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Nevada Geothermal Commercialization Program

Geothermal Area
Development Plan
Resource Areas 4 and 1

September 1980

MASTER

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NEVADA GEOTHERMAL
COMMERCIALIZATION PROGRAM

GEOTHERMAL AREA DEVELOPMENT PLAN-

RESOURCE AREA 4 - CARSON CITY

RESOURCE AREA 1 - WASHOE COUNTY

PREPARED BY MAGGIE PUGSLEY

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WORK PERFORMED UNDER CONTRACT NO. DE-FC07-80ID12019
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IDAHO OPERATIONS OFFICE

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Carson City

**Geothermal Area
Development Plan-
Resource Area 4**

GEOHERMAL RESOURCE AREA 4

Carson City, Nevada

Area Development Plan

by

**Nevada Department of Energy
1050 East Williams, Suite 405
Carson City, Nevada 89710**

Maggie Pugsley

December, 1979

Work Performed under Contract

No. DE-FC07-79ID12019

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SUMMARY

Geothermal Resource Area 4 includes all of the land in Carson City, Nevada. Within this area are three known geothermal anomalies: Carson Hot Springs, Prison Hot Springs, and Pinyon Hills.

After evaluating the physical characteristics of the Carson City area, the various land ownership and zoning patterns, existing population and projected growth rates, transportation facilities, energy use by the residents, businesses, and industries of Carson City in relationship to the physical characteristics of the geothermal resource itself it appears that the existing resources could be used for the following purposes:

Carson Hot Springs

1. Recreation
2. Residential Space Heating
3. Commercial, Industrial, and Domestic Hot Water
4. Greenhouses
5. Aquaculture

Prison Hot Springs

1. Aquaculture
2. Agriculture
3. Residential Space Heating
4. District Space Heating
5. Industrial Space Heating

Pinyon Hills

1. Residential Space Heating
2. District Space Heating
3. Domestic Hot Water

The geothermal resource in Carson City is somewhat limited in its development potential. However, even if only a portion of the available resource is developed, significant savings of fossil fuels could result.

Much of the information presented about characteristics of the geothermal resource in Carson City is preliminary. The Nevada Bureau of Mines and Geology is in the process of conducting a detailed assessment of the available resource. The report about this assessment is due for completion in the fall of 1980. For additional information concerning the geothermal resource in Carson City, it is suggested that contact be made with the Bureau of Mines and Geology at the University of Nevada, Reno.

I. INTRODUCTION

Geothermal Resource Area 4 includes all of the lands in Carson City, Nevada (Figure 1). Carson City is a small consolidated city/county unit located in western Nevada. It is one of Nevada's 17 counties (Figure 2).

There are three areas of known geothermal resources in the county: Carson Hot Springs, Prison Hot Springs, and Pinyon Hills. Historically, there has been only limited use of these resources.

It is the purpose of this document to encourage the development of the various geothermal resources found in Carson City. To further the goal, this Area Development Plan was prepared to provide information to both the public and private developer about the geothermal resource, the physical and socioeconomic setting of Carson City, and the potential for developing various uses of this so far almost untapped 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 the Carson City area in terms of its physical, socioeconomic, and energy use characteristics. The second section describes the geothermal resources found in the Carson City area. The third section describes the potential uses for each of the resources based on a study of the geothermal resource characteristics, land use and zoning, social conditions, and various business and economic factors.

NEVADA

LOCATION OF
GEOTHERMAL RESOURCE
AREA 4

FIGURE 1

FIGURE 2
COUNTIES OF NEVADA

II. The Area

A. Physical Characteristics (12)

1. Location and Relief

Carson City is the smallest of Nevada's 17 counties. It covers only about 151 square miles. Located in west-central Nevada the county extends eastward from the shores of Lake Tahoe, across the Carson Range of the Sierra Nevada Mountains, to Eagle Valley and the Pine Nut Mountains (Figure 3). Elevations range from a high of 9,274 feet on Snow Valley Peak to a low of 3,850 feet along the Carson River.

2. Vegetation (15)

Because of the great range in elevations in Carson City many different vegetation communities are present. At lower elevations, and where the soil salinity is higher, vegetation characteristic of the salt desert shrub community is found. At somewhat higher elevations the northern desert shrub community predominates. Sagebrush and bitterbrush, the most common plants of this community, cover most of the Eagle Valley portion of Carson City. On the east side of Eagle Valley ascending into the Pine Nut Mountains the pinyon-juniper community is dominant. The Sierra Nevada Mountain portion of Carson City has several different plant communities present. At lower elevations, and in areas of recent wildfires, a mountain chaparral community characterized by manzanita and tobacco bush is found. Ascending the mountains is a zone characterized by Yellow Pine and White Fir, a zone characterized by Red Fir, and a zone characterized by Lodgepole Pine

CARSON CITY

FIGURE 3

MAJOR TOPOGRAPHIC AND PHYSICAL
FEATURES IN CARSON CITY

and Mountain Hemlock. Along stream channels and by areas of standing water, a riparian community characterized by willow and cottonwood is commonly found growing.

3. Surface Water

One large river runs through the Carson City area. The Carson River has its headwater to the south of the Sierras. The flow of this river through Carson City varies dramatically from a low of about 1.6 cubic foot per second in the summer months to as high as 30,000 cubic feet per second in the winter months. Several small creeks flow down the east slope of the Sierras into Eagle Valley. Clear Creek, Kings Canyon Creek, and Ash Canyon Creek all have minimum flows of approximately 0.16 cubic foot per second and maximum flows of approximately 25 cubic feet per second (U.S. Geological Survey, Water Resources Division).

Three small creeks flow down the west slope of the Carson Range into Lake Tahoe: Secret Harbor Creek, North Canyon Creek and, Bliss Creek. No flow rate information is currently available on these streams. Marlette Lake, standing several hundred feet higher than Lake Tahoe, is the only lake located in Carson City.

4. Climatic Conditions (17)

The climatic conditions found in Carson City are variable from area to area based on the great relief of the area. The U.S. Weather Bureau maintains a local meteorological station at an elevation of 4,651 feet. The climatological information recorded at this station is shown in Table 1.

Table 1

CLIMATOLOGICAL SUMMARY

LATITUDE N39 09
LONGITUDE W119 46

MEANS AND EXTREMES FOR PERIOD 1951-1978

CARSON CITY, NV
ELEVATION 4681

MONTH	TEMPERATURE (°F)													PRECIPITATION TOTALS (INCHES)														
	MEANS			EXTREMES					MEAN NUMBER OF DAYS				MEAN	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	SNOW, SLEET					MEAN NUMBER OF DAYS				
									MAX.		MIN.								MEAN	MAXIMUM MONTHLY	YEAR	GREATEST DEPTH	YEAR	DAY	.10 or MORE	.50 or MORE	1.00 or MORE	
	90° AND ABOVE	32° AND BELOW	32° AND BELOW	6° AND BELOW																								
					DAILY MAXIMUM	DAILY MINIMUM	MONTHLY	RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR																DAY
JAN	46.4	20.2	33.3	75	59	18	-16	71	3	0	3	27	2	2.16	7.31	69	2.31	63	31	7.8	25.2	52	15.0	67	29	4	2	0
FEB	51.8	24.9	38.2	78+	72	28	-6	36	2	0	0	24	0	1.39	6.39	82	3.03	63	1	3.9	19.8	69	12.0	59	17	3	1	0
MAR	55.5	27.2	41.4	81	66	31	-3	52	21	0	0	23	0	.91	3.48	52	1.30	32	19	8.2	34.5	52	19.0	52	19	2	0	0
APR	62.3	31.6	47.0	87	61	3	12+	72	20	0	0	18	0	.34	1.01	38	1.64	38	3	1.6	7.5	38	7.0	58	3	2	0	0
MAY	70.8	38.9	54.9	93	51	27	18	67	1	0	0	3	0	.70	2.02	64	1.20	68	12	1.0	12.5	64	3.0	71	20	2	0	0
JUN	79.7	49.4	62.6	100	61	21	27	34	6	3	0	1	0	.30	2.34	83	1.24	63	10	.0	.3	59				1	0	0
JULY	89.0	50.3	69.8	100+	60	19	34	66	3	16	0	0	0	.29	1.07	38	.83	38	16	.0						1	0	0
AUG	87.4	48.3	67.9	103	72	8	26	68	23	13	0	0	0	.28	1.20	38	.67	38	17	.0						1	0	0
SEPT	80.9	40.8	60.9	99	53	6	20	63	18	3	0	6	0	.33	1.09	31	1.09	31	18	.1	1.8	71				1	0	0
OCT	70.0	32.2	51.1	91+	64	6	8	71	29	0	0	16	0	.49	1.92	62	1.90	62	14	.4	4.0	71	4.0	71	16	1	0	0
NOV	56.2	25.3	40.8	70+	60	2	0	38	17	0	0	23	0	1.14	4.03	70	.96	73	14	1.7	7.0	61	4.0	61	21	3	1	0
DEC	47.7	20.6	34.2	73	58	4	-18+	72	13	0	2	27	1	2.39	10.39	58	3.02	55	24	7.2	25.3	64	14.0	64	31	3	2	1
YEAR	66.3	33.8	50.2	103+	72	8	-18+	72	11	37	3	168	3	11.12	10.39	58	3.03	63	1	28.9	34.5	52	15.0	62	19	26	6	1

+ ALSO ON EARLIER DATES

Climatological data are very limited at higher elevations in the Sierra Nevada and Pine Nut Mountains. Temperatures are expected to decrease at a rate of about 3 1/2°F per 1,000 vertical feet according to the normal environmental lapse rate. This temperature decrease may be somewhat less than expected on the Lake Tahoe side of the Sierras because the lake itself is acting as a large heat reservoir.

The total amount of precipitation increases with higher elevations based on typical orographic precipitation effects. Figure 4 illustrates this effect specifically for Eagle Valley.

Because of the decreased temperatures and increased precipitation, the Sierra Nevada Mountains develop an annual snowpack of some eight to nine feet of snow at about the 9,000 foot elevation. This snowpack usually begins to develop in the middle of November and is usually maintained to mid or late June.

5. Geologic Setting (16)

Portions of two distinct geomorphic provinces are represented in Carson City. The western area of the city is in the Sierra Nevada Geomorphic Province. The rocks of this area are predominantly granitic and are part of the Sierra Nevada Batholith of Mesozoic age. Structurally, the Sierra Nevada Mountains are a large fault block that has been tilted to the west. This gives the mountains a very asymmetric east-west profile with an abrupt and steep east front and a much longer and more gentle backslope. The eastern front is

FIGURE 4
RELATION BETWEEN
ALTITUDE AND MEAN ANNUAL PRECIPITATION
IN EAGLE VALLEY

composed of a series of normal faults along which several thousands of feet of vertical displacement have occurred uplifting the Sierras to their present height.

Lake Tahoe occupies a depressed block fault basin (graben) between the main crest of the Sierra Nevada and the Carson Range. The graben is bounded on both the east and the west by north-south trending normal faults parallel to the east bounding fault of the Sierra Nevada.

The eastern portion of Carson City lies in the Basin and Range Geomorphic Province. This area is characterized by the extensive development of alternating north-south trending mountains and valleys. This distinctive pattern is caused by a series of normal faults and represents an area of typical fault block structure. Rock units in Carson City range in age from the early Mesozoic to Quaternary. Mostly, however, they are Tertiary volcanics with smaller areas of low-grade metamorphic rocks.

B. Land Ownership and Land Use (12)

Carson City consists of only 97,920 acres of land.

Private parties own more than 32 percent of the total land area in the county and state, county, and federal government agencies hold the remaining 68 percent (Figure 5).

Land use patterns, or zoning, in the Eagle Valley portion of Carson City as developed by the Carson City Planning Department can be broken down into six categories: residential, governmental, commercial, industrial, agricultural, and conservation reserve. The largest land use type is residential. Single family dwellings comprise the largest percentage of this residential land use. Multiple family dwellings and mobile homes make up the remaining (Figure 6).

Governmental and institutional land uses constitute the second largest use in the area. Subdivisions of this category include: education, medical, religious, penal, parks and playgrounds, and public administration.

Commercial land uses occupy a more limited areas. The areas zoned commercial have a very evident "strip" character. More than 90 percent of the commercial uses may be found within two blocks either side of Carson Street or East William Street. General retail facilities comprise most of the commercial activities. Other major activities include; service stations, restaurants, motels, hotels, and casinos.

Industrial land uses occupy several areas around Carson City. The uses consist primarily of light manufacturing and storage facilities. The largest industrially zoned area is

found near the Carson City Airport. Other such areas can be found by the Carson City Airport, Nevada State Prison, and along Fairview Lane.

The two remaining land uses, agriculture and conservation reserve, can be found along the periphery of Carson City. Agriculture is primarily located along the Carson River. It consists generally of irrigated pasture for livestock and for the production of hay and alfalfa. Conservation reserves are either large tracts of land that have physical characteristics that make them difficult to develop, such as very steep slopes, or are being held for future development.

The mountainous areas both on the east and west of Carson City have not been zoned as such. Both of these areas are primarily owned by the Federal Government and are used for recreation activities and for wildlife, timber, range, and watershed management.

FIGURE 5
LAND OWNERSHIP
IN THE URBANIZED
PORTION OF CARSON CITY

C. Population

The population in Carson City has been constantly growing over the past 30 years. During the 1960 to 1970 decade, the annual growth rate was 9.1 percent. Increases between 1970 and 1979 show an annual gain of 13.8 percent. The State Planning Coordinator's Office anticipates that this high rate of growth will continue into the future. Table 2 illustrates the population trend between 1940 and 1979. (3)

TABLE 2
Population Trends in Carson City, Nevada
1940-1979

Year	Population	Percent Change	
		Annual	10 Year
1940	3,209		
1950	4,172		30
1960	8,063		93.3
1970	15,468		91.8
1971	18,300	18.3	147.7
1972	20,000	9.3	
1973	21,801	9.0	
1974	23,700	8.7	
1975	25,300	6.8	
1976	25,992	2.8	
1977	27,145	4.4	
1978	29,457	8.5	
1979	34,667	17.7	
1980	38,315	10.5	

The Nevada State Planning Coordinator's Office has made the official projections on population growth in Carson City to the year 2020. These projections are shown in Table 3.

TABLE 3

Population Projections to the year 2020 in Carson City

<u>Year</u>	<u>Population</u>	<u>Percentage Change</u>
1980	38,315	
1990	73,500	91.8
2000	104,500	42.6
2010	126,500	21.2
2020	139,800	10.5

Carson City is approximately 151 square miles in size. The residents of the city are not evenly distributed around this entire area. Most of the population is located in the urbanized, Eagle Valley portion of the city. Two small population centers, Lakeview Estates and Pinyon Hills, are separated from the main urbanized area by a distance of several miles. Population estimates from these two areas are included in the city totals. The land in the Sierra Nevada portion of Carson City is all publically owned. Hence, there are no full time residents living in this portion of the city.

D. Transportations Facilities

Two important highways pass through Carson City. (8) U.S. 50 is a major east-west route beginning in Ocean City, Maryland and ending in Oakland, California. In Nevada, this route passes through Ely, Eureka, Austin, Fallon, South Lake Tahoe and Carson City. U.S. 395 connects Cascade,

Washington to the north with Tijuana, Mexico to the south. The route passes through Stead, Reno, Carson City, and Minden-Gardnerville in Nevada (Figure 7).

There are about 330 miles of road in Carson City. Of this, a total of 165 miles are unimproved or dirt. (8) Forty-one miles of the 165 miles of improved road are on the federal-aid highway system. The remaining 124 miles of road is either on the municipal or the urban street system.

