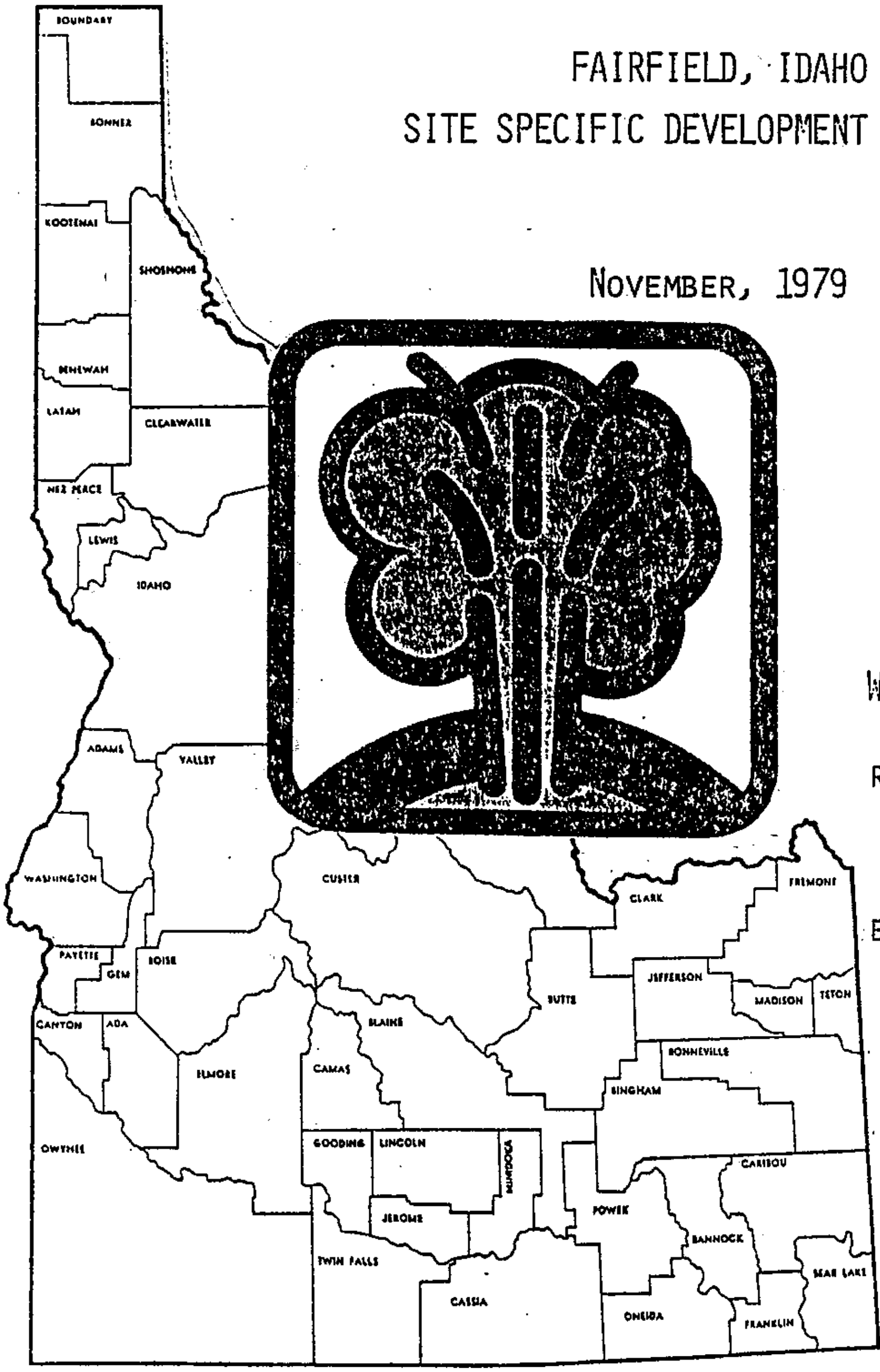
Idaho Geothermal Report

FAIRFIELD, IDAHO

SITE SPECIFIC DEVELOPMENT ANALYSIS

NOVEMBER, 1979



BY

DAVID W. MCCLAIN

AND

WILLIAM B. EASTLAKE

With a Section On
Resource Evaluation

By

Roger C. Stoker
Energy Services Inc.

IDAHO OFFICE of ENERGY
Office of the Governor

Prepared for the United States Department of Energy, Division of Geothermal Energy
Idaho Falls Operations Office-DOE/ID/12010-7

FAIRFIELD, IDAHO

SITE SPECIFIC DEVELOPMENT ANALYSIS

November 1979

By

David W. McClain

and

William B. Eastlake

with a section on
Resource Evaluation
by

Roger C. Stoker
Energy Serivces Inc.

IDAHO OFFICE OF ENERGY

OFFICE OF THE GOVERNOR

Prepared for the United States Department of Energy
Division of Geothermal Energy, Idaho Falls Operations Office
DOE/ID/12010-7

NOTICE

This report was prepared to document work sponsored by the United States Government. Neither the United States nor its agent, the United States Department of Energy Administration, nor any Federal employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FAIRFIELD, IDAHO

SITE SPECIFIC DEVELOPMENT ANALYSIS

Preface:

Fairfield, Idaho is a small agricultural community located on the Camas Prairie in central Idaho. The community is located at an elevation of 1543.8 meters (5,065 ft.) and has 8,575 heating degree days. The Camas Prairie area has been classified by the Idaho Department of Water Resources as a Geothermal Resource Area. All wells drilled deeper than 914.4 meters (3,000 ft.) in the Camas Prairie must have a geothermal resource permit from the State. Hot springs located in the area vary in temperature from 32.2 °C to 71° C (90° F to160° F). The community of fairfield and the Camas County are interested in developing these local resources for possible industrial application and spaceheating of public buildings.

The Fairfield area was selected for a site development analysis because: the State Water Resources Department has classified the area as a Geothermal Resource Area, the City has requested assistance from the Idaho Office of Energy regarding potential for spaceheating public buildings; and Camas County, through the Wood River Resource Council, requested assistance from the Office of Energy regarding an evaluation of potential resource locations for industrial applications.

The Office of Energy contractedEnergy Services, Inc. of Idaho Falls, Idaho to make a brief and limited evaluation of the geothermal resource potential of the Fairfield, Idaho area.

1.0 Introduction

A site development analysis is a preliminary qualitative and quantitative analysis of technical, economic, environmental, and institutional factors which influence the scale and timing of geothermal development. The analysis is based on current information available in the literature and reflects the intent of public and private development interest in the Fairfield area. Resource data for the Fairfield area was evaluated for the Office of Energy by Energy Service Inc. of Idaho Falls, Idaho and that evaluation was based on published information provided by the Idaho Department of Water Resources and the U.S. Geological Survey.

A review of current available socio-economic data and technical papers on industrial and spaceheating applications of geothermal energy was conducted to determine the scale and estimated cost of resource development. Federal, state, and local planning and regulatory documents were reviewed to determine the institutional factors affecting development.

The Fairfield Site Development Analysis describes the institutional, logistical, and cost parameters which will affect the exploration for geothermal resources in the Fairfield area. Two development concepts are considered: 1) providing hot water to the City of Fairfield for spaceheating, and 2) developing geothermal resources with the intent of locating industrial applications at the wellhead.

