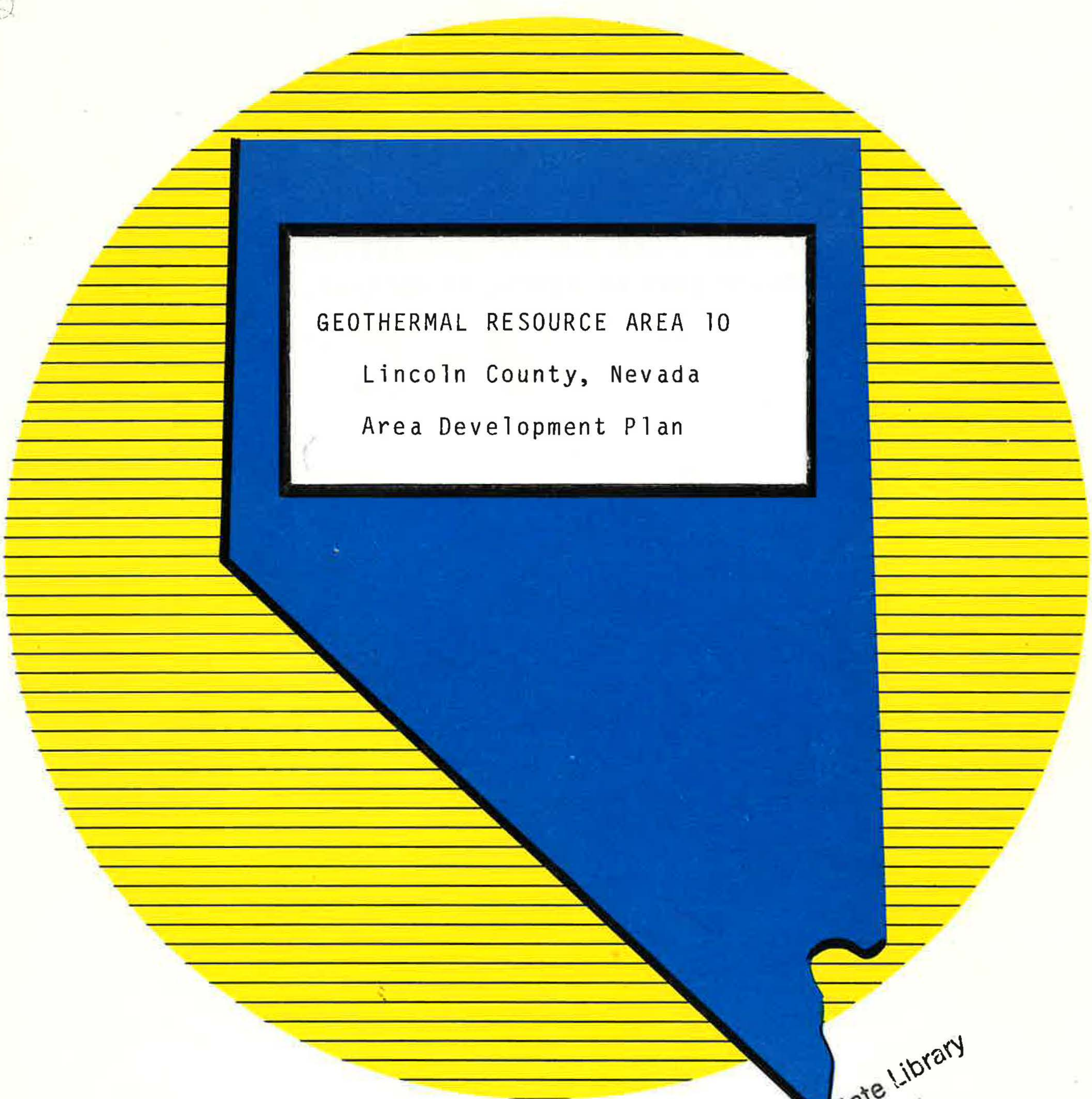

GEOTHERMAL RESOURCE AREA 10

Lincoln County, Nevada

Area Development Plan

NEVADA DEPARTMENT OF ENERGY

O-1842

GEOTHERMAL RESOURCE AREA 10

Lincoln County, Nevada

Area Development Plan

Prepared under the direction of:

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1981

Contract Number: DE-FC03-80RA50075

DISCLAIMER

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SUMMARY

Geothermal Resource Area 10 includes all of the land in Lincoln County, Nevada. Within this area are 10 known geothermal anomalies: Caliente Hot Springs, Panaca Warm Springs, Delume's Springs, Flatnose Ranch Spring, Hiko Springs, Crystal Springs, Ash Springs, Geyser Ranch Springs, Hammond Ranch Springs, Sand Springs, and Bennett's Springs.

The geothermal resource in Lincoln County, though somewhat limited, has some potential for development. All of the known geothermal areas have measured temperatures of less than 160° F. Most have temperatures of less than 100° F. Because of the low temperature of the resource and, for the most part, the distance of the resource from any population base, the potential application types are somewhat restricted.

Two of the 10 sites have significant potential in relation to local energy and economic requirements. Caliente has already partially developed the resource located under the community. It is now supplying some hot water and space heating needs for a trailer court, several homes, and a hospital. The energy already on-line in Caliente is making a significant impact on the economic base of the community and decreasing the demand for conventional energy resources. Recent studies have indicated the technical and economic feasibility of installing a district space heating system. If such a system were developed, it could only increase the economic benefits received from this alternative energy resource.

Ash Springs has already been developed into a recreational area. Because of the high flow rate and the adequate water temperature of the resource, prawn or fish farming may have good potential at this site.

The development of the geothermal resources in Lincoln County could contribute to a significant savings of fossil fuel energy and potentially broaden the economic base of the county.

I. INTRODUCTION

Geothermal Resource Area 10 encompasses all the land areas of Lincoln County. There are 10 known geothermal anomalies in this area which are addressed in this plan: Caliente Hot Springs, Panaca Warm Springs, Flatnose Ranch Springs, Hiko Springs, Crystal Springs, Ash Springs, Geyser Ranch Springs, Hammond Ranch Springs, Sand Springs, and Bennett's Springs.

The purpose of this document is to provide public and private decision makers with information that will facilitate the development of the various geothermal resources found in Lincoln County (Figure 4). To further this goal, this Area Development Plan was prepared to provide information about the geothermal resource, the physical and socio-economic setting of Lincoln County, and the potential for developing various uses of these under-utilized resources.

This report has been divided into three major sections to enable the reader to more easily interpret the information presented. The first section describes Lincoln County in terms of its physical and socio-economic characteristics. The second section describes the resource itself based upon the best currently available information. The third section describes the potential uses for the resources based on a study of the geothermal resource characteristics, land use, and various other factors.

II. THE AREA

A. Physical Characteristics

1. Location and Relief

Lincoln County is located in southeastern Nevada and has a total land area of 10,649 square miles. It is the third largest county in the state containing about ten percent of the total land area.

The county is bordered on the north by White Pine County; on the east by the State of Utah; on the south by Clark County; and on the east by Nye County (Figure 2).

Lincoln County is characterized by alternating, linear mountains and valleys. The largest of the mountain ranges include the Worthington Range, Wilson Creek Range, Delmar Range, Clover Range, the Groom Range, Creek Range, and the Mormon Mountains. The largest of the valleys include Cave Valley, Lake Valley, Dry Lake Valley, Tule Desert, Kane Springs Valley, Pahranagat Valley, and Tikaboo Valley. The range of elevation in Lincoln County varies from a high of 8,850 feet at Worthington Peak in the Worthington Range to a low of about 1,900 feet is found east of the Mormon Mountains in the Tule Wash area.

2. Climatic Conditions

The climatic conditions in Lincoln County are quite variable due to the large physical size and the relief of the area. Detailed climatological information is available for Lincoln County only at two meteorological recording stations: Pioche, elevation 6,120 feet; and Caliente, elevation 4,404 feet. Tables 1 and 2 give a detailed climatological summary for each of these sites.

The climate of Lincoln County is essentially arid with hot summers and cool winters. The continental type of climate is affected by the distant Sierra Nevada Range to the west and the

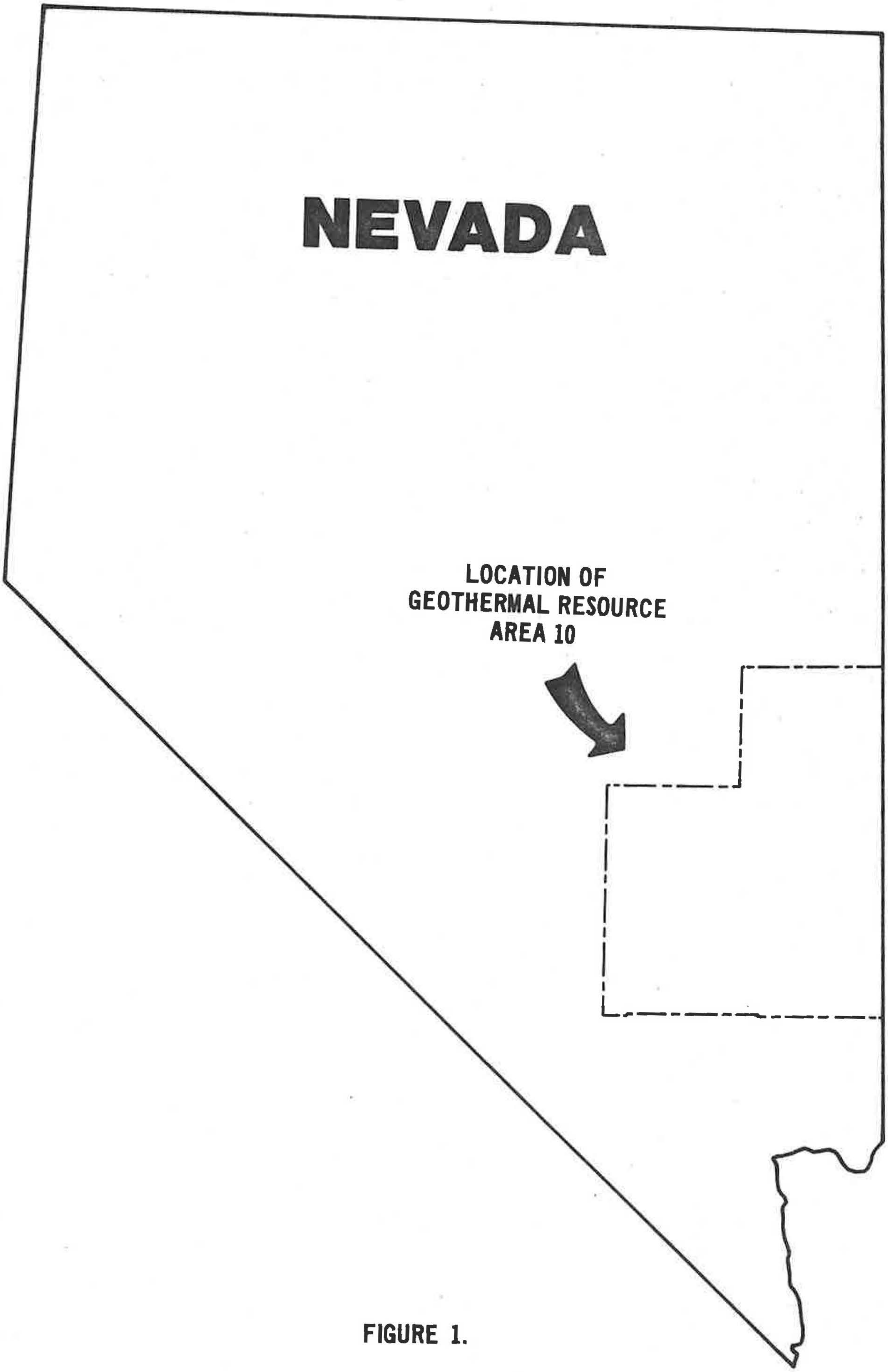

FIGURE 1.