Transportation services are limited in Carson City. Only five interstate truck lines provide freight service to the area. However, none of these maintains any terminal facilities. The nearest such facilities are located about 30 miles north in Reno, Nevada.

Passenger and some parcel service is provided by two interstate bus lines. These bus lines have 17 regularly scheduled stops in Carson City.

Limited air service is available at the Carson City Airport. This small airfield has one 6,000 foot long runway. It has the capability of handling small to moderate sized aircraft. The fuels available include: 80 octane, 100 octane, and Jet A. There are no regularly scheduled commercial flights. Charter service is available. The nearest, full scale, commercial airport in the region is Cannon International in Reno, about 30 miles to the north.

No railroad facilities are available in Carson City. The nearest tracks belong to the Southern Pacific and the

Western Pacific Railroads. They are about 32 miles north in Reno, Nevada.

Local passenger transportation is primarily by taxi. No municipal bus lines are currently in operation. Special categories of persons such as the physically handicapped, mentally retarded, or elderly have several special transportation programs available to them at reasonable or no cost.

FIGURE 7

**MAJOR TRANSPORTATION
FACILITIES IN CARSON CITY**

E. Economic Base (2,3)

The economic base of Carson City has historically been governmental employment. Most recent economic data (1978 Employment and Payroll, Employment Security Department) indicates that this industry accounts for about 39 percent of the entire labor force or about 5,550 jobs. Persons employed in the governmental sector account for about 66 million dollars in person income or 39.2 percent of the total area income (Table 4).

Utilities, Finance-Insurance-Real Estate, Trade and Service sectors employed 6,259 persons in the most recent record period and generated over 46 million dollars in personal income. This is about 29.1 percent of the area personal income. Trade and service sectors account for 38.3 percent of all employment and 24 percent of personal income.

Light manufacturing accounted for 1,285 employees and 9.18 million dollars of 9.7 percent of the areas personal income. Since 1970, there has been moderate growth in this industry. Major employers are Mallory Electric, Durafiber Corporation, Richdel, and Sacoma Sierra. Each of these firms manufactures specialized goods which have national markets.

Employment in construction trades was 1,247 and accounted for 10.7 million dollars of personal income or 6.2 percent of total reported income. Construction has been stimulated by general growth of the population in the city and increased requirements for housing and services. Major firms in this category were various construction contractors operating

throughout western Nevada.

Building permits for January-May 1979 indicate the various new economic offerings throughout Carson City: Six warehouses and storage units; five restaurants; a hanger, a small racebook and casino, a centrally located 7-11 grocery store; a Public Employee's Retirement Building; a First National Bank of Nevada Building; three savings and loans facilities; a dental office; and two distribution firms. A small, local stationary store is becoming a department store and is locating in the northern part of town.

TABLE 4

Employment by Sector in Carson City-1978

Sector	Employed	Percentage of Labor Force
Mining	8	.05
Construction	1,247	8.7
Manufacturing	1,285	8.9
Transportation	428	2.9
Trade	2,414	16.8
Finance, Insurance, and Real Estate	302	2.3
Services	3,085	21.5
Government	5,543	38.6

F. Water Availability (20)

The Eagle Valley portion of Carson City is both a topographic and a hydrologic basin. The ground-water from this basin has historically been the primary source of municipal water for Carson City. But, because of the recent, rapid increase in population growth, the demand for ground-water is approaching the limits of the locally available resource.

The basic water resource in Carson City is the water yield from the nearby Sierra Nevada Mountain area. The mean annual water yield is about 9,000 acre-feet/year. Of this water, 7,800 acre-feet/year occurs as surface water and about 1,200 acre-feet/year occurs as direct ground-water recharge. Part of the surface water, about 1,000 acre-feet/year, is diverted for municipal use. Most of the remainder is diverted for agricultural use.

Agricultural use of water in Eagle Valley is primarily for flood irrigation of pasturelands. The mean annual water available for this purpose is about 6,800 acre-feet. Some of this water is in excess of irrigation needs and discharges into the Carson River. In the Clear Creek area, about 30 percent or 1,100 acre-feet/year, actually reaches the Carson River. In the Kings Canyon-Ash Creek area, less than 10 percent of the surface water reaches the Carson River.

The difference between the surface water available for agricultural use and the discharge into the Carson River is the water available for consumption and for ground-water recharge. This difference is about 5,400 acre-feet per year. Several studies have been done to determine the water use by pasture grasses. Computations based on figures resulting from these studies indicate that the net consumptive use of water in agriculture is about 2,300 acre-feet/year. Table 5 develops a simple agricultural water budget for the Eagle Valley area.

TABLE 5 --Agricultural water budget

Source of water	Surface water available (S _A) (acre-ft/yr)	Surface-water discharge to Carson River (acre-ft/yr)	Pasture area (acres)	Consumptive use (acre-ft/yr)	Ground-water recharge (acre-ft/yr)
Kings Canyon and Ash Canyon Creeks	2,900	300	360	1,100	1,500
Clear Creek	3,900	1,100	400	1,200	1,600
Total	6,800	1,400	760	2,300	3,100

TABLE 6 --Municipal water budget
(Records from Carson City and Nevada Division of Buildings and Grounds)

Year	Imported Water (acre-feet)	Surface water (acre-feet)	Ground water (acre-feet)	Sewage effluent (acre-feet)	Lawn area (acres)	Consumptive use (acre-feet)	Ground-water recharge (acre-feet)
1967	400	1,300	900	1,600	160	480	520
1968	690	1,100	860	1,500	170	510	640
1969	520	1,200	960	1,800	180	540	340
1970	420	1,200	1,500	2,100	190	570	450
1971	470	1,300	1,400	2,100	200	600	470
1972	720	1,100	2,000	2,100	230	690	1,000
1973	160	850	2,600	2,500	250	750	360
1974	210	1,100	2,800	2,800	270	810	500
1975	330	1,000	3,000	3,200	300	900	230
1976	340	550	4,000	3,200	330	990	700
1977	640	320	3,700	2,800	360	1,100	760
	4,900	11,000	24,000	26,000		7,900	6,000

Water available for municipal use comes from three sources: surface water, ground-water, and imported water. To evaluate the amount available for municipal use data from a 10 year period was used. In this period, there was approximately 40,000 acre-feet of inflow into Eagle Valley. The total discharge was about 26,000 acre-feet. The difference, 14,000 acre-feet was the amount consumed or recharged into the ground-water system. (Table 6)

The most consumptive use results from the irrigation of lawns and other domestic plants. Studies done indicate the water use by these plants is similar to pasture grasses. Based on the increasing lawn area in Eagle Valley, it was estimated that about 7,900 acre feet of water was used in the 10 year base period. The remaining 6,000 acre feet are believed to have been recharged into the ground-water system. Table 6 develops a municipal water budget for Carson City.

Summarizing, it is estimated that about 65 percent of the municipal water is discharged as waste, 20 percent is used, and 15 percent is recharged into the ground-water system. Twenty-one percent of the agricultural water is discharged, 34 percent is used, and 45 percent is recharged into the ground-water.

G. Design Information

The engineering design characteristics for the urbanized portion of Carson City area are as follows:

Latitude	39°1'
Longitude	119°5'
Elevation	4,675 Feet

Winter Design Dry-Bulb Temperature

99%	4°F
97.5%	9°F

Summer Design Dry-Bulb and Mean Coincident Wet-Bulb Temperature

1%	94°/60°F
2.5%	91°/50°F
5%	89°/58°F

Mean Daily Temperature Range	42°F
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Design Wet Bulb Temperature

1%	63°F
2.5%	61°
5%	60°

Degree Heating Days	5,753
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H. Energy Use

Tables 7, 8, and 9 illustrate the anticipated use of energy by the residents, businesses, and industries in Carson City in the years 1980, 1990, and 2000. These estimates are based on current energy use information supplied by Sierra Pacific Power and Southwest Gas and on projected population growth rates in Carson City supplied by the State Planning Coordinator's Office.

TABLE 7

Carson City Energy Use-1980

Energy consumed that could easily be replaced by geothermal energy (heating)
All units expressed in 10^{12} BTU's

Energy Type	Residential and Small Commercial	Large Commercial	Industrial	Total
Electricity	.20	.70	.23	1.13
Natural Gas	1.17	.43	1.40	3.00
Oil	.18	.64	.21	1.03
Other	.05	.18	.06	.29
Total Replacable Energy	1.60	1.95	1.90	5.45

Energy consumed that could not be easily replaced by geothermal energy (lighting,
cooking, air conditioning, etc.)

Electricity	.21	2.64	.24	3.09
Total Energy Used	1.81	4.59	2.14	8.54

TABLE 8

Carson City Energy Use-1990

Energy consumed that could easily be replaced by geothermal energy (heating).
All units expressed in 10^{12} BTU's

Energy Type	Residential and Small Commercial	Large Commercial	Industrial	Total
Electricity	.36	1.35	.44	2.15
Natural Gas	2.25	.83	2.69	5.77
Oil	.33	1.24	.40	1.97
Other	.09	.34	.11	.54
Total Replacable Energy	3.03	3.76	3.64	10.43

Energy consumed that could not be easily replaced by geothermal energy (lighting,
cooking, air conditioning, etc.).

Electricity	.40	5.06	.46	5.92
Total Energy Used	3.43	8.82	4.10	16.35

TABLE 9

Carson City Energy Use-2000

Energy consumed that could easily be replaced by geothermal energy (heating).
All units expressed in 10^{12} BTU's

Energy Type	Residential and Small Commercial	Large Commercial	Industrial	Total
Electricity	.52	1.92	.62	3.06
Natural Gas	3.20	1.18	3.83	8.21
Oil	.48	1.76	.57	2.18
Other	.13	.48	.16	.77
Total Replacable Energy	4.33	5.34	5.18	14.85

Energy consumed that could not be easily replaced by geothermal energy (lighting,
cooking, air conditioning, etc.).

Electricity	.57	7.20	.65	8.42
Total Energy Used	4.90	12.54	5.83	23.27

These tables are divided into two sections: one showing the energy that is currently being used in applications that can be readily converted to use geothermal energy; and one showing the energy that is being used in applications that are not readily converted to use geothermal energy. Geothermal energy has several types of space heating applications and could be substituted for natural gas, electricity, and oil for heating purposes. However, unless the resource is high enough in temperature to be able to generate electricity it cannot be used for applications such as lighting and cooking.

As can be seen by an evaluation of the information presented in these tables the amount of energy consumed in Carson City for heating applications is anticipated to increase by about 81 percent by the year 1990 and by another 42 percent by the year 2000. If geothermal energy could be substituted for only five percent of the total energy demand by the year 2000 some 3.84×10^{13} BTU's of fossil fuel energy could be saved. This is equivalent to about 6,600,000 barrels of crude oil.

III. The Resources

A. General Information

Three areas in Carson City have been identified as having geothermal potential: Carson Hot Springs, Prison Hot Springs, and the Pinyon Hills area. These three areas were delineated on the basis of known hot springs and hot wells (Figure 8).

The Nevada Bureau of Mines and Geology began a study of the geothermal potential in Carson City in May, 1979. This study has included an evaluation of existing well data, gravity

studies, soil mercury sampling, shallow temperature gradient holes, and shallow resistivity. The results of this study should be available for public review by the end of 1980.

Calculation of the geothermal reservoir size and heat capacity is difficult because of the limited information currently available. The estimates that follow are based on methodology presented in U.S.G.S. Circular 790. Because of the resource characteristics, two alternations in that methodology were made. 1) All potential uses of the resource in Carson City are anticipated to be small commercial, industrial, or residential applications. Because of the expense of drilling wells (\$25.00 per foot for cased wells), the cost is too great for most developers of these applications to drill deep wells. To take this fact into consideration when calculating geothermal reservoir size it was assumed that the maximum reservoir depth was 750 feet. Even at this moderately shallow depth, a well could cost a developer around \$18,750.00. It should be remembered, however, that the reservoir may be much deeper. As economic conditions change it may become feasible to drill deeper wells and tap more energy than indicated. 2) The second alteration to the U.S.G.S. methodology was in the calculation of the geothermal reservoir surface area. The geological control on most of the geothermal reservoirs in the Great Basin appears to be fault related. This control tends to give the resource a linear, north-south trending character. Because of this, when calculating the surface area of a geothermal reservoir

with only one known exposure it was assumed that the resource area was 0.75 miles long and 0.2 miles wide. If two or more exposures are known, the reservoir was calculated to include all of those exposures.

Calculation of several factors gives an estimated potential heat found in the geothermal reservoir. These factors include: surface area of the reservoir, depth of the reservoir, temperature of the reservoir, and the specific heat of the rock.

Existing technology is not capable of extracting all of this energy from the reservoir. To give a more realistic value of the energy obtainable, an assumption of 25 percent of the total reservoir capacity is used.

It should be emphasized that the information presented about each geothermal reservoir in Carson City is based on limited information. The exact conditions in these reservoirs may be considerably different than indicated. Any party investigating the development of any of these resources is urged to contact the Nevada Bureau of Mines and Geology for additional information and to engage the services of a reputable consulting firm that has had successful experience in assessing geothermal reservoirs.

FIGURE 8
LOCATION OF THE
GEOTHERMAL RESOURCE

B. Carson Hot Springs

1. Description

The Carson Hot Spring is located north of Hot Springs Road in the north-central portion of the city. The actual hot spring area covers less than one acre though a small stream flows south from the area.

The hot spring has a very long history of use. Archaeological evidence suggests that this site was a winter campsite for the Washoe Indians. Though little excavation has been done in the Carson Hot Spring area, surface surveys indicate that this may be the most significant archaeological site in Eagle Valley.

The Carson Hot Spring was first developed in 1860 when a small mineral bath was constructed. Since 1860, a swimming pool and several buildings have been added. Periodically, these have been renovated to bring them up to more modern standards.

The current owner of Carson Hot Spring is DRL Investments. The company holds title to about 200 acres of land located around the spring area. The existing facilities include a bar, dinner house, and a hot swimming pool. Only the swimming pool is currently heated using the hot geothermal water. The bar and dinner house use conventional fuels for heating purposes.

2. The Reservoir

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

Area

Surface Area.....0.15 square mile
Depth..... 750 feet

Temperature

Surface or near surface conditions.....122°F
Depth.....167°F
Assumed reservoir temperature for
calculation purposes.....167°F

Discharge

75 gallons per minute

Water Chemistry (11)

The following is the chemical analyses run on water from the Carson Hot Springs. (All units are expressed in parts per million.)

Identification

	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	NO ₃	B	TDS
Carson Hot Springs	-	-	2.6	0.4	96	96	36	28	96	29	-	-	-
Carson Hot Springs	44	-	6	2	104	41	27	84	34	-	-	-	326
Nevada Safe Drinking Water Standards		.03		125				250	250				500

Water from the Carson Hot Springs meets all criteria for safe drinking water.

Energy Content

Potential heat energy found in the reservoir... 1.364×10^{13} BTU

Heat energy extractable with existing technology.. 1.41×10^{12} BTU

C. Prison Hot Spring

1. Description

The second area of known geothermal activity in Carson City is the Prison Hot Spring. This spring is located immediately outside of the Nevada State Prison Maximum Security Facility on land owned by the State of Nevada. The hot spring flows into an existing warm duck pond that drains into a several acre marshy area immediately north of the prison. In addition to the actual spring, the Carson City Public Works Department has drilled a 210 foot well into the geothermal reservoir approximately one half mile northeast of the prison site on Sewer Treatment Plant property.

The Prison Hot Spring is the site of the historic Warm Springs Hotel. This hotel was first constructed in 1869 and was used for two years before it was converted into a prison. During this time the Warm Springs Hotel was used as the territorial legislature building.