2.0 Site Description

2.1 Location

Fairfield, Idaho, the county seat, is located in the center of Camas County and on the northern edge of the Camas Prairie Area of southcentral Idaho. Fairfield is situated approximately 75.6 km (47 mi.) northeast of Mountain Home and 43.5 km (27 mi.) southwest of Hailey (See Figure 2.1).

Fairfield has an elevation of 1,543.8 meters (5,065 ft.) and is located in an east-west trending intermountain basin which is surrounded by mountains of the Idaho batholith and Bennett Ranges. The area is a transition zone between the granitic rocks of the batholith and the volcanic rocks of the Snake River Plain.

2.2 Demographics

The city of Fairfield has an estimated, 1979, population of 450 persons. The community has experienced a steady increase in population since 1970. If the current immigration continues, the population of Fairfield will reach 500 by 1985. Camas County is rural agriculture country with a 1977 population of 900. Table 2.2 lists the State of Idaho population and employment forecast of Camas County and Fairfield. These forecasts are based on historical trends and do not consider the prospect of new employment.

FIGURE 2.1
Location of Fairfield, Idaho

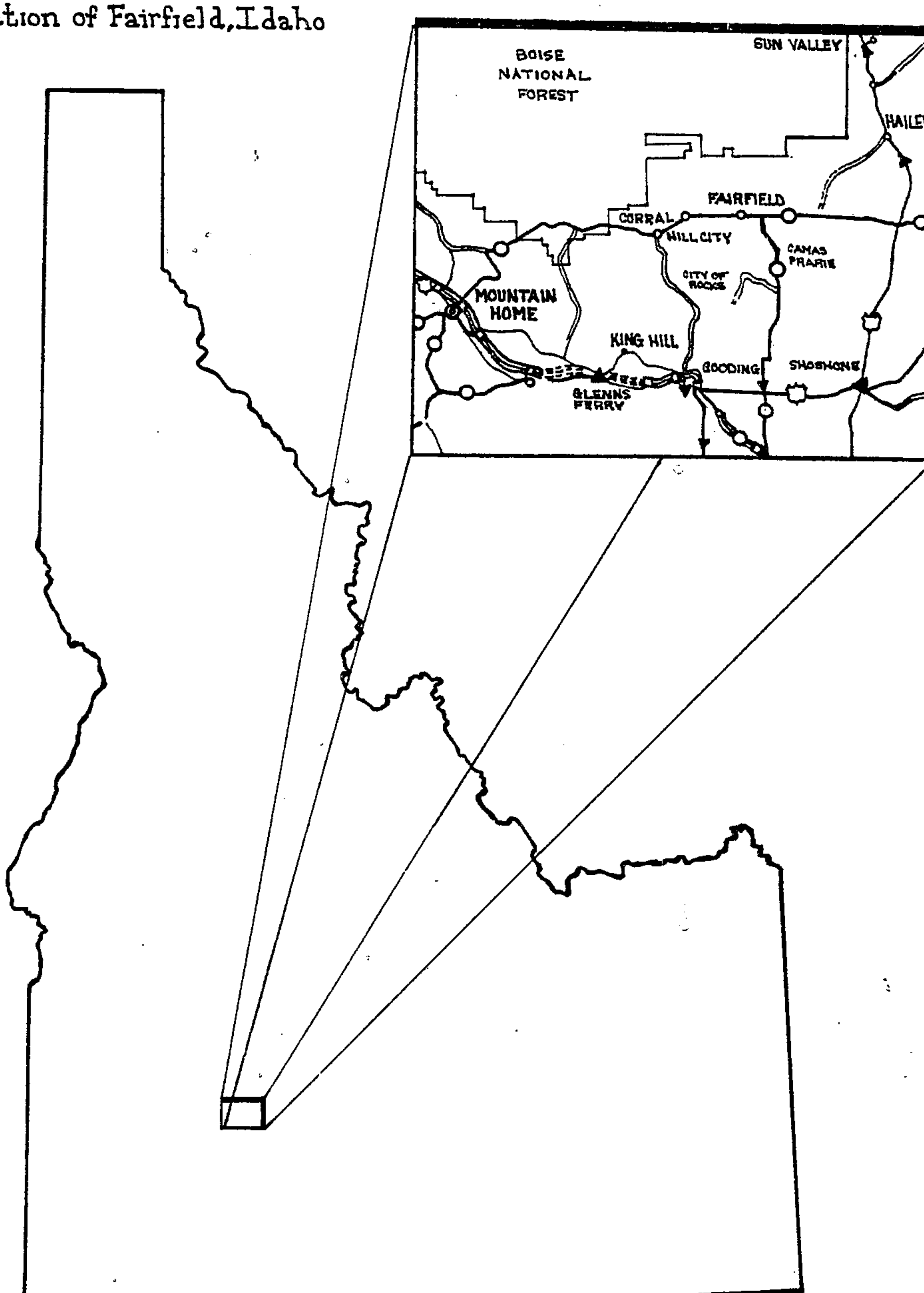


TABLE 2.2

POPULATION AND EMPLOYMENT FORECAST - July 1978
Camas County

EMPLOYMENT SUMMARY

	1972	1975	1989	1985	1990	1995	2000
AGRICULTURE	175	164	152	139	128	119	111
CONSTRUCTION	17	3	3	3	4	4	4
WOOD PRODUCTS	25	33	36	39	43	46	50
TRANS. COMM. AND UTILS	11	10	11	11	12	13	14
WHSLE AND RETAIL TRADE	56	68	68	68	69	69	70
SERVICES AND MISC.	6	81	85	87	90	94	97
STATE AND LOCAL GOVT.	65	81	81	82	84	85	86
FEDERAL GOVERNMENT	17	22	22	22	22	22	22
TOTAL	372	462	461	456	454	455	458

FORECAST SUMMARY

	1970	1975	1980	1985	1990	1995	2000
TOTAL POPULATION	720	860	940	940	840	770	750
TOTAL EMPLOYMENT*	370	460	460	450	450	450	450
LABOR FORCE **	400	460	460	450	440	450	460
TOTAL SCHOOL ENROLLMENT	230	250	230	190	180	180	170
NURSERY	0	0	0	0	0	0	0
KINDERGARTEN	0	10	10	10	10	10	0
ELEMENTARY	160	140	120	120	120	110	100
HIGH SCHOOL	60	100	90	50	40	40	60
COLLEGE	0	0	0	0	0	0	0
HOUSEHOLD HEADS	210	230	260	270	250	230	220

* Employment Base Year = 1972
** Labor Force Base Year = 1970
** Labor Force is Dependent Upon Unemployment Rate and the Average Number of Jobs Held by Each Worker

SOURCE: Idaho Department of Water Resources and Center for Research, Grants and Contracts, Boise State University

Population and Employment Forecast - July 1978

2.3 Economy of Site Area

Camas County's economic activities were analyzed to provide a working knowledge of the present and past economic base as well as insight into what type of future activities might be possible. Camas County has had a stable but stagnant economy in terms of total employment and per capita income for the past ten years. The county has not experienced any significant growth since 1970. Table 2.3 lists the major elements of Camas County's economy.