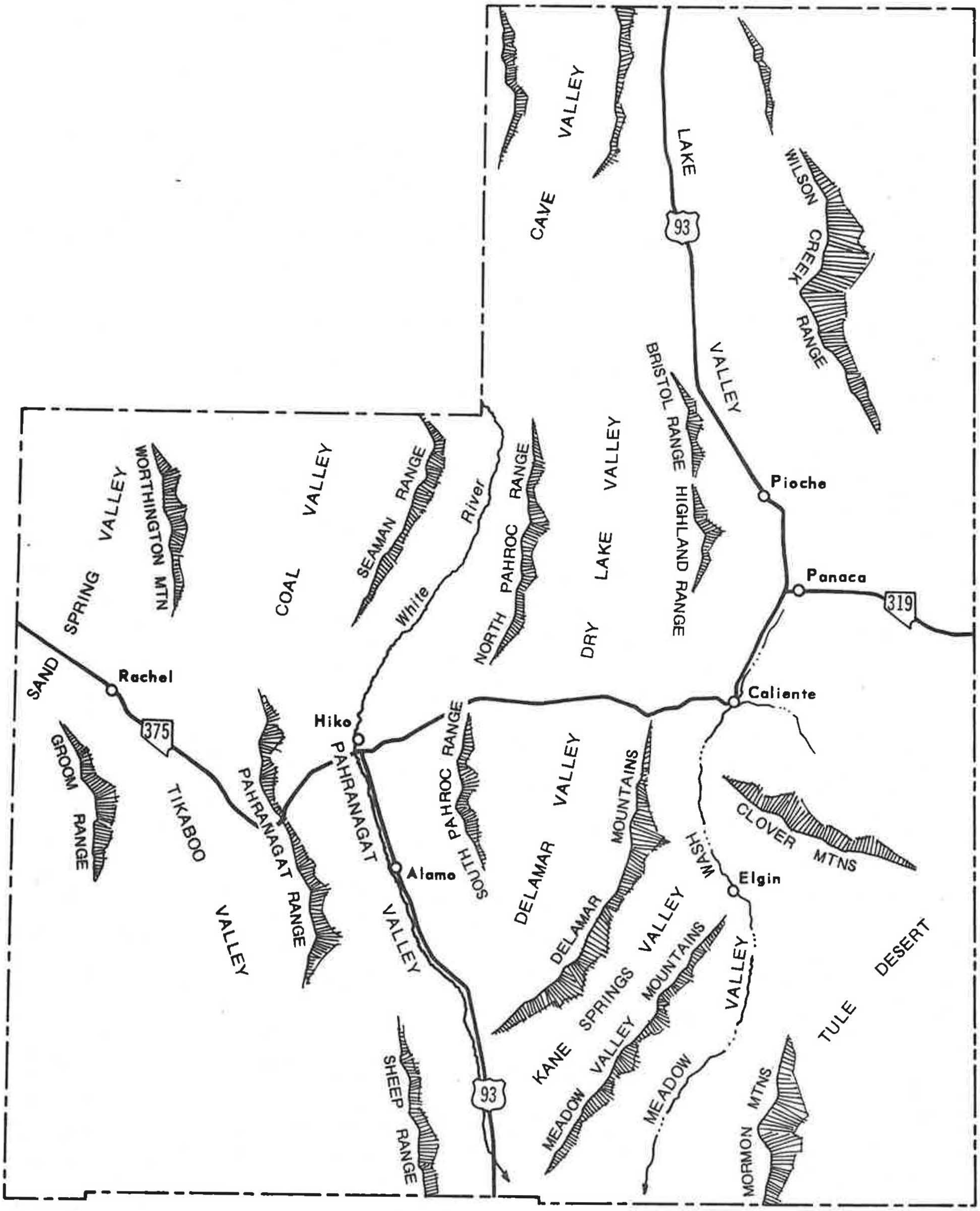

FIGURE 2. TOPOGRAPHICAL AND PHYSICAL FEATURES OF LINCOLN COUNTY.

Rocky Mountains to the east. Pacific storms moving west to east must pass over the Sierras before reaching Lincoln County. As moist air rises it cools and loses much of its moisture. As the air mass descends into the Great Basin it warms up and becomes relatively dry. Consequently, heavy precipitation in this area is infrequent.

The Rocky Mountains to the east also play an important role in determining the climate of Lincoln County. These mountains deflect the cold arctic air from Canada so that it moves east onto the Great Plains. This results in a mild winter climate over much of the area.

Summer thunderstorms occur approximately 15 to 20 days per year. Warm, moist air from over the Gulf of Mexico flows northward for several months in the summer. Thunderstorms are common in these months. Hail averages three days per year and occurs in association with these storms. Rainfall from the thunderstorms can be quite heavy. As much as three inches of rain has fallen from a single storm.

Temperatures in Lincoln County range from mild to hot. Summer minimums are in the 40's (F.) while summer maximums are in the 90's (F.). Winter minimums are in the teens and maximums in the 40's (F.). The hottest recorded temperature is 109° F. and the coldest recorded temperature is -31° F. The growing season averages about 148 days per year. Temperature characteristics at other locations in Lincoln County may be inferred by applying the environmental lapse rate of 3-1/2° F. per 1,000 vertical feet lower or higher than the recording station. Care must be taken, however, when using temperatures derived from using the envirnomental lapse rate as local conditions may influence exact temperature readings.

TABLE 1

CLIMATOLOGICAL SUMMARY

LATITUDE 37° 56'
LONGITUDE 114° 27'
ELEV. (GROUND) 6120 Feet

STATION PIOCHE, NEVADA

MEANS AND EXTREMES FOR PERIOD 1941-1970

Month	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days **	Precipitation Totals (Inches): Mean	Greatest daily	Year	Snow, Ice Pellets: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days: Precip. .10 inch or more	Temperatures Max.: 90° and above	32° and below	Min.: 32° and below	0° and below	Month
(a)	30	30	30	30		30		30	30	30		30	30		30		30	30	30	30	30	
Jan	41.4	20.9	31.2	64	1961	-11	1963	1047	1.47	2.26	1969	11.2	40.0	1949	12.0	1954+	3	0	5	29	1	Jan
Feb	45.2	23.7	34.5	70	1963	- 5	1949	854	1.24	1.50	1969	7.3	37.0	1969	12.0	1969	3	0	2	25	1	Feb
Mar	50.6	26.9	38.7	79	1968	.4	1966	815	1.37	1.33	1958	8.8	33.3	1952	11.0	1952	3	0	1	24	0	Mar
Apr	60.4	34.5	47.5	81	1946	12	1963	525	1.29	1.00	1950	4.2	16.8	1941	7.5	1945	3	0	0	13	0	Apr
May	70.6	42.8	56.7	91	1951	22	1964	257	0.73	1.45	1947	0.5	4.2	1961	3.5	1961	2	0	0	3	0	May
Jun	80.6	50.7	65.6	102	1954	30	1954+	90	0.40	1.11	1948	0.1	2.0	1950	2.0	1950	1	4	0	0	0	Jun
Jul	88.9	58.1	73.5	101	1966+	46	1956+	0	1.14	1.94	1970	0.0	T	1953	T	1953	3	15	0	0	0	Jul
Aug	86.0	56.8	71.5	99	1958	38	1968+	0	1.25	1.10	1970	0.0	T	1955+	T	1955+	3	9	0	0	0	Aug
Sep	78.8	50.0	64.4	96	1950	25	1948	0	0.64	2.68	1966	0.0	1.0	1965	1.0	1965	1	2	0	0	0	Sep
Oct	66.4	39.7	53.0	85	1964	19	1961	383	0.95	1.27	1968	1.3	9.0	1951	7.0	1951	2	0	0	8	0	Oct
Nov	51.9	28.9	40.4	74	1949	4	1952	738	1.19	1.56	1944	4.7	19.5	1957	10.0	1957	3	0	1	18	0	Nov
Dec	43.2	22.8	33.0	65	1942	- 4	1948	992	1.70	3.02	1966	9.4	37.7	1947	18.5	1947	3	0	5	28	0	Dec
Year	63.7	37.9	50.8	102	1954	-11	1963	5701	13.37	3.02	Dec 1966	47.5	40.0	1949	18.5	1947	30	30	14	148	2	Year

(a) Average length of record, years.

T Trace, an amount too small to measure.

** Base 65°F

\+ Also on earlier dates, months, or years.

* Less than one half.

