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GEOTHERMAL RESOURCE AREA 5

Churchill, Douglas, Lyon
and Storey Counties

Area Development Plan

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SUMMARY

Geothermal Resource Area 5 includes Churchill, Douglas, Lyon, and Storey Counties. Within this four county area there are many known geothermal resources ranging in temperatures from 70° F. to over 350° F. Thirteen of these resources are considered major and have been selected for evaluation in this Area Development Plan.

Various potential uses of the energy found at each of the 13 resource sites discussed in this Area Development Plan were determined after evaluating the study area's physical characteristics, land ownership and land use patterns, existing population and projected growth rates, and transportation facilities. These factors were then compared with the site specific resource characteristics. The uses considered were divided into five main categories: electrical generation; space heating; recreation; industrial process heat; and agriculture. Within two of these categories certain subdivisions were considered separately.

The following summarizes the findings about each of the geothermal sites considered in this Area Development Plan:

Brady's Hot Springs

The Brady's Hot Springs geothermal reservoir has a reported temperature of 418° F. It is located about 20 miles northeast of Fernley on I-80. Geothermal Food Processors has constructed a vegetable dehydration plant at this site. Industrial process heat has the highest development potential. Because of the resource characteristics many other types of applications are also considered feasible.

Desert Peak

This high temperature geothermal anomaly (406° F.) is believed to hold good potential for both electrical generation and industrial process heat applications. It is located about four miles southeast of Brady's Hot Springs.

Soda Lakes--Upsal Hogback Thermal Area

This resource has both the temperature (291° F.) and the location (near Fallon) to make its development feasible. A wide variety of applications could reasonably be developed.

Stillwater Thermal Area

The Stillwater resource is a moderately high temperature (265° F.) anomaly located near the communities of Fallon and Stillwater. Because of its location and temperature characteristics, many types of geothermal applications are feasible. Industrial process heat, greenhousing, and aquaculture hold the greatest potential for development.

Lee Hot Springs

The Lee Hot Springs geothermal anomaly has a temperature of approximately 265° F. It is a fairly small resource located south of Fallon. Greenhousing, recreation, and industrial process heat are believed to hold the greatest potential for development; electrical generation and district space heating the least.

Dixie Valley

The resources in Dixie Valley range in temperature to greater than 425° F. The resource area is located many miles from the population centers of the state. Electrical generation and industrial process heat are the applications considered most feasible at this time. Other types of uses require resource or site characteristics not found in the Dixie Valley area.

Walley's Hot Springs

Walley's Hot Springs (181° F.) are located immediately adjacent to the Sierra Nevada Mountains. The springs have an historical use as a spa and recreation area. Other uses probably will not be developed because of existing land ownership.

Saratoga Hot Springs

Saratoga Hot Springs are a low temperature (122° F.) resource located in the southern portion of Carson Valley. These springs are considered to have high development potential for aquacultural industries. Recreation and space heating applications also appear promising.

Hobo Hot Springs

This geothermal resource is a small, low temperature (114° F.) resource located in the northern portion of Douglas County. Because of temperature characteristics, uses seem limited at this time. Aquaculture and small residential space heating applications may be feasible.

Wabuska Hot Springs

Wabuska Hot Springs are a moderate temperature (223° F.) good quality geothermal resource. An ethanol production facility has already been constructed at this site and it appears that additional such facilities may be planned. Both greenhousing and aquaculture facilities are being developed at this site.

Hazen Area

The Hazen Area geothermal area has a temperature of 275° F. It is located on the main highway between Fallon and Fernley. Developments such as greenhousing, industrial process heat, and aquaculture are considered to have the greatest potential for development. Space heating and recreation have the least potential.

Hind's Hot Springs and Others Associated with the East Slope of the Pine Nut Mountains.

This is a series of distinct small geothermal reservoirs with temperatures between 117° and 143° F. Because of the temperatures of these reservoirs and their locations, small residential space heating or agricultural developments seem most likely.

Comstock Mining District

The geothermal anomaly located in the Comstock Mining district has a maximum recorded temperature of 167° F. It is diffuse and apparently quite irregular in distribution. No uses are anticipated to be developed in the near future unless new mining operations use the hot water in their milling process or for space heating.

I. INTRODUCTION

Geothermal Resource Area 5 covers all of the area in Churchill, Douglas, Lyon, and Storey Counties of Nevada. There are numerous geothermal anomalies within this area of which thirteen are considered major and are evaluated in this document. These include: Brady's Hot Springs, Desert Peak, Soda Lakes--Upsal Hogback, Stillwater, Lee Hot Springs, Dixie Valley, Walley's Hot Springs, Saratoga Hot Springs, Hobo Hot Springs, Wabuska Hot Springs, Hazen, and Hind's Hot Springs and others associated with the east slope of the Pine Nut Mountains.

It is the purpose of this document to provide public and private decision makers with information that will facilitate the development of the various geothermal resources found in Geothermal Resource Area 5. To further this goal, this Area Development Plan was prepared to provide information concerning the geothermal resource, the physical and socio-economic setting of the study area, and the potential for developing this so far under utilized resource.

This report has been divided into three major sections to enable the reader to more easily interpret the information presented. The first section describes Geothermal Resource Area 5 in terms of its physical and socio-economic characteristics. The second describes the resource itself based on the best currently available information. The third 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

Geothermal Resource Area 5 is located in western Nevada and covers a total of 7,878 square miles or approximately seven percent of the total land area of the state (Figure 1). The study area is bordered on the north by Washoe and Pershing Counties; on the east by Lander, Nye, and Mineral Counties; on the south by the State of California; and on the west by Carson City.

Geothermal Resource Area 5 is essentially mountainous with interspaced low valleys. There are several notable mountain ranges in the area including the Sierra Nevada, Pine Nut, Virginia, Stillwater, Clan Alpine, and Desatoya Ranges. Major valleys include Carson Valley, Carson Sink, Dixie Valley, Churchill Valley, Smith Valley, and Mason Valley. Elevations in the study area range from a high of 9,600 feet along the Sierra Nevada Range to a low of 3,900 feet in the Carson Sink area of Churchill County (Figure 2).

2. Climatic Conditions (29-33)

The climatic conditions of the study area are quite variable. Detailed climatological information is available for this area at three recording stations: Yerington, elevation 4,375 feet; Minden, elevation 4,730 feet; and Fallon, elevation 3,965 feet. Tables 1, 2, and 3 give a detailed climatological summary for each of these three stations.

The Sierra Nevada Mountains are very effective in reducing the moisture content of storms moving in from the Pacific during the October to May period. The Rocky Mountains to the east effectively protect the area from long, cold outbreaks of Arctic air

NEVADA

LOCATION OF
GEOTHERMAL RESOURCE
AREA 5

FIGURE 1

FIGURE 2. TOPOGRAPHICAL AND PHYSICAL FEATURES OF
CHURCHILL, DOUGLAS, STOREY, AND LYON COUNTIES

which flow down from Canada during the same period of time. The result is an arid type of climate with hot summers, moderate winters, and cool nights year around. Even in the winter months the sunshine averages over 60 percent.

The annual temperature range is quite large. The highest recorded temperature is 108° F. and the lowest is -24° F. Summer temperatures often go over 90° F. during the day and drop to around 40° F. at night. Temperatures in the winter season range from about 16° F. as a minimum to about 45° F. as a maximum. Temperatures below 0° F. are infrequent but do occur several times a year. Temperature characteristics at other locations in Geothermal Resource Area 5 may be inferred by applying the environmental lapse rate of an increase or decrease of 3-1/2° F. per 1,000 vertical feet higher or lower than the nearest recording station. Care must be taken, however, in using temperatures derived from this lapse rate as local conditions may influence exact temperature readings. For example, the temperatures in the Lake Tahoe Basin are several degrees higher than would normally be found at that elevation because the lake itself acts as a large heat reservoir keeping the surrounding area warmer than would be expected.

Winter precipitation, caused mostly by Pacific storm fronts, represents over 75 percent of the annual total precipitation. There is an average annual snowfall of about 18 inches per year at an elevation of 5,000 feet. The greatest snowfall recorded at that elevation was 83 inches in one winter. Because of the mild daytime temperatures, snow that does fall is rapidly melted. An annual snowpack is developed on the Sierra Nevada Range which usually lasts until mid-June.

Summer in the area is almost totally without adverse weather of any kind. On the average, only 12 thunderstorms occur each year and heavy cloudbursts are a rarity. Precipitation that does occur is the product of a moist southerly flow off the Gulf of Mexico and is usually light and short in duration. Humidity is normally low enough that temperatures are rarely uncomfortable. Even though the area has abundant sunshine, the growing season of 140 days is short and frost has been known to occur in every month except July.

Table 1

CLIMATOLOGICAL SUMMARY-YERINGTON

LATITUDE 36° 59' N
 LONGITUDE 119° 11' W
 ELEV. (GROUND) 4375 feet

CLIMATOLOGICAL SUMMARY

STATION Yerington, Nevada

MEANS AND EXTREMES FOR PERIOD (Means: 1936-1965)
 (Extremes: 1936-1968)

Month	Temperature (°F)								Mean degree days	Precipitation Totals (Inches)							Mean number of days						Month	
	Means			Extremes						Mean	Greatest daily	Year	Snow, Sleet					Precip. 10 inch or more	Temperatures					
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean					Maximum monthly	Year	Greatest daily	Year	Max.		Min.					
																	90° and above		32° and below	32° and below	0° and below			
(a)	30	30	30	33		33			30	33		30	33		33		30	30	30	30	30			
Jan	46.4	15.2	30.8	70	1964+	-26	1937	1054	0.35	1.40	1943	3.0	20.4	1949	6.0	1954	2	0	3	28	3	Jan		
Feb	52.6	20.5	36.6	74	1950	-14	1949	812	0.63	1.28	1962	2.0	8.7	1948	5.5	1948	2	0	•	26	1	Feb		
Mar	59.3	23.9	41.6	81	1960	• 2	1950	719	0.41	0.98	1941	2.0	8.0	1954	6.0	1945	1	0	•	27	0	Mar		
Apr	68.3	30.4	49.4	88	1950	5	1944	468	0.33	0.80	1951	•	4.0	1967	3.0	1967+	1	0	0	18	0	Apr		
May	74.7	37.6	56.2	95	1954	15	1960	291	0.75	1.90	1939	0	6.5	1964	4.0	1964	2	1	0	7	0	May		
Jun	82.4	43.8	63.1	102	1961	26	1954	129	0.55	0.79	1945	0	7	1963+	7	1963	2	7	0	1	0	Jun		
Jul	91.7	49.5	69.1	105	1960	30	1955	22	0.30	0.85	1945	0	0	•	0	•	1	22	0	0	0	Jul		
Aug	90.3	46.5	70.0	105	1967	26	1960	43	0.22	0.55	1936	0	0	•	0	•	1	18	0	0	0	Aug		
Sep	83.2	39.4	61.3	100	1955+	20	1959	153	0.27	2.02	1955	0	0	•	0	•	1	7	0	5	0	Sep		
Oct	71.6	31.3	51.5	90	1952	12	1956	434	0.40	1.40	1943	•	2.0	1943	4.0	1943	1	•	0	18	0	Oct		
Nov	57.4	21.0	39.2	79	1958	0	1956	777	0.49	0.92	1944	1.0	11.5	1961	5.6	1943	1	0	•	27	0	Nov		
Dec	49.1	17.0	33.1	74	1939	-20	1948	1008	0.53	2.00	1955	2.0	16.5	1936	5.0	1941	2	0	1	28	1	Dec		
Year	68.9	31.3	50.2	105	1967+	-26	1937	5910	5.23	2.02	1955	10.0	20.4	1949	6.0	1954+	17	55	4	185	5	Year		

(a) Average length of record, years.

+ Also on earlier dates, months, or years.

• Trace, an amount too small to measure.

* Less than one half.

•• Base 65°F

Table 2
CLIMATOLOGICAL SUMMARY-MINDEN

LATITUDE 38° 57' N
LONGITUDE 119° 46' W
ELEV. (GROUND) 4730 feet

CLIMATOLOGICAL SUMMARY

STATION Minden, Nevada

Means: 1936-1965
MEANS AND EXTREMES FOR PERIOD Extremes: 1936-1968

Month	Temperature (°F)								Mean degree days	Precipitation Totals (Inches)								Mean number of days						Month
	Means			Extremes						Mean	Greatest daily	Year	Snow, Sleet					Precip. .10 inch or more	Temperatures					
																			Max.		Min.			
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean					Maximum monthly	Year	Greatest daily	Year	90° and above		32° and below	32° and below	0° and below			
(a)	30	30	30	33		33		12	30	33		30	33		30		30	30	30	30	30			
Jan	44.5	16.7	30.6	69	1964	-24	1949	1076	1.43	3.03	1963	5.1	15.5	1956	7.0	1956	3	0	4	28	2	Jan		
Feb	50.1	21.4	35.8	75	1951	-10	1949	824	1.29	1.55	1938	3.6	26.0	1938	14.0	1938	3	0	1	26	*	Feb		
Mar	55.6	24.0	39.8	79	1966	-9	1952	777	0.85	1.83	1952	2.1	10.0	1945	5.0	1954	2	0	*	27	*	Mar		
Apr	64.2	30.2	47.2	84	1966+	9	1963	592	0.48	0.95	1952	0.7	4.0	1950	4.0	1950	1	0	0	20	0	Apr		
May	71.7	36.7	54.2	93	1953	16	1948	355	0.58	1.08	1968	*	2.0	1965	2.0	1964	1	*	0	9	0	May		
Jun	80.7	42.2	61.5	102	1961	22	1954	155	0.43	0.90	1963	0	7	1950	7	1950	1	5	0	2	0	Jun		
Jul	90.1	47.3	68.7	105	1960	33	1955	22	0.36	0.83	1945	0	0	--	0	--	1	18	0	0	0	Jul		
Aug	86.0	44.9	65.5	101	1960	28	1945	31	0.28	1.35	1965	0	0	--	0	--	1	16	0	*	0	Aug		
Sep	82.2	38.4	60.3	102	1950	20	1965	183	0.23	0.71	1965	*	1.0	1948	1.0	1948	1	5	0	6	0	Sep		
Oct	71.1	30.8	51.0	91	1959	11	1948	416	0.53	1.71	1962	*	2.0	1941	2.0	1941	1	0	0	18	0	Oct		
Nov	56.4	24.8	40.6	80	1962	-9	1958	765	0.91	2.55	1950	0.6	12.0	1951	6.0	1958	2	0	*	26	*	Nov		
Dec	48.5	19.2	33.9	72	1958	-18	1968	946	1.59	2.36	1955	6.1	37.0	1941	12.0	1964	4	0	2	30	1	Dec		
Year	66.8	31.4	49.1	105	July 1960	-24	Jan 1949	6142	8.96	3.03	Jan 1963	18.2	15.5	Jan 1956	14.0	Feb 1938	21	44	7	192	3	Year		

(a) Average length of record, years.

+ Also on earlier dates, months, or years.

I Trace, an amount too small to measure.

* Less than one half.

** Base 65°F

Table 1

CLIMATOLOGICAL SUMMARY-FALLON

CLIMATOLOGICAL SUMMARY

STATION Fallon, Nevada

LATITUDE 39° 27' N
 LONGITUDE 118° 47' W
 ELEV. (GROUND) 3965

(Means: 1936-1965)
 MEANS AND EXTREMES FOR PERIOD (Extremes: 1936-1968)

Month	Temperature (°F)							** Mean degree days	Precipitation Totals (Inches)							Mean number of days					Month	
	Means			Extremes					Mean	Greatest daily	Year	Snow, Sleet					Precip. .10 inch or more	Temperatures				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year					Mean	Maximum monthly	Year	Greatest daily	Year		Max.		Min.		
																		90° and above	32° and below	32° and below		0° and below
(a)	30	30	30	33		30		##	30	33		30	33		33		30	30	30	30	30	
Jan	44.3	16.6	30.5	71	1950	-25	1949	1070	.50	1.02	1943	2.5	15.8	1937	8.5	1956	2	0	4	28	2	Jan
Feb	51.1	22.6	36.9	74	1951	-17	1937	815	.63	.98	1945	1.8	7.0	1962	5.0	1949	2	0	1	25	1	Feb
Mar	57.3	27.0	42.2	84	1966	3	1948	701	.55	.95	1954	1.3	5.5	1945	4.0	1964	2	0	0	25	0	Mar
Apr	66.9	34.2	55.1	89	1961	15	1945	438	.38	.98	1968	*	4.5	1963	1.5	1967+	1	0	0	14	0	Apr
May	73.8	42.0	57.9	97	1967	21	1964	257	.73	.96	1962	*	8.0	1964	6.0	1964	3	1	0	3	0	May
Jun	82.5	48.0	65.3	106	1961	30	1950	99	.45	.90	1954	0	0	--	T	1950	2	8	0	*	0	Jun
Jul	92.0	54.1	73.1	107	1960	35	1948	0	.19	.56	1946	0	0	--	0	--	1	23	0	0	0	Jul
Aug	89.8	51.2	70.5	105	1960	35	1947	28	.17	1.12	1967	0	0	--	0	--	1	17	0	0	0	Aug
Sep	81.8	43.0	62.4	98	1958	23	1965	132	.22	.59	1952	0	0	--	0	--	1	6	0	2	0	Sep
Oct	70.2	34.4	52.3	91	1963	16	1948	406	.42	.66	1944	*	2.0	1948	1.5	1961	1	*	0	12	0	Oct
Nov	55.4	24.2	39.8	80	1960	4	1964	765	.36	.76	1943	*	4.0	1961	3.0	1961	2	0	*	25	0	Nov
Dec	47.3	19.6	33.5	79	1939	-11	1948	1001	.46	.72	1966	1.5	11.0	1941	5.5	1955	2	0	1	29	*	Dec
Year	67.7	34.7	51.5	107	July 1960	-25	Jan 1949	5712	5.06	1.12	1967	7.1	15.8	Jan 1937	8.5	Jan 1956	19	54	6	162	3	Year

Estimated from monthly means using Weather Service Office Formula

(a) Average length of record, years.