Camas County's economy depends primarily on agriculture. Unemployment has increased steadily since 1970 and is acute during the winter months when unemployment is often over twenty percent.

2.4 Land Use Considerations

The major land uses in Camas County are rangeland, agricultural land, and forest land. These land uses are, to a large extent, predetermined by the ownership. The Federal Government owns over 65% of the land in Camas County. These lands are primarily forest and rangelands. The State owns owns approximately 3% of the land in the county, and these lands are leased for grazing. Private ownership accounts for 31% of the land in Camas County, and this land is primarily used for agricultural purposes. See Table 2.4.

2.5 Climate

Camas County has a very cool climate. Located in a high intermountain valley the area has cool summer evenings and cold winters with long periods of deep snow coverage. Table 2.5 summarizes the climatic data for Camas County .

3.0 Resource Evaluation

This section of this study was conducted by Energy Services, Inc. of Idaho Falls, Idaho under a contract with the Idaho Office of Energy to provide technical assistance regarding the evaluation of geothermal resource potential within the State of Idaho.

Energy Services, Inc. was directed by the Office of Energy to make a brief and limited evaluation of the geothermal resource and potential of the Fairfield, Idaho Area. Available geological data concerning the area was reviewed and a temperature versus depth well study was conducted. The most helpful and reliable report for reference purposes was "Geothermal Investigations In Idaho, Part 7," by John C. Mitchell of the Idaho Department of Water Resources. Most of the geological evaluation section is drawn from that report. This section, more specifically, presents interpretation of the pertinent data, reconnaissance findings, and recommendations concerning the geothermal potential of the area.

TABLE 2.3

ELEMENTS OF CAMAS COUNTY ECONOMY

Percent of average monthly unemployment - 1976

Jan. 20.7% Feb. 16.6% Mar. 20.0% Apr. 12.5% May 11.0% Jun. 5.1%

Jul. 3.8% Aug. 2.0% Sep. 3.8% Oct. 6.6% Nov. 8.2% Dec. 13.7%

Percent of labor force unemployed: 1970 4.8% 1972 8.7% 1975 12.2% 1976 10.5%

Month and percentage of highest unemployment: 1975: Feb. - 22.2% 1976: Jan. - 20.7%

Month and percentage of lowest unemployment: 1975: Aug. - 3.7% 1976: Aug. - 2.0%

Percent of females (16+) in labor force: 1960 (14+): 29.1% 1970: 25.6%

Employment (B.E.A. data)	1967	1970	1974	1975
Total employment	386	383	411	435
Farm proprietors	120	120	115	114
Non-farm proprietors	25	42	45	45
Wage and salary employment:				
Federal civilian	15	15	26	22
Military	—	—	—	—
State & local	54	62	74	81
Manufacturing	D	D	D	D
Mining	—	D	—	—
Construction	D	—	D	D
Trans., Comm. & Pub. Util.	10	10	17	D
Trade	19	20	26	24
Finance, Insurance & Real Estate	D	—	—	—
Services	18	5	12	26
Other	D	—	—	—
Farm	67	57	56	78

D Not shown to avoid disclosure of confidential information

Average Idaho tax return (county) - 1976: $ 373

Average Idaho tax return (State) - 1976: $ 396

Total assessed valuation: 1975*: $4,241,656 1976: $4,304,154
*1974 subsequent rolls, 1975 real and personal rolls, and 1975 utilities.

Average levy county-wide paid per $100 assessed valuation:
1973: $6.19 1974: $6.21 1975: $5.79 1976: $6.35

Sales tax: 1974*: $ 24,124 1975*: $ 28,351 1977*: $ 30,408 *Fiscal Year
Property tax as percent of full value: County - 1976: 1.19% State - 1976 1.55%
Per capita income: 1970 $ 4,509 1974 $6,861 1975 $3,652
% of national average: 1970 113.7% 1974 125.9% 1975 61.9%
% of state average: 1970 137.1% 1974 139.5% 1975 70.5%
Median family income - 1969: $10,095 Median family income* - 1976: $14,000
Transfer payments (thousands of dollars - county) 1970 $292 1974 $466 1975 $547
Number of business establishments - 1974: 19
Percent of families below poverty level - 1969: 2.7%

TABLE 2.4

LAND USE AND OWNERSHIP

Land ownership - 1977	Hectares	Acres	% Total
Federal land	178,377	(440,763)	65.3
BLM	48,168	(118,992)	27.0
National Forests	130,163	(321,628)	73.0
Other	51	(143)	----
State land	8,118	(20,059)	3.0
Endowment land	8,101	(20,018)	99.8
Fish and Game	16	(41)	.2
County land	939	(2,320)	.3
Municipal land	---	---	---
Private land	85,638	(211,610)	31.4
Total land ownership acres	273,072	(674,752)	100.0

Land use* - 1976			
Urban or built-up land	243	(600)	1
Agricultural land	49,454	(122,200)	18.0
Rangeland	162,406	(401,300)	59.2
Forest land	60,462	(149,400)	22.0
Water	850	(2,100)	.3
Barren land	1,113	(2,800)	.4
Total land use acres	274,548	(678,400)	100.0

*U.S.G.S. land use/cover classification system. The water category and the rounding and estimating of satellite based data results in slightly higher totals for land use.

TABLE 2.5

CLIMATOLOGICAL DATA FOR FAIRFIELD, IDAHO

Elevation: 1,543.8 meters (5,065 ft)

Years of Record: 20

Mean Daily Temperature

January Minimum:	- 16° C	(3.2° F)
January Maximum	- 2.4° C	(27.6° F)
July Minimum:	7.8° C	(46.0° F)
July Maximum	29.3° C	(84.8° F)

Lowest Temperature of Record:	-38.8° C	(-38° F)
Highest Temperature of Record:	37.8° C	(100° F)

Average Annual Days

Maximum of 32° C (90°): 13 days
Minimum of 0° C (32° F) or less: 211 days

Growing Season (Average Freeze Free Period): 68 days

Average Precipitation

Annual Precipitation:	39.7 cm	(15.64 in.)
Annual Snow Fall:	211.3 cm	(83.2 in.)
January Precipitation:	7.26 cm	(2.86 in.)
July Precipitation:	.63 cm	(.25 in.)

Average Annual Number of Days with Precipitation

.25 cm (.10 in.) or more:	44
1.27 cm (.50 in.) or more:	10

Heating Degree Days: 8,575

Source: Idaho Climatological Summary Data by Counties National Weather Service Climatology in Cooperation with the Idaho Department of Commerce and Development Boise, Idaho - October 1977.

3.1 Topography and Geology

Fairfield, Idaho is located on a broad structural valley known as the Camas Prairie. This valley is approximately 64 km (40 mi) long (E-W) and 16 Km (7 to 10 mi) wide (N-S). The prairie is completely enclosed by hills and mountains of the Idaho Batholith to the north and volcanic rocks associated with the Snake River Plain to the south. It is a relatively flat plain that slopes (.1%) from west to east with an elevation difference of only 79 meters (260 ft.) over the entire length of 64 km (40 mi).