TABLE 2

CLIMATOLOGICAL SUMMARY

LATITUDE N37 37 — LONGITUDE W114 31

MEANS AND EXTREMES FOR PERIOD 1951-1973

CALIENTE, NV — ELEVATION 4402

TEMPERATURE (°F)

MONTH	MEANS: DAILY MAXIMUM	MEANS: DAILY MINIMUM	MEANS: MONTHLY	EXTREMES: RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	MEAN NUMBER OF DAYS MAX. 90° AND ABOVE	MAX. 32° AND BELOW	MIN. 32° AND BELOW	MIN. 0° AND BELOW
JAN	47.9	17.4	32.7	69	71	31	-10+	63	13	0	2	29	2
FEB	54.2	23.2	38.7	76	63	6	-1	56	17	0	1	25	0
MAR	60.4	26.5	43.4	90	71	30	2	58	9	0	0	26	0
APR	68.8	33.4	51.1	88+	54	17	16	66	20	0	0	14	0
MAY	78.7	41.7	60.2	98	51	26	24	67	1	3	0	3	0
JUN	88.9	49.4	69.2	109	54	22	33+	71	1	15	0	0	0
JULY	95.9	56.6	76.3	107+	60	17	40	58	18	29	0	0	0
AUG	93.3	56.0	74.6	105+	60	7	38	57	31	23	0	0	0
SEPT	86.3	45.5	65.9	102+	55	6	27+	65	20	10	0	1	0
OCT	74.6	35.0	54.8	94	63	1	14+	71	30	1	0	11	0
NOV	59.3	25.4	42.4	80	62	2	0	56	20	0	0	25	0
DEC	49.0	18.8	33.9	69+	58	5	-13	67	21	0	1	29	1
YEAR	71.4	35.7	53.6	109	JUN 54	22	-13	DEC 67	21	81	4	163	3

PRECIPITATION TOTALS (INCHES)

MONTH	MEAN	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	SNOW, SLEET: MEAN	MAXIMUM MONTHLY	YEAR	GREATEST DEPTH	YEAR	DAY	MEAN NUMBER OF DAYS: .10 or MORE	.50 or MORE	1.00 or MORE
JAN	.71	2.50	69	.90	52	18	2.4	10.0	55	8.0	67	22	2	0	0
FEB	.68	2.83	69	.85	69	25	.9	8.8	59	4.0	51	27	2	0	0
MAR	.78	3.08	73	1.07	52	16	.7	8.0	51	6.0	52	16	2	0	0
APR	.74	3.05	65	1.15	63	26	.0						2	0	0
MAY	.49	1.91	57	.80	58	11	.0						2	0	0
JUN	.32	.99	56	.99	56	30	.0						1	0	0
JULY	.91	2.23	68	1.00	52	30	.0						3	0	0
AUG	.95	3.35	71	1.04	73	5	.0						3	0	0
SEPT	.62	2.82	67	1.56	66	19	.1	2.0	71				1	0	0
OCT	.77	3.26	72	2.10	72	10	.0						2	0	0
NOV	.81	3.08	60	1.80	60	6	.7	5.5	57	4.0	57	3	2	1	0
DEC	.66	1.89	66	.89	66	7	2.3	9.8	70	6.0	67	21	2	0	0
YEAR	8.44	3.35	AUG 71	2.10	OCT 72	10	7.1	10.0	JAN 55	8.0	JAN 67	22	24	1	0

+ ALSO ON EARLIER DATES

3. Geologic Setting[18, 19, 20]

Lincoln County is located in the Basin and Range Geomorphic Province. The area has a geologic character more or less typical of the province with elongate mountains separated by long alluvial filled valleys.

About one-third of Lincoln County is covered by Cenezoic sedimentary rocks; another third by Cenezoic volcanic rocks; and the remainder by igneous, metamorphic, and sedimentary rocks that range in age from Precambrian to Triassic. Paleozoic rocks cover much of the area. They are composed primarily of limestone, dolomite, shale, and quartzite. Lower Mesozoic rocks are exposed in several areas and consist primarily of clastic sedimentary rocks. No middle to upper Mesozoic sedimentary rocks are found in the area. Cenezoic rocks consist primarily of various volcanics and continental sedimentary rock units. The youngest Quaternary and Recent rocks consist of alluvial and lacustrine sediments filling most of the valley basins.

The Basin and Range topography, which characterizes most of Lincoln County, has been developed over all of these rock types. This topography has developed because of the characteristic fault block structure of the Basin and Range which is caused by normal faulting and is expressed as long north-south trending mountains and valleys. Most of the Basin and Range Province in Lincoln County is an area of internal drainage with many large ephemeral lakes. Part of the county is, however, located in the Colorado River Basin which drains into the Pacific Ocean.

The geothermal resource in Lincoln County is associated with the long north-south trending normal faults characteristic of the Basin and Range Province. Water, originating as rainfall, sinks deep into the earth where it is heated by contact with a geothermal heat source. This heat source may be either a cooling magmatic body or just rock heated by the earth's geothermal gradient. The heated water then rises to the surface along the deep faults which offer permeable conduits for fluid movement. If these faults cut the earth's surface, hot springs and other surface manifestations of geothermal energy may appear. It should be noted that geothermal resources may be present without such surface indications. One of the goals of modern exploration geology is to locate these "hidden" resources.

4. Hydrology(8, 9)

Lincoln County contains portions of four hydrographic regions found in Nevada. These regions include the: Central Region; Colorado River Basin; Great Salt Lake Basin; and Escalante Desert.

The Colorado River Basin covers the largest portion of Lincoln County. All runoff waters falling in the medium to low elevation valleys flow through a series of tributary streams into the Colorado River, which eventually flows into the Pacific Ocean.

The Central Region covers much of the western portion of the study area. This area is characterized by long, narrow valleys with small, intermittent streams emptying into the valley bottoms where the flows evaporate. The perennial streams are usually only a few miles long. There are no large standing bodies of water even though the area is characterized by internal drainage.

A very small portion of the Great Salt Lake Basin occurs in the north-eastern Lincoln County. This part, the Hamlin Valley, supplies runoff water to the Great Salt Lake to the east.

The fourth hydrographic region in the study area is the Escalante Desert. This region, located in the east-central portion of the county, is only a very small part of the entire region, most of which occurs in Utah. The region is characterized by low valleys with internal drainage.

The hydrology of the area is typical of that occurring in a desert environment. Precipitation is markedly seasonal, occurring primarily in the winter as rain or snow and in the summer as sudden thunderstorms. Streamflows are equally seasonal with peak flows occurring in the winter. With uncontrolled conditions, runoff reaches a peak flow in late spring and an annual low flow in late summer or early fall. Exceptions are the exceedingly large flows due to severe thunderstorms which can occur any time during the summer. These flash floods are highly unpredictable and last only a few hours. The seasonal variation in flow ranges from about 45 percent of the total from November to March, to 17 percent during June and July. These wide ranges in flow create multiple problems. Seasonal high flows often result in flood damage with serious erosion and sedimentation occurring. Low flows limit agricultural production and tend to cause high water temperatures. Both sedimentation and high water temperatures impact adversely on fish life and general water quality.

The Nevada State Engineer has defined five designated groundwater basins out of the 28 found in Lincoln County. These basins are those in which the amount of water allocated is believed to exceed the annual recharge into the basin. The Division of Water Resources has several regulations and permitting procedures which are required before water from these designated basins can be used. Table 3 shows these designated groundwater basins and the associated order number so designating those basins.

Table 3

DESIGNATED GROUNDWATER BASINS IN LINCOLN COUNTY

Designated Basin	Basin Number	Order Number	DATE
Penoyer (Sand Springs) Valley	170	712	5-03-78
Lake Valley	183	726	6-11-79
Indian Springs Valley	161	728	8-01-79
Panaca Valley	203	734	1-17-80
Virgin River Valley	222	753	8-18-80

Because Lincoln County's geothermal resources are the water dominated type, any use of those resources may affect local ground water conditions. This may impact historical use of groundwater in those areas and raise questions concerning water rights and water allocation. However, geothermal energy development is considered to be a preferred use of the groundwater. Any developer of geothermal energy resources in these basins must contact the State Water Engineer early in any project's planning phase to insure that all water related questions are answered.

B. Land Ownership and Land Use

Lincoln County totals nearly 10,649 square miles in size or approximately ten percent of the total land area of the State of Nevada. Table 4 shows the land ownership of the county.(13)

Table 4

LAND OWNERSHIP PATTERN IN LINCOLN COUNTY

Public Land	Acres	Percent
Federal	6,587,946	96.69
State	6,682	0.09
County	2,000	0.02
Total Public	6,596,628	96.8
Private Land		
Indian	0	0
Tax Roll	219,372	3.2
Total Private	219,372	3.2

Existing land use patterns in Lincoln County are based primarily on proximity to the major centers of Caliente, Pioche, and the other smaller communities. Away from these centers the land has historically been used for agriculture, ranching, mining, wildlife management, and open space (Figure 3). The Bureau of Land Management has classified most of the 5,667,994 acres of the public land it manages as being for multiple use. This classification includes all types of uses from recreation, wildlife management, watershed management, and livestock, grazing, to timber production on the more heavily forested portions of the land. The only lands not managed according to this concept are those that are being studied as potential wilderness areas. Other federal agencies holding title to land in Lincoln County, such as the U.S. Forest Service and the Bureau of Reclamation, at this time are also managing their lands according to the multiple use concept where possible. Remaining federal land located within the Nevada Test Site and Gunnery Range is closed to all public uses.

There are eight BLM Wilderness Study Areas in Lincoln County: Table Mountain, White Rock Range, Worthington Mountains, Weepah Springs, South Pahrocs/Hiko, East Pahranagat, Medsger Pass, and Lower Pahranagat Lake.[16] These study areas are those which BLM believes meets the following criteria:

1. Size--must have at least 5,000 or more acres of contiguous public land or be of a size to make practical its preservation and use in an unimpaired condition;
2. Naturalness--must be substantially natural or generally appear to have been affected primarily by the forces of nature with the imprint of man's work substantially unnoticeable.
3. Outstanding solitude or recreation--must have either outstanding opportunities for solitude or a primitive and unconfined type of recreation;