+ Also on earlier dates, months, or years.

T Trace, an amount too small to measure.

* Less than one half.

3. Geologic Setting(2, 22, 25, 39)

Portions of two distinct geomorphic provinces are located in Geothermal Resource Area 5. The eastern portion of the study area has a geologic character more or less typical of the Basin and Range Geomorphic Province with elongate mountains separated by long alluvial filled valleys. West of the Carson Valley the Basin and Range Province rapidly changes into the Sierra Nevada Geomorphic Province.

Most of the rocks found in Geothermal Resource Area 5 range in the age between Permian and Recent. Most of the pre-Tertiary rocks are metamorphic sediments and volcanics intruded by granitic bodies. A great majority of the rocks in the study area are Tertiary in age and consist of lava flows, pyroclastic deposits, and various sized igneous intrusions. The youngest Quaternary and Recent rocks consist primarily of alluvial and lacustrine sediments filling most of the valley floors.

The Basin and Range topography, which characterizes most of the study area, has been developed over all of these rock types. This topography has developed because of the characteristic fault block structure of the province which is caused by normal faulting. It is expressed as north-south trending mountains and valleys. The topography is expressed as long north-south trending mountains and valleys. The Great Basin portion of the Basin and Range province is an area of internal drainage and has many large ephemeral lakes.

The Sierra Nevada portion of Douglas County is primarily composed of the intrusive granitic rock forming the Sierra Nevada Batholith. The Sierras are an exposure of this batholith. They display a very asymmetric east-west profile with an abrupt and very steep east front and a much larger and more gentle western backslope. This is due to extensive normal faulting caused by tilting the entire Sierra Nevada range block to the southwest. In some areas along the front fault, the Sierras have been raised more than 10,000 feet higher than the surrounding plains. In Douglas County, Freel Peak is about 6,000 feet higher than the Carson Valley. The Carson Range of the Sierra Nevada, which

separates the Washoe Valley, Eagle Valley, and Carson Valley from the Lake Tahoe area, is considered to be an additional fault block tilted to the southwest in the same manner as the main range of the Sierras.

The geothermal resource in the study area is associated with the long north-south trending normal faults characteristic to 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 rock heated by the earth's geothermal gradient. The heated water then rises toward the surface along the deep faults which offer permeable conduits for fluid movement. If these faults cut the earth's surface, hot springs, geysers, and other surface expressions 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(11, 12, 13, 14)

Geothermal Resource Area 5 contains portions of five major hydrographic regions found in Nevada. These regions include the Truckee River Basin, Carson River Basin, Walker River Basin, West Central Region, and Central Region.

The Truckee River Basin region is based on drainage into a large regional stream and is found in portions of Douglas and Storey Counties. The Truckee River originates in California at Lake Tahoe and flows northerly out of Lake Tahoe to Truckee, California where it turns east to flow down the east slope of the Sierra Nevada into the Truckee Meadows area of Washoe County. It continues east down the Truckee Canyon in the Virginia Mountains to Wadsworth where it turns north, flows several more miles and terminates in Pyramid Lake. Several small tributary streams feed into the Truckee River from other places in the study area.

A large portion of the Carson River Basin lies in Lyon, Douglas, and Churchill Counties. The Carson River has its origin high in the Sierra Nevadas and flows northerly through Douglas County and into Carson City where it swings eastward into Lahontan Reservoir. Water from this reservoir is used for irrigation in the Newlands Project in Churchill County. Excess water accumulates in the Stillwater area. Before the initiation of the Newlands project, the Carson River continued northeast to its terminus in the Carson Sink area of the Carson Desert.

The Walker River Basin is the third hydrographic region occurring in the study area. It covers much of the southern portion of Douglas and Lyon Counties. The basin's river system is comprised of the East and West Walker Rivers, the Walker River, and several small tributaries. The East Walker River heads in the vicinity of Bridgeport, California, flows generally north until it enters Nevada and continues for about 40 miles to Mason Valley. The West Walker River also heads in California about 20 miles west of Bridgeport, flows north and enters Nevada. The West Walker River flows north through Smith Valley and merges with the East Walker near the southern end of Mason Valley. The Walker River then continues to flow north for about 20 miles, makes a wide turn southeast for another 20 miles and terminates in Walker Lake. The entire drainage area forms a closed basin with no outlet to the sea.

A small portion of the West Central Region occurs in the northwestern part of Churchill County. This region is characterized by small to medium sized valleys and topographically closed valleys with no exterior drainage. Any precipitation falling on the area either infiltrates into the ground water system or is evaporated back into the atmosphere.

The Central Region is the last of the hydrographic regions occurring in the study area. It covers much of the eastern portion of Churchill County. The area is characterized by long, narrow valleys with small and intermittent streams emptying into the valley bottoms where the flows evaporate. The perennial streams usually are only a few miles long and there are no standing bodies

of water even though the area is characterized by internal drainage.

The hydrology of Geothermal Resource Area 5 is typical of that occurring in the eastern Sierra Nevada rain shadow. Precipitation is very seasonal, most of which occurs in the winter as snow. Summer precipitation is generally in the form of afternoon thundershowers. Streamflows graphically show the seasonality of precipitation with peak flows occurring in late spring as the result of snowmelt. Approximately 50 to 55 percent of the annual runoff occurs in May and June with only four percent occurring in September and October. These wide ranges in flow create multiple problems. Seasonal high flows often result in flood damage, with serious erosion and sedimentation. Low flows limit agricultural production and tend to cause high water temperatures. Both sedimentation and high water temperatures adversely impact fish life and general water quality.

The Nevada State Engineer has defined 17 designated groundwater basins in Geothermal Resource Area 5 out of a total of about 30 basins. A designated groundwater basin is one which has had more groundwater allocated than believed to be annually recharged as often happens in a populated area. The Division of Water Resources has several special regulations and permitting procedures which are required before water from these designated basins can be used. Table 4 shows these designated groundwater basins and the associated order number designating those basins. Because the study area's geothermal resources are the water dominated type, use of those resources may affect local groundwater conditions. This may impact historical use of groundwater in those areas and raise questions concerning water rights and water allocation. It should be noted, however, that geothermal development is considered to be a preferred use of groundwater. Any developer of geothermal energy resources is encouraged to contact the State Water Engineer early in the project's planning process to insure that all such water related questions are answered.

Table 4

DESIGNATED GROUNDWATER BASINS IN GEOTHERMAL RESOURCE AREA 5

BASIN	BASIN NUMBER	ORDER NUMBER	DATE
Smith Valley	107	245	6-20-60
Eagle Valley	104	424	2-23-72
Dayton Valley	103	487	2-22-73
Mason Valley	108	627	1-20-77
Carson Valley	105	684	6-14-77
Churchill Valley	102	689	8-23-77
Fernley Area	76	600	12-30-77
Tracy Segment	83	705	3-1-78
Antelope Valley	106	714	5-25-78
Dixie Valley	128	715	6-8-78
Eastgate Valley Area	127	715	6-8-78
Cowkick Valley	126	715	6-8-78
Stingaree Valley	125	715	6-8-78
Fairview Valley	124	715	6-8-78
White Plains	74	716	7-6-78
Carson Desert	101	716	7-6-78
Buena Vista Valley	129	732	10-02-79

B. Land Ownership and Land Use(20)

Geothermal Resource Area 5 comprises an area of 7,878 square miles, approximately seven percent of the total land area of the State of Nevada. Table 5 shows the distribution of the land ownership in the study area (Figure 3).

Table 5

LAND OWNERSHIP PATTERNS IN GEOTHERMAL RESOURCE AREA 5

CHURCHILL COUNTY

Public Land	Acres	Percent
Federal	2,717,500	95.54
State	11,799	.41
County	31,813	1.12
Total Public	2,761,112	97.08
Private Land		
Indian	49,036	1.72
Tax Roll	34,092	1.20
Total Private	83,128	2.92

DOUGLAS COUNTY

Public Land		
Federal	182,595	37.99
State	189	0.04
County	2,000	0.42
Total Public	184,784	38.45
Private Land		
Indian	61,349	12.76
Tax Roll	234,507	48.79
Total Private	295,856	61.55

LYON COUNTY

Public Land		
Federal	870,206	67.18
State	17,749	1.37
County	1,710	0.13
Total Public	889,665	68.68
Private Land		
Indian	48,693	3.76
Tax Roll	357,002	27.56
Total Private	405,695	31.32

Table 5 (continued)

STOREY COUNTY

Public Land	Acres	Percent
Federal	13,830	8.25
State	-0-	-0-
County	753	0.45
Total Public	14,583	8.70
Private Land		
Indian	-0-	-0-
Tax Roll	153,097	91.30
Total Private	153,097	91.30

Existing land use patterns in Geothermal Resource Area 5 are based primarily on the proximity of the area to the major population centers of Minden/Gardnerville, Stateline, Yerington, Fallon, Virginia City, and the other historically smaller population centers. Away from these centers, the land has been used for agriculture, ranching, mining, wildlife management, and open space. The Bureau of Land Management has classified most of the 3,211,898 acres of public land it administers in this area as being for multiple use with the only exception being those units studied as potential wilderness areas. This multiple use 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. Other federal agencies holding title to land in Geothermal Resource Area 5, such as the U.S. Forest Service and the Bureau of Reclamation, are also managing their lands according to the multiple use concept.

There are five BLM Wilderness Study Areas in the study area: Desatoya Mountains, Clan Alpine Mountains, Augusta Mountains, Jobs Peak, and Stillwater Range.(27)

These study areas are those which the 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;
4. Supplemental values--must have supplemental values, which include ecological, geological, or other natural features of scientific, educational, scenic, or historical value.

These five 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 the 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 compatible. Such uses include residential, commercial, governmental/institutional, various types of industrial, and agricultural. Geothermal development must be compatible with existing development in these zoned areas.

C. Population(23)

The population trend in each of the four counties in Geothermal Resource Area 5 is quite different. Douglas County has had the largest overall population increase, 558 percent between 1920 and 1976. Churchill County has had a population increase of 157 percent, and Lyon County had an increase of 156 percent. In the same time period, Storey County experienced a 25 percent population reduction. All counties except Churchill experienced some period of population decrease in this 56 year period. Geothermal Resource Area 5 taken as a whole, experienced a 195 percent population increase. The State Planning Coordinator's Office anticipates that growth will continue. Table 6 illustrates the past growth trend in each of the four counties in Geothermal Resource Area 5.

FIGURE 3. LAND OWNERSHIP IN
STOREY, DOUGLAS, LYON, AND CHURCHILL COUNTIES

The existing population of Geothermal Resource Area 5 is not evenly distributed but is localized into distinct population centers with only scattered persons in the rural areas. The major communities in each county are listed below:

- Churchill County
 - Fallon
 - Fallon Naval Air Station
- Douglas County
 - Minden/Gardnerville
 - Genoa
 - Glenbrook
 - Stateline
- Lyon County
 - Yerington
 - Fernley
 - Silver Springs
 - Wellington
 - Dayton
 - Mason
- Storey County
 - Virginia City

Table 7 illustrates the anticipated growth for these communities. The State Planning Coordinator's Office anticipates that all cities will experience some growth with Minden/Gardnerville and Fallon growing by the largest numbers. The smaller communities are also anticipated to grow, but will not become as large as these two communities. These, and the county population projections, are based on historical population growth data. Should any types of new, unanticipated development activities occur, these estimates could be invalid.

As the population of the study area grows, geothermal development should be encouraged to help supply energy needs of the new residents. Such development could in addition, supply new jobs and provide a broadened economic base for the study area.

Table 6

PAST AND PROJECTED POPULATION TREND
IN GEOTHERMAL RESOURCE AREA 5

YEAR	CHURCHILL	DOUGLAS	LYON	STOREY
1920	4,649	1,825	4,078	1,469
1930	5,075	1,840	3,810	660
1940	5,317	2,956	4,076	1,216
1950	6,161	2,029	3,679	671
1960	8,452	3,481	6,143	568
1961	8,716	3,951	6,655	582
1962	8,640	3,969	6,578	615
1963	8,608	4,044	6,663	597
1964	8,744	4,144	6,823	551
1965	8,984	5,195	7,146	663
1966	9,367	5,503	7,445	668
1967	9,568	5,604	7,584	679
1968	9,516	5,826	7,747	634
1969	10,382	6,749	7,934	696
1970	10,513	6,882	8,221	695
1971	11,100	7,500	9,200	700
1972	11,500	8,500	9,500	700
1973	11,849	9,548	10,042	881
1974	11,900	10,400	10,300	900
1975	12,000	11,100	10,400	1,000
1976	11,992	11,965	10,578	1,053
1977	12,102	12,758	10,663	1,110
1978	12,589	13,850	9,768	1,165
1979	13,075	14,943	8,874	1,219
1980	13,562	16,035	7,979	1,274
1981	13,823	16,767	7,993	1,315
1982	14,084	17,500	8,009	1,357
1983	14,346	18,232	8,024	1,398
1984	14,607	18,965	8,040	1,440
1985	14,868	19,697	8,055	1,481
1990	16,061	21,130	8,571	1,619
1995	17,430	25,370	8,793	1,848
2000	18,730	28,700	9,088	2,047

Table 7

POPULATION PROJECTION FOR THE MAJOR COMMUNITIES IN
GEOTHERMAL RESOURCE AREA 5 TO THE YEAR 2000

Area	1980	1990	2000	2010	2020
CHURCHILL COUNTY					
Fallon	5,500	8,000	12,500	18,800	23,400
Fallon Naval Air Station	1,100	1,200	1,300	1,400	1,500
DOUGLAS COUNTY					
Minden/Gardnerville	2,900	4,200	5,600	11,480	15,600
Genoa	200	400	700	900	1,100
Glenbrook	100	200	300	400	500
Stateline	6,700	7,900	9,100	10,000	10,600
LYON COUNTY					
Yerington	2,600	2,700	2,800	3,400	4,000
Fernley	2,800	2,900	3,000	9,900	16,000
Silver Springs	800	900	1,000	2,100	3,200
Wellington	200	250	300	400	500
Dayton	800	900	1,000	1,200	2,200
Mason	30	350	400	500	600
STOREY COUNTY					
Virginia City	580	860	1,140	1,400	1,600

D. Transportation Facilities(8, 9, 10)

Three national highways pass through Geothermal Resource Area 5. U.S. 95 is a major north-south route entering Nevada north of the town of McDermitt. It connects Interstate 80 in northern Nevada with Interstate 15 in southern Nevada passing through the towns of Fallon, Hawthorne, Tonopah, Goldfield, Beatty, and Las Vegas (Figure 4).

Interstate 80 passes through the northern part of the study area. I-80 is one of 12 east-west interstate routes in the United States. It connects eastern and western Nevada and the towns of Wells, Elko, Carlin, Battle Mountain, Winnemucca, Lovelock, Fernley, Wadsworth, Sparks, Reno, and Verdi.

The third major route is U.S. 50, an east-west route connecting the central portion of the state. The towns of Ely, Eureka, Austin, Fallon, Carson City, and Stateline are on this route.

The study area has a total of 5,268 miles of roadway with 622 miles on the federal aid system, 205 miles on the state aid system, 4,405 miles on the county system, and 36 miles on the city or local system. The area has 4,195 miles of unpaved road and 1,073 miles of roadway paved to various standards.

Transportation services are rather limited. Truck service is available to all areas, although no interstate trucking firms maintain terminal facilities in the area. The nearest freight center with terminal facilities is in Reno. Limited air service is available from the small facilities in Yerington, Fallon, and Minden/Gardnerville. No regularly scheduled commercial airlines fly into any of these airport facilities but charter service is available. The nearest full service airport in the region is Reno Cannon International Airport. The Southern Pacific Railroad maintains limited freight service into Lyon and Churchill Counties.

Counties. No passenger service is available. Two interstate bus lines provide the various communities with passenger service.

E. Economic Activity

1. Churchill County

a. Background(20)

Churchill County is named after Fort Churchill, an early military post now located in Lyon County. The county was created by a Territorial Act approved November 21, 1861 and the county seat established at the community of Stillwater, 12 miles northwest of Fallon, on February 19, 1864.