Camas Prairie consists of poorly sorted sediments of Pliocene to Holocene Age derived from the mountains to the north and ranging in size from clay to boulders. A bedrock of Cretaceous granite exists at a depth of 152 meters to 167 meters (500 to 550 ft) near the center of the prairie. Soldier Mountains to the north and part of Mount Bennett Hills to the southwest are made up of Cretaceous granitic rocks from the Idaho Batholith whose main body lies further to the north. Part of the Soldier Mountains consist of Challis volcanic rocks which crop out along the northcentral part of the basin. These volcanic flows and lower Pliocene volcanic rocks are also found along southern portions of Camas Prairie. Other basalt flows are found along the southeastern and western edges.

The structural control of the Camas Prairie Basin is to a large extent unknown. Two conflicting ideas exist: one describes the prairie merely as a shallow depression in the granitic surface that has been partially filled with sediment from the marginal highlands. Evidence to support this theory is the occurrence of Cretaceous granitic rock on the northern and southern boundaries as well as at a relatively shallow depth of 152 meters (500 ft) near the center of the valley. There are no visible structural trends that would strongly indicate any other geological setting, although that conclusion may be attributed to the lack of geologic work being done in the area. On the other hand the Camas Prairie has been described as a graben and some evidence was found for fault control of the valley in a study of the Mount Bennett Hills. This east-west trending range is a complexly faulted, southerly and easterly tilted upthrown fault block.

Camas Pairie is separated from the Snake River Plain by the low-lying, flat-topped Mount Bennett Hills. A low divide separates the Prairie from the South Fork Boise River drainage basin to the west. To the north, Soldier Mountains rise abruptly to a height of 3077 meters (10,095 ft) at Smokey Dome. To the east, a low divide (Clay Bank Hills) separates Camas Prairie from the plain of the upper Big Wood River drainage basin.

3.2 Hydrology

Camas Creek constitutes the surface drainage originating on the Western divide near Packer Butte and draining into Magic Reservoir on the eastern edge of the prairie. The majority of tributary streams originate in the Soldier Mountains to the north. Little additional flow is contributed by the few intermittent streams originating in the Mount Bennett Hills to the south.

3.2 Hydrology - Continued

The movement of groundwater in the Camas Prairie generally parallels Camas Creek and its tributaries. The major source of ground water is the Soldier Mountains to the north with minimal input from the Mount Bennett Hills to the south. Two major acquifers composed of fine grained sands and gravels of low permeability exist in the valley fill at approximately 61 to 121 meters (200 to 400 ft).

3.3 Hot Springs

There are several hot springs in and around the Camas Prairie that may be used as indications of the geothermal system that exists in the area. Surface discharge temperatures and predicted reservoir temperatures for these springs are tabulated in Table 3.3. This data should be reviewed with caution and only used as indicators of possible geothermal reservoirs in the area of interest.

Barron's Hot Springs, the strongest evidence of a geothermal resource of the prairie, is located approximately 12 kilometers (7 mi) southwest of Fairfield. A surface temperature has been recorded of 72° C (163° F) with a predicted reservoir temperature of 125° C (257° F). The springs issue from the valley fill material.

Two other hot springs in the area show strong evidence of a moderate temperature geothermal resource existing below the valley fill. Hot Springs Ranch (Wardrup Hot Springs) and Elk Creek Hot Springs both have discharge temperatures above 54° C (130° F).

3.4 Existing Water Wells

Most of the irrigation wells in the area have higher than normal water temperatures. Unusually high temperatures indicate that a geothermal resource is present in the area and has mixed with cold ground water at depth.

Water well temperatures have been plotted at the 91.4 meter (300 ft) depth in Figure 3.4 and contours were constructed that connect the points of equal temperature. Two areas stand out as geothermal anomalies in Figure 3.4. One in the area southwest of Fairfield, just north of Barron's Hot Springs. Wells with temperatures near 21.1° C (70° F) are common in this area and Barron's Hot Spring is an extremely high point at 71.1° C (160+° F). The second anomalous area is centered approximately 3.2 km (2 mi) south of Fairfield. Temperatures(91.4 meters (300 ft) below ground level) above 21.1° C (70° F), occur in an area 9.6 km (6 mi) long (E-W) and 1.6 km (1 mi) wide (N-S).

In Figure 3.4 the contours have been drawn to predict ground water temperatures at 91.4 meters (300 ft) using known well water temperatures at depth and calculated temperature gradients. Gradients were used in order to extend the known well temperatures below their drilled depth to 91.4 meters (300 ft). The general trend suggests that hotter water exists at shallow depths to the south of Fairfield. Due to the lack of data, it is difficult to determine the trend further to the south near Twin Lakes Reservoir and to the north more than 1 km (.6 mi) past Fairfield.

TABLE 3.3

CAMAS PRAIRIE
WARM SPRINGS AND WELLS

	Distance From Fairfield	Surface Temp.		Predicted Reservoir Temperature Silica**		Na/K/Ca**	
		°C	(°F)	°C	(°F)	°C	(°F)
Hot Springs Ranch (Wardrup H.S.)							
IN-13E-32abc 1S		60	(140)	125	(257)	33.9	(93)
IN-13E-32abc 2S	11.6 km (7.2 mi)	66.7	(152)	125	(257)	135	(275)
IN-13E-32abc 3S		63.9	(147)	125	(257)	85	(185)
Elk Creek Hot Springs							
IN-15-E-14ada 1S		55	(131	125	(257)	95	(203)
IN-15-E-14ada 2S	15.8 km (9.8 mi)	55	(131	125	(257)	85	(185)
IN-15-E-14ada 3S		45	(113)	125	(257)	85	(185)
IS-12E-16cba 1S	20.1 km (12.5 mi)	45	(113)	115	(239)	55	(131)
1S-12E-16cab 1S	20.1 km (12.5 mi)	48.9	(120)	115	(239)	55	(93)
1S-13E-22ccc 1	9.5 km (5.9 mi)	26.1	(79)	125	(257)	90	(194)
1S-13E-27ccb 1	10.3 km (6.4 mi)	35	(95)	125	(257)	63.9	(147)
1S-13E-27ccb 2	10.3 km (6.4 mi)	45	(113)	115	(239)	95	(203)
Barron's Hot Springs							
1S-13E-34bcc 1	10.8 km (6.7 mi)	48.9	(120)	125	(257)	95	(203)
1S-13E-34bcb 1S		72.8	(163)	125	(257)	125	(257)
Magic Hot Springs Well	32.5 km (20.2 mi)						
1S-17E-23aab 1		72.2	(162)	140	(284)	175	(347)

* Table compiled from Idaho Department of Water Resources Bulletin No. 30, Part 7.

** Silica and Na-K-Ca geothermometer indicated temperatures are less reliable at the lower temperatures. None of the predicted temperatures were made using the enthalpy/chemical dilution correction model, which would give higher results than shown here.