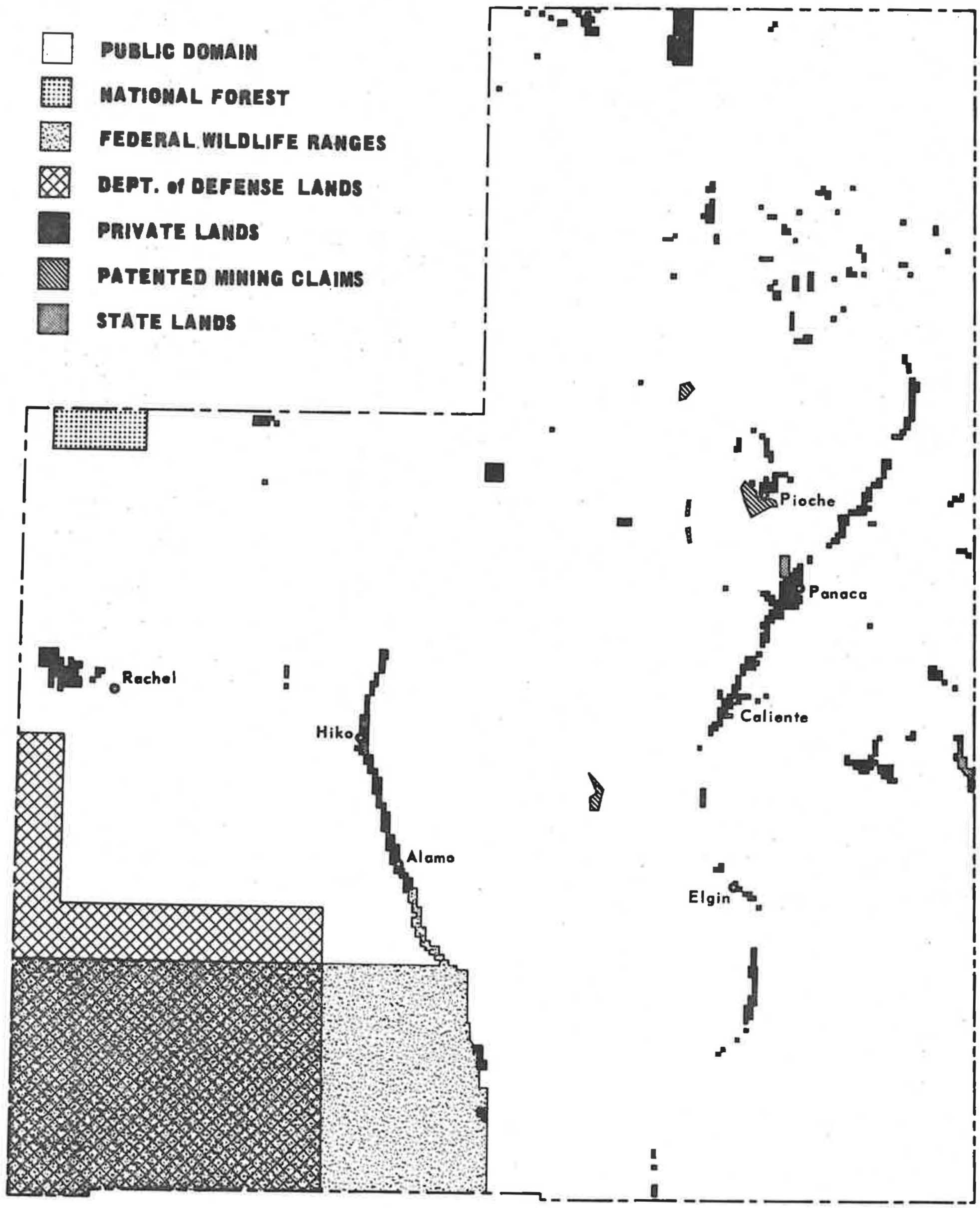

FIGURE 3. LAND OWNERSHIP IN LINCOLN COUNTY.

4. Supplemental values--must have supplemental values, which include ecological, geological, or other natural features of scientific, educational, scenic, or historical value.

These eight Wilderness Study Areas will continue to be managed under special guidelines directed by Congress to preserve the wilderness values until a final determination of wilderness suitability or unsuitability is made.

There are no known geothermal resources within the boundaries of any of the potential wilderness areas. Should any be located in the future, the development of those resources will be subject to BLM Wilderness Area Management Policy.

Larger urban communities develop various zoning classifications to segregate various land uses within the community to those which are deemed compatable. Such uses include residential, commercial, governmental/institutional, various types of industrial, and agricultural use. Geothermal development must be compatible with existing development in these zoned areas.

C. Population[4]

The population of Lincoln County increased approximately 22 percent during the 56-year period between 1920 and 1976. This growth rate has not been consistent. There were several periods of population decline as well as those periods of population increase. Table 5 illustrates the past and projected population figures for Lincoln County.

The existing population of Lincoln County is not evenly distributed around the entire county. It is, instead, localized into distinct population centers with only scattered persons in the rural area. The four largest communities found in Lincoln County are Caliente, Panaca, Pioche, and Alamo.

The State Planning Coordinator's Office anticipates that all the communities in Lincoln County will grow somewhat by the year 2020. Because of the small size of the existing communities and the moderately low rate of growth, the total number of persons added to Lincoln County will be small. Table 6 illustrates the State Planning Coordinator's projections for the four largest communities. These, and the county population projections are based on historical population growth data. Should any new, unanticipated development activities occur, these estimates could be invalidated.

Table 5

POPULATION TREND IN LINCOLN COUNTY(4)

Year	Population	Year	Population
1920	2,287	1973	2,338
1930	3,601	1974	2,500
1940	4,130	1975	2,700
1950	3,837	1976	2,803
1960	2,431	1977	2,734
1961	2,164	1978	2,853
1962	2,140	1979	2,972
1963	2,113	1980	3,091
1964	2,038	1981	3,163
1965	2,162	1982	3,235
1966	2,398	1983	3,307
1967	2,316	1984	3,379
1968	2,334	1985	3,451
1969	2,454	1990	3,728
1970	2,557	1995	4,717
1971	2,300	2000	5,039
1972	2,200		

Table 6

POPULATION PROJECTIONS FOR THE MAJOR COMMUNITIES OF LINCOLN COUNTY TO THE YEAR 2020

City	1980	1990	2000	2010	2020
Caliente	900	1,000	1,200	1,400	1,550
Panaca	550	650	800	950	1,000
Pioche	650	850	1,100	1,350	1,500
Alamo	890	1,030	1,400	1,600	1,700

D. Transportation Facilities[5, 6, 7]

Only one major highway passes through Lincoln County. U.S. 93 is a major north-south route connected to I-80 in the north and I-15 in the south. It runs down the entire east side of the state connecting the towns of Wells, Ely, Pioche, Caliente, and Las Vegas. Lincoln County has a total of about 3,429 miles of roadway. There are about 384 miles on the federal aid system, 29 miles on the state aid system, 3,009 miles on the county system, and eight miles on city or local systems. The area has a total of about 3,099 miles of unpaved road and 331 miles of roadway paved to various standards.

Transportation services are rather limited in Lincoln County. Three interstate trucking lines do service the area but terminal facilities are not available. The nearest facilities are located approximately 175 miles south of Pioche in Las Vegas. Limited air service is available into various portions of the county. There is one commercial airport and five landing strips. No commercial airlines have scheduled service, though charter service is available. The nearest airport in the region is McCarran International Airport located in Las Vegas. The Union Pacific Railroad has a main east-west line running through Caliente and one freight-only

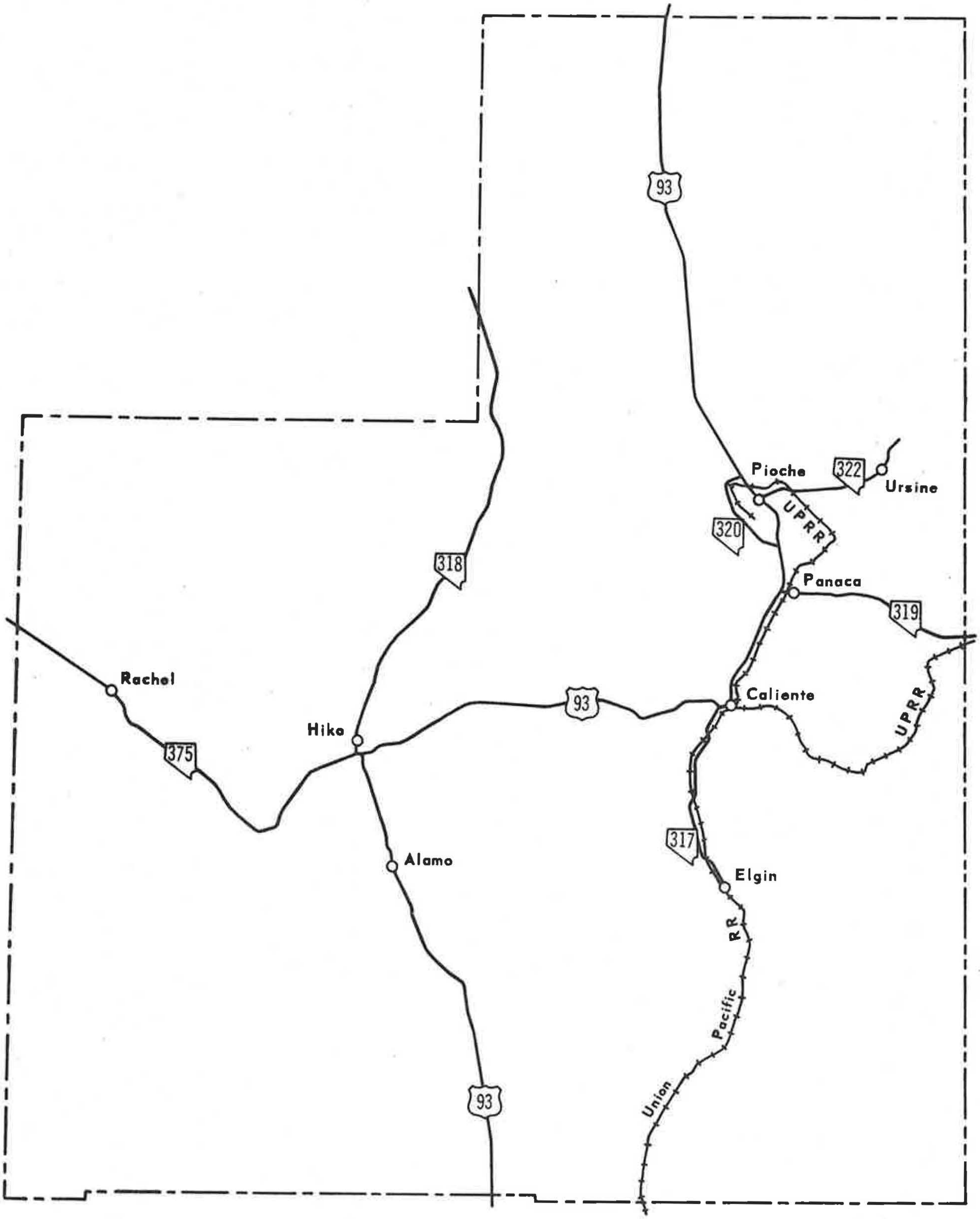

FIGURE 4. MAJOR TRANSPORTATION FACILITIES IN LINCOLN COUNTY.

spur into the central part of the county. Limited facilities are one interstate bus line serves passenger transportation needs.

E. Economic Activities

1. Background(13)

Lincoln County was created by the State Legislature in 1867 as the result of the personal efforts of Governor Blasdel. At that time the county was separated from Nye County. The boundaries were changed again in 1909.

Rich ore deposits began to attract miners to the county in the early 1860's. Several towns such as Hiko, Pioche, and Eldorado developed as result of this migration. Panaca was established by the Mormons as a way station for travelers and mail carriers moving between southern California and Salt Lake City. In 1871, the area now known as Caliente was settled by two brothers, Charles and William Culverwell. Much of the Caliente area was purchased for a railroad in 1901.