After construction of the prison the warm water from the spring was used as a source of water for inmate showers. Currently, the geothermal resource is not being used for any practical application.

2. The Reservoir

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

Area

Surface area.....0.3 square mile
Depth.....750 feet

Temperature

Surface or near surface conditions.....75°F
Depth.....86°F
Assumed reservoir temperature
for calculation purposes86°F

Discharge

No information available

Water Chemistry

No information available

Energy Content

Potential heat found in the reservoir..... 1.919×10^{13} BTU
Heat energy extractable with existing
technology..... 4.79×10^{12} BTU

D. Pinyon Hills

1. Description

The third area with a potential for geothermal development in Carson City is Pinyon Hills. This area is a housing development of approximately 170 units located east of the Carson River along the base of the Pine Nut Mountains. There is no surface indication of geothermal activity in the area. The resource was located by privated individuals drilling for domestic water.

Today, there are about 40 hot water wells in the area ranging in temperature from about 79°F to about 140°F. There is one problem with this resource--poor water quality. Chemical analysis of this water indicates that it has a total dissolved solid content of about 1,550 parts per million.

There is very little use of these thermal waters in the Pinyon Hills area. There is only one space heating application at this time, and only one swimming pool is heated using geothermal heat.

2. The Reservoir

The following parameters are believed to describe the Pinyon Hills geothermal reservoir:

Area

Surface area.....0.3 square mile
Depth.....750 feet

Temperature

Measured in shallow wells.....between 79°F and 140°F
Assumed reservoir temperature for
calculation purposes.....212°F

Discharge

No information available

Water Chemistry (11)

Water chemistry information is available only on two wells in the Pinyon Hills area. These analyses are as follows:
(All units are in parts per million)

Identification

	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS
Well	-	0.01	275	3	254		29	6	1000	33	4.3	-	-	1551
Well	-	0.01	-	-	71		10	-	112	20	1.6	0.5	-	-
Nevada safe drinking water standards		.03		125					250	250				500

The water from the Pinyon Hills area is heavily mineralized. It violates most of the Safe Drinking Water Standards.

Energy Content

Potential heat energy found in the reservoir 3.865×10^{13} BTU
Heat energy extractable with existing technology... 9.65×10^{12} BTU

VI The Uses

A. General

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. Neither of these requirements appears to be met by the geothermal resources found in Carson City. For this reason, no further consideration will be given to the development of electrical generation facilities in this geothermal resource area.

Direct uses of geothermal energy are more varied and can economically utilize both lower temperature and smaller resources. Figure 9 illustrates the types of uses that geothermal energy can be put to and the temperature requirements for each use.

Essentially, direct uses of geothermal energy can be divided into six major categories space heating (residential, district, and industrial); low, medium, and high temperature industrial processes; domestic, commercial, and industrial hot water; hot water for various agricultural needs such as drying agricultural crops and various animal husbandry operations; warm water for aquacultural enterprises, and water for recreation.

Each of these use categories will be evaluated to see which would be the most practical and beneficial to develop in the Carson City area.

FIGURE 9 GEOTHERMAL USE TEMPERATURES

B. Carson Hot Springs

The Carson Hot Springs Geothermal Use Evaluation Table (Table 10) summarizes the potential uses of the energy believed available at the Carson Hot Springs and the factors either favorable or detrimental for the development. An evaluation of this table gives a picture of what applications would be appropriately developed at this site.

Four out of the 12 use categories can be eliminated from further consideration because there is some physical or land use factor that would preclude its development. Lack of agricultural zoning and low source temperature eliminates agricultural production, medium to high industrial process heats, and electrical generation.

Development in the other eight use categories is technically possible based on existing conditions though development in some of the categories is more economically feasible. Ranking the possible use categories based on their development average (see Table 10) reveals the following sequence:

1. Recreation (2.9)
2. Residential Space Heating (2.7)
3. Commercial, Industrial, and Domestic Hot Water (2.7)
4. Greenhouses (2.6)
5. Aquaculture (2.6)
6. Low Temperature Industrial Process Heat (2.5)
7. Industrial Space Heating (2.2)
8. District Space Heating (2.1)

Those use categories with higher development averages are considered more practical to develop at this time. As conditions change through time, however, those uses with lower development averages become developable.

Based on an evaluation of the various possible uses of the Carson Hot Spring Resource, the use with the highest development average is recreation. As this has historically been the use of the springs this development can be considered to be completed although additional facilities could be added at some future date.

Residential home space heating would be the second level of development. Though there is only one known exposure of the geothermal resource found at the actual hot spring area, the reservoir is anticipated to extend some distance north and south of this site into areas with proper zoning for residential development. Water with temperatures sufficient to heat individual residences and other small buildings is anticipated to occur in this reservoir and could be obtained by drilling wells into the proper areas. Private development of various space heating applications could be considered to be a beneficial use of this resource.

The third level of development is supplying hot water for various industrial commercial, and individual needs. This application could be developed separately or in conjunction with space heating applications.

The fourth and fifth levels of development include greenhousing and aquacultural industries. Both of these industries are considered to be appropriate applications for the energy found in the Carson Hot Springs geothermal reservoir.

Carson Hot Springs GEOTHERMAL USE EVALUATION TABLE 10

Characteristics - Constraints	Space Heating			Low Temp. Industrial Process	Medium Temp. Industrial Process	High Temp. Industrial Process	Commercial Industrial Domestic Water	Agriculture			Recreation	Electrical
	Individual	District	Industrial					Production	Greenhouses	Aquaculture		
Water Temperature	3	1	2	2	0	0	3	3	3	3	3	0
Flow Rate or Discharge	3	1	1	2	2	2	3	2	2	2	3	0
Reservoir Size	3	1	1	2	2	2	3	2	2	2	3	0
Zoning, Land Use, Land Ownership, Location	3	3	3	3	3	3	3	0	3	3	3	3
Environmental Considerations	3	3	3	3	3	3	3	3	3	3	3	0
Industrial Labor Force	NA	3	3	3	3	3	NA	3	3	3	3	3
Transportation Facilities for Raw Materials or Products	NA	NA	NA	3	3	3	NA	3	3	3	NA	NA
Financing Accessibility	2	2	2	2	2	2	2	2	2	2	2	2
Product Market	NA	NA	NA	3	3	3	NA	3	3	3	3	3
Water Availability	2	2	2	2	2	2	2	2	2	2	3	2
Community Support	3	3	3	3	3	3	3	3	3	3	3	3
Development Average	2.7	2.1	2.2	2.5	0	0	2.7	0	2.6	2.6	2.9	0

Legend

- 0 Factor precludes development from indicated application
- 1 Factor would preclude development in all but extraordinary situations
- 2 Factor is neither advantageous or harmful to potential development

- 3 Factor is advantageous to potential development
- NA Not applicable
- No information available

C. Prison Hot Springs

The Prison Hot Springs geothermal resource has been evaluated using the same procedures and criteria as used for the Carson Hot Springs. Table 11 evaluates the resource available at this site and the factors either favorable or detrimental to the development of various uses.

Six of the 12 use categories can be eliminated from further consideration based on some physical or land use characteristic. The remaining applications include space heating for various individuals, district, or industrial purposes, aquaculture and greenhousing.

Development of an agricultural and greenhouse industry has potential at the Prison Hot Springs. Temperatures are sufficient and zoning is appropriate. There are only two problems facing this type of development: the resource is on publically owned land, and there is only fragmentary information on the discharge from the spring area. It would be very difficult for a private developer to gain rights to the water from this source, however, Nevada State Prison officials could be encouraged to develop agricultural and horticultural programs to supply needs of inmates. Unfortunately, at this time not enough is known about the discharge from this source. It may be that there is insufficient water available for this use. Before any development can occur much detailed study of the character of this resource must be done.

Space heating applications are the second major type of possible use. Water temperatures at this site are relatively low; however, there are several types of mechanical systems that can make use of these temperatures. The hot spring area is on property owned by the Nevada State Prison. There is the possibility that when the price of fossil fuels becomes high enough it would be economically feasible to use water at this temperature to run a water to water heat pump and heat the prison facilities.

Additionally, land in the vicinity of the hot springs is zoned residential. As this land develops the installation of a district heating system in the homes could have good potential. The only potential problem with these applications is again the fragmentary information as to the actual discharge of the springs. If this discharge rate is too low it would preclude the development of various space heating application.

Prison Hot Springs GEOTHERMAL USE EVALUATION TABLE 11

Characteristics - Constraints	Space Heating			Low Temp. Industrial Process	Medium Temp. Industrial Process	High Temp. Industrial Process	Commercial Industrial Domestic Water	Production	Agriculture Greenhouses	Aquaculture	Recreation	Electrical
Individual	District	Industrial										
Water Temperature	1	1	1	0	0	0	2	0	1	1	2	0
Flow Rate or Discharge	---	---	---	---	---	---	---	---	---	---	---	---
Reservoir Size	3	1	1	1	1	1	3	1	2	2	3	0
Zoning, Land Use, Land Ownership, Location	3	3	3	3	3	3	3	3	3	3	0	3
Environmental Considerations	3	3	3	3	3	3	3	3	3	3	3	0
Industrial Labor Force	NA	3	3	3	3	3	NA	3	3	3	3	3
Transportation Facilities for Raw Materials or Products	NA	NA	NA	3	3	3	NA	3	3	3	NA	NA
Financing Accessibility	2	2	2	2	2	2	2	2	2	2	2	2
Product Market	NA	NA	NA	3	3	3	NA	3	3	3	3	3
Water Availability	3	2	2	2	2	2	2	2	2	2	3	0
Community Support	3	3	3	3	3	3	3	3	3	3	3	3
Development Average	2.6	2.3	2.3	0	0	0	2.6	0	2.5	2.5	0	0

Legend

- 0 Factor precludes development from indicated application
- 1 Factor would preclude development in all but extraordinary situations
- 2 Factor is neither advantageous or harmful to potential development

- 3 Factor is advantageous to potential development
- NA Not applicable
- No information available

D. Pinyon Hills

An evaluation of the potential uses of the geothermal resource found in the Pinyon Hills area (Table 12) indicates that only three of the 12 major use categories can be developed. Nine use categories can be eliminated from further consideration based either on existing zoning patterns or on some physical characteristic of the resource itself. Those uses which can be developed in the Pinyon Hills area include: individual space heating, district space heating, and domestic hot water.

There is great potential for the development of individual home heating systems. Much of the Pinyon Hills development lies directly over the geothermal reservoir. Residents in this portion of the community could directly tap the reservoir. In fact, some 40 existing wells could be converted so that they supply both heat and hot water in addition to just domestic water.

The Pinyon Hills development covers several square miles. As a result there is some part of the area that does not lie over the reservoir. Because of the temperature of the resource and its proximity to the community, it is feasible to develop a district heating system and a distribution network for domestic hot water to supply the needs of those residents not having direct access to the reservoir and those residents not wishing to develop private systems.

Pinyon Hills GEOTHERMAL USE EVALUATION TABLE 12

Characteristics - Constraints	Space Heating			Low Temp. Industrial Process	Medium Temp. Industrial Process	High Temp. Industrial Process	Commercial Industrial Domestic Water	Agriculture				
	Individual	District	Industrial					Production	Greenhouses	Aquaculture	Recreation	Electrical
Water Temperature	3	3	3	3	2	0	3	3	3	3	3	0
Flow Rate or Discharge	3	1	1	2	2	2	3	3	3	3	3	0
Reservoir Size	3	1	1	2	2	2	3	3	3	3	3	0
Zoning, Land Use, Land Ownership, Location	3	3	0	0	0	0	3	0	0	0	0	0
Environmental Considerations	3	3	3	3	3	3	3	3	3	3	3	0
Industrial Labor Force	NA	3	3	3	3	3	3	3	3	3	3	3
Transportation Facilities for Raw Materials or Products	NA	NA	NA	3	3	3	NA	3	3	3	NA	NA
Financing Accessibility	2	2	2	2	2	2	2	2	2	2	2	2
Product Market	NA	NA	NA	3	3	3	NA	3	3	3	3	3
Water Availability	3	2	2	2	2	2	2	2	2	2	2	0
Community Support	3	3	3	3	3	3	3	3	3	3	3	3
Development Average	2.9	2.6	0	0	0	0	2.8	0	0	0	0	0

Legend

- 0 Factor precludes development from indicated application
- 1 Factor would preclude development in all but extraordinary situations
- 2 Factor is neither advantageous or harmful to potential development

- 3 Factor is advantageous to potential development
- NA Not applicable
- No information available

V. Conclusion

A. The Resource and Its Uses

Carson City has three areas of potential geothermal development: Carson Hot Springs, Prison Hot Springs, and Pinyon Hills. There is some potential for development at each of these three sites, however, none of this potential development may be considered to be of major importance. Essentially, all of the sites in Carson City can be developed to supply the needs of individual space heating applications. Other forms of space heating applications may also be developed at various sites. Two of the sites have some potential for aquacultural development. The major question concerning the development of geothermal resources in Carson City is whether or not the economic situation is such as to make the various developments economically attractive. If the cost of conventional fossil fuels continues to rise at the existing rate, the development of these resources could become practical in the very near future.

B. Energy Savings

Because of the limited nature of the geothermal resource in Carson City the amount of fossil fuel energy saved by the development of the geothermal resource in Carson City is anticipated to be small. Table 13 reflects estimates about the amount of energy that could be saved if the Carson City resource were developed for various applications. Total energy savings from even the limited development of Carson City's

geothermal energy resource as indicated could result in a savings as of approximately 650,000 barrels of crude oil.

Geothermal energy has the potential of supplying many of the energy needs of Nevadans if properly developed. Private and public parties should be encouraged to investigate this virtually free energy resource and develop it wherever it is possible.

TABLE 13

Potential Energy Savings By Developing Carson City's Geothermal Resources

Example of use	Energy Savings per year BTU's	Total Energy savings through 2020 BTU's
50 all electric homes either converted or constructed to use geothermal energy, as a source of heat (annual heat demand- 2.4×10^8 BTU each)*	1.2×10^{10}	5.0×10^{11}
50 homes using gas or oil either converted or constructed to use geothermal energy as a source of heat, (annual heat demand 8.07×10^{10})	15×10^{10}	3.15×10^{12}
1 greenhouse with 10,000 square feet developed (annual heat demand 2.3×10^9 BTU)	2.3×10^9	4.8×10^{10}
TOTAL	16.8×10^{10}	$3.8 \times 10^{12} **$

*Amount of energy consumed in the generation of electricity before delivery to individual homes.

** 3.8×10^{12} BTU = 650,000 barrels of crude oil

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
1050 East William, Suite 405
Carson City, Nevada 89710
(702) 885-5157

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

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

U.S. Bureau of Land Management
Room 3008, Federal Building
300 Booth Street
Reno, Nevada 89509
(702) 784-5651

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

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Washoe County

**Geothermal Area
Development Plan-
Resource Area 1**

Part II

GEOHERMAL RESOURCE AREA 1

AREA DEVELOPMENT PLAN

Prepared by Maggie Pugsley

**Nevada Department of Energy
400 West King Street
Carson City, Nevada 89710**

**Work Performed under
Contract No. DE-FC07-79ID12019**

DISCLAIMER

ALTHOUGH THIS REPORT GIVES NUMERICAL ENERGY CAPACITIES TO SITES WITH SPECIFIC NAMES, IT MUST STRONGLY BE EMPHASIZED THAT THE TECHNICAL CRITERIA FOR COMPETENT ESTIMATIONS ARE ALMOST ENTIRELY LACKING. THE ESTIMATES PRESENTED IN THIS DOCUMENT ARE LARGELY SUBJECTIVE. THEY ARE, HOWEVER, BASED ON THE BEST AVAILABLE INFORMATION ABOUT EACH SITE. NEITHER THE NEVADA DEPARTMENT OF ENERGY NOR THE UNITED STATES DEPARTMENT OF ENERGY, NOR ANY OF THEIR EMPLOYEES OR CONTRACTORS, MAKE ANY WARRANTY, EXPRESS OR IMPLIED, OR ASSUME ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE ACCURACY, COMPLETENESS, OR USEFULNESS OF ANY INFORMATION PRESENTED IN THIS DOCUMENT.