The Arid Lands Act establishing the Truckee-Carson Irrigation Project, centered in Fallon, was passed in 1902. Rich mining strikes were made at Fairview, Wonder, and Rawhide. These events led to the rapid growth of the city of Fallon and the demise of Stillwater. Eventually, the county seat was moved to Fallon. Today, about 20 different mining companies produce magnetite, antimony, barite, gold, silver, tungsten, diatomite, salt, and aggregate.

b. Employment(16)

Table 8 illustrates the 1979 employment and income patterns for Churchill County. Government, trade, and service industries employ the largest number of persons and pay the largest amount of wages. Together, they account for about 77 percent of all wages paid. Other industrial categories such as mining, construction, manufacturing, transportation, communications, and utilities and finance, insurance and real estate play an important role in the community but do not employ a significant number of persons.

FIGURE 4. MAJOR TRANSPORTATION FACILITIES IN
CHURCHILL, DOUGLAS, LYON, AND STOREY COUNTIES

The State Planning Coordinator's Office projected that in 1980, 40 percent of Churchill County's labor force was in the governmental classification. Most of these people were employed at the Fallon Naval Air Station with fourteen percent in the service industry and 13 percent in trade.

Unemployment ranged from seven to nine percent between 1972 and 1977. In 1978 it dropped to 5.3 percent but increased to six percent in 1979, third highest unemployment rate in the state.

During 1977 Churchill County's per capita income was \$6,066 which represented only a 0.4 percent increase from 1976. In 1978 the median family income was estimated at \$15,900.

Table 8

1979 EMPLOYMENT PATTERNS -- CHURCHILL COUNTY

Industry	Number of Firms	Number of Employees	Percent of Employees	Total Wages	Percent of Wages
Mining	12	49	1	674,830	2
Construction	57	221	7	3,077,740	8
Manufacturing	12	173	5	2,349,243	6
Trans., Comm., and Util.	16	74	2	1,241,675	4
Wholesale & Retail Trade	129	801	24	7,087,501	19
Fin., Ins., and Real Estate	25	105	3	1,144,094	3
Service Industries*	99	711	21	5,902,186	16
Government	28	1,250	37	15,497,453	42
TOTAL	378	3,384	100	36,974,722	100

*Includes Agricultural Services and Firms not Elsewhere Classified

2. Douglas County

a. Background(20)

Douglas County was one of the original counties formed when the state was created in 1864. Prior to statehood it had been part of Carson City in the Nevada Territory, and previous to that Millard County in the Utah Territory.

Two of the county's important unincorporated areas are Gardnerville and Minden, which are both farming and ranching communities. They were founded in 1881 and 1906, respectively.

In its early days Douglas County was characterized as having a substantially agricultural economy. Today it is developing into an urbanized environment whose economy is becoming more dependent upon the gaming industry. Douglas County has only five mining operations. All of these are mining sand and gravel.

b. Employment and Income(16)

The service industry dominates Douglas County's economy. In 1979 this industry accounted for 70 percent of the total employment in the county and supplied 64 percent (\$104,350,866) of the wages. All remaining industries have a workforce ranging from a low of 9 employees in mining to a high of 1,061 employees in manufacturing (Table 9).

Unemployment rates, which ranged between eight and nine percent between 1972 and 1977, dropped to 5.3 percent in 1978, and in 1979 increased to 5.8 percent.

Per capita income was one of Nevada's highest in 1977 (\$9,520) up 36 percent from 1973. In 1978, 50 percent of the households had incomes of \$16,300 or above.

Table 9

1979 EMPLOYMENT PATTERNS -- DOUGLAS COUNTY

Industry	Number of Firms	Number of Employees	Percent of Employees	Total Wages	Percent of Wages
Mining	4	9	<1	115,763	<1
Construction	182	969	7	15,379,281	10
Manufacturing	18	1,061	7	14,414,860	9
Trans., Comm., and Util.	33	341	2	4,881,837	3
Wholesale & Retail Trade	141	884	6	8,338,853	5
Fin., Ins., and Real Estate	63	355	2	4,344,940	3
Service Industries*	161	10,363	70	104,350,866	64
Government	32	810	6	9,679,931	6
TOTAL	634	14,792	100	161,506,331	100

*Includes Agricultural Services and Firms not Elsewhere Classified

3. Lyon County

a. Background(20)

Lyon County was one of Nevada's original territorial counties being formed by an act approved November 25, 1861 establishing Dayton as the county seat. In 1911 the county seat was moved to Yerington. Since the county's early days, its economy has been based on agriculture and mining.

b. Employment and Income(16)

Lyon County's most significant business activities are government and trade. Manufacturing and the service industries are the next leading employment sources followed by a rapidly declining mining industry.

The unemployment rate was 12.5 percent in 1975. It has continued to be high, although it dropped to seven percent in 1979, second highest in the state.

Between 1973 and 1977 Lyon County's per capita income increased 36 percent from \$4,487 to \$6,120, twelfth in Nevada. Median family income in 1978 was \$13,900.

Table 10

1979 EMPLOYMENT PATTERNS -- LYON COUNTY

Industry	Number of Firms	Number of Employees	Percent of Employees	Total Wages	Percent of Wages
Mining	13	119	5	2,237,000	9
Construction	49	189	8	2,426,048	9
Manufacturing	22	393	17	5,080,407	19
Trans., Comm., and Util.	14	82	4	1,423,864	5
Wholesale & Retail Trade	99	473	20	3,678,859	14
Fin., Ins., and Real Estate	21	81	4	999,556	4
Service Industries*	60	328	14	3,047,750	12
Government	25	641	28	7,201,285	28
TOTAL	303	2,306	100	26,094,769	100

*Includes Agricultural Services and Firms not Elsewhere Classified

4. Storey County

a. Background(20)

Storey County is one of the original counties of the state. There has been no change in its boundaries since the county was first formed in 1861. Virginia City was and still is the principal city. Its mines were the prime movers in establishing Nevada as a territory.

During the boom days between 1860 and 1892 more than \$375 million worth of gold and silver ore was produced from the famous Comstock Lode. Although the main veins were exhausted prior to the 1880's, mining activities have continued until today.

The county's economy has always been dependent upon the mining industry. There are about ten companies currently in operation producing gold, silver, pumice, diatomite, and aggregate. Additionally, the county has developed a booming tourist industry in the historic Comstock Lode.

b. Employment and Income(16)

Storey County is primarily oriented toward colorful Virginia City's tourist trade and mining. Because of this, the economic base is very limited. Mining accounts for 34 percent of the county's employment, wholesale and retail trade accounts for 32 percent, and government accounts for 14 percent. These are the major industries that are expected to show growth through the 1980's. (Table 11).

Storey County's unemployment rate was among the highest in the state in the 1970's. It was over eight percent in 1973, 1974 and 1976. Unemployment decreased to 3.2 percent in 1978 and further decreased to 2.1 percent in 1979, the lowest unemployment rate in the state.

Per capita income was \$5,872 in 1977, third lowest in Nevada for that time period.

Table 11

1979 EMPLOYMENT PATTERNS -- STOREY COUNTY

Industry	Number of Firms	Number of Employees	Percent of Employees	Total Percent o Wages	Percent o Wages
Mining	5	205	34	3,918,441	51
Construction	**	**	**	48,861	<1
Manufacturing	**	**	**	98,947	1
Trans., Comm., and Util.	3	54	9	982,214	13
Wholesale & Retail Trade	30	192	32	1,425,001	18
Fin., Ins., and Real Estate	**	13	2	83,665	1
Service Industries*	14	42	7	314,723	4
Government	7	83	14	816,379	12
TOTAL	64	599	100	7,688,231	100

*Includes Agricultural Services and Firms not Elsewhere Classified

**No Information Available or less than Three Firms

F. Design Information(1)

No engineering design characteristics are available for any community in Geothermal Resource Area 5. The two closest communities with such information available are Reno in Washoe County and Carson City. The design characteristics for these communities are given as reference below:

	<u>Reno</u>	<u>Carson City</u>
Latitude	39°36'	39°09'
Longitude	119°36'	119°46'
Elevation	4,404 ft.	4,611 ft.
Winter Design Dry-Bulb Temperature		
99%	5°F.	4°F.
97.5%	10°F.	9°F.
Summer Design Dry-Bulb and Mean Coincident Wet-Bulb Temperature		
1%	95°/61°F.	94°/60°F.
2.5%	92°/60°F.	91°/59°F.
5%	90°/59°F.	89°/58°F.
Mean Daily Temperature Range	45°F.	42°F.
Design Wet-Bulb Temperature		
1%	64°F.	63°F.
2.5%	62°F.	61°F.
5%	61°F.	60°F.
Degree-Heating Days	6,022	5,753
Degree-Cooling Days	307	374

Degree-heating and degree-cooling day information is available on the following communities in the study area.

	Elevation	Degree-Heating Days	Degree-Cooling Days
Fallon	3,965	5,622	547
Glenbrook	6,400	6,890	150
Lahontan	4,158	5,687	1,094
Minden	4,158	5,687	1,094
Smith	4,750	6,089	274
Yerington	4,375	5,910	274

G. Energy Information

The energy situation in Geothermal Resource Area 5 is typical of that occurring in northern 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 various quantities of coal, wind, hydro, and other alternative energy resources.

Most of the electrical energy used in Geothermal Resource Area 5 is supplied by Sierra Pacific Power Company (SPPCo.). There are areas, however, that have no electrical service available. Users in these areas must generate their own electricity.

The electrical energy supplied by SPPCo. tends to be more costly than electricity supplied by most other companies in Nevada. The primary reason for the higher cost is that SPPCo.'s primary generation facilities, the Tracy and Fort Churchill Powerplants, use oil and natural gas as fuels. Approximately 60 percent of the natural gas used comes from Canada, and nearly all of the oil is imported from neighboring states or foreign countries. Substantial price increases for both of these fuels in the years since the 1973-1974 Arab Oil Embargo have caused rapid escalation in costs to electrical users.

Southwest Gas Company is the principal supplier of natural gas in the region supplying the communities of Fernley, Fallon, Yerington, and Minden/Gardnerville. The company also has authority to service areas within one mile of its main pipelines. Sierra Pacific Power Company also serves a limited number of customers living in northern Storey County. The cost of the natural gas obtained, either directly or indirectly through Southwest Gas, are steadily rising because most of the natural gas purchased for use in northern Nevada is imported from Canada. Substantial price increases have been imposed by the government of Canada on this gas in the last few years.

Natural gas is available in the study area only in the more urbanized locales. Consumers in outlying areas must rely on electricity, liquified petroleum gas (LPG), or other petroleum products to satisfy their energy demands. In remote rural areas the costs of importing these fuels is becoming extremely expensive. Energy costs for petroleum products have more than doubled in the last few years.

Coal is another energy source that has seen limited use in the study area. The amount consumed is very small and consists mainly of residential applications together with one or two large industrial user.

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

Given the existing mix of energy resources that are presently used it is obvious that the potential for developing geothermal resources is very good. In order to assess the potential for geothermal energy to supply energy requirements in the study area, the NDOE has been working with the New Mexico Energy Institute (NMEI) to evaluate the prospects for geothermal energy development through the year 2020. 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 public developers or residential and industrial applications by private developers. Tables 12 and 13 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 2.2×10^{12} BTUs of energy could economically be developed by either municipal or private developers. By the year 2000 this increases to 4.18×10^{12} BTUs and by 2019 it increases to 1.47×10^{12} BTUs. It should be noted that these projections represent an idealized situation where all the resources are

developed to their maximum economic 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, that that total anticipated energy consumption for non-transportation needs in the study in 1990 would be 9.3×10^{12} BTUs. In 2000 it would be about 9.0×10^{12} BTUs. These figures indicate that under ideal conditions approximately 20 percent of the energy demand in the study area could be met by geothermal energy in the year 1990 and over 45 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 are going to 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 production 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 Churchill, Douglas, Lyon, and Storey Counties should be encouraged wherever and whenever possible. This development would benefit both Nevada's citizens and industries, and would assist in the development of energy independence in this country.

Table 12

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	1.02 x 10 ¹¹	739,130	3.0 x 10 ⁷
1984	1.49 x 10 ¹¹	1,079,710	4.4 x 10 ⁷
1985	1.58 x 10 ¹¹	1,144,928	4.6 x 10 ⁷
1986	1.68 x 10 ¹¹	1,217,391	4.9 x 10 ⁷
1987	1.80 x 10 ¹¹	1,304,348	5.3 x 10 ⁷
1988	1.92 x 10 ¹¹	1,391,304	5.6 x 10 ⁷
1989	2.06 x 10 ¹¹	1,492,754	6.0 x 10 ⁷
1990	2.22 x 10 ¹¹	1,608,696	6.5 x 10 ⁷
1991	2.39 x 10 ¹¹	1,731,884	7.0 x 10 ⁷
1992	2.59 x 10 ¹¹	1,876,812	7.6 x 10 ⁷
1993	2.74 x 10 ¹¹	1,985,507	8.0 x 10 ⁷
1994	2.91 x 10 ¹¹	2,108,696	5.5 x 10 ⁷
1995	3.08 x 10 ¹¹	2,231,884	9.0 x 10 ⁷
1996	3.27 x 10 ¹¹	2,369,565	9.6 x 10 ⁷
1997	3.48 x 10 ¹¹	2,521,739	1.0 x 10 ⁸
1998	3.70 x 10 ¹¹	2,681,159	1.1 x 10 ⁸
1999	3.93 x 10 ¹¹	2,847,826	1.2 x 10 ⁸
2000	4.18 x 10 ¹¹	3,028,986	1.2 x 10 ⁸
2001	4.45 x 10 ¹¹	3,224,638	1.3 x 10 ⁸
2002	4.74 x 10 ¹¹	3,434,783	1.4 x 10 ⁸
2003	5.05 x 10 ¹¹	3,659,420	1.5 x 10 ⁸
2004	5.38 x 10 ¹¹	3,898,551	1.6 x 10 ⁸
2005	5.74 x 10 ¹¹	4,159,420	1.7 x 10 ⁸
2006	6.12 x 10 ¹¹	4,434,783	1.8 x 10 ⁸
2007	6.54 x 10 ¹¹	4,739,130	1.9 x 10 ⁸
2008	6.98 x 10 ¹¹	5,057,791	2.0 x 10 ⁸
2009	7.46 x 10 ¹¹	5,405,797	2.2 x 10 ⁸
2010	7.97 x 10 ¹¹	5,774,362	2.3 x 10 ⁸
2011	8.52 x 10 ¹¹	6,173,913	2.5 x 10 ⁸
2012	9.11 x 10 ¹¹	6,601,449	2.7 x 10 ⁸
2013	9.75 x 10 ¹¹	7,062,217	2.9 x 10 ⁸
2014	1.04 x 10 ¹²	7,536,232	3.0 x 10 ⁸
2015	1.12 x 10 ¹²	8,115,942	3.3 x 10 ⁸
2016	1.20 x 10 ¹²	8,695,652	3.5 x 10 ⁸
2017	1.28 x 10 ¹²	9,275,362	3.8 x 10 ⁸
2018	1.37 x 10 ¹²	9,927,536	4.0 x 10 ⁸
2019	1.47 x 10 ¹²	10,652,174	4.3 x 10 ⁸

Table 13

NEW MEXICO ENERGY INSTITUTE--GEOTHERMAL DIRECT USE ENERGY PROJECTIONS--
COMBINED INDUSTRIAL AND RESIDENTIAL APPLICATION WITH PUBLIC 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	1.20 x 10 ¹¹	869,565	3.5 x 10 ⁷
1984	1.49 x 10 ¹¹	1,079,710	4.4 x 10 ⁷
1985	1.58 x 10 ¹¹	1,144,928	4.6 x 10 ⁷
1986	1.68 x 10 ¹¹	1,217,391	4.9 x 10 ⁷
1987	1.80 x 10 ¹¹	1,304,348	5.3 x 10 ⁷
1988	1.92 x 10 ¹¹	1,391,304	5.6 x 10 ⁷
1989	2.06 x 10 ¹¹	1,492,754	6.0 x 10 ⁷
1990	2.22 x 10 ¹¹	1,608,690	6.5 x 10 ⁷
1991	2.39 x 10 ¹¹	1,713,884	7.0 x 10 ⁷
1992	2.59 x 10 ¹¹	1,876,812	7.5 x 10 ⁷
1993	2.74 x 10 ¹¹	1,985,507	8.0 x 10 ⁷
1994	2.91 x 10 ¹¹	2,108,696	8.5 x 10 ⁷
1995	3.09 x 10 ¹¹	2,239,130	9.1 x 10 ⁷
1996	3.28 x 10 ¹¹	2,376,812	9.6 x 10 ⁷
1997	3.48 x 10 ¹¹	2,521,739	1.0 x 10 ⁸
1998	3.70 x 10 ¹¹	2,681,159	1.1 x 10 ⁸
1999	3.93 x 10 ¹¹	2,847,826	1.2 x 10 ⁸
2000	4.18 x 10 ¹¹	3,028,986	1.2 x 10 ⁸
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2002	4.74 x 10 ¹¹	3,434,783	1.4 x 10 ⁸
2003	5.05 x 10 ¹¹	3,659,420	1.5 x 10 ⁸
2004	5.38 x 10 ¹¹	3,898,551	1.6 x 10 ⁸
2005	5.74 x 10 ¹¹	4,159,420	1.7 x 10 ⁸
2006	6.13 x 10 ¹¹	4,442,029	1.8 x 10 ⁸
2007	6.54 x 10 ¹¹	4,739,130	1.9 x 10 ⁸
2008	6.98 x 10 ¹¹	5,057,971	2.0 x 10 ⁸
2009	7.46 x 10 ¹¹	5,405,797	2.2 x 10 ⁸
2010	7.98 x 10 ¹¹	5,782,609	2.3 x 10 ⁸
2011	8.52 x 10 ¹¹	6,173,913	2.5 x 10 ⁸
2012	9.11 x 10 ¹¹	6,601,490	2.7 x 10 ⁸
2013	9.75 x 10 ¹¹	7,065,217	2.9 x 10 ⁸
2014	1.04 x 10 ¹²	7,536,232	3.0 x 10 ⁸
2015	1.12 x 10 ¹²	8,115,942	3.3 x 10 ⁸
2016	1.20 x 10 ¹²	8,695,652	3.5 x 10 ⁸
2017	1.28 x 10 ¹²	9,275,362	3.7 x 10 ⁸
2018	1.37 x 10 ¹²	9,927,537	4.0 x 10 ⁸
2019	1.47 x 10 ¹²	10,652,174	4.3 x 10 ⁸

III. THE RESOURCE

A. General Information

There are approximately 13 geothermal anomalies in Geothermal Resource Area 5 with the potential for commercial development. Of these the most prominent are: Desert Peak, Brady Hot Springs, Dixie Valley, Stillwater Thermal Area, Walley's Hot Springs, and Wabuska Hot Springs (Figure 5). The following portion of this report includes a discussion of the major geothermal areas in Geothermal Resource Area 5 with a brief description of each known characteristics of the resource.