Since the early 1900's, mining and railroad construction have had a profound impact on the county's economy. The Union Pacific Railroad moved its railroad repair shop from Las Vegas to Caliente in 1931. The repair shop remained prosperous until the introduction of the diesel engine. Pioche, whose economy was solely dependent on mining, started to falter in 1957 when the U.S. Government began allowing a large inflow of low-priced foreign metals. Recently, with the increase in the price of precious metals, there has been a resurgence in mining activity through the entire county. Today there are 14 companies mining such ores as gold, silver, tungsten, lime, perlite, and sand and gravel.

2. Employment and Income[11, 13]

Government is Lincoln County's largest employer, representing 37 percent of the total employment in 1979 (Table 7). It is expected to be the largest employer through the 1990's. Mining and trade are the second and third largest employers, accounting for 25 percent and 17 percent of the total labor force.

Lincoln County's unemployment rates have been unstable since 1976. For example, in 1972 unemployment was estimated at 12.1 percent and was the highest in the state. Unemployment was estimated to be 2.6 percent in 1978, increasing to 3.9 percent in 1979.

Per capita income was the state's second lowest at $5,337 in 1977.

Table 7

1979 EMPLOYMENT PATTERNS -- LINCOLN COUNTY

Industry	Number of Firms	Number of Employees	Percent of Employees	Total Wages	Percent of Wages
Mining	11	265	25	5,075,203	37
Construction	3	17	2	419,139	3
Manufacturing	2	11	1	95,285	1
Trans., Comm., and Util	4	36	3	466,156	3
Wholesale & Retail Trade	40	175	17	1,053,763	8
Fin., Ins., and Real Estate	4	13	1	127,132	1
Service Industries*	13	144	14	2,414,529	18
Government	25	379	37	3,974,434	29
TOTAL	102	1,040	100	13,626,641	100

*Includes Agricultural Services and Firms not Elsewhere Classified

F. Design Information (1)

No specific design information is available for any community in Lincoln County. Such information is available for the nearby communities of Ely to the north and Las Vegas to the south. The engineering design characteristics for these communities are as follows:

	Ely	Las Vegas
Latitude	39°17'	36°05'
Longitude	114°51'	115°10'
Elevation	5,075	2,162
Winter Design Dry-Bulb Temperature		
99%	-10°F.	25°F.
97.5%	-4°F.	28°F.
Summer Design Dry-Bulb and Mean Coincident Wet-Bulb Temperature		
1%	89°/57°F.	108°/66°F.
2.5%	87°/57°F.	106°/65°F.
5%	85°/55°F.	104°/65°F.
Mean Daily Temperature Range	39°F.	30°F.
Design Wet Bulb Temperature		
1%	60°F.	71°F.
2.5%	59°F.	70°F.
Degree-Heating Days	7,333	2,709
Degree-Cooling Days	182	2,942

Additional degree-heating and degree-cooling day information is available at the following recording stations in Lincoln County:

	Elevation	Degree-Heating Days	Degree-Cooling Days
Caliente	4,402	4,402	860
Pioche	6,165	5,638	673

G. Energy Information

The energy situation in Geothermal Resource Area 10 is typical of that occurring in eastern Nevada. Electricity and natural gas are the prime sources of energy used in the urban areas with electricity, propane, and distillate fuels being the primary sources of energy in the rural areas. These fuels are supplemented with coal, wind, hydroelectric, and other alternative energy resources.

Electrical energy in Lincoln County is supplied primarily by the Lincoln County Power District. Smaller electrical suppliers such as the North Panaca Irrigation Association, Panaca Power and Light Company, and the South Panaca Power Group purchased their power for resale from the Lincoln County Power Company. Where electric service is not available developments must use diesel-fueled generating systems.

The source for much of the electrical energy used in the Lincoln County area is the generating facilities at Hoover Dam and Powerplant. Because the power districts were treated as preferred customers when this facility went on line, the Lincoln County area was able to obtain electricity at very reasonable rates. There are two primary reasons for this inexpensive electricity: when Hoover Dam and Powerplant were constructed, labor and construction costs were low: and today, hydroelectric power is less expensive to produce because there are no costs for high priced fossil fuels.

Continued growth in the Lincoln County area may cause problems in electrical supplies and costs in the future. The power district is already receiving its allocation of electricity from the Hoover Dam and Powerplant. As the demand for electricity in the county increases, the power district will be forced to purchase more expensive fuels-generated electricity from other sources.

Natural gas is not available in the study area. Consumers must rely on electricity, liquified petroleum gas (LPG), or other petroleum products to satisfy their energy demands. In remote, areas, the cost of importing these fuels has increased. Energy costs for petroleum products have more than doubled in the last few years.

Coal is another energy source that has seen some limited use in the study area. The amount in relation to other energy sources is believed very small and consists mostly of residential applications.

Potential alternative energy resources that have some development possibilities in the near future include solar, geothermal, and wind systems. The Nevada Department of Energy is actively encouraging the development of all of these alternative energy sources.

Given the existing mix of energy resources that are presently used it is obvious that the potential for developing geothermal energy is very good. In order to assess the extent of the role that geothermal energy is supplying energy requirements in the study area, the NDOE has been working with the New Mexico Energy Institute (NMEI) to evaluate the potential of geothermal energy development through the year 2000. Using a computer model developed by NMEI, projections have been made of the amount of geothermal energy that can be economically developed through the next 40 year period. Two primary classes of development are evaluated: residential and industrial applications by municipal developers and residential and industrial applications by private developers. Tables 8 and 9 show the projections that were developed. For comparison, the amount of geothermal energy which could be developed is shown in BTU's and in the equivalent amount of oil and electricity.

Based on these projections it is estimated that by the year 1990, 6.71 x 10^{10} BTU's of energy could economically be developed by either municipal or private developers. By the year 2000 this increases to 7.56 x 10^{10} BTU's and by 2019 it increases to 9.49 x 10^{10} BTU's. It should be noted that these projections represent an idealized situation where all the resources are developed to their maximum potential. Due to the location and physical characteristics of the resources in the study area this probably will not happen.

It has been estimated, using data from the publication Energy in Nevada, the total anticipated energy consumption for nontransportation needs in 1990 would be 7.06 x 10^{11} BTU's. In 2000 it would be about 9.25 x 10^{11} BTU's. These figures indicate that under ideal conditions approximately ten percent of the energy demand in the study area could be met by geothermal energy in the year 1990 and about eight percent could be met by 2000. Because of the location of the population base in relation to the geothermal resources found in the study area, it is not anticipated that the resources will be developed to their greatest potential in this time period. However, if only a portion of the resources were developed, there could be a significant impact on the consumption of fossil fuels, new industry development, and new jobs for the people living in the study area.

Energy costs for fossil fuels such as natural gas and oil will continue to rise in the foreseeable future. This is primarily due to two factors: First, the source of much of this energy is outside of the United States and hence beyond the physical control of the country. Second, domestic sources of energy will be deregulated in cost by 1985. Both of these factors make coal and geothermal energy attractive alternatives to existing energy sources. Coal, one of the major non-renewable energy resources found in abundance in the United States, can be processed into synthetic fuels. The cost of this coal, whether for reproduction of synthetic fuels or for combustion in an electrical powerplant, is also high. Additionally, strip mining of coal and the air pollution created when it is burned pose serious environmental questions.

Geothermal energy, on the other hand, is relatively clean, less expensive to use, and attractive to many types of developers. Geothermal technology is becoming more available to manage geothermal reservoirs, to obtain maximum production over the longest period of time, and to make use of very difficult fluid types. Thus, the development of the geothermal resources in Lincoln County should be encouraged wherever and whenever possible. This development would benefit both Nevada's citizens and industries, and would contribute to the advancement of energy independence in this country.

Table 8

NEW MEXICO ENERGY INSTITUTE--GEOTHERMAL DIRECT USE ENERGY PROJECTIONS--COMBINED INDUSTRIAL AND RESIDENTIAL APPLICATION WITH MUNICIPAL DEVELOPER

Year	Projected geothermal energy on line (BTUs)	Gallons of oil replaced	Kilowatt hours of electricity replaced
1980	-0-	-0-	-0-
1981	-0-	-0-	-0-
1982	-0-	-0-	-0-
1983	6.18×10^{10}	447,826	1.8×10^{7}
1984	6.25×10^{10}	452,899	1.8×10^{7}
1985	6.33×10^{10}	458,696	1.9×10^{7}
1986	6.40×10^{10}	463,768	1.9×10^{7}
1987	6.48×10^{10}	469,565	1.9×10^{7}
1988	6.56×10^{10}	475,362	1.9×10^{7}
1989	6.63×10^{10}	480,435	1.9×10^{7}
1990	6.71×10^{10}	476,232	2.0×10^{7}
1991	6.79×10^{10}	492,029	2.0×10^{7}
1992	6.88×10^{10}	498,551	2.0×10^{7}
1993	6.96×10^{10}	504,348	2.0×10^{7}
1994	7.04×10^{10}	510,145	2.1×10^{7}
1995	7.13×10^{10}	516,667	2.1×10^{7}
1996	7.21×10^{10}	522,464	2.1×10^{7}
1997	7.30×10^{10}	528,986	2.1×10^{7}
1998	7.39×10^{10}	535,507	2.2×10^{7}
1999	7.48×10^{10}	542,029	2.2×10^{7}
2000	7.56×10^{10}	547,826	2.2×10^{7}
2001	7.66×10^{10}	555,072	2.2×10^{7}
2002	7.75×10^{10}	561,594	2.3×10^{7}
2003	7.84×10^{10}	568,116	2.3×10^{7}
2004	7.93×10^{10}	574,638	2.3×10^{7}
2005	8.03×10^{10}	581,884	2.4×10^{7}
2006	8.13×10^{10}	589,130	2.4×10^{7}
2007	8.22×10^{10}	595,632	2.4×10^{7}
2008	8.32×10^{10}	602,899	2.4×10^{7}
2009	8.42×10^{10}	610,145	2.5×10^{7}
2010	8.52×10^{10}	617,391	2.5×10^{7}
2011	8.63×10^{10}	625,362	2.5×10^{7}
2012	8.73×10^{10}	632,609	2.6×10^{7}
2013	8.83×10^{10}	639,855	2.6×10^{7}
2014	8.94×10^{10}	647,826	2.6×10^{7}
2015	9.05×10^{10}	655,797	2.7×10^{7}
2016	9.16×10^{10}	663,768	2.7×10^{7}
2017	9.27×10^{10}	671,739	2.7×10^{7}
2018	9.38×10^{10}	679,710	2.7×10^{7}
2019	9.49×10^{10}	687,981	2.8×10^{7}

Table 9

NEW MEXICO ENERGY INSTITUTE--GEOTHERMAL DIRECT USE ENERGY PROJECTIONS--COMBINED INDUSTRIAL AND RESIDENTIAL APPLICATION WITH PRIVATE DEVELOPER

Year	Projected geothermal energy on line (BTUs)	Gallons of oil replaced	Kilowatt hours of electricity replaced
1980	-0-	-0-	-0-
1981	-0-	-0-	-0-
1982	-0-	-0-	-0-
1983	6.18×10^{10}	447,826	1.8×10^{7}
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2017	9.27×10^{10}	671,739	2.7×10^{7}
2018	9.38×10^{10}	679,710	2.7×10^{7}
2019	9.49×10^{10}	687,981	2.8×10^{7}

III. THE RESOURCE

A. General Information

There are several geothermal areas in Lincoln County with the potential for commercial development. The primary ones are in the Caliente area and Ash Springs. In addition to these, there are several other sites where thermal water has been encountered (Figure 6). The following portion of this report includes a discussion of the known geothermal areas in Lincoln County with a brief description of the known characteristics of the resources.