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SUMMARY

Geothermal Resource Area 1 includes all of the land in Washoe County, Nevada. Within this area are six major geothermal anomalies: Steamboat Hot Springs, Moana Hot Springs, the Needles Rocks, Gerlach Hot Springs, Ward's Hot Springs, and the San Emidio Desert Hot Springs. All of these sites except the Needles Rocks have been defined as Known Geothermal Resource Areas by the United States Geological Survey. The Needles Rocks area does not have this designation as it is located on Indian reservation land. In addition to these major geothermal anomalies there are many minor anomalies at various locations around the country.

Various feasible uses of the energy found at each of the resource sites were determined after evaluating the characteristics of Washoe County. This evaluation included the physical characteristics, the land ownership pattern, existing population and projected growth rates, transportation facilities, and energy use by the residents, businesses, and industries of Washoe County in relationship to the geothermal resource itself. The uses considered were divided into 12 major categories; individual, district, and industrial space heating; low, medium, and high industrial process heat; hot water for various uses; agricultural production; greenhousing; aquaculture; recreation; and electrical generation.

It was determined that the geothermal resources of Washoe County could be used for the following purposes:

Steamboat Hot Springs

All 12 major use categories can feasibly be developed. Electrical generation has the highest potential.

Moana Hot Springs

Individual and district space heating; commercial and domestic hot water; greenhousing; and recreation can be developed. Other uses have been eliminated on the basis of the location of the resource.

The Needles Rocks

All 12 major use categories can be developed. Any development must, however, address the resource's remote location on an Indian reservation, its relative inaccessibility, and its moderate temperature.

Gerlach Hot Springs

All major use categories can feasibly be developed.

Ward's Hot Springs

All major use categories can be developed. Individual space heating and electrical generation have the highest potential. All development must address the remote location of the resource and its moderate temperature.

San Emidio Desert Hot Springs

All 12 major use categories can be developed. Electrical generation has the highest potential. All development must address the remote location of the resource and its relative inaccessibility.

All six major geothermal anomalies in Washoe County have great potential for development. The only limiting factor is that four of the six major sites are located in remote locations away from good roads and other transportation facilities. Great savings of fossil fuel energy could be made even if these six resources were only partially developed.

I. Introduction

A. Washoe County

Geothermal Resource Area 1 includes all of the lands in Washoe County, Nevada (Figures 1 and 2). Within this area the United States Geological Survey has defined five Known Geothermal Areas:

Fly Ranch (Ward's)	20,758.66 acres
San Emidio	7,678.00 acres
Gerlach	17,353.60 acres
Moana	5,120.00 acree
Steamboat	8,914.00 acres

These areas and one other, the Needles Rocks, are considered to be commercially developable. In addition, thermal waters of lower temperature are known to exist in many areas around Washoe County. Historically, the use of these resources has been somewhat limited. The only resource that has had some utilization is Moana Hot Springs. Today there are about 60 homes, three commercial establishments, and a church using the hot water for either heating swimming pools or for space heating applications. Geothermal heat has been used at Steamboat Hot Springs in the casting of plastic explosives. Uses at other geothermal areas have been limited to swimming, health spas, and irrigation.

The Bureau of Land Management is the largest landholder in Washoe County. The agency has actively encouraged the development of geothermal resources on BLM land by offering leases for exploration and development. As of November 20, 1979, 24 non-competitive leases covering 24,825 were issued. Twelve competitive leases covering 18,333 acres have also been issued.

FIGURE 1

FIGURE 2
CITIES IN WASHOE COUNTY

B. The Purpose

It is the purpose of this document to encourage the development of the various geothermal resources found in Washoe County. To further the goal, this Area Development Plan was prepared to provide information to both the public and private developer about the geothermal resource, the physical and socio-economic setting of Washoe County, and the potential for developing various uses of this, so far, virtually untapped 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 the Washoe County area in terms of its physical, socio-economic, and energy use characteristics. The second section describes the geothermal resources found in Washoe County. The third section describes the potential uses for each of the resources based on a study of the geothermal resource characteristics, land use, social conditions, and various economic and business factors.

Much of the information presented about the geothermal resource characteristics in Washoe County is based on the rather limited data available. For additional information, it is suggested that contact be made with the Nevada Bureau of Mines and Geology at the University of Nevada, Reno.

II. The Area

A. Physical Characteristics

1. Location and Relief

Washoe County ranks seventh in size among the seventeen Nevada counties. It has a total land area of 6,366 square miles, or 4,074,240 acres, and contains about six percent of the total land area of the state.

The county is located in Western Nevada. It is bordered by Humboldt, Pershing, Churchill, and Lyon counties on the east, Storey County and Carson City on the south, California on the west and Oregon on the north. It is a narrow strip of land 30 to 50 miles wide and 150 miles long running from the middle of Nevada north to the Oregon border (Figure 3).

Washoe County is, for the most part, mountainous. There are, however, several large valleys. In the northern part of the county the Hays Canyon Range, the Granite Range, and the Sheldon Antelope Range are the most dominant mountains. They tower over nearby valleys up to 6,000 feet in some places. Long Valley, Duck Flat, part of Smoke Creek Desert, and part of Black Rock Desert are the largest valley areas. In the southern part of Washoe County the Fox Range, Lake Range, Truckee Range, Virginia Mountains, Pah Rah Range, Virginia Range, and the Carson Range of the Sierra Nevada are the high mountains. Major valleys include the Truckee Meadows and Washoe Valley. The highest elevation in Washoe County, 10,788 feet, is on Mount Rose of the Carson Range. The lowest elevation is 3,800 feet found at Pyramid Lake.

FIGURE 3
TOPOGRAPHICAL AND
PHYSICAL FEATURES OF WASHOE COUNTY

2. Vegetation (18)

Because of the great relief found in Washoe County a large number of distinct vegetation communities are found. In areas of low elevation and saline soils the Sald Desert Shrub community is dominant. The Pyramid Lake area, the Smoke Creek Desert, and the San Emidio Desert form the largest areas having this type of vegetation. Plants such as saltbrush, shadscale, greasewood, and bud sage are the most common found in this community.

The most abundant vegetation community found in Washoe County is the Northern Desert Shrub community which occurs in most areas of the county. This community exists wherever rainfall is between eight and 12 inches per year. It is best developed on deep, permeable soils along the bases of mountains. Sagebrush, rabbitbrush, bitterbrush, and Mormon tea are the primary species making up this community.

At higher elevations, except in the Sierra Nevada where rainfall exceeds 12 inches per year, the Pinyon-Juniper community predominates. Representatives of this community are found at higher elevations where the soils tend to be coarse and rocky in most of the mountain ranges in Washoe County. The community consists of low, evergreen trees which rarely exceed 20 feet in height. The trees vary greatly in their spacing from a single isolated tree to compact clusters. Usually, there is an understory of grasses and shrubs, though in areas where there is a high density of trees the ground is usually bare. Pinyon trees, juniper trees, sagebrush, rabbitbrush, bitterbrush, gooseberry, and horsebrush are the most common species found in this community.

Located along the east slope of the Sierra Nevada and in the Lake Tahoe Basin are a series of vegetation communities known as the Mountain Zonal Series. This series is composed of different assemblages of shrubs and trees at various, increasing elevations. Increased rainfall in the Sierra Nevada has led to the development of a more varied and richer vegetational area than is found elsewhere in Washoe County. At the lowest elevations the Mountain Brush community is developed. It is characterized by shrubs such as tobacco bush and manzanita. At slightly higher elevations, from about 5,000 to 7,500 feet, the Yellow Pine- White Fir community is developed. Continuing upward in elevation is the Red Fir community from about 7,500 to 9,300 feet; the Lodgepole Pine-Mountain Hemlock community from about 8,300 to about 9,500 feet; and the Whitebark Pine community from about 9,300 feet to about 10,000 feet. At the highest elevations a Sierra Tundra community is found.

Throughout Washoe County are wet areas with plants requiring much more water than is normally found. These riparian plants form distinct communities in meadows, fresh water to slightly brackish marshes, along the shores of streams, and in areas of high ground water. In Washoe County the riparian community is found along flowing streams such as Galena Creek and the Truckee River, in marsh areas such as Gerlach Hot Springs, and in areas of high ground water such as places in the Truckee Meadows. Plants found in this community range from large cottonwood trees, to moderate sized cattails, to small water buttercups.

3. Climatic Conditions(20)

The climatic conditions in Washoe County are quite variable because of the large physical area and the great relief of the area. Detailed climatological information is available for Washoe County only at the one meteorological recording station maintained by the U.S. Weather Service. This weather station is located at an elevation of 4,400 feet in Reno at the Cannon International Airport. The climatic conditions recorded at this station are considered typical of many of the basin areas found in Washoe County. The climatic conditions found at higher elevations may be inferred by assuming that the temperature decreases at a rate of 3.5° F. per every 1,000 feet higher than at the recording station. This lapse rate may be somewhat less than expected in the Lake Tahoe Basin because the lake is acting as a large heat reservoir keeping air temperatures warm and be somewhat different in other basins in the area because of local temperature inversions. Because of typical orographic precipitation effects, the amount of rainfall is considered to increase with increasing altitude. Table 1 summarizes the climatological information recorded in Reno, Nevada.

Table 1
CLIMATOLOGICAL SUMMARY-RENO, NEVADA

LATITUDE 39° 36' N
LONGITUDE 119° 47' W
ELEV. (GROUND) 4404 feet

MEANS AND EXTREMES FOR PERIOD 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	90° and above		Max.		Min.							
																			32° and below	32° and below	0° and below	0° and below						
(a)	30	30	30	33		33		b	30	33		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Jan.	44.4	18.5	31.4	70	1967	-16	1949+	1073	1.19	2.37	1943	6.1	26.6	1937	11.0	1956	3	0	3	26	2	Jan.						
Feb.	49.8	23.2	36.5	74	1967+	-12	1962	823	1.10	1.53	1962	5.5	32.4	1938	13.2	1959	3	0	1	24	1	Feb.						
Mar.	55.5	25.7	40.6	83	1966	-2	1945	729	.73	1.21	1943	4.2	29.0	1952	13.6	1952	2	0	*	24	*	Mar.						
Apr.	64.3	31.1	47.7	88	1966	13	1956+	510	.46	1.56	1952	1.2	7.5	1958	4.2	1958	1	0	0	19	0	Apr.						
May	71.6	38.2	54.9	95	1967	18	1964	357	.65	1.28	1963	1.0	14.1	1964	9.0	1962	2	*	0	6	0	May						
Jun.	80.2	43.8	62.0	101	1967+	25	1954	189	.40	0.66	1945	T	T	1963+	*	1959	1	5	0	1	0	Jun.						
Jul.	90.4	49.1	69.8	104	1945	33	1965+	43	.30	0.80	1949	T	T	1949	0	-----	1	19	0	0	0	Jul.						
Aug.	88.5	46.6	67.6	102	1946+	24	1962	87	.20	0.95	1941	T	T	1949	0	-----	1	15	0	*	0	Aug.						
Sep.	81.2	40.0	60.6	101	1950	20	1965	204	.25	0.80	1950	T	T	1959	T	1959	1	6	0	4	0	Sep.						
Oct.	69.8	32.2	51.0	91	1965	13	1961	490	.47	1.45	1962	*	2.0	1957	2.0	1957	1	*	0	16	0	Oct.						
Nov.	55.9	24.1	40.0	77	1960+	1	1958	801	.60	0.97	1946	1.7	8.7	1961	6.4	1961	2	0	*	25	0	Nov.						
Dec.	47.1	20.7	33.9	69	1958+	-9	1961	1026	1.04	2.02	1955	4.2	22.9	1941	8.5	1941	3	0	1	28	*	Dec.						
Year	66.6	32.8	49.7	104	July 1945	-16	Jan. 1949+	6332	7.39	2.37	Jan. 1943	24.1	32.4	Feb. 1938	13.6	Mar. 1952	21	45	5	173	3	Year						

(a) Average length of record, years.

b Climatological Standard Formulas (1931-1960)
† Trace, an amount too small to measure.

+ Also on earlier dates, months, or years.

* Less than one half.

** Base 65°F

The climate of Washoe County is based on two distinct seasonal storm types: a winter type characterized by cyclonic storms, and a summer type characterized by thunderstorms. The winter storms provide most of the annual precipitation to the Washoe County area. These cyclonic storms have their origin far out in the Pacific Ocean where they pick up large quantities of moisture.

The storms then track onto the land where they are forced to rise over the Sierras. In doing so, most of the moisture is depleted on the west slope. When the storm reaches the Nevada area it is relatively dry and as a result delivers much less moisture to the area than it does to California, just a hundred miles to the west. Enough precipitation is, however, received by the Sierra Nevada portion of Washoe County from these storms to develop an eight to nine foot deep snowpack that is maintained from December to June.

The summer storm type is very different. Moist air from over the Gulf of California moves north over Nevada. This added moisture in the air causes unstable air conditions which leads to the development of large thunderstorms. These storms often have very heavy rainfalls associated with them, which in some cases can lead to flooding conditions.

4. Geologic Setting (3, 19)

Washoe County has a much varied geologic setting. The southern portion of the county has a geologic character more or less typical of the Basin and Range Geomorphic Province with elongated mountains separated by long alluvial filled valleys. West of the Truckee Meadows, in the southern portion of the county, the Great Basin rapidly changes into the Sierra Nevada Geomorphic Province. The northern portion of Washoe County is a high, dissected plateau transitional between the Basin and Range and the Columbia Plateau Geomorphic provinces.

All of the rocks found in Washoe County range in age between Permian (?) and Recent. Most of the pre-Tertiary rocks consist of metamorphosed sedimentary and volcanic rocks that have been intruded by granitic bodies. A great majority of the rocks in the area are Tertiary in age. They 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 characteristic to most of Washoe County has been developed on all of these rock types. This topography has developed because of the characteristic fault block structure caused by normal faulting and 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 portion of Washoe County is primarily composed of 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 the 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 12,000 to 13,000 feet higher than the surrounding plains. In Washoe County, Mount Rose is about 6,000 feet higher than the Truckee Meadows. The Carson Range of the Sierra Nevada, which separates the Washoe Valley, Truckee Meadows portion of Washoe County 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 Sierra.

As indicated, the northern portion of Washoe County is transitional from the Basin and Range province into the Columbia Plateau province. This area lacks the characteristic topographic assemblage of isolated mountain ranges and adjacent intermountain basins with their alluvial fills and ephemeral lakes. Folding is more common than faulting, making the area structurally and warped area. Erosion is fairly advanced and has dissected old basalt flows. In some cases the underlying granites have been exposed.

5. Hydrology (9, 10)

Washoe County lies in portions of four major hydrologic areas that are found in Nevada: the Northwest Region, the Black Rock Desert Region, the Western Region, and the Truckee River Basin. All of these areas are enclosed basins with no outlets to the sea.

There is one hydrologic basin having a major river system in Washoe County, the Truckee River Basin. The Truckee River originates in California at Lake Tahoe. It enters the state west of Verdi, flows east through the Truckee Meadows and a canyon cut into the Virginia Range, to Wadsworth where it swings north to flow into Pyramid Lake.