Evaluation of the geothermal reservoir associated with each resource is difficult because of the limited information currently available. The size of the reservoir was determined either from the U.S.DOE publication Geothermal Direct Heat Use Market Potential or U.S.G.S. Circular 790. The heat energy stored in the reservoir was determined according to U.S.G.S. methodology. 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 the calculation is:(27)

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

qr = reservoir thermal energy in BTUs

pc = volumetric specific heat of rock plus water (40.28 BTU/ft³/°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 that is obtainable using modern technology an assumption of 25 percent of total reservoir capacity is used.

It should be emphasized that the information presented about each geothermal reservoir is based on the best information currently available. The actual conditions in the reservoir may be considerably different than indicated. Any party investigating the development of any of these resources is urged to contact the Nevada Department of Energy for additional information and to engage the services of a reputable consulting firm that has experience in assessing and developing geothermal reservoirs.

FIGURE 5. LOCATIONS OF THE GEOTHERMAL RESOURCES IN
CHURCHILL, LYON, DOUGLAS, AND STOREY COUNTIES

B. Churchill County

1. Brady's Hot Springs(19)

a. Description

Brady's Hot Springs are located approximately 20 miles north of Fernley along Interstate 80. The thermal area is elongate parallel to the "Thermal Fault" and covers approximately six to eight square miles. Aligned along this fault are areas of intense hydrothermal alteration. Spring siliceous sinter deposits and nearby alluvial fan deposits show recent fault movement along the trace of the fault. The fault is normal and dips steeply to the west. The amount of displacement is unknown.

The groundwater supplying Brady's Hot Springs probably moves as underflow southward from Fireball Valley and northward from the Fernley area. It has been suggested that part of the recharge of the thermal area could actually be from outside of the local drainage area.

The first wells were drilled into Brady's Hot Springs in the early 1950's. Prior to that time there were naturally flowing springs. Estimates indicated that the flow from these springs were between 21 and 50 gallons per minute. Following the drilling of the wells and withdrawal of water from them, the springs ceased to flow. The original spring was 180°F. Today, boiling water is reported to stand 20 feet below the surface in one of the wells.

Twelve major geothermal wells have been drilled at Brady's Hot Springs ranging in depth from 241 to 7,275 feet. Temperatures encountered have been up to 418° F. Tests done on several of the wells shortly after drilling indicated 170,000 to 700,000 lbs/hr of fluid. Well pressures between 9.5 and 18.0 lb/in² gage (psig) have been recorded. Steam flashover was reported to be five percent.

There is some scaling problem in the wells. Calcite forms rapidly in the well bores during flow, requiring reaming. The amount of scaling decreases after the wells have been in production for some time.

The thermal water at Brady's Hot Springs is the sodium chloride type. It has a high total dissolved solids content. Several of the wells have over 2,400 parts per million.

Brady's Hot Springs were used as a source of water for the early travelers crossing the Forty-Mile Desert on the Emigrant Trail. Before using the water from the hot springs it had to be collected in barrels and cooled. In the 1880's there were some unsuccessful attempts to extract boric acid from the water. In later years the water was used in a bathhouse and a swimming pool. Today, Geothermal Food Processors makes use of the hot geothermal water from several nearby wells in the dehydration of several different vegetable crops such as onions and celery.

b. Summary of Exploration(19)

Operator	Name	Date Completed	Depth (feet)	Temperature F.
Magma Power Company	Brady No. 1	1958?	700?	
Magma Power Company	Brady No. 2	1959?	241	330
Magma Power Company	Brady No. 3	1961?	610	335
Magma Power Company	Brady No. 4	1961?	723	
Magma Power Company	Brady No. 5	1961?	1,800	340
Magma Power Company	Brady No. 6	?	770	
Magma Power Company	Brady No. 7	?	250	
Earth Energy Inc.	R Brady EE No. 1	1964	5,062?	414
Earth Energy Inc.	Brady Pros. No.1	1965?	1,758?	355
Union Oil Co. of CA	SP-Brady No. 1	1974	7,275	371
Magma Energy Inc.	SP-Brady No. 2	1975	4,446	
Magma Energy Inc.	SP-Brady No. 8	1975	3,469	

c. The Reservoir

The following parameters are believed to describe the Brady's Hot Springs geothermal reservoir:

Reservoir Volume (38)

5.28 $\pm$ cubic miles

Temperature(35)

Surface or near surface conditions (measured) --- 180° to 212°F.

Depth (measured) ----- 418°F.

Mean reservoir temperature ----- 311° to $\pm$ 11°F.

Discharge (19)

Natural-----21 to 50 gallons per minute

Water Chemistry (19)

Examples of water chemistry analyses information from the Brady's Hot Springs area are given in Appendix 1. The most obvious characteristics of the water chemistry from Brady's Hot Springs is the high concentration of sodium, chlorine, and total dissolved solids. These substances exceed the safe drinking water standards by several times and may pose scaling problems in geothermal wells.

Energy Content(38)

Potential heat energy found in the reservoir-----7.9 x 10¹⁵ BTUs

Heat energy extractable with existing technology-----2.0 x 10¹⁵ BTUs

2. Desert Peak Area

a. Description (19)

The Desert Peak geothermal area is located in the northern part of the Hot Springs Mountains four miles southeast of Brady's Hot Springs. There are no surface indications of a geothermal

a geothermal area other than a few small outcrops of siliceous sinter and travertine believed to have been deposited when springs were flowing.

Three wells deeper than 3,000 have been drilled by Phillips Petroleum. These wells encountered Mesozoic metavolcanic and metasedimentary rocks between 3,000 and 4,500 feet in depth. These rocks were overlain by a sequence of Miocene volcanics which probably serve as a seal to the geothermal reservoir.

The reservoir is believed to have a temperature of 406° F. The water is the sodium chloride type containing about 7,500 ppm of total dissolved solids.

This resource was located by Phillips after drilling about 50 temperature gradient holes up to about 500 feet in depth. To date, most of the information concerning this resource is considered private information and has not been released for public review.

b. The Reservoir

The following parameters may be used to describe the Desert Peak geothermal reservoir:

Reservoir Volume (35)*

12.47 $\pm$ 4.32 cubic miles

Temperature(35)

Reported well-----406°F.
Na-K-Ca geothermometer-----437°F.
Sulfate-water isotope geothermometer-----444°F.
Mean reservoir temperature-----429 $\pm$ 9°F.

Discharge or Flow Rate

None known

*Be cautious when evaluating any temperature based on geothermometers as local geological conditions may cause inaccuracies that may invalidate the temperatures.

Water Chemistry

No information available other than the total dissolved solids are 7,500 parts per million.

Energy Content(38)

Potential heat energy found in the reservoir----- 2.7×10^{16} BTUs

Heat energy extractable with existing technology----- 6.8×10^{15} BTUs

3. Soda Lakes--Upsal Hogback Thermal Area

a. Description(19)

The Soda Lakes-Upsal Hogback thermal area is located in the west-central part of the Carson Desert. It is about seven miles northwest of Fallon and covers an area of eight square miles.

There is no surface indication of this geothermal resource. Its presence was not discovered until 1903 when a well drilled in the area hit boiling water at about 60 feet. A bathhouse, built at that time to use the hot water and steam, no longer exists.

The thermal anomaly is apparently related to volcanic activity that created the Soda Lakes and the series of basaltic cones that make up the Upsal Hogback. Soda and Little Soda Lakes are craters that are rimmed by a mixture of basaltic and nonvolcanic debris blown out by repeated gaseous eruptions which are believed to be in part phreatic. The volcanic activity that created the Upsal Hogback was believed to occur during an interpluvial time in the late Pleistocene when Lake Lahontan was dry. As the existing rim of the Soda Lakes has not been cut by any Pleistocene pluvial lake, they are believed to have been created less than 6,900 years ago.

Exposed faults in the area are rare. However, the general alignment of Soda Lakes, the thermal anomaly, and the Upsal Hogback along a north-northeast trend suggests that geothermal waters are migrating by typical Basin and Range faults from some depth.

b. Summary of Exploration(19)

Operator	Name	Completion Date	Depth (feet)	Maximum Temperature (°F)
Chevron-Phillips Chevron Resources Co.	Soda Lake #1-29	1974	4,306	291
Chevron Resources Co.	Soda Lake #44-5	1978	5,070	
	58-34 Federal			

c. The Reservoir

The following parameters are believed to describe the Soda Lake-Upsal Hogback geothermal reservoir:

Reservoir Volume(38)

4.7 $\pm$ 2.7 cubic miles

Temperature (38)

Reported well-----291°F.
 Na-K-Ca geothermometer-----321°F.
 Quartz conductive geothermometer-----329°F.
 Mean reservoir temperature-----314° $\pm$ 3°F.

Discharge(19)

Two wells in the area are capable of total mass flow of more than 185 gallons per minute.

Water Chemistry(19)

Examples of water chemistry analyses from the Soda Lakes--Upsal Hogback geothermal anomaly are given in Appendix 1. The most obvious characteristic of the water from the Soda Lake-Upsal geothermal anomaly is the high concentration of sodium and chlorine. The water violates the safe drinking water standards for chlorine, in one case sulfate, and probably total dissolved solids.

Energy Content(38)

Potential heat energy found in the reservoir----- 7.1×10^{15} BTUs

Heat energy extractable with existing technology----- 1.8×10^{15} BTUs

4. Stillwater Thermal Area

a. Description(19)

The presence of the Stillwater thermal area was not known until 1919 when hot water was encountered during the drilling of a shallow water well. Several other wells drilled in the same vicinity likewise encountered hot water. Occasionally, the wells had artesian head. A store, some ranch buildings, and several homes were heated using the hot water from nearby wells.

Today, the community of Stillwater is near the center of the thermal area. This thermal anomaly is believed to cover about 20 to 25 square miles. The thermal area is in a portion of the Carson Sink that has experienced much Quaternary faulting. The area lies along an extension of the fault bordering the west side of Rainbow Mountain a few miles to the south. The source of the thermal water probably lies at some depth within the pre-Tertiary basement rocks. These hot waters ascend through typical basin and range faults and mix with the shallower groundwater.

b. Summary of Exploration(19)

Operator	Name	Date Completed	Depth (feet)	Temperature (F.)
O'Neill Geothermal Inc.	Reynolds No. 1	1964	4,237	265
Union Oil Co.	Weishaupt No. 1	1976	4,000±	
Union Oil Co.	Weishaupt No. 2	1977	4,000±	
Union Oil Co.	DeBraga No. 1	1979	4,000±	

c. The Reservoir

The following parameters are believed to describe the Stillwater geothermal reservoir:

Reservoir Volume(38)

14.1 $\pm$ 5.2 cubic miles

Temperature(38)

Reported well-----265°F.
Na-K-Ca geothermometer-----284°F.
Quartz adiabatic geothermometer-----315°F.
Na-K-Ca, Mg-corrected geothermometer-----351°F.
Mean reservoir temperature-----315° $\pm$ 4°F.

Discharge

No surface discharge. Several flowing wells. Rates unknown.

Water Chemistry(19)

Examples of water chemistry analyses from the Stillwater thermal area are given in Appendix 1. Water from the Stillwater geothermal reservoir has a very high sodium and chlorine content. It violates the chloride and total dissolved solids standards for safe drinking water.

Energy Content(38)

Potential heat energy found in the reservoir-----2.1 x 10¹⁶ BTUs
Heat energy extractable with existing technology-----5.4 x 10¹⁵ BTUs

5. Lee Hot Springs

a. Description(19)

Lee Hot Springs are located about 20 miles south of Fallon along U.S. 95. Currently, Lee Hot Springs flow from a shallow well in a small area of siliceous sinter. Temperatures are reported to be between 190° F. and boiling. One well has been drilled by Oxy Geothermal to a depth of 3,012 feet.

b. The Reservoir

The following parameters are believed to describe the Lee Hot Springs geothermal reservoir:

Reservoir Volume (38)

0.79 $\pm$ 0.2 cubic mile

Temperature(38)

Measured temperature-----	212°F.
Na-K-Ca geothermometer-----	324°F.
Quartz adiabatic geothermometer-----	324°F.
Quartz conductive geothermometer-----	343°F.
Mean reservoir temperature-----	331° $\pm$ 2°F.

Discharge (19)

Estimated at 35 gallons per minute

Water Chemistry (19)

Examples of water chemistry analyses from Lee Hot Springs are given in Appendix 1. The water from Lee Hot Springs has a very high sodium, sulfate, and chloride content, the latter two violating the Nevada Safe Drinking Water Standards. The amount of total dissolved solids also violates these standards.

Energy Content(38)

Potential heat energy found in the reservoir-----	1.3 x 10 ¹⁵ BTUs
Heat energy extractable with existing technology-----	3.2 x 10 ¹⁴ BTUs

6. Dixie Valley Area

a. Description(19)

There are several occurrences of thermal water along the northwest side of Dixie Valley including the Dixie Hot Springs, the Dixie Comstock Mine, and the Senator Fumeroles. Several wells drilled in the area also have encountered hot water.

The Dixie Hot Springs, which are the southern-most indication of thermal water, appear to be located along a northeast-trending fault line that is believed to be the continuation of the Stillwater range-front fault present to the north at the Dixie Comstock Mine. The most recent movement along this fault was in the 1954 Dixie Valley Earthquake.

Approximately six miles north of the Dixie Hot Springs is the Dixie Comstock Mine. Mining activities in this mine were hindered by the heat and a large quantity of hot water in the mine workings less than 75 feet from the surface. It is believed that these mine workings are near the same fault which moved in 1954. This and nearby related faults continue 5.5 miles to Dixie Hot Springs and north to the Senator Fumaroles.

The Senator Fumaroles are located about 10 miles northeast of the Dixie Comstock Mine. Cinnabar, sulfur, and minor pyrite are present in siliceous sinter deposits in the Senator Mine. This mine is located along the fault which bounds the eastern side of the Stillwater Range. There are no existing hot springs at this site; however, cinnabar is believed to be deposited around two fumaroles about 300 feet east of the main deposit. Small volumes of steam with some hydrogen sulfide gas are being emitted at the vents.

b. Summary of Exploration(19)

There has been much geologic exploration in Dixie Valley. Some of these activities are listed below:

Operator	Name	Date Completed	Depth (feet)	Temperature (F.)
Sunco Energy Devel. Co.	S.W. Lamb No. 1	1978	7,255	425
Phillips Petroleum	"discovery well"	1979		
Thermal Power Company	? (confidential)	1979	8,500	
Southland Royalty	?	1979	9,012	
Sunoco Energy Devel. Co.	? (temp. obs. well)	1979	7,250	320? (Has Potential)

In addition to these wells several new ones were drilled in 1980 by companies such as Sunoco Energy Development. Specific information regarding most of these wells has not been released though several of them are reported to be production wells.

c. The Reservoir(19, 38)

Current exploration activities are gradually giving more definition to the Dixie Valley geothermal reservoir as well as increasing its known size. The major problem in defining the characteristics of this reservoir is that much of the information obtained by the various companies involved in the exploration of Dixie Valley is proprietary and therefore not available to the public.

U.S.G.S. Circular 790 gives some basic estimates for this resource. However, it only discusses the Dixie Hot Springs area and does not include any of the other known geothermal resources in the valley. In this publication, temperatures at Dixie Hot Springs range from an estimated 262° F. to 293° F. Measured temperatures from other areas in the reservoir have been significantly higher (425° F. at the S.W. Lamb No. 1 well.) Because of the limited public information available, no further attempt is made to delineate the geothermal reservoir other than to say geothermal exploration companies are intently looking at the entire northern end of Dixie Valley with an eye to potential electrical generation.