Evaluation of the geothermal reservoir associated with each of these resources is difficult because of the limited information currently available. The size of the reservoirs is taken from the USDOE publication Geothermal Direct Heat Use Market Potential. The heat energy stored in the reservoir was determined according to methodology presented in U.S.G.S. Circular 790. Using this methodology, the potential heat energy found in a geothermal reservoir is calculated using such known factors as the surface area of the reservoir, the depth of the reservoir, the temperature of the reservoir, and the specific heat of rock. The formula used for this calculation is: [27]

$$qr = pc \times a \times d \, (t - t_{ref})$$

where:

qr = reservoir thermal energy in BTU's

pc = volumetric specific heat of rock plus water 40.284 BTU/ft^3/°F

a = reservoir area

d = reservoir thickness

t = reservoir temperature

t_{ref} = reference temperature (59° F.)

Existing technology is not capable of extracting all of the energy from the geothermal reservoir. To give a more realistic value to the energy obtainable, an assumption of 25 percent of total reservoir capacity is used. This value should be considered an estimate and may or may not be representative of the actual reservoir conditions.

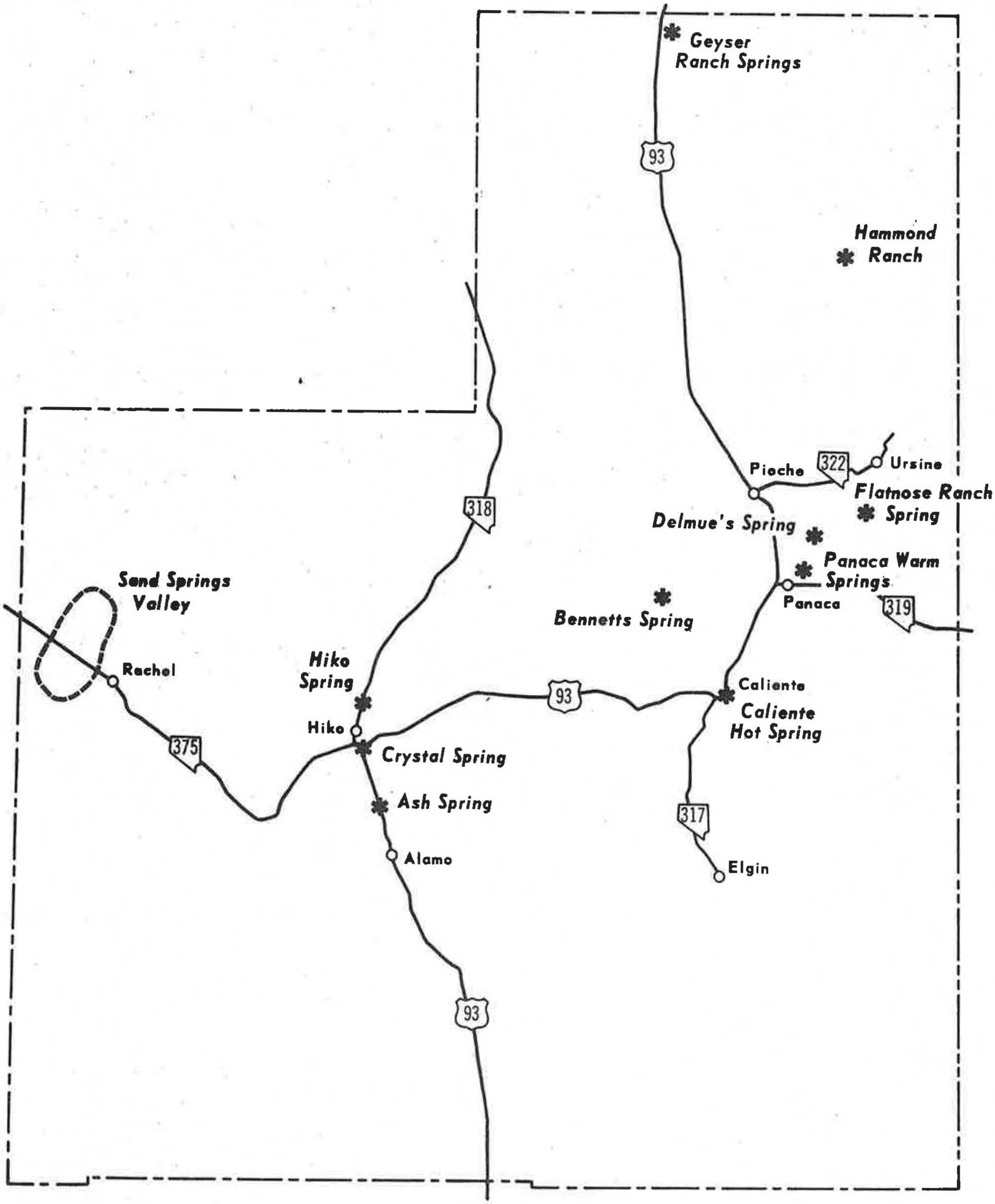

FIGURE 5. LOCATIONS OF THE GEOTHERMAL RESOURCES IN LINCOLN COUNTY.

It should be emphasized that the information presented about each geothermal reservoir is based on the best information currently available. The conditions in the reservoir may be considerably different from those indicated. Any party investigating the development of any of these resources is urged to contact the Nevada Bureau of Mines and Geology or the Earth Science Laboratory of the University of Nevada, Las Vegas for additional resource information and to engage the services of a reputable consulting firm in assessing geothermal reservoirs and planning for their development.

B. Caliente Area

1. Description (12, 21)

The community of Caliente lies in an area of known geothermal resources. Historically, there have been flowing hot springs with recorded temperatures ranging from 100° F. to 118° F. Because of the current water demand in the area these springs are not flowing today. There is, however, some indication that there is underground flow into Caliente Creek.

Hot water has been found in many wells around Caliente. The warmest temperatures recorded in the area was from the Aqua Caliente Trailer Park well. The 160° F. water from this well is currently being used to heat about 20 mobile homes, a laundry facility, and a bath house. As the geothermal fluids mix with the groundwater they apparently become cooler and migrate southward following the direction of the groundwater flow in Meadow Valley Wash. At the Lincoln County medical facility, the maximum recorded temperature is 120° F. As the geothermal fluids move south, temperatures of only 43° F. are recorded in shallow wells (Figure 6).

2. The Reservoir

During the summer of 1979, the Nevada Bureau of Mines and Geology conducted an assessment of the geothermal reservoir in the Caliente area. The following information is based on that assessment.(21)

Temperature[21]

Measured wells		Map Location Number
Cane Spring	54° F.	1
Aqua Caliente Trailer Park	153° F.	2
Lincoln County Medical Facility		
Reinjection well	84° F.	3
Abandoned well	118° F.	3
Hot Spring Motel Well	113° F.	4
L. Van Kirk Well	109° F.	5
L. Van Kirk Well	109° F.	6
R.S. Van Kirk Well	109° F.	7
K. Phillips Well	107° F.	8
Church of the Latter Day Saints Well	75° F.	9
Miller Well	104° F.	10
City Well at park	59° F.	11

Figure 6 shows the location of the wells listed above.

Volume

The limits to the Caliente geothermal reservoir are very difficult to define. The highest temperatures in the reservoir appear to be near the northern part of the community with a gradual decrease towards the south as the geothermal fluids are mixed with local groundwater. Because of this gradual transition between geothermal water and groundwater, exact limits on the size of the reservoir cannot be specifically defined. However, the area in which thermal water has been found covers an area of somewhat less than one square mile. Depth of the reservoir is unknown, but the highest water temperatures recorded were from a well only 88 feet deep. For calculation purposes the volume of the Caliente geothermal reservoir has been determined to be 0.35 cubic mile.[25]