The Western, Black Rock Desert, and Northwest Regions are characterized by small lakes, by some perennial, but mostly intermittent, streams, and by large playas.

The water resource characteristics of Washoe County are typical of high deserts. Precipitation is seasonal, some occurring in the summer as thundershowers, but mostly occurring in the winter as snow. Streamflows are equally seasonal with peak flows occurring in the late spring as the result of snowmelt.

Under uncontrolled conditions, runoff typically reaches a peak flow in late spring. The annual flow period is in late summer or early fall. Approximately 50 percent of the total runoff occurs in May to June.

This wide range in flow creates multiple problems. Seasonal high flows often result in flood damage with serious erosion and sedimentation. Low flows limit agricultural production and causes high water temperatures which adversely affect both fish life and general water quality.

B. Land Ownership and Land Use (25)

Washoe County is a total of about 6,366 square miles in size. This is approximately six percent of the total land area of the State of Nevada. Table 2 shows the land ownership patterns found in Washoe County.

Table 2

LAND OWNERSHIP PATTERNS IN WASHOE COUNTY

Public Land	Acres	Percent
Federal		
Bureau of Land Management	2,648,400	65.1
Other Federal Agencies	160,164	3.9
State	12,423	0.3
County	<u>1,420</u>	<u>0.0</u>
Total Public Lands	2,822,407	69.3
Private Land		
Classified	784,423	18.3
Railroad	27,892	0.7
Indian	<u>475,518</u>	<u>11.7</u>
Total Private Land	1,251,833	30.7
Total County Land	4,074,240	100.0

Existing land use patterns in Washoe County are based primarily on the proximity to the major population center of Reno-Sparks and the other smaller population centers. Away from these centers the land has historically been used for agriculture, ranching, mining, wildlife management, and open space. The Bureau of Reclamation has classified all 2,648,400 acres of the public land it administers as being for multiple use. This classification includes all types of uses from recreation, wildlife management, watershed management, and livestock grazing, to timber production

on the more heavily forested portions of the land. Other federal agencies holding title to land in Washoe County, such as the U.S. Forest Service and the Bureau of Reclamation, at this time are also managing their lands according to the multiple use concept.

Larger urban communities develop various zoning classifications to segregate various land uses within a community to those which are deemed compatible. Such uses include residential, commercial, governmental/institutional, various types of industrial, and agricultural.

- **PUBLIC DOMAIN**
- **NATIONAL FORESTS**
- **FEDERAL WILDLIFE RANGES**
- **PRIVATE LANDS**
- **INDIAN RESERVATIONS**
- **STATE LANDS**

FIGURE 4
LAND OWNERSHIP
IN WASHOE COUNTY

C. Population

The population of Washoe County has been steadily growing over the past century. Between 1960 and 1970 the population grew an estimated 69 percent. For several economic and social reasons the State Planning Coordinator's Office expects that this high rate of growth will continue into the future until some natural limit to growth is reached. Table 3 illustrates the past growth trends in Washoe County as a whole. Table 4 illustrates the projected growth to the year 2020.

Table 3
POPULATION TRENDS IN WASHOE COUNTY
1910-1970

Year	Population	Percent Change
1910	17,434	
1920	18,627	6.8
1930	27,158	45.8
1940	32,476	19.6
1950	50,205	54.6
1960	84,743	68.8
1970	121,068	42.3
1980 (estimated)	186,670	54.2

The existing population of Washoe County is not evenly distributed around the entire county. It is, instead, localized into distinct population centers with only scattered persons in between. The largest of these population centers is the Reno-Sparks metropolitan area located in the Truckee Meadows. Immediately associated with this metropolitan area are Sun Valley, Stead, Verdi, Steamboat, and Washoe Valley. Other population centers include: Crystal Bay and Incline Village along the north shore of Lake

Tahoe; Nixon and Wadsworth south of Pyramid Lake; Empire and Gerlach on the western edge of the Black Rock Desert; and the isolated Black Springs and Vya (Figure 2).

Table 4 graphically illustrates the rapid growth of those communities in or near the Truckee Meadows. The largest area of population growth in Washoe County is expected to be in the Reno-Sparks area. Smaller surrounding communities will also have a large growth rate as the result of development in the metropolitan area. Some features of these outlying communities, such as an aesthetically pleasing environment, lower housing costs, or a lower cost of living, will attract many residents from the metropolitan areas to these outlying "bedroom" communities. Two such communities, Verdi and Wadsworth, are currently experiencing this rapid growth. This growth is expected by the Planning Coordinator to continue at least to the year 2000.

The more isolated communities around the county likewise will experience a population increase, though it will not be nearly the magnitude of the more centralized communities. At this time, these communities do not appear to have the geographic, economic, or social setting necessary to attract large numbers of persons.

Table 4
POPULATION PROJECTIONS TO THE
YEAR 2020 IN WASHOE COUNTY

City	1980	Percent Change	1990	Percent Change	2000	Percent Change	2110	Percent Change	2020
Black Springs	500	40.0	700	21.4	850	41.2	1,200	25.0	1,500
Crystal Bay	1,000	20.0	1,200	16.7	1,400	7.1	1,500	6.7	1,600
Empire	650	7.7	700	7.1	750	6.7	800	6.3	850
Gerlach	250	20.0	300	16.7	350	14.3	400	12.5	450
Incline Village	10,000	80.0	18,000	44.4	26,000	23.1	32,000	18.7	38,000
Nixon	100	20.0	120	16.7	140	14.3	160	12.5	180
Pyramid Lake Indian Reservation	450	11.9	500	10.0	550	9.1	600	8.3	650
Reno	118,000	49.2	176,000	30.7	230,000	10.9	255,000	9.8	280,000
Sparks	50,000	60.0	80,000	4.0	112,000	8.0	121,000	9.9	133,000
Steamboat	700	28.6	900	22.2	1,100	18.2	1,300	15.4	1,500
Sun Valley	10,300	59.2	16,400	37.2	22,500	20.0	27,000	11.1	30,000
Verdi	1,500	260.0	5,400	72.2	9,300	36.6	21,700	18.1	15,000
Vya	100	10.0	110	9.1	120	8.3	130	7.7	140
Wadsworth	820	265.9	3,000	133.3	7,000	100.0	14,000	100.0	28,000
Washoe City	2,300	26.1	2,900	20.7	3,500	20.0	4,200	19.1	5,000
Total County	196,000	55.7	306,230	37.3	420,510	12.0	471,990	13.5	535,870

D. Transportation Facilities (6,7)

Two nationally important highways pass through Washoe County. U.S. 395 is a major north-south route entering Nevada slightly north of Stead. It passes through the Reno-Sparks area to Washoe Valley and on to Carson City and Minden-Gardnerville before leaving the state in the vicinity of Topaz Lake in Douglas County.

I-80 is one of about 12 east-west interstate routes in the United States. I-80 enters Nevada in Elko County at the town of Wendover. It has been constructed through the towns of Elko, Carlin, Battle Mountain, Winnemucca, Lovelock, Fernley, Wadsworth, Sparks, Reno, and Verdi. After passing through Verdi, I-80 begins to ascend the Sierras where it passes into California.

Washoe County has a total of 3,122 miles of roadway. There are 593 miles of road on the federal aid system, 192 miles on the state aid system, two miles on the county system, and 377 miles on the city or local system. The county has 2,153 miles of unpaved road and 969 miles of roadway paved to various standards.

Washoe County has very good transportation facilities in the Truckee Meadows area. Outside of this particular region, transportation facilities may be very primitive or even totally lacking.

There are two airport facilities in Washoe County and three additional landing strips. Cannon International Airport in Reno is the largest such facility serving not only Washoe County but all the surrounding counties in Nevada and California. Cannon

International Airport has two runways: a 9,000-foot long north-south facility, and a 6,000-foot long east-west facility. The lengths of these runways are sufficient to accommodate all types of aircraft from small private planes to the large commercial jets and military aircraft. The fuels that can be obtained are 80/87 octane, 100/137 octane, and Jet A-50. Currently there are 10 major carriers serving the Reno-Sparks areas with over 64 flights daily. Two commuter airlines supply the needs of more short distance regularly scheduled travel. Numerous charter companies are available. One freight carrier supplies the need for rapid freight movement.

Reno-Stead Airport, located north of Reno, was once Stead Air Force Base. This general aviation airport offers only limited services to private aircraft and a small air taxi service. No regularly scheduled commercial aircraft use this facility. There are two runways; an 8,080-foot long southeast-northwest facility and a 7,600-foot long east-west facility.

Two major national railroads serve the Washoe County area, and specifically the Reno-Sparks areas. The largest of these is the Southern Pacific Railroad which has approximately 20 trains per day traveling through the area. Western Pacific Railroad also has tracks through the Reno-Sparks areas and serves the area with two trains per day. All of these trains are freight only. The only passenger service in the area is AMTRAK which serves the area with two trains per day.

The Reno-Sparks area being on I-80 is also on a major trucking route. Approximately 25 interstate trucking firms travel through the area. Most have terminal facilities in the area.

Three interstate bus lines serve the travel needs of local residents and those visiting. Several bus charter services are available to transport persons into the area from various localities in California and elsewhere.

Local transportation in Washoe County is fairly limited. There are two major taxi companies and one public bus line.

FIGURE 5
MAJOR TRANSPORTATION
FACILITIES IN WASHOE COUNTY
24

E. Economic Base

The economic base of Washoe County has historically been the services which includes both the gaming and hotel industry. The 1978 economic data supplied by the Employment Security Department indicated that there are 2,067 individual businesses in this industrial classification. These businesses supply about 38,650 jobs and account for about \$376,213,007 in wages paid.

Wholesale and retail trade industries are the second largest employer in Washoe County. These businesses employ about 21,550 persons and account for about \$214,930,829 in wages.

Government is the third largest employer with 13,799 employees. In 1978, about \$191,986,047 in wages were paid to these employees.

Following government in number of employees and total wages paid are the construction, communication, and utility industries; the finance, insurance, and real estate industries; and the mining industry (See Table 5).

Washoe County has been experiencing an explosive growth rate in both population and industrial employment (Table 6). In the 10-year period between 1960 and 1970, all industrial classifications experienced moderate growth with the total trade industry leading in both growth rate and the number of new employees. The service industry followed as a close second. Beginning in the early 1970's the growth rate began to rapidly increase in all categories. Four out of nine industrial classifications more than doubled the number of employees between 1970 and 1978. (continued on Page 28.)

Table 5

WASHOE COUNTY EMPLOYER GROWTH - 1960 to 1978

	1960			1970			1978	
	Employees	Percent of Labor Force	Percent Growth	Employees	Percent of Labor Force	Percent Growth	Employees	Percent of Labor Force
Mining	138	0.4	73.1	239	0.5	73.7	563	0.5
Construction	2,995	8.6	17.8	3,528	7.2	132.3	8,196	8.0
Manufacturing	2,338	6.7	22.7	2,871	5.9	175.0	7,896	7.8
Trans., Comm., and Util.	3,178	9.1	25.2	3,980	8.2	54.8	6,160	6.0
Wholesale & Retail Trade	6,886	19.9	81.8	12,520	25.6	72.2	21,558	21.1
Fin., Ins., and Real Estate	1,713	4.9	78.6	3,059	6.3	73.9	5,318	5.2
Service Industry**	13,485	38.3	37.2	18,497	37.8	109.0	38,659	37.8
Government	<u>4,018</u>	<u>11.6</u>	<u>3.2</u>	<u>4,160</u>	<u>8.6</u>	<u>231.7</u>	<u>13,799</u>	<u>13.5</u>
TOTALS	34,715	100.0*	40.7	48,864	100.0*	109.1	102,148	100.0*

*May not be exact due to rounding of figures

**Includes Agricultural Services and Firms not Elsewhere Classified

Table 6

1978 WASHOE COUNTY EMPLOYMENT PATTERNS

Industry	Number of Firms	Number of Employees	Percent of Employees*	Total Wages	Percent of Wages
Mining	71	563	1	9,429,474	1
Construction	843	8,196	8	146,231,129	12
Manufacturing	317	7,896	7	104,539,050	8
Trans., Comm., and Util.	190	6,160	6	96,754,910	8
Wholesale & Retail Trade	1,773	21,558	21	214,930,829	17
Fin., Ins., and Real Estate	662	5,318	5	63,437,474	5
Service Industries	2,067	38,659	37	376,213,007	31
Government	74	13,799	15	191,986,047	15
TOTAL	5,997	102,148	100	1,208,661,538	100

*Includes Agricultural Services and Firms not Elsewhere Classified

The remaining five industries experienced a growth rate of between 50 and 75 percent. Total employment in Washoe County more than doubled in the same eight-year period.

Another major data area indicating the rapid growth of Washoe County is the assessed valuation of the property found within the area. The assessed valuation of this land is shown in Table 7. This table graphically illustrates how rapidly the development of the local economy has been proceeding.

Table 7
ASSESSED VALUATION OF WASHOE COUNTY PROPERTY
(Department of Taxation)

<u>Year</u>	<u>Valuation</u>	<u>Percent Increases</u>
1960	\$ 195,263,319	
1970	\$ 525,307,103	269.0
1978	\$1,592,159,262	203.0

The reasons for this growth are varied, but essentially lie in the expansion of both the warehousing and gaming industries. Currently the Reno-Sparks Chamber of Commerce is estimating that the warehousing industry is growing at a rate of about one million new square feet per year.

F. Energy Use

Tables 8, 9 and 10 illustrate the anticipated use of energy by the residents, businesses, and industries in Washoe County in the years 1980, 1990 and 2000. These estimates of energy use are based on information supplied by Sierra Pacific Power Company and Southwest Gas Corporation. The population growth rates in the county were supplied by the State Planning Coordinator's Office.

All of these tables are divided into two sections: one showing the energy that is currently being used in applications that can be readily converted to use geothermal energy; and one showing the energy that is being used in applications that are not readily converted. Geothermal energy can replace natural gas, electricity, and heating oil for space heating applications, processes heat, and hot water. It cannot, however, be used to light homes or cook food.

It can be seen by the information presented in these tables that the energy use in Washoe County can be expected to rise proportionally to the population increase. If geothermal energy could be substituted for only five percent of the heating demand of Washoe County $.0474 \times 10^{12}$ BTU's of energy could be saved by 2000. If only one 50 megawatt electrical generator could be made operational by 1985 it could supply 22.4×10^{12} BTU's of energy by the year 2000.