Any developer interested in this area is referred to documents on file at the Nevada Bureau of Mines and Geology from the U.S.DOE's Industry Coupled Drilling Program. These documents give detailed well log and other technical information.

C. Douglas County

1. Walley's Hot Springs

a. Description(19)

Walley's Hot Springs are located about 2.5 miles south of Genoa on the west side of Carson Valley. In 1862 David Walley built a large hotel and spa on the site. The hotel was partly destroyed by fire and then later completely demolished. Currently, a restaurant and bar are on the site of the old hotel. Plans are being developed to construct a new restaurant, bar, hotel, and spa at the site. The area of hot springs covers several acres. Recorded temperatures range from 136° F. to 160° F. Flows are estimated at 600 gallons per minute.

The springs are located along the trace of Genoa Fault, a major normal fault which forms the edge of the Carson Range. This fault can be followed along its north-south trace for a distance of over 12 miles. Indications of recent fault movement are present although the actual fault scarp is known to be older than 120 years. Displacement along this fault is 44 feet at Walley's Hot Springs and is believed to represent movement from a single earthquake.

U.S. Steel Corporation drilled two wells in the area in 1962. The maximum recorded temperature was 181° F.

b. The Reservoir

The following parameters are believed to describe the Walley's Hot Springs geothermal reservoir:

Volume

0.79 cubic mile

Temperature(19)

Reported well-----181° F.

Discharge or Flow Rate(19)

Flows from wells in the Walley's Hot Springs area range from 20 to 80 gallons per minute. One spring in the area has a natural discharge of about 600 gallons per minute.

Water Chemistry(19)

Examples of water chemistry analyses from Walley's Hot Springs are given in Appendix 1. Water from Walley's Hot Springs meets most of the Nevada Safe Drinking Water Standards although one sample does violate the standard for iron.

Energy Content(38)

Potential heat energy found in the reservoir----- 3.6×10^{14} BTUs
Heat energy extractable with existing technology----- 9.0×10^{13} BTUs

2. Saratoga Hot Springs

a. Description(19)

Saratoga Hot Springs are located on the west side of Hot Springs Mountain on the northeast side of Carson Valley. The springs have not been developed. They are currently being used only as a watering site for livestock. Saratoga Hot Springs are associated with a north trending normal fault typical of the area. This fault has been covered by a six to ten foot deep layer of eolian sand that obscures any surface features. The springs issue from this alluvium.

b. The Reservoir

The following parameters are believed to describe the Saratoga Hot Springs geothermal reservoir:

Volume(36)

0.24 cubic mile

Temperature(19)

Reported Temperature-----122° F.

Discharge(19)

Approximately 350 gallons per minute.

Water Chemistry(19)

A water chemistry analysis for water from Saratoga Hot Springs is given in Appendix 1. Water from Saratoga Hot Springs meets all standards for safe drinking water except for sulfate which exceeds the standard by more than two times.

Energy Content(38)

Potential Heat energy found in the reservoir----- 9.0×10^{13} BTUs

Heat energy extractable with existing technology----- 2.2×10^{13} BTUs

3. Hobo Hot Springs

a. Description(19)

Hobo Hot Springs is located about six miles north of Walley's Hot Springs along the front slope of the Carson Range. Both Hobo and Walley's Hot Springs are apparently associated with the north-trending fault. The water from these springs is currently being used to water livestock and for minor irrigation.

b. The Reservoir

The following parameters are believed to describe the Hobo Hot Springs geothermal reservoir:

Volume(36)

0.24 cubic mile

Temperature(19)

Reported temperature-----114° F.

Discharge or Flow Rate(19)

10 to 15 gallons per minute

Water Chemistry(19)

A water chemistry analysis for water for Hobo Hot Springs is given in Appendix 1. Water from Hobo Hot Springs meets all standards for safe drinking water standards.

Energy Content(38)

Potential heat energy found in the reservoir----- 1.2×10^{14} BTUs

Heat energy extractable with existing technology----- 3.0×10^{13} BTUs

D. Lyon County

1. Wabuska Hot Springs

a. Description(19)

Wabuska Hot Springs include a large geothermal anomaly located about one mile north of the Wabuska railroad siding. These hot springs have reported temperatures ranging from 138° F. to 162° F. The smell of hydrogen sulfide gas is common in the area. Wabuska Hot Springs are believed to occur along an east-west line that coincides with the course of a post-Lake Lahontan fault line which can be seen in the immediate area. In places, a 20-foot fault scarp can be seen. The springs themselves occur in small, circular mounds. Water is collected in the small basins from which it evaporates leaving various saline deposits behind.

Wabuska Hot Springs have been used for several purposes in the past. In the 1930's, the American Sodium Company refined and

shipped sodium sulfate from this location. In 1959, Magma Power drilled three steam wells into the spring area. No use was made of these wells until 1972 when Agri-Technology Corporation constructed greenhouses in the area using the hot geothermal fluids for space heating and for domestic water. Tomatoes and other vegetables were grown hydroponically in these greenhouses. Because of financial considerations, this direct application has since been abandoned.

Recently, a developer studied the possibility of using the hot water from Wabuska Hot Springs as a source of heat in the fermentation and distillation of various bioproducts to form ethanol. This study revealed both the technical and economic feasibility of such a development. A plant has been built and is currently in operation. New greenhousing facilities are currently being constructed along with several acres of cat fish and prawn ponds. The potential of this site appears very promising.

b. Summary of Exploration(19)

Operator	Name	Date Completed	Depth (feet)	Temperature (°F.)
Magma Power Co.	Wabuska No. 1	1959	488	
Magma Power Co.	Wabuska No. 1	1958	532?	
Magma Power Co.	Wabuska No. 3	1959	2,223	227

c. The Reservoir

The following parameters are believed to describe the Wabuska Hot Springs geothermal reservoir:

Volume(38)

4.4 $\pm$ 2.85 cubic miles

Temperature(38)

Reported springs-----138° - 162° F.
 Reported well-----227° F.
 Sulfate-water isotope geothermometer-----284° F.
 Na-K-Ca geothermometer-----295° F.
 Mean reservoir temperature-----268° $\pm$ 16° F.

Discharge

No information available

Water Chemistry(19)

Examples of water chemistry analyses from Wabuska Hot Springs are given in Appendix 1. Water from the Wabuska area violates the sulfate and total dissolved solids standards for safe drinking water.

Energy Content(38)

Potential heat energy found in the reservoir----- 3.0×10^{14} BTUs

Heat energy extractable with existing technology----- 7.4×10^{13} BTUs

2. Hazen Area (Patua Hot Springs)

a. Description(19)

The Patua Hot Springs consist of four springs and two mud domes located about four miles northeast of Hazen. Temperatures are reported to be boiling in the springs.

b. Summary of Exploration(19)

Operator	Name	Completion (Date)	Depth (Feet)	Temperature (°F.)
Magma Power Co.	Hazen No. 1	1962	750	275+
Magma Power Co.	Hazen No. 2	1962	300?	
Magma Power Co.	Hazen No. 3	1962	300	
Magma Energy Inc.	Fernley No. 1	1974	3,668	

c. The Reservoir

The following parameters are believed to describe the Hazen Area geothermal reservoir:

Volume(36)

0.79 cubic mile

Temperature(19)

Reported well-----275+° F.

Discharge

No information available

Water Chemistry(19)

Only one known water sample from the Hazen Area geothermal reservoir has been analyzed. The analysis is given in Appendix 1. Water from the Hazen area geothermal reservoir violates the chlorine, sulfate, and probably the total dissolved solids standards for potable drinking water.

Energy Content(38)

Potential heat energy found in the reservoir----- 1.0×10^{15} BTUs

Heat energy extractable with existing technology----- 2.5×10^{14} BTUs

3. Hind's Hot Springs and Others Associated with the
Slope of the Pine Nut Mountains

a. Description(19)

Hind's Hot Springs are found near the edge of the Pine Nut Mountains along the western margin of Smith Valley. These springs were first used in the 1860's for agriculture, a spa, and milling operations. Today the water is used for irrigation.

Temperatures reported at Hind's Hot Springs are as high as 149° F. Several other low volume, low temperature springs are also found on the edge of the valley from half a mile south of the main springs at Hind's to a point due south of the alkali flats.

Hind's Hot Springs are one of several thermal areas located along the east flank of the Pine Nut Mountains. The contact between the bedrock and valley fill alluvium is a series of normal

faults, some of which show relatively recent activity. Other thermal areas associated with this faulting system include the Wellington Area thermal anomaly and the Artesia Lake thermal anomaly.

Several water wells in the community of Wellington have encountered warm to hot springs. The highest reported temperature is 117° F. This rises to 143° F. when the well is pumped. Water chemistry of this well is similar to that found at Hind's Hot Springs, 10 miles to the south. This suggests a common source for the waters. The water from the 117° F. well is being used for a public swimming pool. One private residence is reportedly using water from this geothermal anomaly for space heating.

Artesia Lake is located about two miles north of Hind's Hot Springs. The thermal anomaly found in this area represents a continuation of the faulting pattern described at Hind's.

E. Storey County

1. Comstock Mining District

a. Description(19)

The Comstock Mining District is noted for the large amount of gold and silver removed in the late 1800's. The mines in the Comstock Lode were noted for the extremely difficult working conditions, particularly high temperatures and occasional floods of scalding water. Temperatures in the mines ranged from 100° F. to 125° F.

Generally, rock temperatures in the mines of the Comstock Lode increased 3-1/2° F. for every 100 feet in depth. This temperature gradient persisted throughout the entire area. During the drilling of the Sutro Tunnel, temperatures increased as the Lode was approached, even though the depth of the tunnel was fairly constant. The highest recorded rock temperature in the Comstock Lode was 167° F. at the 3,000 foot level in the Yellow Jacket Mine. Temperatures less than 140° F. were more commonly found in other areas.

The highest water temperatures recorded were during the New Yellow Jacket Mine flood in November, 1880. Water at 170° F., under considerable pressure, was struck in a drill hole at the 3,080 foot elevation. Water soon filled up the shaft and flooded the entire mine.

Water circulation throughout the Comstock Lode is very eccentric. Numerous clay seams seal off the flow. Cutting those seams frequently released dammed up bodies of water which flooded the mine workings. The seams also appear to have prevented circulation of the hot water to the surface. As a result, there are no surface indications of any thermal activity in the Comstock Lode. There appears to be very little upward flow of hot water in the geothermal reservoir as compared with the downward flow of cooler meteoritic waters. This restricted flow of water throughout the area suggests that the heat source for the thermal water is cooling volcanic and intrusive wall rock.

b. The Reservoir

Very little is known about the characteristics of the geothermal reservoir in the Comstock Lode. The actual limits to the size of the reservoir are unknown. Exploration activities including temperature studies have occurred only in localized areas.

However, an estimate indicates that the reservoir volume is 0.60 cubic mile.(36) The highest recorded water temperature in the reservoir was 170° F. Cooler temperatures are more common. Because of the clay seams characteristic to the Comstock Lode, flow rates are impossible to determine.

Limited chemical analyses of the water from various mines in the Comstock Lode have been made. Several such analyses are given in Appendix 1. Water from the Comstock Lode is quite variable in quality, some meeting all the standards for safe drinking water, others violating many of the standards.

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 practical commercial scale requires both a high temperature resource and a large geothermal reservoir. It appears that several of the geothermal areas in Geothermal Resource Area 5 meet these criteria.

Direct uses of geothermal energy are more varied and can economically use both lower temperature and less extensive resources. In addition, hot water from a high temperature application can be used for other applications requiring lower temperatures after its initial use. Figure 6 illustrates the various types of uses for geothermal energy and the temperature requirements for each use.

For the purpose of this study, direct applications have been broken down into four major categories: space heating; recreation; industrial process heat; and agriculture. Space heating has further been divided into district and residential-commercial systems. Agriculture has been divided into greenhousing, animal husbandry, and the aquacultural raising of fish and prawns. Appendix 1 describes and illustrates the procedure developed by the Nevada Department of Energy to evaluate these uses in reference to a particular geothermal resource site. The reader is encouraged to read this appendix before reading the following "Uses" section. The purpose in developing the geothermal use evaluation method described in Appendix 1 was to give some quantification to statements made about the development potential of a particular site. As with any method of this type there are problems the major being that the method only considers five major site characteristic parameters. There are obviously many more that must be considered by any developer of geothermal resources. At best, the method used in this document can give a good idea of the

FIGURE 6. GEOTHERMAL USE TEMPERATURES

potential of a certain type of application. Before any development occurs, it is recommended that the developer look at detailed site specific information to evaluate the resource and its applicability to the proposed use.

B. Churchill County

1. Brady's Hot Springs

Brady's Hot Springs are a large, high temperature (418° F.) geothermal resource located about 20 miles north of Fernley, Nevada on I-80. Based on the Geothermal Use Evaluation Table for this site (Table 14) the following sequence of potential uses has been determined:

<u>Application</u>	<u>Development Potential</u>
Industrial Process Heat.....	High
Aquaculture.....	Medium
Animal Husbandry.....	Medium
Electrical Generation.....	Medium
Greenhousing.....	Medium
Recreation.....	Medium
Residential-Commercial Space	
Heating.....	Low
District Space Heating.....	Low

This ranking system is useful in assessing the potential for different kinds of geothermal applications. Those applications with development numbers higher than 200, as determined on the Geothermal Use Evaluation Tables, are considered to have high development potential; those with development numbers between 125 and 200 have moderate development potential; and those with development numbers less than 125 have low potential. Characteristics of the geothermal resource or its location not considered in the ranking system, however, may make a potential application more or less feasible than indicated. Detailed, site specific evaluation is mandatory before any development begins.

The Brady's Hot Springs geothermal resource has been used for industrial process heat since 1978 when Geothermal Food Processors constructed a vegetable dehydration facility at the site. The plant was financed through the Geothermal Loan Guarantee Program. This facility uses hot fluids drawn from several nearby wells to dehydrate several different vegetable products such as onions and celery. At this time the waste water, which is about 200° F., is being discharged into a settling pond and allowed to evaporate or infiltrate back into the ground. Brady's Hot Springs is believed to have the potential of being developed into a successful cascading type of geothermal application. The water discharged from the plant facilities could easily be diverted to other applications that require somewhat lower temperatures, such as aquaculture, animal husbandry, greenhousing, or ethanol production.

Several types of geothermal applications probably would not be appropriate to develop at this time. Because of the resource's remote location, district or small scale space heating applications could not be developed other than at the industrial facility itself. If future development of the site leads to the construction of private residences for company employees, the heating systems for those homes could economically make use of geothermal energy from this resource. Recreation is another low potential application. There has been only minor historic use of this site for recreation as temperatures are too high to allow immediate use of the water in a spa facility. Distances to nearby population centers are greater than would allow a significant number of persons to patronize the facility. Should a small community be developed at this site for company employees a swimming pool would be a good recreational investment.

Notable Characteristics of Brady's Hot Springs

1. Moderately high temperature resource
2. Water quality fails to meet Safe Drinking Water Standards
3. Some distance from nearby communities, however, area on major transportation corridor
4. History of industrial interest
5. Development of resource by industry has begun.

Table 14

GEOHERMAL USE EVALUATION--BRADY'S HOT SPRINGS

	Rank	Weight	Product	Development Number
Electrical Generation				
Temperature	81	1	81	
Water Chemistry	3	1.3	3.9	
Land Factors	27	2	54	157
Population Centers	1	0	0	
Depth to Resource	9	2	18	
Space Heating				
-Residential-Commercial				
Temperature	81	1	81	
Water Chemistry	1	1	1	
Land Factors	3	1.3	3.9	104
Population Centers	27	0	0	
Depth to Resource	9	2	18	
-District				
Temperature	27	2	54	
Water Chemistry	1	1	1	
Land Factors	3	1	3	76
Population Centers	81	0	0	
Depth to Resource	9	2	18	
Recreation				
Temperature	27	1	27	
Water Chemistry	1	0.5	0.5	
Land Factors	9	1.5	13.5	128
Population Centers	81	1	81	
Depth to Resource	3	2	6	
Industrial Process Heat				
Temperature	81	2	162	
Water Chemistry	9	0.3	2.7	
Land Factors	27	2	54	225
Population Centers	1	0	0	
Depth to Resource	3	2	6	
Agriculture				
-Greenhousing				
Temperature	81	1	81	
Water Chemistry	9	0.3	2.7	
Land Factors	1	2	2	140
Population Centers	3	0	0	
Depth to Resource	27	2	54	
-Aquaculture				
Temperature	27	1	27	
Water Chemistry	3	1	3	
Land Factors	1	2	2	194
Population Centers	9	0	0	
Depth to Resource	81	0	162	
-Animal Husbandry				
Temperature	81	1	81	
Water Chemistry	3	1.3	3.9	
Land Factors	9	2	18	157
Population Centers	1	0	0	
Depth to Resource	27	0	54	

2. Desert Peak Area

The Desert Peak Area is a high temperature (406° F.) site located about four miles southeast of Brady's Hot Springs in Churchill County. Based on the Geothermal Use Evaluation Table for this site (Table 15), the following sequence of potential uses has been determined:

<u>Application</u>	<u>Development Potential</u>
Electrical Generation.....	High
Industrial Process Heat.....	Medium
Animal Husbandry.....	Low
Residential-Commercial Space Heating.....	Low
Greenhousing.....	Low
District Space Heating.....	Low
Recreation.....	Low
Aquaculture.....	Low

This ranking system illustrates the fact that only two potential applications are considered feasible at this time: electrical generation and industrial process heat. Because of factors such as temperature, remoteness, lack of information concerning water chemistry, or depth to the resource, the development potential of the other applications is not high.