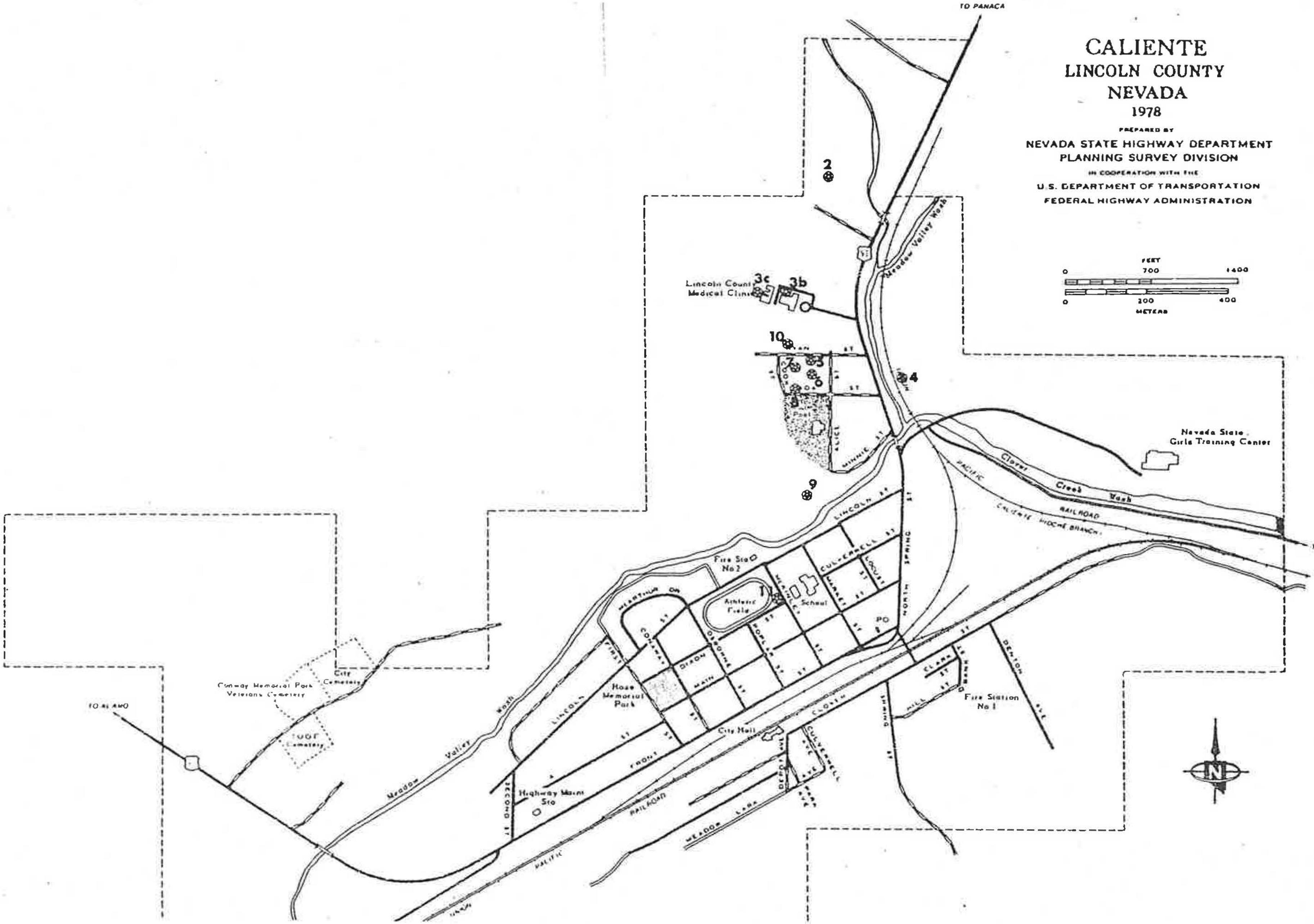

FIGURE 6
Location of Measured Wells

Water Chemistry

Table 8 shows the water chemistry analyses for 12 wells in the study area. These analyses indicate that the water meets all standards for safe drinking water although a few samples violate the iron standard.

Energy Content(27)

Potential heat energy found in the reservoir-------2.1×10^{14} BTUs
Heat energy extractable with existing technology---5.2×10^{13} BTUs

B. Other Geothermal Resources in Lincoln County

1. Panaca Warm Springs(12)

Panaca Warm Springs are located immediately north of the town of Panaca. The springs range in temperature from 85° to 88° F. The flow ranges between 1,800 and 6,277 gallons per minute. Currently, water from this area is being used for Panaca's municipal water supply. Nearby wells have water ranging in temperatures 70° to 78° F. Typical water chemistry analyses are listed in Appendix 1. These analyses indicate that water from Panaca Warm Springs meets all standards for safe drinking water. The volume of the Panaca Warm springs geothermal reservoir is estimated at 0.24 cubic mile.(24)

Energy Content(27)

Potential heat energy found in the reservoir-------4.1×10^{13} BTUs
Heat energy extractable with existing technology---1.0×10^{13} BTUs

Special Note

Panaca Warm Springs are located in a designated ground water basin and are subject to special regulation by the State Water Engineer's Office.

2. Delmue's Springs[12]

The two Delmue's Springs are located about six miles northeast of Panaca Warm Springs. The temperature of the springs are 70° F. with a 200-gallon per minute flow rate. The water is used for irrigation. No water chemistry information is available. The volume of this reservoir is estimated at 0.24 cubic mile.[25]

Energy Content[27]

Potential heat energy found in the reservoir-------1.6×10^{13} BTUs
Heat energy extractable with existing technology---3.9×10^{12} BTUs

3. Flatnose Ranch Springs[12]

The Flatnose Ranch Springs are about 12 miles northeast of Panaca Warm Springs. Temperatures up to 77° F. have been recorded. Flow rates are up to 400 gallons per minute. The water is used for irrigation. One typical water chemistry analysis for the Flatnose Ranch Springs is given in Appendix 1. Water from this geothermal reservoir meets all standards for safe drinking water. The volume of this reservoir is estimated at 0.24 cubic mile.[24]

Energy Content(26)

Potential heat energy found in the reservoir-------2.6×10^{13} BTUs
Heat energy extractable with existing technology---6.4×10^{12} BTUs

4. Hiko Springs[12]

Hiko Springs are located in the northeastern portion of Pahranagat Valley. Temperatures range between 80° and 90° F. and flow rates between 538 and 2,499 gallons per minute. The water is currently used for irrigation and for domestic purposes. Typical water chemistry analyses are listed in Appendix 1. Water from

Hiko Springs meets all standards for safe drinking water. The volume of this geothermal reservoir is estimated to be 0.24 cubic mile.(25)

Energy Content(27)

Potential heat energy found in the reservoir-------4.1 x 10^{13} BTUs

Heat energy extractable with existing technology---1.1 x 10^{13} BTUs

5. Crystal Springs(12)

Crystal Springs is located about five miles south of Hiko Springs. Temperatures range from 81° to 90° F. and flow rates from 2,680 to 9,000 gallons per minute. There are at least two springs. The water has been used for irrigation and for domestic purposes. Three typical water chemistry analyses are given in Appendix 1. Water from Crystal Springs meets all standards for safe drinking water. The volume of this reservoir is estimated to be 0.24 cubic mile.(24)

Energy Content(27)

Potential heat energy found in the reservoir-------4.4 x 10^{13} BTUs

Heat energy extractable with existing technology---1.1 x 10^{13} BTUs

6. Ash Springs(12)

Ash Springs are located about seven miles south of Crystal Springs. There are six main springs ranging in temperature between 88° and 97° F. Flow rates range between 7,630 and 10,300 gallons per minute. The water is used for irrigation, recreation and domestic purposes. Typical water chemistry analyses are reproduced in Appendix 1. Water from Ash Springs meets all standards for safe drinking water. The Ash Springs geothermal reservoir is estimated to have a volume of 0.24 cubic mile.(25)

Energy Content[27]

Potential heat energy found in the reservoir-------5.4×10^{13} BTUs

Heat energy extractable with existing technology---1.4×10^{13} BTUs

7. Geyser Ranch Springs[12]

A series of warm springs are located in the Geyser Ranch at the north end of Lake Valley. Reported temperatures range between 65° and 75° F. and flow between 50 and 1,400 gallons per minute. The water is used for irrigation purposes. A typical water chemistry analysis is given in Appendix 1. Water from Geyser Ranch Springs meets all standards for safe drinking water. This reservoir is estimated to have a size of at 0.24 cubic mile.[25]

Energy Content[26]

Potential heat energy found in the reservoir-------2.3×10^{13} BTUs

Heat energy extractable with existing technology---5.7×10^{12} BTUs

Special Note

Geyser Ranch springs is located in a designated groundwater basin and is subject to special regulation by the State Water Engineer's Office.

8. Hammond Ranch[12]

A large warm spring is located at the head of Camp Valley on the Hammond Ranch. The water has a temperature of 84° F. and is used for irrigation. No water chemistry information or flow rate is currently available on this warm spring. The volume is estimated to be 0.24 cubic mile.[25]

Energy Content[27]

Potential heat energy found in the reservoir-------3.6×10^{13} BTUs

Heat energy extractable with existing technology---8.9×10^{12} BTUs

9. Sand Springs[12]

Sand Springs is the only reported thermal area in northwestern Lincoln County. It has a temperature of 96° F. and a flow rate of 0.2 gallons per minute. Several wells in the vicinity have temperatures ranging from "just warm" up to 83° F. One typical water chemistry analysis is given in Appendix 1. This analysis indicates that water from the Sand Springs area meet all standards for safe drinking water. The Sand Springs area geothermal reservoir is estimated to be 0.24 cubic mile in size.[25]

<u>Energy Content</u>[27]

Potential heat energy found in the reservoir-------3.4 10^{13} BTUs
Heat energy extractable with existing technology---8.5 x10^{12} BTUs

<u>Special Note</u>

Sand Springs is located in a designated groundwater basin and is subject to special regulation by the State Water Engineer's Office.

10. Bennett's Springs

Bennett's Springs are located about 12 miles west of Panaca Warm Springs. They have a temperature of 70° F., a flow of 10 gallons per minute, and are used to water cattle. No water chemistry analyses are available. The volume of this geothermal reservoir is estimated to be 0.24 cubic mile.[25]

<u>Energy Content</u>[27]

Potential heat energy found in the reservoir-------1.6 x 10^{13} BTUs
Heat energy extractable with existing technology---3.9 x 10^{12} BTUs

IV. THE USES

A. General Information

Uses for geothermal energy fall into two broad categories; electrical generation and direct use of the hot water. Electrical generation on a practial commercial scale requires both a high temperature resource and a large geothermal reservoir. It appears that none of the geothermal areas in Lincoln County meet these criteria.

Direct uses of geothermal energy are more varied and can economically use both lower temperature and less extensive resources. Figure 7 illustrates the various types of uses for geothermal energy and the temperature requirements for each use. Several of these uses may be developed in Lincoln County.

B. Caliente Area

The geothermal resource found in the Caliente area has been put to use to the advantage of several of the citizens of the community. In 1978, the United States Department of Energy awarded a $30,000 Appropriate Technology Grant to the Aqua Trailer Park to install the necessary facilities to supply the heating demands of about 50 trailer sites, a laundry building, and a bath and shower house.

In 1979, another Appropriate Technology Grant was issued to the William C. Dils Medical Center in Caliente for the purpose of drilling two wells and retrofitting the hospital's heating system to use geothermal heat. Two wells have been drilled. The warmest is 100° F. at 80 feet. It is estimated that geothermal energy is supplying about 75 percent of the heating needs at the hospital.