Table 8

COUNTY ENERGY USE - 1980

Energy Consumption Data
Expressed in BTU x 10¹²

Energy consumed that could easily be replaced
by geothermal energy (heating)

Energy Type	Residential and Small Commercial	Large Commercial	Industrial	Total
Electricity	1.09	.29	.07	1.45
Natural Gas	6.73	1.78	.43	8.94
Oil	2.55	.67	.16	3.38
Other	.49	.13	.03	.65
	<u>10.86</u>	<u>2.87</u>	<u>.69</u>	<u>14.42</u>

Energy consumed that could not be easily replaced by geothermal
energy (cooking, lighting, air conditioning, etc):

Electricity	1.57	25.63	3.45	30.65
TOTAL	<u>12.43</u>	<u>28.50</u>	<u>4.14</u>	<u>45.07</u>

Table 9

COUNTY ENERGY USE - 1990

Forecast Energy Consumption Data
Expressed in BTU x 10¹²

Energy consumed that could easily be replaced
by geothermal energy (heating)

Energy Type	Residential and Small Commercial	Large Commercial	Industrial	Total
Electricity	1.70	.45	.11	2.26
Natural Gas	10.48	2.77	.67	13.92
Oil	3.97	1.04	.25	5.26
Other	.76	.20	.05	1.01
	<u>16.91</u>	<u>4.46</u>	<u>1.08</u>	<u>22.45</u>

Energy consumed that could not be easily replaced by geothermal
energy (cooking, lighting, air conditioning, etc):

Electricity	2.44	39.91	5.37	47.72
TOTAL	<u>19.35</u>	<u>44.38</u>	<u>6.45</u>	<u>70.17</u>

Table 10

COUNTY ENERGY USE - 2000

Energy Consumption Data
Expressed in BTU x 10¹²

Energy consumed that could easily be replaced
by geothermal energy (heating)

Energy Type	Residential and Small Commercial	Large Commercial	Industrial	Total
Electricity	2.33	.62	.15	3.10
Natural Gas	14.39	3.80	.92	19.11
Oil	5.45	1.43	.34	7.22
Other	1.04	.27	.05	1.38
Electricity	<u>23.21</u>	<u>6.12</u>	<u>1.48</u>	<u>30.81</u>

Energy consumed that could not be easily replaced by geothermal
energy (cooking, lighting, air conditioning, etc):

	3.35	54.80	7.37	65.52
TOTAL	<u>26.56</u>	<u>60.92</u>	<u>8.85</u>	<u>96.33</u>

G. Design Information (1)

The engineering design characteristics of the Reno-Sparks area of Washoe County are as follows:

Latitude 39° 3'

Longitude 119° 5'

Elevation 4,404 feet

Winter Design Dry-Bulb Temperature

99% 5° F.

97.5% 10° F.

Summer Design-Dry Bulb and Mean Coincident Wet-Bulb Temperature

1% 95/61° F.

2.5% 92/60° F.

5% 91/59° F.

Mean Daily Temperature Range 45° F.

Design Wet-Bulb Temperature

1% 64° F.

2.5% 62° F.

5% 61° F.

Degree Heating Days 6,022

III. The Resource

A. General Information (24)

There are several geothermal sites in Washoe County with the potential for commercial development. The largest of these include: Steamboat Hot Springs, Moana Hot Springs, the Needles Rocks, Gerlach Hot Springs, Ward's Hot Springs and the San Emidio Desert Hot Springs. In addition to these large geothermal sites there are several areas around the county where cooler thermal water can be found.

The following portion of this report includes a discussion of each of the major geothermal areas in Washoe County with a brief discussion of the resource in general, a summary of exploration at the area, and a description of the reservoir.

Evaluation of the geothermal reservoir is difficult because of the limited information currently available. To estimate the size of the geothermal reservoir and the heat energy stored in it, methodology presented in U.S.G.S. Circular 790 was used. Using this methodology, the potential heat energy found in a geothermal reservoir is calculated using such known factors as: the surface area of the reservoir, the depth of the reservoir, the temperature of the reservoir, and the specific heat of rock. The formula used for this calculation is:

$$q_R = pc * a * d * (t - t_{ref})$$

where:

q_R = reservoir thermal energy in joules (J)

pc = volumetric specific heat of rock plus water (2.7 Jcm³)

a = reservoir area

d = reservoir thickness

t = reservoir temperature

t_{ref} = reference temperature (15° C)

Existing technology is not capable of extracting all of the energy from the geothermal reservoir. To give a more realistic value to the energy obtainable, an assumption of 25 percent of total reservoir capacity is used.

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 Bureau of Mines and Geology for additional information and to engage the services of a reputable consulting firm that has had successful experience in assessing geothermal reservoirs.

FIGURE 6
LOCATION OF THE GEOTHERMAL
RESOURCES IN WASHOE COUNTY

B. Steamboat Hot Springs (14)

1. Description

The Steamboat Hot Springs area of Washoe County is located approximately nine miles south of downtown Reno near the junction of U.S. 395 and the Mount Rose Highway. The area, in which there is surface expression of the geothermal resource, covers an area of about one square mile and consists of a main terrace composed of siliceous spring deposits and a larger area of highly altered and bleached rock. Hot water has been encountered over an additional area of about four square miles.

The Steamboat Hot Springs area is one of the most extensively studied geothermal systems in the state. Various studies have indicated that the system is between one and three million years in age. The major heat source is believed to be a cooling magmatic body at some depth. Cool water originating in the nearby Sierras percolates downward along faults and joints. These cool waters are eventually heated by contact with the magmatic body and rise to the surface along faults. The total amount of water discharged by the hot spring system is estimated to be in excess of 800 gallons per minute.

Spring discharge temperatures range from about 120° F. to 200° F. Temperatures around 370° F. have been encountered in deep wells. Temperatures around 280° F. have been found in some relatively shallow wells. Because of the relatively high temperatures near the surface much steam and geyser activity is present.

The Steamboat Hot Springs area has been used since aboriginal times when the Washoe Indians are believed to have used the area as a winter camp site. The springs were first located by white man in 1860 and were named because the escaping steam gave the sound and appearance of a steamboat. Several different types of development occurred in the area before 1871 when the Virginia and Truckee Railroad was completed to this point and a small town started. A post office was constructed in 1880 and exists to this day. Since that time the Steamboat Springs area has been used primarily for resort and health spa applications. One unique use has been made as the source for heat in the manufacture of plastic explosives.

2. Summary of Exploration

Operator	Name	Date Completed	Depth	Temp.
Nevada Thermal Power Co.	Steamboat No. 1	1954	1,830'	
Nevada Thermal Power Co.	Steamboat No. 2	1959	964'	
Nevada Thermal Power Co.	Steamboat No. 3	1960	1,263'	
Nevada Thermal Power Co.	Steamboat No. 4	1960	520'?	367° F.
Nevada Thermal Power Co.	Steamboat No. 5	1961	826'	347° F.
Nevada Thermal Power Co.	Steamboat No. 6	1961	716'	354° F.
Phillips Petroleum		1979	3,000'?	

3. The Reservoir

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

Reservoir Volume (24)

6.96 $\pm$ 2.88 cubic mile

Temperature (24)

Surface or near surface conditions
(measured)-----120°F. to 200°F.

Depth (measured)-----250°F. to 370°F.

(Assumed reservoir temperature-for
calculation purposes)-----392°F. $\pm$ 3° F.

Discharge (14)

About 800 gallons per minute

Water Chemistry

The water chemistry throughout the Steamboat Hot Springs area is quite variable. Examples of several analyses on different wells illustrates this variability. (All units are in parts per million).

Identification	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS
Cox Well	125	0	7.8	1.2	665	69	212	62	118	889	2.0	1	36	3555
Steamboat Hot Springs	293	0.05	50	0.8	653	71	305	0	100	865	1.8	-	49	3210
Geyser Well	245	-	15	1.0	667	63	340	0	122	885	-	-	52	2322
Nevada Safe Drinking Water Standards		.03		125					250	250				500

The most obvious characteristics of water chemistry from Steamboat is the high total dissolved solids and chloride content. Both of these factors exceed the Nevada State Safe Drinking Water Standards by three or more times.

Energy Content

Potential heat energy found in the reservoir

$$1.38 \cdot 10^{15} \pm 3.98 \cdot 10^{14} \text{ BTU}$$

Heat energy extractable with existing technology

$$3.45 \cdot 10^{14} \pm 9.95 \cdot 10^{13} \text{ BTU}$$

Moana Hot Springs (14)

1. Description

Moana Hot Springs are located in the southwestern part of Reno in the Truckee Meadows. Today, there is no surface discharge of water from this area though it is believed to have occurred in the past. Several wells drilled in the area are artesian. The area having thermal water covers an area of about four or five square miles. The hottest temperatures are located in about a two square mile area concentrated in the Sweetwater Lane and Manzanita Lane area. However, even within this known geothermal area there are localities where cold water is encountered in wells. There is no guarantee of striking hot water when drilling into any particular area.

Moana Hot Springs were formerly the site of a spa and a warm swimming pool. For several years the swimming pool was heated using a hot water well in the immediate vicinity. Lowering of water production and poor water quality finally lead to the abandonment of this application.

The location of the Moana Hot Springs is believed to be controlled by the faulting that parallels the front of the Carson Range. It appears that the thermal zone is astride a fault. Even though there is no visible recent vulcanism in the Moana area, it is believed that the heat source is magmatic. The relationship between Moana Hot Springs and Steamboat Hot Springs to the south is as yet unclear.

The hydrothermal waters associated with the Moana system are believed to have the same source as those occurring at Steamboat. Cool water originating in the Sierra Nevada range percolates downward along various faults until it is heated by contact with the magmatic source. It then migrates upward toward the land surface along major faults acting as paths of least resistance. At a depth of between 100 and 200 feet a thick layer of blue clay is encountered. It is believed that this rather impervious clay is acting as a cap and forcing the hot water to flow laterally away from the fault. Hot water is generally found below this blue clay zone.

Water temperatures encountered at the Moana geothermal area are between 160° and 200° F. at a depth greater than 100 feet. Deeper wells do not generally have the highest temperatures suggesting that the temperatures deep in the system may not be significantly different than those encountered near the surface.

2. Summary of Exploration

There are no deep exploration wells in the Moana Hot Springs area. There are, however, about 95 shallower wells supplying water with temperatures from about 70° to about 204° F.

3. The Reservoir

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

Reservoir Volume (24)

2.11 $\pm$ 0.43 cubic mile

Temperature (24)

Surface and deep wells (measured)-----160°F. to 200°F

(Assumed reservoir temperature-for
calculation purposes)-----240°F. $\pm$ 9° F.

Discharge

No information available

Water Chemistry (14)

The water chemistry throughout the Moana Hot Springs area is quite variable. Examples of several analyses on different wells illustrates this variability. (All units are in parts per million).

Identification	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS
Etcheberry Well 92	-	22	0.8	259	7.2	99	-	478	53	4.8	-	2.1	1012	
Old Yates Well 102	-	23.4	0.21	243	7.4	86	-	457	500	4.8	-	2.0	1367	
Crano Well	79	0.77	21	4.1	199	3.7	211	0	325	32	1.5	-	0.74	856
Beglin Well	106	-	23	0.08	236	8.0	86	-	455	48	5.1	-	1.9	969
Nevada Safe Drinking Water Standards	0.03		125						250	250				500

The most obvious characteristics of water chemistry from Moana Hot Springs is characterized by the chemical species being in excess of the Nevada Safe Drinking Water Standards: total dissolved solid sulfates and iron.

Energy Content

Potential heat energy found in the reservoir

$$2.27 \cdot 10^{15} \pm 1.52 \cdot 10^{14} \text{ BTU}$$

Heat energy extractable with existing technology

$$5.67 \cdot 10^{14} \pm 3.8 \cdot 10^{13} \text{ BTU}$$

D. The Needles Rocks (14)

1. Description

The Needles Rocks geothermal area is located at the northwest corner of Pyramid Lake. Warm springs believed associated with the Needles Rock area are located on Anaho Island and Pyramid Island, several miles to the southeast. The actual Needles Rocks and Pyramid Island are large masses of calcareous tufa which were deposited underwater when the lake level of Pyramid Lake was much higher than it is today. Now, divers are locating new tufa towers developing under the present Pyramid Lake.

The Needles Rocks geothermal area and the warm springs to the southeast lie on a major right-lateral strike-slip fault zone named the Walker Lane. The thermal activity appears directly related to hot springs migrating upward from great depths along the fault zone.

Springs in the Needles Rocks area have recorded temperatures of between 151° F. and 208° F. The spring on Anaho Island is reported to be 120° F. Several wells have been drilled into the Needles Rocks area. The deepest, about 6,700 feet, has encountered water with a temperature of about 240° F.

Special Note:

The Needles Rocks are located on the Pyramid Lake Indian Reservation. Any development of this resource must be done under the auspices of the Tribal Council.

Evidence indicates that this area may be archaeologically significant. In addition, the area is believed to be religiously important to the Paiute Indians. Any development of the Needles Rocks geothermal resource must address these two factors.

2. Summary of Exploration

Operator	Name	Date Completed	Depth	Temp
Western Geothermal Inc.	Needles No. 1	1964	5,888'	240° F.
Western Geothermal Inc.	Needles No. 2	1962	4,000'±	
Western Geothermal Inc.	Needles No. 3	1964	?	

3. The Reservoir

The following parameters are believed to describe the Needles Rock geothermal reservoir:

Reservoir Volume (24)

0.79 ± 0.02 cubic mile

Temperature (24)

Surface or near surface conditions
(measured)-----151°F. to 208°F.

Depth (measured)-----240° F.

(Assumed reservoir temperature-for
calculation purposes)-----253°F. ± 3° F.

Discharge

No information available

Water Chemistry (14)

Water analyses at the Needles Rocks have been done at several sites. Three representative samples are shown below. (All units are in parts per million.)

Identification	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS
Needles No. 1	95	.02	282	0.1	1080	31	11.5	0	388	1841	3	0.1	-	3676
Spring	110	-	198	0.3	1040	120	110	-	350	1760	-	-	-	3770
Spring	82	-	315	0.4	1150	280	100	0	330	1850	-	-	-	4680
Nevada Safe Drinking Water Standards		.03		125					250	250				500

As indicated, the waters from the Needles Rock tend to be very saline. They violate the Nevada Safe Drinking Water Standards in almost all areas such as: iron, sulfate, chloride, and total dissolved solids.

Energy Content

Potential heat energy found in the reservoir

$$9.19 \times 10^{14} \pm 2.55 \times 10^{14} \text{ BTU}$$

Heat energy extractable with existing technology

$$2.29 \times 10^{14} \pm 6.37 \times 10^{13} \text{ BTU}$$

E. Gerlach Hot Springs (14)

1. Description

The Gerlach geothermal area is located at the south end of the Granite Range in the southern Black Rock Desert. The springs, which are separated by a distance of about one mile, are located approximately one mile north of the town of Gerlach.

The Gerlach Hot Springs area was first described by John C. Fremont in 1845. At that time he recorded a surface temperature of 208° F. at the Great Boiling Springs and described it as "the most extraordinary locality of hot springs we had met during our journey."

The Great Boiling Springs have been used extensively for bathing purposes for a number of years. A bathhouse, steamhouse, and warmpools are still in use today. The main spring area is, however, too hot for swimming and must be diluted with cooler water. Mud Springs has been used only for stock watering and for irrigation.

The Great Boiling Springs and Mud Springs appear to be related to a series of northeast trending faults along the east side of the Granite Range. In the immediate area of the hot springs, exposures of basement rock have been hydrothermally altered. Siliceous sinter deposits can be found around the spring areas.

Mud vent and mud volcano activity occasionally occurs in the Great Boiling Springs area. The mud volcanos have been reported to erupt mud clods up to heights of about 100 feet.

2. Summary of Exploration

Operator	Name	Completed	Depth	Temp.
----------	------	-----------	-------	-------

Sunco Energy
Development Co. Holland Ranch No. 1-15-G 1979

3. The Reservoir

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

Reservoir Volume (25)

0.79 $\pm$ 0.02 cubic mile(25)

Temperature

Surface or near surface conditions
(measured)-----208°F.

Depth (measured)-----240° F.to 347°

(Assumed reservoir temperature-for
calculation purposes)-----352°F. $\pm$ 6° F.

Discharge

No information available

Water Chemistry (14)

Water chemistry for several sites at the Gerlach Hot Springs area are as follows:

Identification	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS
Great Boiling Springs	135	-	102	26	1467	-	227	0	353	2016	-	-	-	4135
Gerlach Hot Springs	199	-	67	5	1576	-	97	0	363	2146	-	-	-	4486
Nevada Safe Drinking Water Standards		.03		125					250	250				500

As indicated, the water from the Gerlach Hot Springs area violates several of the Nevada Safe Drinking Water Standards: most notably sulfate, chloride and total dissolved solids.