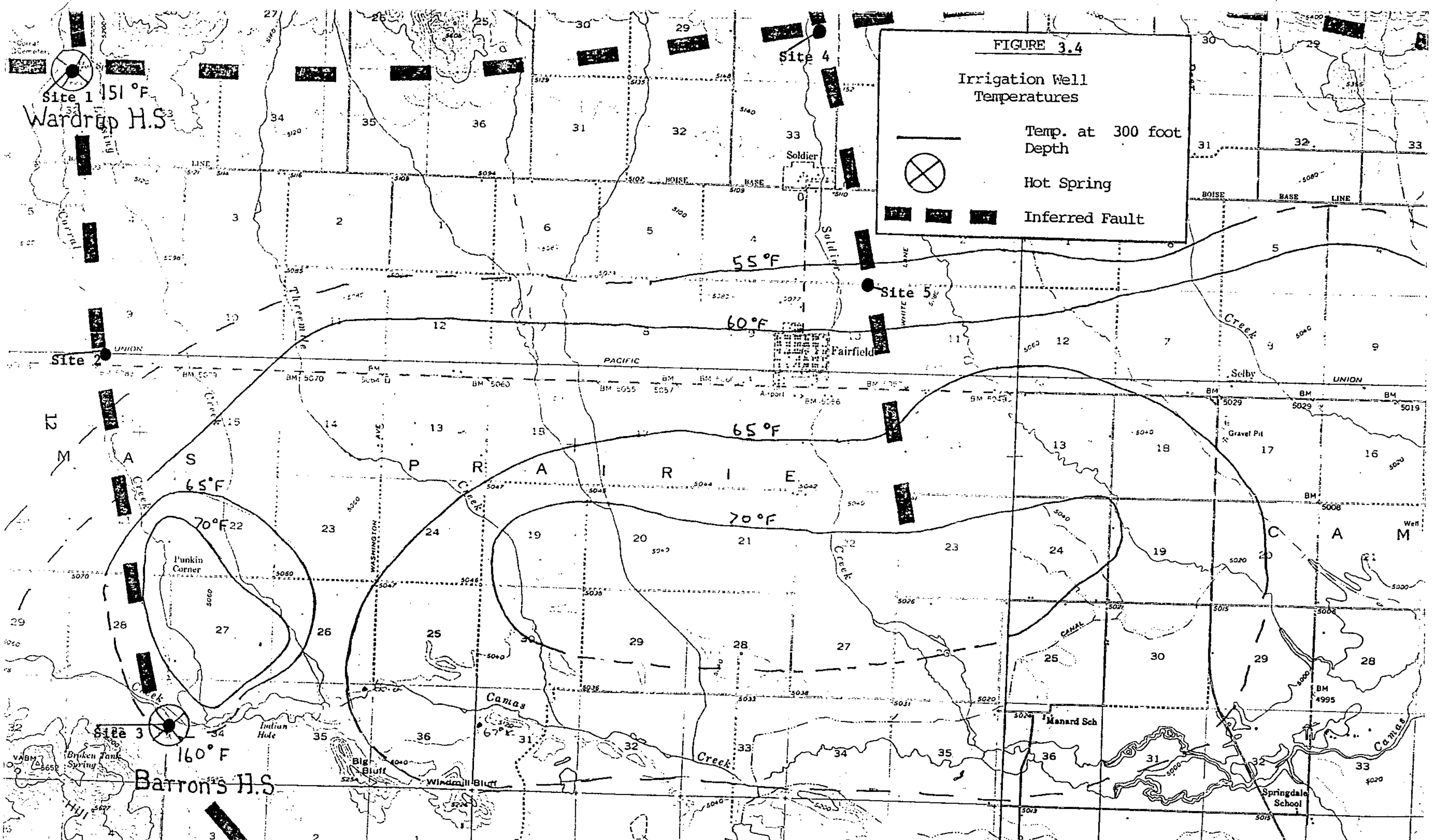


FIGURE 3.4

Irrigation Well Temperatures

Temp. at 300 foot Depth

Hot Spring

Inferred Fault

3.5 Temperature Gradients

Temperature gradients (rate of temperature increase with depth) in the area depict, roughly, the same information as Figure 3.4. A temperature gradient of 146° C/km (8° F/100 ft) has been calculated in the area to the southwest of Fairfield around Barron's Hot Springs. However, a temperature gradient of less than 36° C/km (2° F/100 ft) (still above normal) was calculated for the area to the southeast of Fairfield although well water temperatures are near 21.1° C (70° F). The two areas have the same near-surface temperatures, but the area around Barron's Hot Springs has a known hotter resource (hot spring source) at depth whereas the other area has unknown temperatures at depth.

3.6 Geothermal Development

Geothermal potential of Fairfield and Camas Prairie Area can be developed economically if the specific resource site can be located reasonably close 3.2 km (2 - 3 mi) to a large user facility. A comparison of the geothermal system (well, distribution and retrofit) costs and facility benefit savings can be accomplished for several different potential users.

Camas Prairie appears to be a shallow depression in granitic bedrock that is influenced by visible faulting in the hills to the south and mountains to the north. Some of these southern faults (Bennett Hills) are shown on the 1978 State Geological Map and in the report by Mitchell (1974). The State Geological Map shows an inferred fault crossing the western part of the prairie from the hills on the south into the mountains to the north. These faults do not appear to structurally control the valley, but apparently have a relationship to the geothermal water encountered in the area.

Figure 3.4 shows three inferred faults that are based on this study. One runs roughly east-west on the north side of the prairie and marks the break between the mountains and prairie. A second fault runs out of the canyon north of Fairfield and is thought to extend into the valley. The third fault connects Barron's Hot Spring with the Hot Spring's Ranch (Wardup Hot Spring) geothermal occurrence. This fault trace represents a slight modification of the trace shown on the State Geological Map. The fault traces shown in Figure 3.4 are based on an area reconnaissance only. There has been almost no published geological work done in the area, especially in the mountains to the north. More detailed work would help determine the true origin of Camas Prairie.

Maximum temperature and production of geothermal resources occur whenever the permeability of the rock is sufficient enough to allow the geothermal fluids to move freely. The most successful areas of exploratory drilling are around fault zones that extend down to great depths. Generally, wide and long fault zones have better probability of successful geothermal wells. Camas Prairie appears to be a shallow depression, but the shallow geothermal fluids appear to be dependent upon faults for their upward migration. There is undoubtedly some lateral movement of the geothermal water whenever permeable beds are encountered by the fault zones. However, for maximum production and temperature, the area fault zones should be explored by drilling.

3.7 Potential Geothermal Exploration

There are three possible sources for the area's geothermal resource. The first is from the mountains to the north, the second is from the hills to the south, and the third is a combination of the first two. The authors believe that the major source of geothermal water is from the north. The water migrates to depth where it is heated and then moves upward in a southern direction along zones of permeability (faults).

There are three areas around Fairfield that appear to offer excellent to good chances for geothermal exploration. The area around Barron's Hot Springs, on the downdip (east) side of the fault, appears an excellent area for both shallow and deep exploration. This includes the area between Barron's Hot Springs and Hot Springs Ranch (Wardrup Hot Springs). A second area, also rated excellent for shallow exploration is located south of Fairfield and enclosed by the 21.1° C (70° F) contour shown on Figure 3.4. The third area is rated as a very good area for deep exploration and is located along the downdip (east) side of the N-S trending inferred fault passing just to the east of Fairfield.

There is little direct evidence resulting from the well study on which to evaluate the third area immediately around Fairfield. However, this is due to a lack of data from wells deeper than 45 meters (150 ft) and is not indicative of negative data. The presence of numerous reported warm springs in the mountains to the north and the strong evidence of a major fault trending onto the Prairie from the canyon north of Fairfield, combine to make this area a very good exploration site. Geothermal wells must be drilled into fault zones in order to encounter permeable zones that will result in maximum production and temperature.