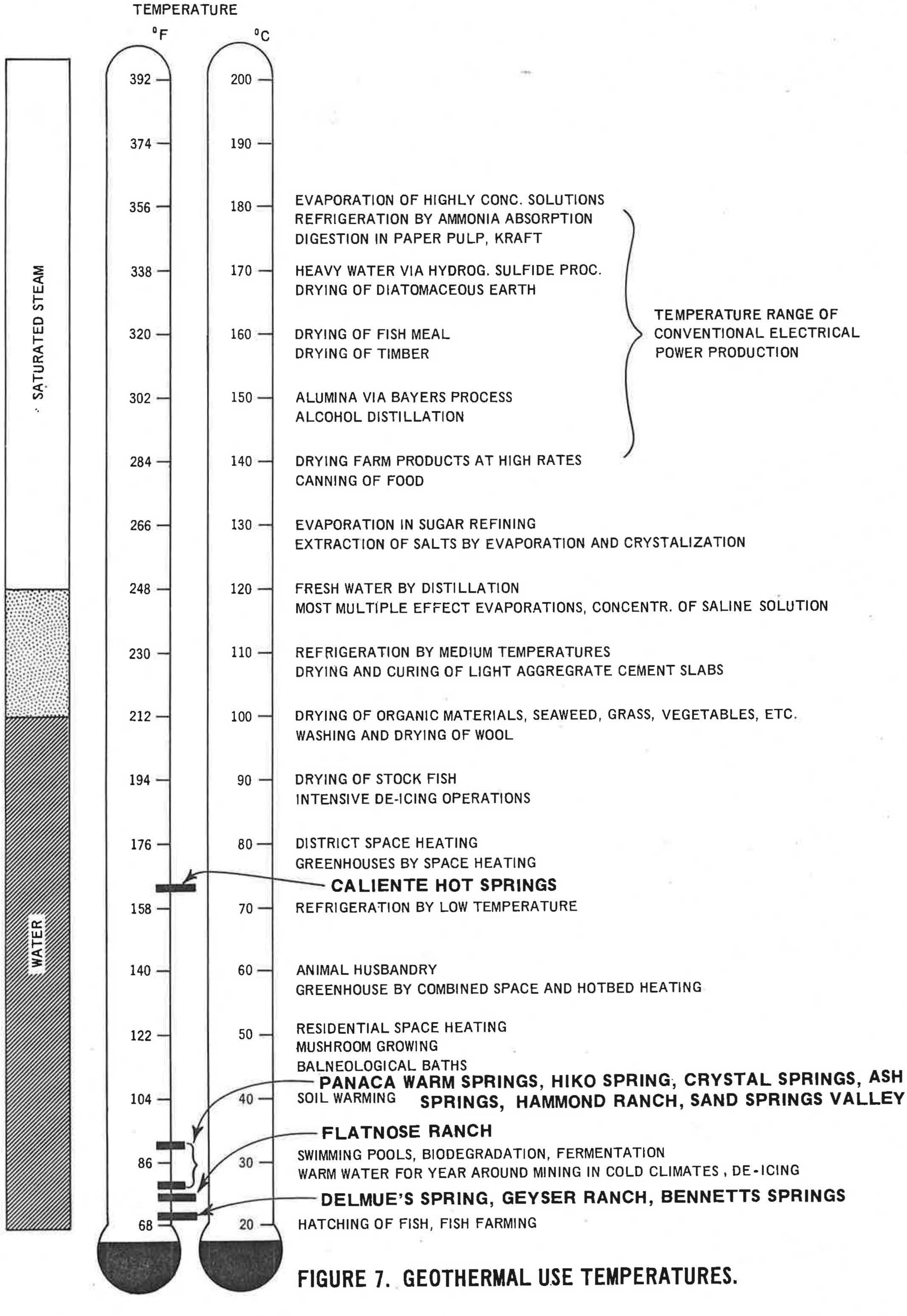

FIGURE 7. GEOTHERMAL USE TEMPERATURES.

Continued interest by the people of Caliente prompted the Nevada Department of Energy (NDOE), the Nevada Bureau of Mines and Geology (NBMG), and the Oregon Institute of Technology (OIT) to do a geologic study of the geothermal system and an engineering and economic feasibility study of installing a district heating system for the community.

The geological study by the NBMG[21] included such tasks as: collection of existing geologic and hydrologic data; aerial-photo interpretation to define structural controls; reconnaissance geologic investigations; temperature measurements of existing water wells; collection and analyses of water samples from existing wells, surface waters, and springs; a two-meter temperature probe survey; and collection of soil samples for mercury analysis. Following the execution of all of these tasks and the receipt of all laboratory results, geologists from the NBMG made the siting recommendation for two production wells.

Concurrently with the geological study, the NDOE and OIT conducted a joint engineering and economic feasibliity study for the district space heating system.[17] The results of this study indicated that such a geothermal heating system is economically feasible assuming that a 160° F. source capable of delivering a peak load of 850 gallons per minute from a relatively shallow depth can be located within or near the city boundaries. The community, with the assistance of the NDOE is currently exploring methods of financing such a development.

There are several other types of applications that could make use of water in the temperature range found in Caliente. These include the aquacultural raising of fish and prawns, greenhousing, various animal husbandary practices, recreation, and low temperature industrial processing. Several of these activities could be combined in a cascading sequence where the water is passed from one user to another as the temperature decreases.

B. Other Geothermal Resources in Lincoln County

The potential uses for the other ten geothermal resources in Lincoln County somewhat are limited by both their low temperatures and remote locations. All of the remaining thermal springs in Lincoln County have temperatures of less than 100° F. With the exception of Ash Springs, all are some distance from any nearby population centers.

Typical uses for geothermal water with temperatures characteristic of these springs include recreational developments, fish farming, prawn farming and heating, or cooling using heat pumps. Ash Springs, near the small community of Alamo, has already undergone development into a recreational facility for local residents and an occasional tourist. The other springs are too close to Ash Spring, or too far from any population base for significant recreational development.

The staff of the University of Nevada, Reno is investigating the development potential of various springs in Lincoln County for the prawnfarming industry. The results of this investigation suggests that the only spring with the temperature and flow sufficient for economically feasible development is Ash Springs. It is conceptually possible to divert water from the channel leaving the recreational development into large prawn ponds. This water could then be disposed of by diverting it into the existing drainage channels. The water leaving the prawn ponds would have picked up nutrients from the ponds making it advantageous for ranchers to use for irrigation. There are two potential problems with this type of development: obtaining the necessary land on which to build the prawn ponds, and obtaining rights to use the water. Even though most of the water will be only temporarily diverted, some will evaporate. If water is in extreme demand in the area, such a loss in the diversion may adversely affect end users. The Nevada State Water Engineer's Office is being contacted by University staff to evaluate the existing water rights and the potential of such a problem.

Ranching is an important factor to the economy of the area. The use of several warm springs for various types of animal husbandary activities could only improve the economic situation of the agricultural community.

V. CONCLUSION

The potential for geothermal development in Lincoln County is somewhat limited. In spite of this, there has already been substantial development in the Caliente area. A trailer park, several private residents, and a hospital are using geothermal energy to meet some of their space heating and hot water needs.

Recent studies completed by NBMG, NDOE, and OIT indicate that it is technically and economically feasible to develop a geothermal district space heating system in Caliente. In this study, NBMG located two potential well locations.(21) OIT's study indicated that, based on an eight percent bond financing of a capital investment for equipment of $2,500,000, a present worth of about $5,400,000 would be generated over the project life,(17) thus making it economically feasible to develop a district heating system in the community.(17)

The total energy saved by the installation of such a district heating system would be 63 million KWH of electricity and 7.5 million therms of fossil fuel over the life of the system.

Such a saving in electrical energy could reduce the impact of the growth of the county on future electrical energy demands. By reducing this demand, the need to import expensive electrical energy from new suppliers would be diminished.

Ash Springs, near the community of Alamo, also has some potential for the development of an aquacultural industry in addition to the current use of the site as a recreational area. If such a development did indeed occur, the benefits derived from having a new industry in the area to broaden the economic base of the community would be noticeable.

The other warm springs in Lincoln County appear at this time to have somewhat restricted development potential. The temperatures in these springs, their distance from any population base, and flow rate characteristics would make the development of these resources somewhat less than optimal. However, if existing conditions changed and became conducive to the development of these resources, that development could add much to the economic base of the county.

Summarizing, there are many different types of benefits to be derived from the development of the geothermal resources in Lincoln County. These include, but are not limited to:

1. Creating new industry.
2. Expanding existing industry.
3. Creating new jobs.
4. Creating additional spendable income in the region.
5. Broadening both the economic and tax base of both the county and the state.
6. Displacing the use of expensive, diminishing fossil fuel for either direct use of for electrical generation.

The development of the geothermal resources located in Lincoln county is thusly considered to be beneficial to the county, the state, and to the nation. For these reasons, such development should be encouraged wherever possible.

VI. ADDITIONAL INFORMATION

Additional information on the occurrence, character, or development of Nevada's geothermal resources may be obtained by writing, calling, or visiting any of the following:

Nevada Department of Energy
400 West King, Suite 106
Carson City, Nevada 89710
(702) 885-5157

Nevada Department of Conservation
and Natural Resources
201 South Fall Street
Carson City, Nevada 89710
(702) 885-4380

Nevada Bureau of Mines and Geology
University of Nevada-Reno
Reno, Nevada 89557
(702) 784-6691

U.S. Bureau of Land Management
Room 3008, Federal Building
300 Booth Street
Reno, Nevada 89509
(702) 784-5748

U.S. Geological Survey
District Geothermal Office
4600 Kietzke Lane
Reno, Nevada 89502
(702) 784-5676

University of Nevada, Las Vegas
Environmental Research Center
Division of Earth Science
255 Bell
Reno, Nevada 89503
(702) 784-6151

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VIII. Appendix

1. Water Chemistry Analyses

Identification	pH	SiO_2	Fe	Ca	Mg	Na	K	HCO_3	CO_3	SO_4	Cl	F	NO_2	B	TDS
Panaca Warm Springs															
Spring	8.1	46	0.3	40	23	2.1		178	0	27	18	-	0	-	283
C. Kenneth Lee South Well		51	0	31	9.8	38	6.8	189	-	29	15	1.6	2.6	0.1	271
Flatnose Ranch Springs															
Spring	-	20	-	30	10		42	162	0	44	20	0	-	-	247
Hiko Springs															
Spring	8.0	33	-	44	23	29	7.2	260	0	36	11	.05	.05	12	494
Spring	-	-	-	45	27	17	-	268	-	24	8.9	-	-	-	-
Spring	-	-	-	48	23.2	29.9	-	281	0	35.5	10.5	-	-	-	-
Crystal Springs															
Spring	7.2	31	-	46.2	22.2	23.9	5.5	242	0	47	9.9	2.9	0.6	0.4	-
Spring	-			55	23	37	-	264	-	13	7.0	-	-	-	-
Spring	8.4	28	0	45	23	23	5.2	272	-	27	8.0	0.5	1.1	0.2	295
Ash Springs															
Little Ash Spring	7.6	29	.01	56	14	31	5.6	266	0	34.1	21	-	0.7	-	332
Spring		-	-	46	18.1	20.9	-	256	0	43.8	10.5	-	-	.37	-
Spring	6.4			53.6	10.0	47.2	-	264	-	40.7	13.6	-	-	-	-
Geyser Ranch Springs															
Geyser Springs	8.0	13	-	30	3.4	3.0	1.0	103	-	5.0	3.0	0	0.6	115	181
Sand Springs															
Spring	8.0	-	-	36	22	-	67	357	0	25	5	-	-	-	-
Nevada Safe Drinking Water Standards			.03	125						250	250				500