Desert Peak is considered to be one of the potential geothermal electrical generation sites in the state. In the future, it is conceivable that this site could also be developed into a cascading type of geothermal energy use system whereby the waste fluids from the electrical generation process could be used for other applications requiring lower temperatures.

As indicated, several applications are considered impractical at this time including residential-commercial space heating, district space heating, aquaculture, recreation, greenhousing, and animal husbandry. As the resource is developed in the future such applications may become more practical and should be considered for development as the need arises.

Notable Characteristics of the Desert Peak Area

1. High temperature resource
2. Water quality does not meet Nevada Safe Drinking Water Standards
3. Site being actively explored

Table 15

GEOHERMAL USE EVALUATION--DESERT PEAK AREA

	Rank	Weight	Product	Development Number
Electrical Generation				
Temperature	81	2	162	
Water Chemistry	3	0	0	
Land Factors	27	1.5	40.5	213
Population Centers	1	0	1	
Depth to Resource	9	1	9	
Space Heating				
-Residential-Commercial				
Temperature	81	1	81	
Water Chemistry	1	0	0	
Land Factors	3	0.5	4.5	86
Population Centers	27	0	0	
Depth to Resource	9	0	0	
-District				
Temperature	27	2	54	
Water Chemistry	1	0	0	
Land Factors	3	0.5	1.5	56
Population Centers	81	0	0	
Depth to Resource	9	0	0	
Recreation				
Temperature	27	1	27	
Water Chemistry	1	0	0	
Land Factors	9	0.5	4.5	32
Population Centers	81	0	0	
Depth to Resource	3	0	0	
Industrial Process Heat				
Temperature	81	2	162	
Water Chemistry	9	0	0	
Land Factors	27	1	27	192
Population Centers	1	0	0	
Depth to Resource	3	1	3	
Agriculture				
-Greenhousing				
Temperature	81	1	81	
Water Chemistry	9	0	0	
Land Factors	1	1	1	82
Population Centers	3	0	0	
Depth to Resource	27	0	0	
-Aquaculture				
Temperature	27	1	27	
Water Chemistry	3	0	0	
Land Factors	1	0.5	0.5	28
Population Centers	9	0	0	
Depth to Resource	81	0	0	
-Animal Husbandry				
Temperature	81	1	81	
Water Chemistry	3	0	0	
Land Factors	9	1.5	13.5	95
Population Centers	1	0	0	
Depth to Resource	27	0	0	

3. Soda Lakes--Upsal Hogback Thermal Area

Table 14 illustrates the potential applications for the geothermal energy found in the Soda Lakes-Upsal Hogback Thermal Area. This resource is a fairly substantial one (291° F.) that could apparently support a wide variety of geothermal applications. The following sequence of potential uses has been determined on the basis of the Geothermal Use Evaluation Table (Table 15):

<u>Application</u>	<u>Development Potential</u>
District Space Heating.....	High
Greenhousing.....	High
Industrial Process Heat.....	High
Recreation.....	High
Aquaculture.....	High
Residential-Commercial Space Heating.....	Medium
Electrical Generation.....	Low
Animal Husbandry.....	Low

Temperatures sufficient to support a district heating system have been encountered in this thermal anomaly. Distances to nearby communities are small enough to make the development of a distribution system practical from an engineering standpoint. Further study must be done to determine it is economically practical. The development of a greenhousing industry is another potential application. One problem with the development of this industry is that when more detailed studies of the resource are completed, it may be found that the water quality of the area is too poor to allow for economical vegetable, fruit, or flower production. Industrial process heat is another good potential application. The area of the Soda Lakes-Upsal Hogback Thermal anomaly has good transportation facilities including a railroad spur and has a good potential labor market.

The development of animal husbandry and electrical generation facilities are considered remote at this time. Animal husbandry industries suffer from the lack of good surface water with which to water stock. Additionally, the native vegetation in the area is considered to be poor quality so that large tracts of land are required to supply the needs of an individual animal.

Electrical generation is considered impractical at this time because of the temperature of the resource. As technology advances and materials and methods of generating electricity from lower temperature geothermal fluids become available, the economic suitability of the Soda Lakes-Upsal Hogback Thermal Area will be improved.

Notable Characteristics of the Soda Lakes--Upsal Hogback Thermal

1. Potentially large resource
2. Moderately high temperature
3. Water quality below Nevada Safe Drinking Water Standards

Table 16

GEOTHERMAL USE EVALUATION--SODA LAKES--UPSAL HOGBACK THERMAL AREA

	Rank	Weight	Product	Development Number
Electrical Generation				
Temperature	81	1	81	
Water Chemistry	3	1	3	
Land Factors	27	2	54	158
Population Centers	1	2	2	
Depth to Resource	9	2	18	
Space Heating				
-Residential-Commercial				
Temperature	81	1	81	
Water Chemistry	1	1.5	1.5	
Land Factors	3	2	6	161
Population Centers	27	2	54	
Depth to Resource	9	2	18	
-District				
Temperature	27	2	54	
Water Chemistry	1	1	1	
Land Factors	3	2	6	241
Population Centers	81	2	162	
Depth to Resource	9	2	18	
Recreation				
Temperature	27	1	27	
Water Chemistry	1	0	0	
Land Factors	9	2	18	213
Population Centers	81	2	162	
Depth to Resource	3	2	6	
Industrial Process Heat				
Temperature	81	2	162	
Water Chemistry	9	0.5	4.5	
Land Factors	27	2	54	229
Population Centers	1	2	2	
Depth to Resource	3	2	6	
Agriculture				
-Greenhousing				
Temperature	81	2	162	
Water Chemistry	9	0.5	4.5	
Land Factors	1	2	2	229
Population Centers	3	2	6	
Depth to Resource	27	2	54	
-Aquaculture				
Temperature	27	1	27	
Water Chemistry	3	0	0	
Land Factors	1	2	2	209
Population Centers	9	2	18	
Depth to Resource	81	2	162	
-Animal Husbandry				
Temperature	81	1	81	
Water Chemistry	3	0.5	1.5	
Land Factors	9	1.5	13.5	152
Population Centers	1	2	2	
Depth to Resource	27	2	54	

4. Stillwater Thermal Area

The Stillwater Thermal Area geothermal resource is a moderately high temperature (265° F.) large resource located near the communities of Stillwater and Fallon. Because of these factors the potential of developing this resource is good. Many types of applications are feasible. Development numbers as determined on Table 17 illustrate the following sequence of potential applications:

<u>Application</u>	<u>Development Potential</u>
Industrial Process Heat.....	High
Greenhousing.....	High
Recreation.....	High
Aquaculture.....	High
Residential-Commercial Space Heating.....	Medium
District Space Heating.....	Medium
Electrical Generation.....	Medium
Animal Husbandry.....	Medium

Because of the fairly extensive surface area of this resource, the characteristics of the resource tend to be somewhat variable place to place. Because of this, any potential developer of the Stillwater geothermal resource must do an analysis of the site specific resource characteristics of the location where development is planned. Generally, however, industrial process heat, recreation, and greenhousing applications have the highest potential overall closely followed by aquaculture. Various space heating applications are considered to have good development potential. In fact, this application has already been developed in certain areas.

Notable Characteristics of the Stillwater Thermal Area

1. Moderately high temperature
2. Large surface area
3. Water quality below Nevada Safe Drinking Water Standards
4. Near communities of Stillwater and Fallon

Table 17

GEOTHERMAL USE EVALUATION--STILLWATER THERMAL AREA

	Rank	Weight	Product	Development Number
Electrical Generation				
Temperature	81	1	81	
Water Chemistry	3	1	3	
Land Factors	27	2	54	157
Population Centers	1	1	1	
Depth to Resource	9	2	18	
Space Heating				
-Residential-Commercial				
Temperature	81	1	81	
Water Chemistry	1	1	1	
Land Factors	3	2	6	160
Population Centers	27	2	54	
Depth to Resource	9	2	18	
-District				
Temperature	27	2	54	
Water Chemistry	1	0.6	0.6	
Land Factors	3	2	6	160
Population Centers	81	1	81	
Depth to Resource	9	2	18	
Recreation				
Temperature	27	1	27	
Water Chemistry	1	0.5	0.5	
Land Factors	9	2	18	214
Population Centers	81	2	162	
Depth to Resource	3	2	6	
Industrial Process Heat				
Temperature	81	2	162	
Water Chemistry	9	0.6	5.4	
Land Factors	27	2	54	228
Population Centers	1	1	1	
Depth to Resource	3	2	6	
Agriculture				
-Greenhousing				
Temperature	81	2	162	
Water Chemistry	9	0.6	5.4	
Land Factors	1	2	2	226
Population Centers	3	1	3	
Depth to Resource	27	2	54	
-Aquaculture				
Temperature	27	1	27	
Water Chemistry	3	0.5	1.5	
Land Factors	1	2	2	211
Population Centers	9	2	18	
Depth to Resource	81	2	162	
-Animal Husbandry				
Temperature	81	1	81	
Water Chemistry	3	0.6	1.8	
Land Factors	9	2	18	156
Population Centers	1	1	1	
Depth to Resource	27	2	54	

5. Lee Hot Springs

Lee Hot Springs are a small, moderate temperature (212° F.) resource located about 20 miles south of Fallon. Little is known about the site specific characteristics of the resource. Based on the limited information currently available, the following sequence of development potential has been developed from Table 18:

<u>Application</u>	<u>Development Potential</u>
Greenhousing.....	High
Industrial Process Heat.....	High
Recreation.....	High
Aquaculture.....	High
Animal Husbandry.....	Medium
Residential-Commercial Space Heating.....	Medium
Electrical Generation.....	Medium
District Space Heating.....	Low

There has been little historic use of the water from these springs other than for livestock watering. Because of the characteristics of the resource and the distance from nearby communities, the potential for developing this resource is not considered high. However, there has been some exploration interest shown in the area. If these exploration activities show that the resource's characteristics are better than now believed, the potential for the development of the resource would be higher than with current information.

Notable Characteristics of Lee Hot Spring's

1. Water quality below Nevada's Safe Drinking Water Standards
2. Some distance from nearby communities. Roads, however, are good
3. Apparently small resource

Table 18

GEOHERMAL USE EVALUATION--LEE HOT SPRINGS

	Rank	Weight	Product	Development Number
Electrical Generation				
Temperature	81	1	81	
Water Chemistry	3	1.3	3.9	
Land Factors	27	1.3	35.1	138
Population Centers	1	0	0	
Depth to Resource	9	2	18	
Space Heating				
-Residential-Commercial				
Temperature	81	1	81	
Water Chemistry	1	1.3	1.3	
Land Factors	3	0.6	1.8	156
Population Centers	27	2	54	
Depth to Resource	9	2	18	
-District				
Temperature	27	2	54	
Water Chemistry	1	1.3	1.3	
Land Factors	3	1	3	76
Population Centers	81	0	0	
Depth to Resource	9	2	18	
Recreation				
Temperature	27	1	27	
Water Chemistry	1	1.5	1.5	
Land Factors	9	1.5	13.5	210
Population Centers	81	2	162	
Depth to Resource	3	2	6	
Industrial Process Heat				
Temperature	81	2	162	
Water Chemistry	9	1.3	11.7	
Land Factors	27	1.3	35.1	215
Population Centers	1	0	0	
Depth to Resource	3	2	6	
Agriculture				
-Greenhousing				
Temperature	81	2	162	
Water Chemistry	9	1.3	11.7	
Land Factors	1	2	2	230
Population Centers	3	0	0	
Depth to Resource	27	2	54	
-Aquaculture				
Temperature	27	1	27	
Water Chemistry	3	1.5	4.5	
Land Factors	1	2	2	196
Population Centers	9	0	0	
Depth to Resource	81	2	162	
-Animal Husbandry				
Temperature	81	1	81	
Water Chemistry	3	1.3	3.9	
Land Factors	9	2	18	157
Population Centers	1	0	0	
Depth to Resource	27	2	54	

6. Dixie Valley

There are several distinct known thermal areas in the northern end of Dixie Valley: Dixie Hot Springs; Dixie Comstock Mine; and Senator Fumaroles. These three areas are believed to be the surface expressions of a much larger, hidden geothermal resource that is now being actively explored by several different companies. Based on known characteristics of the resource, the following sequence of potential applications has been developed:

<u>Application</u>	<u>Development Potential</u>
Electrical Generation.....	High
Industrial Process Heat.....	Medium
Greenhousing.....	Medium
Animal Husbandry.....	Low
Residential-Commercial Space Heating.....	Low
District Space Heating.....	Low
Recreation.....	Low
Aquaculture.....	Low

As illustrated, the characteristics of the resource and its location apparently preclude many different types of developments at this time. Electrical generation, industrial process heat, and greenhousing have good to moderate development potential. The resource is just too remote from the state's population centers or too deep for smaller types of applications.

Notable Characteristics of the Dixie Valley Area

1. High temperature resource
2. Remote location over poor roads
3. Reservoir very deep

Table 19

GEOHERMAL USE EVALUATION--DIXIE VALLEY AREA

	Rank	Weight	Product	Development Number
Electrical Generation				
Temperature	81	2	162	
Water Chemistry	3	---	---	
Land Factors	27	1.5	40.5	203
Population Centers	1	0	0	
Depth to Resource	9	0	0	
Space Heating				
-Residential-Commercial				
Temperature	81	1	81	
Water Chemistry	1	---	---	
Land Factors	3	1	3	84
Population Centers	27	0	0	
Depth to Resource	9	0	0	
-District				
Temperature	27	2	54	
Water Chemistry	1	---	---	
Land Factors	3	0.5	1.5	56
Population Centers	81	0	0	
Depth to Resource	9	0	0	
Recreation				
Temperature	27	1	27	
Water Chemistry	1	---	---	
Land Factors	9	1	9	36
Population Centers	81	0	0	
Depth to Resource	3	0	0	
Industrial Process Heat				
Temperature	81	2	162	
Water Chemistry	9	---	---	
Land Factors	27	1	27	189
Population Centers	1	0	0	
Depth to Resource	3	0	0	
Agriculture				
-Greenhousing				
Temperature	81	2	162	
Water Chemistry	9	---	---	
Land Factors	1	1	1	163
Population Centers	3	0	0	
Depth to Resource	27	0	0	
-Aquaculture				
Temperature	27	1	27	
Water Chemistry	3	---	---	
Land Factors	1	1	1	28
Population Centers	9	0	0	
Depth to Resource	81	0	0	
-Animal Husbandry				
Temperature	81	1	81	
Water Chemistry	3	---	---	
Land Factors	9	1	9	90
Population Centers	1	0	0	
Depth to Resource	27	0	0	

C. Douglas County

1. Walley's Hot Springs

Walley's Hot Springs are a moderate temperature (181° F.) geothermal resource located near the communities of Genoa and Minden/Gardnerville in Douglas County, Nevada. The springs have historically been used as a recreational area and as supply for irrigation water. Based on the geothermal use evaluation table (Table 20) the following sequence of potential uses for this resource has been developed:

<u>Application</u>	<u>Development Potential</u>
Recreation.....	High
Residential-Commercial Space	
Heating.....	High
Aquaculture.....	Medium
Animal Husbandry.....	Medium
Greenhousing.....	Medium
District Space Heating.....	Medium
Industrial Process Heat.....	Low
Electrical Generation.....	Low

Walley's Hot Springs are located in a scenic area. The old recreational resort facilities at Walley's Hot Springs have recently been undergoing renovation. Plans are being made to add several new buildings to those facilities to make a hotel/restaurant complex in conjunction with the hot springs area. The developer of this site holds title to most of the property overlying the geothermal resource. Because of this, other applications probably will not be developed in the foreseeable future.

