropods, coelenterates, bryozoa, brachiopods, and corals are listed from the Devonian and Mississippian periods. While plant fossils of the Miocene and Pliocene age, and non-marine aquatic and terrestrial mollusks and fossil mammal remains of the Tertiary-Quarternary period are found in the area of the NTS, none are recorded in the NNWSI study area. Firby concludes that the southwestern NTS study area is an area of low paleontological potential, and that the Paleozoic marine fossils found here are not unique.

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