3.8 Recommendations for Exploration

A. Conduct geophysical (electromagnetic VLF radio and earth magnetic) surveys to pinpoint the existence and attitude of faults in the valley that extend down into the granitic basement.

B. Select one of the three areas identified (or modified by geophysical data) and drill to a 243 meter to 609 meter (800 to 2,000 ft) deep geothermal exploratory well with 20 cm (8 in) casing installed in the top 60 meters to 152 meters (200 to 500 ft) of the well.

3.9 Potential Applications

Camas County is interested in developing the area's geothermal resources for spaceheating public buildings and for locating a new industrial park. Other potential applications include controlled breeding conditions for livestock and green house. The following section describes the estimated cost of exploration at several potential sites in Camas County.

4.0 Site Specific Applications

Based on the resource analysis outlined in Section 3.0, five sites on the Camas Prairie, near Fairfield, were selected by the Idaho Office of Energy for the purpose of estimating cost of geothermal development. Sites were selected based on the following criteria:

a) Site must be located on a known or inferred fault and/or area of high geothermal gradient.

b) Site must be located near a transportation corridor.

Figure 3.4 locates each potential development site on a map of the Fairfield area. Each site is identified by a number which corresponds with a potential development scenario outlined in Table 4.0. Table 4.0 lists the estimated drilling depth and potential direct heat application for each site. It is recommended that detailed geophysical surveys be conducted prior to any exploration drilling.

TABLE 4.0

POTENTIAL DEVELOPMENT SITES

Site Number	Description	Depth	Potential Appl.
Site #1	Wardrup Hot Springs 1N-13E-32	244 meters (800 ft)	Industrial Park
Site #2	Intersection of North Trending Fault w/Railroad 1S-13E-9	610 meters (2,000 ft)	Industrial Park
Site #3	Barron Hot Springs 1S-13E-34	244 meters (800 ft.)	Industrial Park
Site #4	Intersection of Two Inferred Faults 1N-14E-28	610 meters (2,000 ft.)	Industrial Park
Site #5	NE of Fairfield 1S-14E-3	610 meters (2,000 ft.)	Spaceheating for Fairfield

4.1 Considerations for Direct Applications of Geothermal Energy

The most important question to ask is whether the geothermal water will generate enough heat to meet potential demand. For Sites 1 through 4 no specific projection of potential demand will be made. The intention for these sites is only to indicate that a certain quantity of heat may be available at a location near transportation facilities for possible industrial use. For Site #5, with a potential for spaceheating the town of Fairfield, an estimate of demand was made. Based on a city population estimate of 450 by the Idaho State Division of Budget, Policy, Planning, and Coordination and an average family size of just over three persons, the projected number of households in Fairfield is 150. Assuming an average home uses about $.2 \times 10^{9}$ BTU's per year, total heating demand for Fairfield is about 3×10^{10} BTU's per year. Since Fairfield has 8575 heating degree days, the annual heat load translates into a design heat load of 1.17×10^{7} BTU's per hour, the peak heat load any heating system must satisfy.

With an expected water temperature of 100° C (212° F), the temperature drop to be expected is 14° C (57° F). With that temperature drop and the expected flow of 500 gallons per minute, the heat delivered by the water is 1.43×10^{7} BTU's per hour or 1.25×10^{11} BTU's per year. Thus, available heat from the geothermal water is expected to be sufficient to meet the Fairfield spaceheating demand.

4.2 Proposed Facilities

4.2.1 Transmission System

Four of the sites considered will be industrial parks located close enough to the geothermal water source to keep piping costs negligible. The fifth site, for spaceheating of the City of Fairfield, will require a transmission system detailed on Figure 4.2.1.

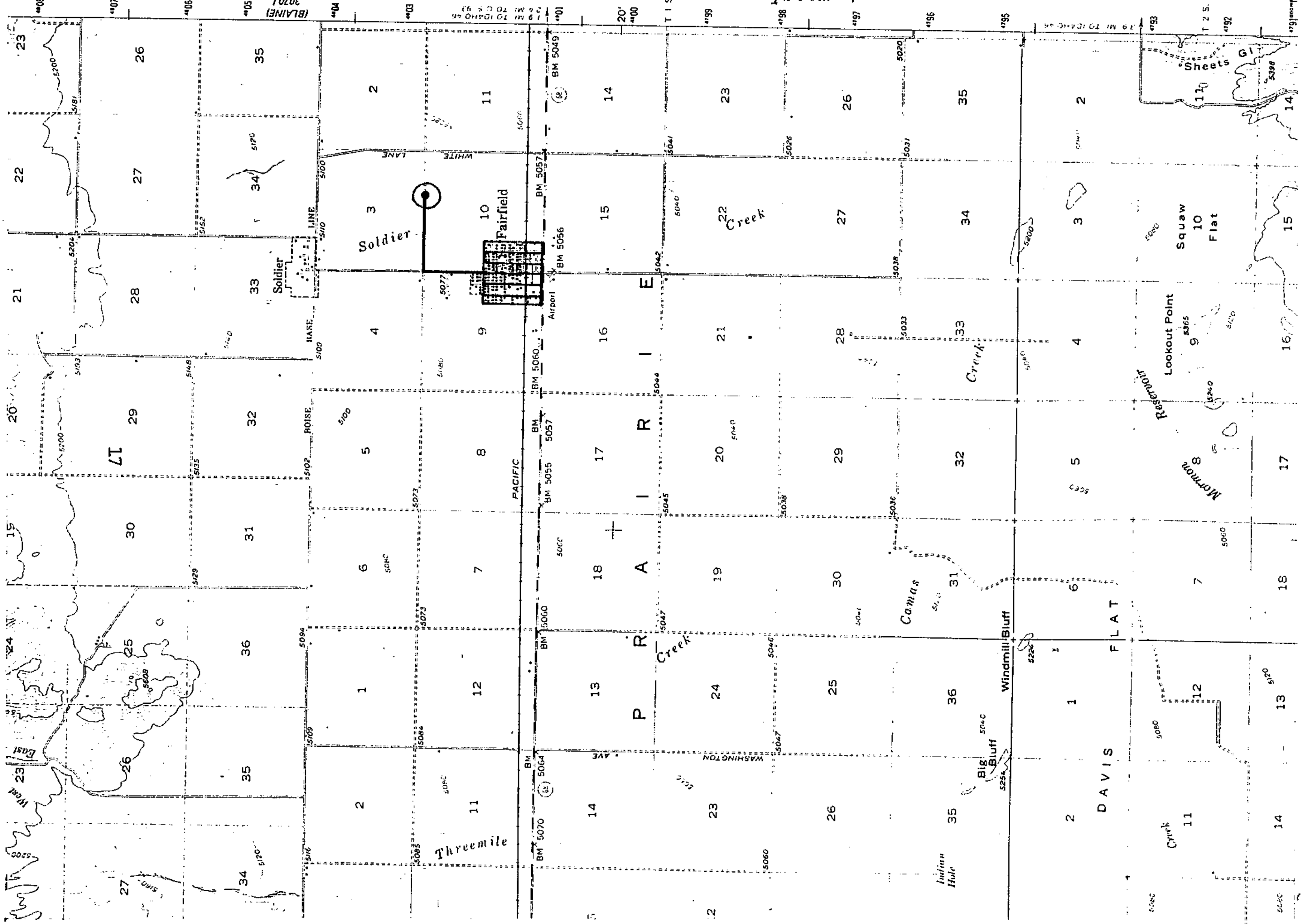
The Fairfield transmission system would pipe fluids 1768 meters (5,800 ft) along road right of way in 20 cm (8 in) pipe to the city limits, thence in 15 cm (6 in) pipe 3,292 meters (10,800 ft) about the perimeter of the city, and finally 3,962 meters (13,000 ft) on five connectors of 8 cm (3 in) across the perimeter. All pipe would be asbestos cement, buried and insulated with polyurethane foam. Costs are projected at $24 per foot for 20 cm (8 in), $16 for 15 cm (6 in.), and $11 for 8 cm (3 in) pipe.