Notable Characteristics of Walley's Hot Springs

1. Scenic area
2. Good access
3. Good flow rates
4. Good water quality
5. Moderate temperature

Table 20

GEOHERMAL USE EVALUATION--WALLEY'S HOT SPRINGS

	Rank	Weight	Product	Development Number
Electrical Generation				
Temperature	81	0	0	
Water Chemistry	3	1	3	
Land Factors	27	1.3	35.1	57
Population Centers	1	1	1	
Depth to Resource	9	2	18	
Space Heating				
-Residential-Commercial				
Temperature	81	2	162	
Water Chemistry	1	1.3	1.3	
Land Factors	3	1.6	4.8	213
Population Centers	27	1	27	
Depth to Resource	9	2	18	
-District				
Temperature	27	1	27	
Water Chemistry	1	0.3	0.3	
Land Factors	3	2	6	132
Population Centers	81	1	81	
Depth to Resource	9	2	18	
Recreation				
Temperature	27	1	27	
Water Chemistry	1	0.5	0.5	
Land Factors	9	2	18	214
Population Centers	81	2	162	
Depth to Resource	3	2	6	
Industrial Process Heat				
Temperature	81	1	81	
Water Chemistry	9	0.6	5.4	
Land Factors	27	1	27	120
Population Centers	1	1	1	
Depth to Resource	3	2	6	
Agriculture				
-Greenhousing				
Temperature	81	1	81	
Water Chemistry	9	0.6	5.4	
Land Factors	1	2	2	145
Population Centers	3	1	3	
Depth to Resource	27	2	54	
-Aquaculture				
Temperature	27	1	27	
Water Chemistry	3	1	3	
Land Factors	1	2	2	203
Population Centers	9	1	9	
Depth to Resource	81	2	162	
-Animal Husbandry				
Temperature	81	1	81	
Water Chemistry	3	1.3	3.9	
Land Factors	9	2	18	158
Population Centers	1	1	1	
Depth to Resource	27	2	54	

2. Saratoga Hot Springs

Saratoga Hot Springs are a low temperature (122° F.) geothermal resource located on the southeast side of Carson Valley. There has been no development of the springs other than for livestock watering. Based on the limited information currently available about this resource the following sequence of potential applications has been developed (Table 21).

<u>Application</u>	<u>Development Potential</u>
Aquaculture.....	High
Residential-Commercial Space Heating.....	High
Recreation.....	Medium
Animal Husbandry.....	Medium
Industrial Process Heat.....	Medium
Greenhousing.....	Medium
District Space Heating.....	Low
Electrical Generation.....	Low

Several different plans are being formulated by private parties to use the Saratoga Hot Springs resource. The NDOE has supplied information about developing geothermal resources to persons considering a greenhousing complex and a district heating system based on this resource. Both aquaculture and residential space heating have high development numbers and hence high development potential. Before such a development occurs it would be wise for the developer to extensively investigate the resource. There are several unknown factors, such as flow rate, that could substantially affect the success of any such development.

Notable Characteristics of Saratoga Hot Springs

1. Moderately low temperature
2. Poor access

Table 21

GEOHERMAL USE EVALUATION--SARATOGA HOT SPRINGS

	Rank	Weight	Product	Development Number
Electrical Generation				
Temperature	81	0	0	
Water Chemistry	3	1	3	
Land Factors	27	2	54	76
Population Centers	1	1	1	
Depth to Resource	9	2	18	
Space Heating				
-Residential-Commercial				
Temperature	81	2	162	
Water Chemistry	1	1	1	
Land Factors	3	2	6	214
Population Centers	27	1	27	
Depth to Resource	9	2	18	
-District				
Temperature	27	0	0	
Water Chemistry	1	1	1	
Land Factors	3	2	6	106
Population Centers	81	1	81	
Depth to Resource	9	2	18	
Recreation				
Temperature	27	2	54	
Water Chemistry	1	1	1	
Land Factors	9	2	18	160
Population Centers	81	1	81	
Depth to Resource	3	2	6	
Industrial Process Heat				
Temperature	81	1	81	
Water Chemistry	9	1	9	
Land Factors	27	1.6	43.2	140
Population Centers	1	1	1	
Depth to Resource	3	2	6	
Agriculture				
-Greenhousing				
Temperature	81	1	81	
Water Chemistry	9	1	1	
Land Factors	1	2	2	141
Population Centers	3	1	3	
Depth to Resource	27	2	54	
-Aquaculture				
Temperature	27	2	54	
Water Chemistry	3	1	3	
Land Factors	1	2	2	230
Population Centers	9	1	9	
Depth to Resource	81	2	162	
-Animal Husbandry				
Temperature	81	1	81	
Water Chemistry	3	1	3	
Land Factors	9	2	18	157
Population Centers	1	1	1	
Depth to Resource	27	2	54	

3. Hobo Hot Springs

Hobo Hot Springs in Douglas County, at this time, appears to be the surface expression of a small, low temperature (114° F.) geothermal resource. The resource is currently being used for stock watering and for limited irrigation. Very little is known about the characteristic of the resource or its relationship to Walley's Hot Springs to the south. Because of the limited nature of this resource no attempt has been made to evaluate the potential uses according to the geothermal use evaluation method. It appears, however, that the potential uses are limited. The temperature is insufficient for almost any type of development. However, marginal types of aquaculture, animal husbandry, recreation, or possibly residential space heating could be developed. The possibility of these applications being successful is considered less than for similar developments at higher quality sites.

Notable Characteristics of Hobo Hot Springs

1. Low temperature
2. Low flow rate
3. Water quality meets Nevada's Safe Drinking Water Standards

D. Lyon County

1. Wabuska Hot Springs

Wabuska Hot Springs are a moderate temperature (223° F.) resource located at the north end of Mason Valley in Lyon County. Based upon the geothermal use evaluation procedure (Table 22), the following sequence of potential uses was determined:

<u>Application</u>	<u>Development Potential</u>
Animal Husbandry.....	High
Industrial Process Heat.....	High
Greenhousing.....	High
Aquaculture.....	Medium
Residential-Commercial Space	
Heating.....	Medium
Electrical Generation.....	Medium
District Space Heating.....	Low
Recreation.....	Low

There have been several past attempts to use the geothermal resource at Wabuska Hot Springs. Such attempts have included a sodium sulfate evaporating facility and a hydroponic tomato growing greenhouse neither of which are currently in operation. Recently, there has been much interest shown in the Wabuska Hot Spring resource as a potential site for the development of an ethanol production facility. This interest has lead to the construction of a 400,000 gallon a year plant using hot water from wells drilled several years ago. The developer will import grain from the Midwest on a nearby railroad spur and will use the heat from the thermal area in the fermentation and distillation of the ethanol which will be sold for the production of gasohol. Other developers are looking at adjacent areas with the anticipation of developing greenhousing facilities and another ethanol plant.

As indicated by the geothermal use evaluation procedure, these are the types of applications that appear to have the most potential for success. The other applications have lower development potential although some may be successfully developed. Before any development takes place, the developer must do a site specific analysis of the resource to determine whether or not it is capable of supporting the needs of the development.

Notable Characteristics of Wabuska Hot Springs

1. Moderately high temperature
2. Good access
3. Good transportation facilities
4. Fairly large
5. Water quality below Nevada's Safe Drinking Water Standards

Table 22

GEOHERMAL USE EVALUATION--WABUSKA HOT SPRINGS

	Rank	Weight	Product	Development Number
Electrical Generation				
Temperature	81	0	81	
Water Chemistry	3	.6	1.8	
Land Factors	27	2	54	155
Population Centers	1	0	0	
Depth to Resource	9	2	18	
Space Heating				
-Residential-Commercial				
Temperature	81	2	162	
Water Chemistry	1	0.6	0.6	
Land Factors	3	1.6	1.8	182
Population Centers	27	0	0	
Depth to Resource	9	2	18	
-District				
Temperature	27	2	54	
Water Chemistry	1	0.3	0.3	
Land Factors	3	1	3	75
Population Centers	81	0	0	
Depth to Resource	9	2	18	
Recreation				
Temperature	27	1	27	
Water Chemistry	1	0.5	0.5	
Land Factors	9	1.5	13.5	47
Population Centers	81	0	0	
Depth to Resource	3	2	6	
Industrial Process Heat				
Temperature	81	2	162	
Water Chemistry	9	0.6	5.4	
Land Factors	27	2	54	227
Population Centers	1	0	0	
Depth to Resource	3	2	6	
Agriculture				
-Greenhousing				
Temperature	81	2	162	
Water Chemistry	9	0.6	5.4	
Land Factors	1	2	2	223
Population Centers	3	0	0	
Depth to Resource	27	2	54	
-Aquaculture				
Temperature	27	1	27	
Water Chemistry	3	1	3	
Land Factors	1	2	2	194
Population Centers	9	0	0	
Depth to Resource	81	2	162	
-Animal Husbandry				
Temperature	81	2	162	
Water Chemistry	3	0.6	1.8	
Land Factors	9	2	18	236
Population Centers	1	0	0	
Depth to Resource	27	2	54	

2. Hazen Area

Very little is known about the Hazen Area Hot Springs. These springs, located about four miles northeast of Hazen, are small and moderately high (275° F.) in temperature. Based upon the limited knowledge available, the following sequence of potential uses was developed using the geothermal use evaluation procedure (Table 21).

<u>Application</u>	<u>Development Potential</u>
Greenhousing.....	High
Industrial Process Heat.....	High
Aquaculture.....	High
District Space Heating.....	Medium
Animal Husbandry.....	Medium
Recreation.....	Medium
Residential-Commercial Space	
Heating.....	Low
Electrical Generation.....	Low

The Hazen Area Hot Springs are located between Fernley and Fallon, approximately a mile from a main road. These springs appear to have potential to supply applications such as greenhousing, aquaculture, and industrial process heat. The location and quality, of this resource makes it a prime candidate for development in the near future.

Notable Characteristics of the Hazen Area Hot Springs

1. Moderately high temperature
2. Located near good transportation facilities
3. Water quality violates Nevada's Safe Drinking Water Standards

Table 23

GEOHERMAL USE EVALUATION--HAZEN AREA

	Rank	Weight	Product	Development Number
Electrical Generation				
Temperature	81	0	0	
Water Chemistry	3	1.6	4.8	
Land Factors	27	1.3	35.1	59
Population Centers	1	1	1	
Depth to Resource	9	2	18	
Space Heating				
-Residential-Commercial				
Temperature	81	1	81	
Water Chemistry	1	1	1	
Land Factors	3	1.3	3.9	122
Population Centers	27	1	27	
Depth to Resource	9	1	9	
-District				
Temperature	27	2	54	
Water Chemistry	1	1	1	
Land Factors	3	1.5	4.5	159
Population Centers	81	1	81	
Depth to Resource	9	2	18	
Recreation				
Temperature	27	1	27	
Water Chemistry	1	1.5	1.5	
Land Factors	9	1.5	13.5	129
Population Centers	81	1	81	
Depth to Resource	3	2	6	
Industrial Process Heat				
Temperature	81	2	162	
Water Chemistry	9	1	9	
Land Factors	27	1.6	43.2	221
Population Centers	1	1	1	
Depth to Resource	3	2	6	
Agriculture				
-Greenhousing				
Temperature	81	2	162	
Water Chemistry	9	1	9	
Land Factors	1	2	2	230
Population Centers	3	1	3	
Depth to Resource	27	2	54	
-Aquaculture				
Temperature	27	1	27	
Water Chemistry	3	1.5	4.5	
Land Factors	1	2	2	205
Population Centers	9	1	9	
Depth to Resource	81	2	162	
-Animal Husbandry				
Temperature	81	1	81	
Water Chemistry	3	1	3	
Land Factors	9	2	18	157
Population Centers	1	1	1	
Depth to Resource	27	2	54	

3. Hind's Hot Springs and Others Associated with the East Slope of the Pine Nut Mountains

The warm springs associated with the east slope of the Pine Nut Mountains are all low temperature geothermal resources (117° F. to 143° F.) that have historically been used for stock watering and limited irrigation. Hot water from a well in the Wellington area has been used to heat a swimming pool.

Because of the low temperatures of these resources and their location which, for the most part, is some distance from any population base, it is not considered likely that they will undergo much development in the foreseeable future. If such development did occur, probably residential space heating or small scale aquaculture would stand the greatest chance of success. Other applications are not considered to be practical under existing needs and technology. If these conditions change in the future, the characteristics of the resources may make successful development of the resource possible.

E. Storey County

1. Comstock Mining District

The geothermal resource found in the Comstock Mining District is deep, diffuse, and apparently quite irregular in its distribution. Known temperatures are only moderate (167° F.).

Historically, there has been no development of the resource. In fact, the hot water has been considered more of a nuisance than a resource.

Virginia City, the community overlying much of the resource, is an active tourist area that is not seeking new industrial development. Because of this, it does not appear that development of the resource will occur in the foreseeable future. Several mining companies are, however, beginning to explore the old Comstock Lode to locate additional gold and silver deposits. If such deposits are found, and mining activities begun anew, hot water encountered by those activities could potentially be used in any milling operations and for space heating needs.

V. CONCLUSION

Geothermal Resource Area 5 has 13 areas of potential geothermal development. Additionally, there are many smaller thermal areas the region that could supply the heating needs of a single residence or small development. Table 24 summarizes the development potential for various applications at the major sites. Based upon the information presented in this Area Development Plan, the sites in the study area considered most appropriate for each type of development use has been determined. These are listed below:

Electrical Generation

Desert Peak
Dixie Valley

Residential-Commercial Space Heating

Soda Lakes-Upsal Hogback Thermal Area
Walley's Hot Springs
Saratoga Hot Springs

District Space Heating

Soda Lakes-Upsal Hogback Thermal Area
Stillwater Thermal Area

Recreation

Wally's Hot Springs
Lee Hot Springs
Stillwater Thermal Area

Industrial Process Heat

Brady's Hot Springs
Wabuska Hot Springs
Stillwater Thermal Area

Greenhousing

Stillwater Thermal Area
Lee Hot Springs
Hazen Area Hot Springs
Wabuska Hot Springs

Aquaculture

Soda Lakes--Upsal Hogback Thermal Area
Saratoga Hot Springs
Stillwater Thermal Area

Animal Husbandry

Wabuska Hot Springs
Brady's Hot Springs
Wally's Hot Springs

There are many different types of benefits to be derived from the development of the geothermal resources in Geothermal Resource Area 5. These include, but are not limited to:

1. Creation of new industry;
2. Expanding old industry;
3. Creation of new jobs;
4. Adding additional spendable income to the region;
5. Broadening both the economic and the tax base of the region and state; and
6. Displacing the use of expensive, diminishing fossil fuels for either direct use or for electrical generation.

The development of the geothermal resources located in the study area is thusly considered to be beneficial to the local region, the State, and the nation. For these reasons, such development should be encouraged wherever and whenever possible.

Table 24--GEOTHERMAL USE EVALUATION-SUMMARY
CHURCHILL, DOUGLAS, LYON, AND STOREY COUNTIES

Site	Electrical Generation	Space Heating		Recreation	Industrial Process Heat	Agriculture		
		Residential- Commercial	District			Green- housing	Aqua- culture	Animal Husbandr
CHURCHILL COUNTY								
Brady Hot Springs	M	L	L	M	H	M	M	M
Desert Peak Area	H	L	L	L	M	L	L	L
Soda Lakes--Upsal Hog- back Thermal Area	M	M	H	H	H	H	H	M
Stillwater Thermal Area	M	M	M	H	H	H	H	M
Lee Hot Springs	M	M	L	H	H	H	M	M
Dixie Valley Area	H	L	L	L	M	M	L	L
DOUGLAS COUNTY								
Walley's Hot Springs	L	H	M	H	L	M	M	M
Saratoga Hot Springs	L	H	L	M	M	M	H	M
Hobo Hot Springs	L	L	L	L	L	L	L	L

Table 24--GEOTHERMAL USE EVALUATION-SUMMARY
CHURCHILL, DOUGLAS, LYON, AND STOREY COUNTIES (Continued)

Site	Electrical Generation	Space Heating			Recreation	Industrial Process Heat	Agriculture		
		Residential- Commercial	District				Green- housing	Aqua- culture	Animal Husban
LYON COUNTY									
Wabuska Hot Springs	M	M	L	L	H	H	M	H	
Hazen Area	L	L	M	M	H	H	H	M	
Hind's Hot Springs and Others Associated with the East Slope of the Pine Nut Mountains	L	L	L	M	L	L	L	L	
STOREY COUNTY									
Comstock Mining District	L*	L	L	L	L	L	L	L	

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 Street, Room 106
Carson City, Nevada 89710
(702) 885-5157

Nevada Department of Conservation
and Natural Resources
Division of Water 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

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

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

VII. BIBLIOGRAPHY

1. ASHRAE Handbook and Product Directory - 1977 Fundamentals.
New York: American Society of Heating, Refrigeration,
and Air Conditioning Engineers, Inc. 1977.
2. Bonham, Harold. Geology and Mineral Deposits of Washoe and
Storey Counties, Nevada. Nevada Bureau of Mines and
Geology, Report 21. 1973.
3. Department of Economic Development. Churchill County-Data-
file. 1976.
4. Department of Economic Development. Douglas County-Datafile.
1976.
5. Department of Economic Development. Lyon County-Datafile.
1976.
6. Department of Economic Development. Storey County-Datafile.
1976.
7. Department of Economic Development. Nevada Industrial Di-
rectory. 1978.
8. Department of Highways. Nevada's Federal and State Systems -
Descriptions and Index. 1978.
9. Department of Highways. Non-Federal Aid State Aid Routes.
1978.
10. Department of Transportation. Status of Road Systems.
1979.
11. Division of Water Resources. Alternative Plans for Water
Resource Use--Walker River Basin--Area I. 1974.
12. Division of Water Resources. Alternative Plans for Water
Resource Use--Carson Truckee River Basin--Area II.
1974.
13. Division of Water Resources. Alternative Plans for Water
Resource Use--Humboldt River Basin--Area III. 1974.
14. Division of Water Resources. Alternative Plans for Water
Resource Use--Central Region--Area IV. 1974.
15. EG&G, Inc. Nevada Hydrothermal Commercialization Baseline.
1979.
16. Employment Security Department. Nevada Employment and Pay-
rolls. 1976, 1977, 1978, 1979.