Energy Content

Potential heat energy found in the reservoir

$$1.38 \cdot 10^{15} \pm 3.98 \cdot 10^{14}$$

Heat energy extractable with existing technology

$$3.45 \cdot 10^{14} \pm 9.95 \cdot 10^{13}$$

F. Ward's Hot Springs (14)

1. Description

Ward's Hot Springs are located in an area called Haulapai Flat about 15 miles north of the town of Gerlach. The Granite Mountain Range lies immediately to the west. The springs area is the largest in northwestern Nevada covering an area of about 75 acres. In this area there are some 30 to 40 separate pools.

Ward's Hot Springs appears to be related to several faults believed to be part of a regional, and probably deep-seated, fault zone that may extend up to 40 to 50 miles from Winnemucca Lake north along the west side of the Selenite Range, through Gerlach Hot Springs, along the east side of the Granite Range, along the west side of Haulapai Flat, and northward to High Rock Lake. It has been suggested that the hydrothermal activity at Ward's Hot Springs results from deep circulation of water along the deep seated fractures where this north-south fault zone intersects a major northwest-trending fracture system that terminates at the north end of the Granite Range west of Hualapai Flat.

A shallow well drilled into the hot springs area in 1916 has been discharging hot water since then. Because of the mineralization in the water a calcareous tufa tower 15 feet high has been deposited at the well head. Spring deposits at Ward's Hot Springs consist of both siliceous sinter and calcareous travertine. The surface flow from these hot springs historically has been used for irrigation purposes.

Water temperatures in wells and springs in the area of Ward's Hot Springs range up to about 200° F. The reservoir has been estimated to be about 226° F.

2. Summary of Exploration

Operator	Name	Date		Depth	Temp.
		Completed			
Western Geothermal Inc.	Fly Ranch No. 1(?)	1964		1,000'	

3. The Reservoir

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

Reservoir Volume (24)

1.05 $\pm$ 0.31 cubic miles

Temperature (24)

Surface or near surface conditions
(measured)-----200°F.

Depth (measured)-----257° F.

(Assumed reservoir temperature-for
calculation purposes)-----226°F. $\pm$ 4° F.

Discharge

No information available

Water Chemistry (14)

Water chemistry information is available on most
springs and wells in the Ward's Hot Springs area.

Below are three such analyses.

Identification	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS
The Geyser " "														
Well	76	-	18	4.6	386	16	336	40	205	250	7.9	0.2	2.1	1840
Western Geothermal														
nc. Fly Ranch														
o. 1 well	-	-	33	4.1	335	13.8	431	-	186	229	-	-	-	1768
ard's Hot														
prings	113	-	36	3	335	19	-	tr	390	239	-	-	-	-
evada Safe														
inking Water														
tandard		.03		125					250	250				500

As illustrated, the water from Ward's Hot Springs meets the Nevada Safe Drinking Standards in all areas except total dissolved solids.

Energy Content

Potential heat energy found in reservoir

$$1.06 \times 10^{16} \pm 3.31 \times 10^{14} \text{ BTU}$$

Heat energy extractable with existing technology

$$2.65 \times 10^{14} \pm 8.27 \times 10^{13} \text{ BTU}$$

G. San Emidio Desert (14)

1. Description

The San Emidio Desert geothermal anomaly is represented by a small group of hot springs and a zone of altered and mineralized rocks on the east side of the San Emidio Desert. The alteration and mineralization appears to represent a time when the springs were much more active than they are today.

The hot springs still lie in a geothermal active area. The ground is warm two to three feet below the surface and the temperature of water standing in shallow holes at this depth is as high as 128° F. A nearby flowing spring has water 86° F. in temperature and a shallow well in the area has recorded water temperatures of 212° F. at 87 feet. Two deep wells have been drilled but no temperature data are available.

2. Summary of Exploration

Operator	Name	Date Completed	Depth	Temp.
Chevron Oil Co.	Cosmos No. 1-8	1975	4,013	
Chevron Oil Co.	Cosmos No. 1-9	1978	5,367	

3. The Reservoir

The following parameters are believed to describe the San Emidio geothermal reservoir:

Reservoir Volume (24)

0.79 $\pm$.02 cubic miles

Temperature (24)

Surface or near surface conditions
(measured)-----128° F.

Depth (measured)-----212° F.

(Assumed reservoir temperature-for
calculation purposes)-----303°F. $\pm$ 9° F.

Discharge

No information available

Water Chemistry

No information available

Energy Content

Potential heat energy found

in reservoir-----1.38*10¹⁵ $\pm$ 3.98*10¹⁴ BTU

Heat Energy extractable with

existing technology--3.45*10¹⁴ $\pm$ 9.95*10¹³ BTU

H. Miscellaneous Washoe County Geothermal Areas

Besides the six major geothermal sites already discussed there are about 15 smaller geothermal anomalies in Washoe County. The more notable of these include: Pleasant Valley, Lawton Hot Springs, Wedekind Mine, and Bowers Hot Springs.

Pleasant Valley is a small enclosed valley located on U.S. 395 between Reno and Washoe Valley. Several wells have been drilled between 100 and 2,000 feet. They have encountered water with temperature between 70° and 100° F.

Lawton Hot Springs are located along the Truckee River about six miles west of downtown Reno. The springs have temperatures of 120° F. and an artesian well with a temperature of 140° F. The hot water is currently being used in a bathhouse and swimming pool.

Wedekind Mine is located north of Sparks in the Truckee Meadows. In 1903 mining activities encountered hot acid water at 213 feet. Because few wells have been drilled in this area other information on this resource is lacking.

Bowers Mansion is today one of Washoe County's parks. It is located along the base of the Sierra Nevada on the west side of Washoe Valley. Water from a well on the site is 117° F. It is used to heat an olympic sized swimming pool and a childrens wading pool. The thermal water appears to be associated with a large fault uplifting the Carson Range.

There are about 10 other areas around Washoe County that have reported some thermal activity. Water temperatures in these areas tend to be from low to moderate. Most of these sites are used for domestic water or irrigation.

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 Washoe County 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 geothermal electrical generation plant can be used for other applications after going through the turbine. Figure 7 illustrates the various types of uses for geothermal energy and the temperature requirements for each use.

Essentially, direct uses of geothermal energy can be divided into six major categories: space heating (residential, district, and industrial); low, medium, and high process heat; domestic, commercial, and industrial hot water; hot water for various agricultural needs such as drying crops and various animal husbandry operations; warm water for aquacultural enterprises; and warm water for recreation.

Each of these use categories will be evaluated to see which would be the most practical and beneficial to develop at the major geothermal sites in Washoe County.

FIGURE 7 GEOTHERMAL USE TEMPERATURES

B. Steamboat Hot Springs

Steamboat Hot Springs is a large, high temperature resource. For this reason, it is technically and economically possible to develop just about any application from space heating to electrical generation.

The Steamboat Hot Springs Geothermal Use Evaluation Table (Table 11) summarizes the various potential uses of the energy occurring in this geothermal resource area and the factors either favorable or detrimental to development. The evaluation table assigns a development average to each potential use. These development averages are based on the physical characteristics of the geothermal reservoir and various economic, land use and economic considerations. By ranking the various potential uses by their assigned development average the following three development levels can be determined:

First Development Level (2.8 development average)

- Electrical Generation
- Recreation

Second Development Level (2.7 development average)

- Residential Space Heating
- District Space Heating
- Industrial Space Heating
- Commercial, Industrial, and Domestic Hot Water
- Agricultural Production
- Greenhousing
- Aquaculture

Third Development Level (2.6 development average)

- Low Temperature Industrial Processes
- Medium Temperature Industrial Processes
- High Temperature Industrial Processes

These development levels are useful in assessing the potential for different kinds of applications. The applications with the higher development levels would probably have the higher potential for development. However, in some cases, unique features of a site may make the potential higher than indicated.

It should be noted that the development averages at Steamboat Hot Springs are very close, with little difference between the low and high. This indicates the wide range of options available to any developer of this resource.

The geothermal resources at Steamboat Hot Springs have historically been used for swimming and for hot baths. There has been one industrial application keeping plastic explosives soft and workable. Other development is currently under consideration or just beginning to occur.

Phillips Petroleum Company has just completed an approximately 3,000-foot deep production well for the generation of electricity. It is believed that the well encountered temperatures at which electrical generation is economically possible. Their development plans for this well or other they may be planning to drill in the area are at this time unknown.

The developer of the DaMonte Ranch near Steamboat Hot Springs is planning a development which, when finished, will have over 6,000 residences. To support these residences, shopping centers, professional buildings, schools, fire stations, and police stations will be constructed. The developer of this community is currently considering the installation of a district heating system using hot water from several wells on the property.

Several types of development would probably not be appropriate to develop in the Steamboat Hot Springs area. It should be noted that the water quality of the area is below safe drinking water standards. In addition, there appears to be little surface water of higher quality available. This factor would limit the development of several applications such as aquaculture and other agricultural activities where a good quality water is needed.

Unique Features of the Steamboat Hot Springs Resources

1. High temperature
2. Poor water quality
3. Close to metropolitan area
4. Large anticipated reservoir volume

Table 11 - Geothermal Use Evaluation

Site: Steamboat Hot Springs
 Low Temp. Industrial Process
 Medium Temp. Industrial Process
 High Temp. Industrial Process
 Commercial Industrial Domestic

Characteristics - Constraints	Residential	Space Heating District	Industrial	Low Temp. Industrial Process	Medium Temp. Industrial Process	High Temp. Industrial Process	Commercial Industrial Domestic	Water	Production Greenhouses	Agriculture Aquaculture	Recreation	Electrical
Water Temperature	3	3	3	3	3	3	3	3	2	2	3	3
Flow Rate or Discharge	3	3	3	3	3	3	3	3	3	3	3	3
Reservoir Size	3	3	3	3	3	3	3	3	3	3	3	3
Zoning, Land Use, Land Ownership, Location	3	3	3	1	1	1	3	3	3	3	3	3
Environmental Considerations	3	3	3	3	3	3	3	3	3	3	3	3
Industrial Labor Force	NA	3	3	3	3	3	3	3	3	3	3	3
Transportation Facilities for Raw Materials or Products	NA	NA	NA	3	3	3	NA	3	3	3	NA	NA
Financing Accessibility	2	2	2	2	2	2	2	2	2	2	2	2
Product Market	NA	NA	NA	3	3	3	NA	3	3	3	3	3
Water Availability	2	2	2	2	2	2	2	2	2	2	2	2
Community Support	3	3	3	3	3	3	3	3	3	3	3	3
Development Average	2.7	2.7	2.7	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.8	2.8

Legend

0 Factor precludes development from indicated application

1 Factor would preclude development in all but extraordinary situations

2 Factor is neither advantageous nor harmful to potential development

3 Factor is advantageous to potential development

NA Not applicable

--- No information available

*If any factor is assigned "0" the development average will be 0--there is no potential for development

C. Moana Hot Springs

The Moana Hot Springs geothermal resource is unique in Washoe County because it is actually located in a large metropolitan area. Moana Hot Springs is a large, moderately high-temperature resource that has been used as a source of hot water to heat buildings and swimming pools for many years. Today, many swimming pools, some 60 residences, three commercial establishments, and a church are heated from this resource reservoir.

The Moana Hot Springs Geothermal Use Evaluation Table (Table 12) summarizes the various potential uses of the energy stored in the Moana Hot Springs reservoir. As can be seen, several potential use categories cannot be developed because of the location of the resource. These categories include: industrial applications; agricultural production; and aquaculture. The Moana Hot Springs area has already been developed with homes and commercial establishments. The area in the vicinity of the resource has been zoned only for these two purposes. Other potential use categories such as individual and district space heating, commercial and domestic hot water, greenhousing, and recreational facilities could feasibly be developed.

To stimulate development of direct uses of geothermal energy, the United States Department of Energy, Division of Geothermal Energy, has issued two Program Opportunity Notices. Encouragement is being given to the private sector through a program whereby

The U. S. Department of Energy shared the cost of the front end financial risk in a limited number of demonstration projects. One such demonstration project is located in the Moana Hot Springs area. The project is to develop a space heating and domestic hot water system for the Sundance West apartment complex. Currently the Hydrothermal Energy Corporation is getting the necessary agreements signed and is in the planning stage for drilling the first well.

Table 12 - Geothermal Use Evaluation

Site: Moana Hot Springs

Characteristics - Constraints	Residential	Space Heating District	Heating Industrial	Low Temp. Industrial Process	Medium Temp. Industrial Process	High Temp. Industrial Process	Commercial Industrial Domestic Water	Production	Agriculture Greenhouses	Aquaculture	Recreation	Electrical
Water Temperature	3	3	3	3	2	2	3	2	2	3	3	0
Flow Rate or Discharge	---	---	---	---	---	---	---	---	---	---	---	---
Reservoir Size	3	3	3	3	3	3	3	3	3	3	3	3
64 Zoning, Land Use, Land Ownership, Location	3	3	0	0	0	0	3	0	3	0	3	0
Environmental Considerations	3	3	3	3	3	3	3	3	3	3	3	0
Industrial Labor Force	NA	3	3	3	3	3	3	3	3	3	3	3
Transportation Facilities for Raw Materials or Products	NA	NA	NA	3	3	3	NA	3	3	3	NA	NA
Financing Accessibility	2	2	2	2	2	2	2	2	2	2	2	2
Product Market	NA	NA	NA	3	3	3	NA	3	3	3	3	3
Water Availability	2	2	2	2	2	2	2	2	2	2	2	2
Community Support	3	3	3	0	0	0	3	0	3	3	3	0
Development Average	2.8	2.8	0	0	0	0	2.8	0	2.8	0	2.8	0

Legend

0 Factor precludes development from indicated application

1 Factor would preclude development in all but extraordinary situations

2 Factor is neither advantageous nor harmful to potential development

3 Factor is advantageous to potential development

NA Not applicable

--- No information available

*If any factor is assigned "0" the development average will be 0--there is no potential for development

D. The Needles Rocks

The Needles Rocks geothermal area is a moderate size and temperature resource located on the remote north end of Pryamid Lake. The site is about 30 miles form the nearest community of Nixon, Nevada and is located on the Pyramid Lake Indian Reservation. To date, there has been no development of this resource although three exploration wells have been drilled in the area.

The Geothermal Use Evaluation Table for the Needles Rocks resource (Table 13) summarizes the potential uses of this resource:

First Development Level (2.2 development average)

- Individual Space Heating
- Industrial Space Heating
- Recreation
- Commercial, Industrial, and Domestic Hot Water

Second Development Level (2.1 development average)

- Low Temperature Industrial Process Heat
- Medium Temperature Industrial Process Heat
- High Temperature Industrial Process Heat
- Agricultural Production
- Greenhousing
- Aquaculture

As this division into development levels indicates, the uses of the geothermal resource at the Needles Rocks all have about the same potential for development. Because of the distance to nearby communities over fair to poor quality dirt roads, the development potential for any use of this site is not considered high. Though remoteness is not considered a major factor in the location of electrical generation facilities, the lower temperature character of this resource would not be conducive to the development of this capability since higher temperature resources can be found in the general area.

One factor not considered on the evaluation table may have considerable impact on the development of the Needles Rocks geothermal resource: it is located within the Pyramid Lake Indian Reservation. The potential for development of this resource could be greatly enhanced if members of the tribal council were to actively encourage development for the benefit of the tribe.