4.2.2 Supply System - Wells

A. Sites 1 and 3 will have 244 meter (800 ft) wells. These wells will be drilled 25 cm (10 in) to a depth of 61 meters (200 ft) and 20 cm (8 in) casing will be set. Then drilling will proceed another 183 meters (600 ft) at a diameter of 20 cm (8 in) with 15 cm (6 in) casing set. Sites 2, 4, and 5 will extend 549 meters (1800 ft) below the initial casing.

Drilling costs are estimated at $1 per inch of diameter foot up to 600 feet; $2.50 per inch of diameter per foot from 600 to 1,000 feet; $3.50

FIGURE 4.2.1 Fairfield Transmission System



4.2.2 Supply Systems - Continued

A. Wells

per inch of diameter per foot for the next 500 feet; and $4.5 per inch of diameter per foot from 1,500 to 2,000 feet. This means a cost, including a 30% contingency figure of $18,720 for 244 meters (800 ft) of well and a cost of $74,880 for 610.6m (2,000 ft) of well.

B. Pumps

A two-stage, vertical turbine downhole pump of 25 HP would be used to pump 500 GPM. The pump would be set for 15 meters (50 ft), and using electricity at 2¢ per kwh, would require a maximum of $3,267 in power cost. Total cost for the pump, motor, main valves, and installation would be about $12,000.

4.2.3 Disposal System

For this preliminary analysis due to the uncertainty as to the possible uses of geothermal fluids in the Fairfield area, plant construction costs and disposal costs have been omitted. The purpose of the analysis has been limited to projecting the cost of BTU's deliverable at the wellhead for possible further use. Further specification of actual usage of geothermal fluids is necessary before a projection of disposal costs can be made. In general, injection wells are similar in cost to production wells though they usually require less pumping power.

4.3 Cost Analysis

Table 4.3.1 details the capital and operating costs of providing 500 GPM of 100° C (212° F) at the wellhead for the four potential commercial sites and the City of Fairfield for space heating purposes. The only operating cost of providing the water for the commercial-industrial sites would be the power cost for pumping, $3,267 per year. Maintenance would be minimal with no pipeline yet under consideration. Since the space heating project for the City of Fairfield has a substantial pipeline, a maintenance expense equal to ½ % of the cost of piping plus 3% of the cost of pumps, in addition to the $3,267 power costs, was included.

Total heat available with a 14° C (57° F) temperature drop and a flow of 500 GPM was divided by the available cubic feet of water at

TABLE 4.3.1

CAPITAL AND OPERATING COSTS FOR POTENTIAL SITES

Site	(1) Well Cost	(2) Pump Cost	(3) Trans-mission Cost	(4) Capital Cost	(5) Maint-enance Cost	(6) Power Cost	(7) Operating Cost	(8) Amortized Capital Cost
1	18,720	$12,000	-----	30,720	------	3,267	3,267	3,608
2	74,880	12,000	----	86,880	-----	3,267	3,267	10,205
3	18,720	12,000	----	30,720	-----	3,267	3,267	3,608
4	74,880	12,000	----	86,880	----	3,267	3,267	10,205
5	74,880	12,000	455,176	542,056	2,635	3,267	5,902	63,670

(4) Capital Cost = (1) + (2) + (3)
(7) Operating Cost = (5) + (6)
(8) Amortized Capital Cost = (4) amortized over 20 years at 10%

that flow to establish heat content of the water. This heat content figure was multiplied by the available water and Fairfield's heat load factor (.294) to establish the number of therms of heat available. Given the figures above, Fairfield has 1.029 X 10^7 ft.^{3} of geothermal water available with a total heat content of 36,750 therms or 3.675 X 10^{10} BTU's during a normal year. These figures are used for Site #5 (space heating Fairfield) to derive the costs listed in Table 4.3.2.

For a space heating system water and heat availability must be tempered with the local heat load factor to reflect the fact that they are not in use all year at peak levels. For commercial or industrial (nonspace heating) uses, the variation in load characteristic of heating does not apply. Therefore, for Sites #1 through #4, we have used the total BTU's per year and total volume of water per year, undiminished by this fractional heat load factor. The 500 GPM well operating at a constant rate year-round would produce 3.5 X 10^7 ft.^{3} of geothermal water. With the assumed temperature drop of 14° C (57° F), this volume of water would contain 1.25 X 10^{11} BTU's. These yearly figures are used to derive costs for Sites #1 through #4.

Table 4.3.2 derives cost figures per 10^6 BTUs for all five potential sites. The figures allow comparison with the conventional fuels listed in Table 4.3.3.

Table 4.3.3 presents price projections for conventional fuel sources, in billing terms and converted to millions of BTU's for easier comparison. These prices have been adjusted for conversion efficiency so that final prices are for millions of usable BTU's. (Electricity is assumed to be 100% efficient, gas 80%, and oil 70%). All prices in Table 4.3.3, plus all other energy prices in the overall analysis, have been escalated at rates given in the Dames and Moore study prepared for the Idaho Public Utilities Commission. These projections were prepared in late 1977 and today there is considerable doubt as to their accuracy. Particularly for gas prices, the Dames and Moore rates are low. Since no more comprehensive set of projections has appeared, we will continue to use Dames and Moore.

Keep in mind that if a case for geothermal heat can be made, with these rates of increase for conventional fuel alternatives, which we know are conservative, actual increases beyond these conservative projections only serve to enhance the competitiveness of geothermal heat.

The final colum in Table 4.3.3 represents an unofficial estimate by IPUC staff of the impact of the proposed NW Energy Policy Planning Act on Electricity prices. Basically, it projects that the Northwest Energy Bill will put off price increases for about three years, at which time electricity rates will start to rise at a rate of 13% per year. (Table 4.3.3 carries the 13% rate all the way to 1988. Figure 4.3.4 presents a graphical picture of these same projections.)