17. Flynn, Thomas, et. al. Area Specific Investigations of Three Low-to Moderate-Temperature Geothermal Resource Locations in Nevada. Nevada Bureau of Mines and Geology. Unpublished report.
18. Garside, Larry. Geothermal Exploration and Development in Nevada Through 1973. Nevada Bureau of Mines and Geology, Bulletin 21. 1974.
19. Garside, Larry J., and Schilling, John H. Thermal Waters of Nevada. Mackay School of Mines, Bulletin 91. 1979.
20. Governor's Office of Planning Coordination. The Comprehensive Economic Development Plan. Vol. 1, 2, and 3. 1980.
21. Governor's Office of Planning Coordination. Directory of Local Planning Organizations. 1979.
22. Moore, James G. Geology and Mineral Deposits of Lyon, Douglas, and Ormsby Counties. Nevada Bureau of Mines and Geology, Bulletin 75. 1969.
23. Nevada Department of Energy. Energy in Nevada. 1980.
24. Rush, E. Eugene. Index to Hydrographic Areas. Division of Water Resources. Water Resources-Information Series, Report 6. 1978.
25. Thornbury, William D. Regional Geomorphology of the United States. New York: John Wiley and Sons, Inc. 1965.
26. Trexler, D.T., et. al. Assessment of Low-to Moderate-Temperature Geothermal Resources of Nevada. Nevada Bureau of Mines and Geology. Final Report-NV0701556-1. 1979.
27. U.S. Bureau of Land Management. Wilderness Study Area Decisions. 1980.
28. U.S. Department of Commerce. Climatological Summary-Yerington, Nevada. 1936-1968.
29. U.S. Department of Commerce. Climatological Summary-Minden, Nevada. 1936-1968.
30. U.S. Department of Commerce. Climatological Summary - Lahontan Dam, Nevada. 1941-1970.

31. U.S. Department of Commerce. Climatological Summary- Glenbrook, Nevada. 1936-1968.
32. U.S. Department of Commerce. Climatological Summary - Fallon, Nevada. 1936-1968.
33. U.S. Department of Commerce. Climatological Summary - Carson City. 1936-1968.
34. U.S. Department of Energy. Direct Heat Application Program Summary. 1979.
35. U.S. Department of Energy. Environmental Development Plan - Geothermal Energy Systems. 1979.
36. U.S. Department of Energy. Geothermal Direct Heat Use Market Potential/Penetration Analysis for Nevada, DOE Region IX. 1979.
37. U.S. Department of Energy. Regional Operations Research Program for Development of Geothermal Energy in the Southwestern United States. Appendix 8. 1979.
38. U.S. Geological Survey. Assessment of Geothermal Resources of the United States. Circular 790. 1978.
39. Willdon, Ronald, and Speed, Robert. Geology and Mineral Deposits of Churchill County. Nevada Bureau of Mines and Geology Bulletin 83. 1974.

VIII. APPENDIX

Appendix 1 --Water Chemistry Analyses

Identification	pH	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS
BRADY HOT SPRINGS															
Brady No. 4	8.8	190	-	33	tr	813	6	13	56	336	986	5	-	0.3	2440
Brady No. 5	6.4	166	-	14	tr	738	5	-	-	282	834	tr	-	0.2	1880
SODA LAKES-UPSAL HOGBACK															
Well CDAH-2A	-	56	-	26	9	940	1	354	-	22	1400	0.8	0.2	6.1	-
Well CDAH-37	-	-	-	360	46	1800	160	305	-	2500	1800	0.6	0.1	3.4	-
Well CDAH-30A	-	130	-	100	2.4	1100	50	181	-	480	1400	0.6	0.0	0.53	-
Well BRCDDH-14A	-	170	-	170	0.8	1650	50	106	0	68	2800	1.9	-	13.52	-
STILLWATER THERMAL AREA															
Well	-	170	-	108	1.7	1480	42	90	tr	190	2200	5.0	-	15	-
Well	7.5	-	-	91	1	1400		108	0	190	2080	.6	-	-	-
LEE HOT SPRINGS															
Spring	7.4	180	-	44	0.6	450	26	114	tr	470	380	7.9	-	2.4	-
Allen's Hot Springs (Probably Lee Hot Springs)	-	-	-	49	16	431	-	132	17	440	374	-	-	-	-
Nevada Safe Drinking Water Standards			.03		125					250	250				500

Appendix 1 --Water Chemistry Analyses - (continued)

Identification	pH	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS
WALLEY'S HOT SPRINGS															
Spring	9.0	60	-	9.6	0.5	137	2.9	40	2.7	200	46	5.0	0.3	-	492
Genoa Hot Springs	8.9	54	0.08	14	0.4	118	2.2	58	0	180	36	4.1	0.1	-	437
Spring	9.1	61	0.01	9.6	0.5	137	2.9	12	24	200	46	5.0	0.3	-	492
SARATOGA HOT SPRINGS															
Spring	9.0	20	-	172	0	160	---	4	7	678	39	-	-	-	429
HOB0 HOT SPRINGS															
Spring	8.9	47	0.03	6	0.7	125	1.7	51	17	109	74	7.1	0	1.5	415
WABUSKA HOT SPRINGS															
Wabuska No. 1	-	-	.02	38	0		384	61	10	760	507?	9.3	-	-	1279
Wabuska No. 2	8.8	-	.02	38	75		279	66	12	740	50	6.2	-	-	1231
Wabuska No. 3	8.8	100	.01	37	8.7		276	8	-	566	45	7.6	0	1	1090
HAZEN - PATUA HOT SPRINGS															
Spring		150	.02	70	1.5	620	38	100	-	400	820	4.2	-	5.6	-
COMSTOCK MINING DISTRICT															
Ophir Shaft	---	38	tr	78	98	19	11	-	76	198	6	-	-	-	-
C & C Shaft	---	133	6.3	100	5.8	130	53	-	20	475	19	-	-	-	-
Savage Mine	---	300	-	155	24	7.4	74	-	100	390	1.34	-	-	-	-
Gould & Curry Mine	---	60	-	112	-	146	82	-	242	273	14	-	-	-	-
Nevada Safe Drinking Water Standards			.03		125					250	250				500

Appendix 2A. Methodology for Evaluating Geothermal Applications

A major problem in evaluating potential uses of Nevada's geothermal resources is their diverse character. Temperatures range from 60° F. to over 400° F. The total dissolved solids (TDS) found in the geothermal fluid can range from less than 150 parts per million to well over 6,000 parts per million. The resource may have surface discharge points or may be located over 5,000 feet in depth. It may be located in an urban environment or it may be many miles from the nearest community and inaccessible by land vehicles.

In order to develop any method of evaluating geothermal resources the following criteria must be met:

1. The method must be generally applicable.
2. The method must be sufficiently flexible to allow for future data input or changing priorities in resource requirements.
3. The method must be simple and yet produce semi-quantitative results.

To develop the method of evaluating geothermal resources used in this and similar Area Development Plans, the Nevada Department of Energy borrowed and expanded the method developed by the Nevada Bureau of Mines and Geology.⁽²⁶⁾ This method describes eight potential geothermal application categories: residential-commercial space-heating, district space-heating, recreation, electrical generation, industrial process heat, greenhousing, aquaculture, and animal husbandry. Most types of known geothermal applications fit into one of these categories.

Several different parameters can be used to describe the development potential of a particular geothermal resource. These parameters include, but are not limited to: temperature, rock type and age, depth to resource, population centers nearby;

geophysical data, water chemistry, flow rates, permeability, recharge, economics, structural controls, environmental considerations, and land factors such as area extent, accessibility, and existing land use and zoning. Although all of these factors influence the development potential of a geothermal resource, data about several of the factors are insufficient to evaluate at this time. For this reason, the decision was made to evaluate only the following parameters in which data are generally available: temperature, water chemistry, land factors, population centers, and depth to the resource. It must be remembered however, that these represent only a portion of the total number of development parameters that make geothermal application successful and as such indicate only the potential of a site. Any actual developer must use this information only for preliminary purposes and must develop more site specific data before any development occurs.

These five parameters are of differing importance to different applications. After consulting with professionals in the specific applications, NDOE staff ranked the parameters according to their relative importance to the application. For example, in the electrical generation industry, the temperature of the resource is the prime parameter followed by land factors, depth to resource, water chemistry, and population centers. Each rank is accorded a number based on decreasing powers of three. This method was selected because it preserves the established order of importance. Temperature in the electrical generation industry has a rank of 81; land factors 27; depth to resource 9; water chemistry 3; and population centers 1.

The second step in evaluating the resource is to assign weighting factors to the characteristics of the specific resource. A weighting factor of "2" indicates the most desirable range of the parameter; a weighting factor of "1" is an intermediate factor; and a weighting factor of "0" is considered least desirable. These weighting factors have been tailored for each particular

application. Appendix 2B to 2I illustrate the specific weighting factors assigned to specific resource characteristics for each potential application.

For each particular application, all of the parameters are ranked and weighted. The development number for the application is obtained by adding all of the separate products. This number can be used in conjunction with the other seven development numbers to give a relative sequence of development potential. Those applications with the lower development numbers probably would have less potential for successful development than those with higher development numbers.

Appendix 2B - Electrical Generation --
Weighting Factors

Temperature	
less than 300° F.	0
300° - 350°	1
greater than 350° F.	2

Water Chemistry--average all three
categories for weighting factor

pH	
less than 5	0
5 - 6.6	1
6.6 - 7.4	2
7.4 - 9	1
greater than 9	0

TDS-ppm	
greater than 1000	0
500 - 1000	1
0 - 500	2

Corrosives-Scaling Compounds	
high	0
moderate	1
low	2

Land Factors--average all three
categories for weighting factor

Areal extent--square miles	
less than .5	0
.5 to 1.5	1
greater than 1.5	2

Accessibility--miles from paved road	
greater than 15	0
5 - 15	1
0 - 5	2

Zoning/Land Use	
not appropriate	0
semi-appropriate	1
appropriate	2

Population Centers--within 10 miles	
0 - 500 persons	0
500 - 5000 persons	1
greater than 5000 persons	2

Depth to Resources---feet	
greater than 7000	0
3500 - 7000	1
0 - 3500	2

Appendix 2C - Residential-Commercial - Space Heating Weighting Factors

Temperature	
less than 86° F.	0
87° - 140° F.	1
140° - 250° F.	2
greater than 250° F.	1

Water Chemistry--average all three categories for weighting factor

pH	
less than 5	0
5 - 6.6	1
6.6 - 7.4	2
7.4 - 9	1
greater than 9	0

TDS-ppm	
greater than 1000	0
500 - 1000	1
0 - 500	2

Corrosives-Scaling Compounds	
high	0
moderate	1
low	2

Land Factors--average all three categories for weighting factor

Areal extent--square miles	
less than .5	0
.5 to 1.5	1
greater than 1.5	2

Accessibility--miles from paved road	
greater than 15	0
5 - 15	1
0 - 5	2

Zoning/Land Use	
not appropriate	0
semi-appropriate	1
appropriate	2

Population Centers--within 10 miles	
0 - 500 persons	0
500 - 5000 persons	1
greater than 5000 persons	2

Depth to Resources---feet	
greater than 800	0
400 - 800	1
0 - 400	2

Appendix 2D - District - Space Heating Weighting Factors

Temperature	
less than 150° F.	0
150° - 200° F.	1
greater than 200° F.	2

Water Chemistry--average all three categories for weighting factor

pH	
less than 5	0
5 - 6.6	1
6.6 - 7.4	2
7.4 - 9	1
greater than 9	0

TDS-ppm	
greater than 1000	0
500 - 1000	1
0 - 500	2

Corrosives-Scaling Compounds	
high	0
moderate	1
low	2

Land Factors--average both categories for weighting factor

Accessibility--miles from paved road	
greater than 15	0
5 - 15	1
0 - 5	2

Zoning/Land Use	
not appropriate	0
semi-appropriate	1
appropriate	2

Population Centers--within 10 miles	
0 - 500 persons	0
500 - 5000 persons	1
greater than 5000 persons	2

Depth to Resources---feet	
greater than 800	0
400 - 800	1
0 - 400	2

Appendix 2E - Recreation -- Weighting Factors

Temperature	
less than 70° F.	0
70° - 90° F.	1
90° - 200° F..	2
greater than 200° F.	1

Water Chemistry--average both categories for weighting factor

pH	
less than 5	0
5 - 6.6	1
6.6 - 7.4	2
7.4 - 9	1
greater than 9	0

TDS-ppm

greater than 1000	0
500 - 1000	1
0 - 500	2

Land Factors--average both categories for weighting factor

Accessibility--miles from paved road

greater than 15	0
5 - 15	1
0 - 5	2

Zoning/Land Use

not appropriate	0
semi-appropriate	1
appropriate	2

Population Centers--within 30 miles

0 - 500 persons	0
500 - 5000 persons	1
greater than 5000 persons	2

Depth to Resources---feet

greater than 200	0
100 - 200	1
0 - 100	2

Appendix 2F - Industrial Process Heat -- Weighting Factors

Temperature	
less than 105° F.	0
106° - 212° F.	1
greater than 212° F.	2
Water Chemistry--average all three categories for weighting factor	
pH	
less than 5	0
5 - 6.6	1
6.6 - 7.4	2
7.4 - 9	1
greater than 9	0
TDS-ppm	
greater than 1000	0
500 - 1000	1
0 - 500	2
Corrosives-Scaling Compounds	
high	0
moderate	1
low	2
Land Factors--average all three categories for weighting factor	
Areal extent--square miles	
less than .5	0
.5 to 1.5	1
greater than 1.5	2
Accessibility--miles from paved road	
greater than 15	0
5 - 15	1
0 - 5	2
Zoning/Land Use	
not appropriate	0
semi-appropriate	1
appropriate	2
Population Centers--within 10 miles	
0 - 500 persons	0
500 - 5000 persons	1
greater than 5000 persons	2
Depth to Resources---feet	
greater than 7000	0
3500 - 7000	1
0 - 3500	2

Appendix 2G - Greenhousing -- Weighting Factors

Temperature	
less than 100° F.	0
100° - 200° F.	1
200° - 350° F.	2
greater than 350° F.	1
Water Chemistry--average all three categories for weighting factor	
pH	
less than 5	0
5 - 6.6	1
6.6 - 7.4	2
7.4 - 9	1
greater than 9	0
TDS-ppm	
greater than 1000	0
500 - 1000	1
0 - 500	2
Corrosives-Scaling Compounds	
high	0
moderate	1
low	2
Land Factors--average both categories for weighting factor	
Accessibility--miles from paved road	
greater than 15	0
5 - 15	1
0 - 5	2
Zoning/Land Use	
not appropriate	0
semi-appropriate	1
appropriate	2
Population Centers--within 10 miles	
0 - 500 persons	0
500 - 5000 persons	1
greater than 5000 persons	2
Depth to Resources---feet	
greater than 800	0
400 - 800	1
0 - 400	2

Appendix 2H - Aquaculture -- Weighting Factors

Temperature		
less than 70° F.		0
70° - 110° F.		1
110° - 150° F.		2
greater than 150° F.		1
Water Chemistry--average both categories for weighting factor		
pH		
less than 5		0
5 - 6.6		1
6.6 - 7.4		2
7.4 - 9		1
greater than 9		0
TDS-ppm		
greater than 2000		0
1000 - 2000		1
0 - 1000		2
Land Factors--average both categories for weighting factor		
Accessibility--miles from paved road		
greater than 15		0
5 - 15		1
0 - 5		2
Zoning/Land Use		
not appropriate		0
semi-appropriate		1
appropriate		2
Population Centers--within 10 miles		
0 - 500 persons		0
500 - 5000 persons		1
greater than 5000 persons		2
Depth to Resources---feet		
greater than 400		0
200 - 400		1
0 - 200		2

Appendix 2I - Animal Husbandry -- Weighting Factors

Temperature	
less than 100° F.	0
100° - 150° F.	1
150° - 250° F.	2
greater than 250° F.	1

Water Chemistry--average all three categories for weighting factor

pH	
less than 5	0
5 - 6.6	1
6.6 - 7.4	2
7.4 - 9	1
greater than 9	0

TDS-ppm	
greater than 1000	0
500 - 1000	1
0 - 500	2

Corrosives-Scaling Compounds	
high	0
moderate	1
low	2

Land Factors--average all two categories for weighting factor

Accessibility--miles from paved road	
greater than 15	0
5 - 15	1
0 - 5	2

Zoning/Land Use	
not appropriate	0
semi-appropriate	1
appropriate	2

Population Centers--within 10 miles	
0 - 500 persons	0
500 - 5000 persons	1
greater than 5000 persons	2

Depth to Resources---feet	
greater than 800	0
400 - 800	1
0 - 400	2