Unique Features of the Needles Rocks resource

1. Remoteness
2. Water Quality Below Safe Drinking Water Standards
3. On Indian Reservation

Table 13 - Geothermal Use Evaluation
Site: The Needles Rock

Characteristics - Constraints	Residential	Space Heating District	Industrial	Low Temp. Industrial Process	Medium Temp. Industrial Process	High Temp. Industrial Process	Commercial Industrial Domestic Water	Production	Agriculture Greenhouses	Aquaculture	Recreation	Electrical
Water Temperature	3	3	3	3	3	3	3	2	2	3	3	0
Flow Rate or Discharge	---	---	---	---	---	---	---	---	---	---	---	---
Reservoir Size	3	3	3	3	3	3	3	3	3	3	3	3
Zoning, Land Use, Land Ownership, Location	1	0	1	1	1	1	1	1	1	1	1	1
Environmental Considerations	3	3	3	3	3	3	3	3	3	3	3	3
Industrial Labor Force	NA	2	2	2	2	2	2	2	2	2	2	2
Transportation Facilities for Raw Materials or Products	NA	NA	NA	1	1	1	NA	1	1	1	NA	NA
Financing Accessibility	2	2	2	2	2	2	2	2	2	2	2	2
Product Market	NA	NA	NA	2	2	2	NA	2	2	2	2	3
Water Availability	2	2	2	2	2	2	2	2	2	2	2	2
Community Support	2	2	2	2	2	2	2	2	2	2	2	2
Development Average	2.2	0	2.2	2.1	2.1	2.1	2.2	2.1	2.1	2.1	2.2	0

Legend

- 0 Factor precludes development from indicated application
- 1 Factor would preclude development in all but extraordinary situations
- 2 Factor is neither advantageous nor harmful to potential development

- 3 Factor is advantageous to potential development*If any factor is assigned "0" the development average will be 0-there is no potential for development
- NA Not applicable
- No information available

E. Gerlach Hot Springs

The Gerlach Hot Springs geothermal reservoir is a moderate sized high temperature resource located near Gerlach, Nevada. Because of the high temperatures found at this geothermal site it is believed technically and probably economically possible to develop most types of applications. One potential application has very limited potential: residential heating from a private well. The reason for this is that 90 percent of the Gerlach Hot Springs area is on land owned by the Bureau of Land Management. It is very unlikely that any private residences will be constructed on this land to make use of the resource. A district heating system for private residences does, however, have potential. It would be possible to develop a well on BLM land and transport the water a short distance to Gerlach or even to Empire, though the initial cost would be somewhat higher.

Other types of developments of Gerlach Hot Springs may be hampered by the remoteness of the area. The hot springs are located approximately 100 miles north of Reno on State Route 447, a two-lane secondary road.

The geothermal resource at Gerlach Hot Springs has had very little use in the past. That use has been limited to irrigation, swimming, and bathing.

The Geothermal Use Evaluation Table describing Gerlach Hot Springs (Table 14) summarizes the potential uses of this geothermal resource:

First Development Level (2.6 development average)

Electrical Generation
District Space Heating
Industrial Space Heating
Commercial, Industrial, and Domestic Water

Second Development Level (2.5 development average)

Low Temperature Industrial Process Heat
Medium Temperature Industrial Process Heat
High Temperature Industrial Process Heat
Agricultural Production
Greenhousing
Aquaculture
Recreation
Individual Space Heating

These development levels are useful in assessing the potential for the development of different types of geothermal use application. As indicated by the closeness of the development levels, the range of options open to a developer is great.

Unique Features of the Gerlach Hot Springs Resources

1. High temperature resource
2. Water quality below safe drinking water standards
3. Fairly remote site

Table 14 - Geothermal Use Evaluation
Site: Gerlach Hot Springs

Characteristics - Constraints	Residential	Space Heating District	Industrial	Low Temp. Industrial Process	Medium Temp. Industrial Process	High Temp. Industrial Process	Commercial Industrial Domestic Water	Production	Agriculture Greenhouses	Aquaculture	Recreation	Electrical
Water Temperature	3	3	3	3	3	3	3	3	3	3	3	3
Flow Rate or Discharge	---	---	---	---	---	---	---	---	---	---	---	---
Reservoir Size	3	3	3	3	3	3	3	3	3	3	3	3
Zoning, Land Use, Land Ownership, Location	2	3	3	3	3	3	3	3	3	3	3	3
Environmental Considerations	3	3	3	3	3	3	3	3	3	3	3	3
Industrial Labor Force	NA	2	2	2	2	2	2	2	2	2	2	2
Transportation Facilities for Raw Materials or Products	NA	NA	NA	2	2	2	NA	2	2	2	NA	NA
Financing Accessibility	2	2	2	2	2	2	2	2	2	2	2	2
Product Market	NA	NA	NA	2	2	2	NA	2	2	2	2	3
Water Availability	2	2	2	2	2	2	2	2	2	2	2	2
Community Support	3	3	3	3	3	3	3	3	3	3	3	3
Development Average	2.5	2.6	2.6	2.5	2.5	2.5	2.6	2.5	2.5	2.5	2.6	0

Legend

0 Factor precludes development from indicated application

1 Factor would preclude development in all but extraordinary situations

2 Factor is neither advantageous nor harmful to potential development

3 Factor is advantageous to potential development*If any factor is assigned

NA Not applicable

--- No information available

"0" the development average will be 0--there is no potential for development

F. Ward's Hot Springs

Ward's Hot Springs is a moderate temperature resource located about 20 miles north of Gerlach, Nevada on State Route 34. This route and others into the area are fair quality dirt roads.

The Geothermal Use Evaluation Table for Ward's Hot Springs (Table 15) summarizes the potential uses of this geothermal resource:

First Development Level (2.4 development average)

Individual Space Heating

Second Development Level (2.2 development average)

Industrial Space Heating
Commercial, Industrial, and Domestic Hot Water
Recreation

Third Development Level (2.1 development average)

Low Temperature Industrial Process Heat
Medium Temperature Industrial Process Heat
High Temperature Industrial Process Heat

Though the highest development level is individual space heating, the remoteness of this site and the distance to any nearby communities is considered to make this application of the geothermal energy available at Ward's Hot Springs not practical at this time. Other industries and agricultural enterprises would probably tend to locate where they are closer to a city, transportation facilities, and a market for their products.

Unique Features of the Ward's Hot Springs Resource

1. Remoteness
2. Water quality below safe drinking water standards

Table 15 - Geothermal Use Evaluation
Site: Ward's Hot Springs

Characteristics - Constraints	Residential	Space Heating District	Industrial	Low Temp. Industrial Process	Medium Temp. Industrial Process	High Temp. Industrial Process	Commercial Industrial Domestic Water	Production Greenhouses	Agriculture Aquaculture	Recreation	Electrical
Water Temperature	3	3	3	3	3	3	3	3	3	3	0
Flow Rate or Discharge	---	---	---	---	---	---	---	---	---	---	---
Reservoir Size	3	3	3	3	3	3	3	3	3	3	2
Zoning, Land Use, Land Ownership, Location	1	0	1	1	1	1	1	1	1	3	3
Environmental Considerations	3	3	3	3	3	3	3	3	3	3	3
Industrial Labor Force	NA	1	1	1	1	1	1	1	1	1	1
Transportation Facilities for Raw Materials or Products	NA	NA	NA	1	1	1	NA	1	1	NA	NA
Financing Accessibility	2	2	2	2	2	2	2	2	2	2	2
Product Market	NA	NA	NA	2	2	2	NA	2	2	2	3
Water Availability	2	2	2	2	2	2	2	2	2	2	2
Community Support	3	3	3	3	3	3	3	3	3	3	3
Development Average	2.4	0	2.2	2.1	2.1	2.1	2.2	2.1	2.1	2.2	0

Legend

0 Factor precludes development from indicated application

1 Factor would preclude development in all but extraordinary situations

2 Factor is neither advantageous nor harmful to potential development

3 Factor is advantageous to potential development*If any factor is assigned

NA Not applicable

--- No information available

*If any factor is assigned "0" the development average will be 0-there is no potential for development

G. San Emidio Desert

The San Emidio Desert geothermal resource is a moderate sized, high temperature site located about 25 miles south of Gerlach, Nevada on the east flank of the Lake Range. Because of the high temperature found at this site it is believed technically possible to develop most types of applications.

There are several limitations that must be taken into consideration, however. At this time the only access to the area is over a poor quality dirt road. In addition, the site is many miles from any city.

Another factor that must be considered is that 68 percent of the land in the San Emidio Desert Known Geothermal Resource Area is owned by the Bureau of Land Management and is subject to its geothermal leasing procedures.

The Geothermal Use Evaluation Table for the San Emidio Desert Hot Spring geothermal site (Table 16) summarizes the potential uses of this resource:

First Development Level (2.5 development average)

Electrical Generation

Second Development Level (2.4 development average)

Individual Space Heating

Third Development Level (2.2 development average)

Industrial Space Heating

Commercial, Domestic, and Industrial Hot Water

Recreation

Fourth Development Level (2.1 development average)

Low Temperature Industrial Process Heat
Medium Temperature Industrial Process Heat
High Temperature Industrial Process Heat
Agricultural Production
Greenhousing
Aquaculture

By ranking the various applications of geothermal energy into these development levels the potential for development at the San Emidio Desert geothermal area can be evaluated. The particular use with the highest potential for development is electrical generation. This is because the resource has a high temperature and because the electricity generated can be transported easily.

Individual space heating is in the second development level. Though fairly high in the ranking, this application is believed to have only limited potential because of the distance to nearby cities and the relative inaccessability of the area. However, if an electrical generation facility were constructed, the residences of the employees at the site could be heated using waste hot water from the plant.

Other areas have less potential. Because of the inaccessability of the resource it is less likely that industrial or agricultural developers would use this resource.

Unique Features of the San Emidio Desert Resource

1. Inaccessability
2. Remoteness
3. High temperature resource
4. Lack of current development

Table 16 - Geothermal Use Evaluation

Site: San Emidio Hot Springs

Characteristics - Constraints	Residential	Space Heating District	Industrial	Low Temp. Industrial Process	Medium Temp. Industrial Process	High Temp. Industrial Process	Commercial Domestic Water	Production	Agriculture Greenhouses	Aquaculture	Recreation	Electrical
Water Temperature	3	3	3	3	3	3	3	3	3	3	3	3
Flow Rate or Discharge	---	---	---	---	---	---	---	---	---	---	---	---
Reservoir Size	3	3	3	3	3	3	3	3	3	3	3	3
75 Zoning, Land Use, Land Ownership, Location	1	0	1	1	1	1	1	1	1	1	1	3
Environmental Considerations	3	3	3	3	3	3	3	3	3	3	3	3
Industrial Labor Force	NA	1	1	1	1	1	1	1	1	1	1	1
Transportation Facilities for Raw Materials or Products	NA	NA	NA	1	1	1	NA	1	1	1	NA	NA
Financing Accessibility	2	2	2	2	2	2	2	2	2	2	2	2
Product Market	NA	NA	NA	2	2	2	NA	2	2	2	2	3
Water Availability	2	2	2	2	2	2	2	2	2	2	2	2
Community Support	3	3	3	3	3	3	3	3	3	3	3	3
Development Average	2.4	0	2.2	2.1	2.1	2.1	2.2	2.1	2.1	2.1	2.2	2.5

Legend

- 0 Factor precludes development from indicated application
 1 Factor would preclude development in all but extraordinary situations
 2 Factor is neither advantageous nor harmful to potential development

- 3 Factor is advantageous to potential development*If any factor is assigned "0" the development average will be 0-there is no potential for development
 NA Not applicable
 --- No information available

H. Miscellaneous Washoe County Geothermal Anomalies

There are many other smaller areas around Washoe County with the potential for limited geothermal development. Bowers Hot Springs in Washoe Valley may have the potential to supply the space needs of Bowers Mansion, a use the Washoe County Parks Department has investigated. Lawton Hot Springs possibly could be developed to supply the heating needs of the River Inn in addition to supplying warm water for the swimming pool.

Other warm springs and warm wells in Washoe County have the potential for supplying hot water and, in some cases, the heating needs of private residences. Because of the site specific character of these resources they should be evaluated by a qualified consulting firm with experience in assessing geothermal reservoirs before any development takes place.

IV. Conclusion

Washoe County has six major areas of potential geothermal development: Steamboat Hot Springs; Moana Hot Springs; the Needles Rocks; Gerlach Hot Springs; Ward's Hot Springs; and the San Emidio Desert Hot Springs. In addition there are many smaller thermal areas around the county that could supply the heating needs of an individual home or small area. All of the major sites except Moana Hot Springs have the potential of being developed in any use category. However, some of the uses are much less likely because of the location of the resource. It is unlikely, for example, that a district heating system could be developed at the San Emidio Desert or Ward's Hot Springs areas because of the remoteness of the sites and their distance to any nearby communities.

Based on an evaluation of the information presented in this document the two sites most appropriate for development in each of the use categories has been determined (See Table 17):

- Individual Space Heating
 - Moana Hot Springs
 - Steamboat Hot Springs

- District Space Heating
 - Moana Hot Springs
 - Steamboat Hot Springs

- Industrial Space Heating
 - Steamboat Hot Springs
 - Gerlach Hot Springs

- Low Temperature Industrial Process Heat
 - Steamboat Hot Springs
 - Gerlach Hot Springs

Moderate Temperature Industrial Process Heat
Steamboat Hot Springs
Gerlach Hot Springs

High Temperature Industrial Process Heat
Steamboat Hot Springs
Gerlach Hot Springs

Commercial, Industrial, and Domestic Hot Water
Moana Hot Springs
Steamboat Hot Springs

Agricultural Production
Steamboat Hot Springs
Gerlach Hot Springs

Greenhousing
Moana Hot Springs
Steamboat Hot Springs

Aquaculture
Steamboat Hot Springs
Gerlach Hot Springs

Recreation
Steamboat Hot Springs
Moana Hot Springs

Electrical Generation
Steamboat Hot Springs
Gerlach Hot Springs

Table 17 - Geothermal Use Evaluation - Summary

	Industrial	Space Heating District	Heating Industrial	Low Temp. Industrial Process	Medium Temp. Industrial Process	High Temp. Industrial Process	Commercial Industrial Domestic Water	Production	Agriculture Greenhouses	Aquaculture	Recreation	Electrical
Steamboat Hot Springs	2.7	2.7	2.7	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.8	2.8
Moana Hot Springs	2.8	2.8	0	0	0	0	2.8	0	2.8	0	2.8	0
The Needles Rocks Hot Springs	2.2	0	2.2	2.1	2.1	2.1	2.2	2.1	2.1	2.1	2.2	0
Gerlach Hot Springs	2.5	2.6	2.6	2.5	2.5	2.5	2.6	2.5	2.5	2.5	2.5	2.6
Ward's Hot Springs	2.4	0	2.2	2.1	2.1	2.1	2.2	2.1	2.1	2.1	2.2	0
San Emidio Desert Hot Springs	2.4	0	2.2	2.1	2.1	2.1	2.2	2.1	2.1	2.1	2.2	2.5

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
Carson City, Nevada 89710
(702) 885-5157

Nevada Department of Conservation
and Natural Resources
Nevada Division of Water Resources
201 South Fall Street
Carson City, Nevada 89710
(720) 885-4380

Nevada Bureau of Mines and Geology
University of Nevada-Reno
Reno, Nevada 89557
(920) 784-6691

U.S. Bureau of Land Management
Room 3008, Federal Building
300 Booth Street
Reno, Nevada 89509
(702) 784-5651

U.S. Geological survey
District Geothermal Office
4600 Kietzke Lane
Reno, Nevada 89502
(720) 784-5676

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