TABLE 4.3.2

GEOTHERMAL COSTS PER 10^6 BTU FOR POTENTIAL SITES

Site	(A) Capital Cost Per 10^6 BTU	(B) Annual Cost Per 10^6 BTU
1	$ .246	$ .055
2	.695	.108
3	.246	.055
4	.695	.108
5	14.70	$1.89

A Capital cost from Table 4.3.1 divided by $1.25X10^{11}$ BTU's for sites 1 through 4; by 3.675×10^{10} BTU's for site 5

B Annual cost is the sum of maintenance cost plus power cost plus amortized capital cost from Table 4.3.1 divided by 1.25×10^{11} BTU's for sites 1 through 4; by 3.675×10^{10} BTU's for site 5

Table 4.3.3
FUEL PRICES - PROJECTED 20 YEARS

	Electricity		Gas		#2 Fuel Oil		Electricity with Planning Bill	
	$/Kwh	$/10^6 BTU	$/Therm	$/10^6 BTU	$/Gal.	$/10^6 BTU	$/Kwh	$/10^6 BTU
1979	.02497	7.316	.382	4.776	.739	7.610	.02497	7.316
1980	.02724	7.982	.409	5.115	.789	8.127	.02487	7.287
1981	.02972	8.708	.438	5.478	.843	8.680	.02477	7.258
1982	.03243	9.501	.469	5.867	.900	9.270	.02824	8.274
1983	.03492	10.101	.506	6.284	.961	9.901	.03219	9.432
1984	.03761	10.879	.544	6.730	1.027	10.574	.03670	10.753
1985	.04051	11.716	.586	7.208	1.097	11.293	.04184	12.259
1986	.04363	12.618	.632	7.720	1.171	12.061	.04769	13.973
1987	.04699	13.716	.680	8.268	1.251	12.881	.05437	15.930
1988	.05060	14.909	.733	8.855	1.338	13.783	.06198	18.160
1989	.05450	16.207	.789	9.483	1.432	14.748	.07066	20.703
1990	.05870	17.617	.850	10.157	1.532	15.780	.08055	23.601
1991	.06322	19.149	.915	10.878	1.640	16.885	.09183	26.906
1992	.06808	20.815	.986	11.650	1.754	18.066	.10468	30.671
1993	.07333	22.626	1.061	12.477	1.877	19.831	.11934	34.967
1994	.07897	24.594	1.143	13.363	2.009	20.684	.13605	39.863
1995	.08505	26.734	1.231	14.312	2.149	22.132	.15509	45.441
1996	.09160	29.060	1.326	15.328	2.300	23.681	.17681	51.80
1997	.09866	31.588	1.428	16.416	2.461	25.339	.20156	59.057
1998	.10625	34.336	1.538	17.582	2.633	27.113	.22978	67.326

FIGURE 4.3.4

20 YEAR PROJECTION OF ENERGY PRICES

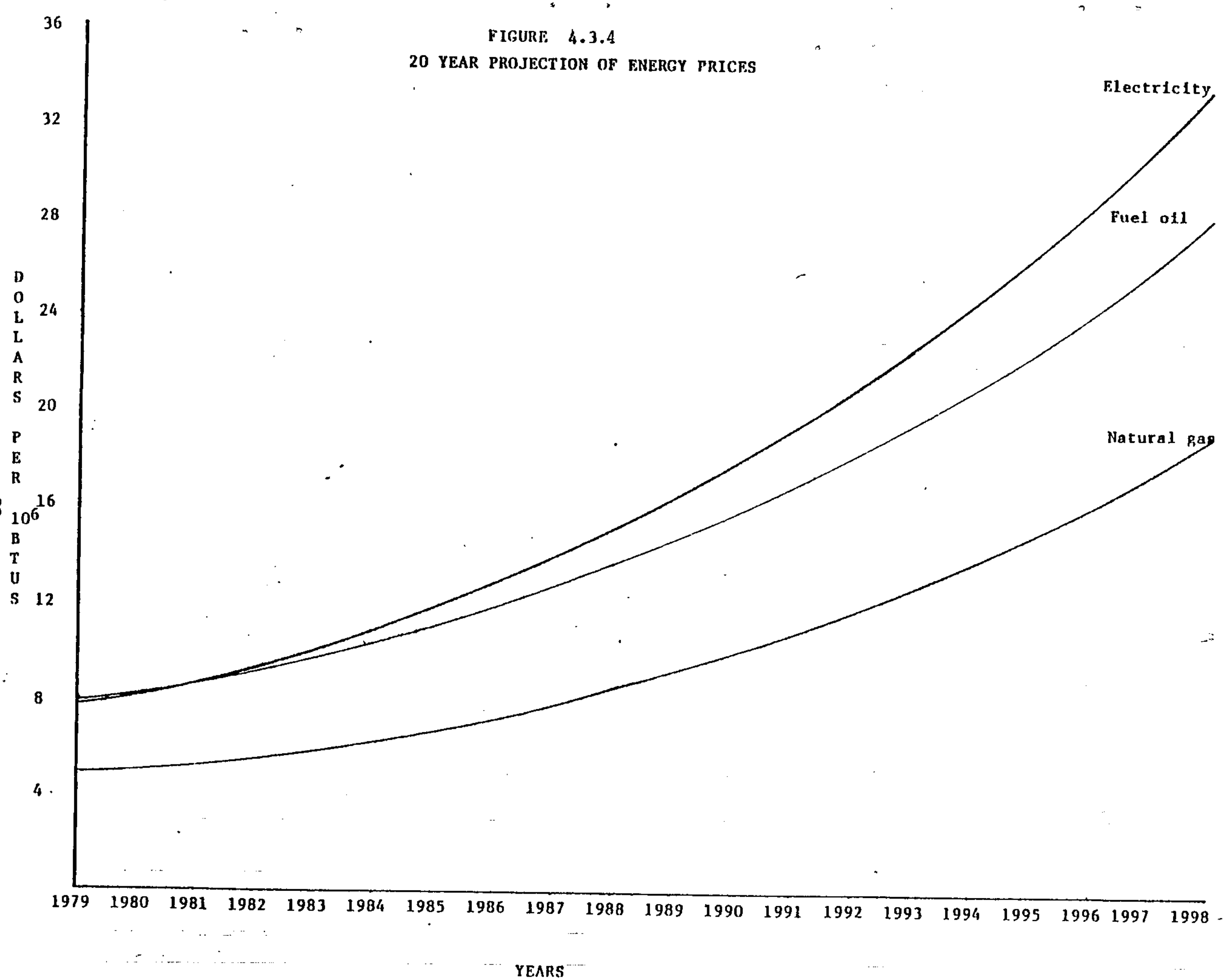


TABLE 4.4

20-YEAR COST COMPARISON OF PROPANE WITH GEOTHERMAL HEAT

YEAR	(1) PROPANE COST	(2) GEOTHERMAL COST	(3) SAVINGS	(4) PRESENT WORTH (10%)
1979	$ 18984	$ 5902	$ 13982	$ 11893
1980	20256	6383	13873	11465
1981	21613	6906	14707	11050
1982	23061	7471	15590	10648
1983	24399	8023	16376	10168
1984	25814	8617	17197	9707
1985	27311	9255	18056	9266
1986	28895	9939	18956	8039
1987	30571	10676	19895	7670
1988	32252	11527	20725	7264
1989	34026	12448	21578	6875
1990	35898	13443	22453	6504
1991	37872	14518	23354	6150
1992	39955	15679	24276	5811
1993	42153	16936	25217	5488
1994	44471	18294	26177	5179
1995	46917	19761	27156	4884
1996	49497	21348	28149	4603
1997	52220	23065	29155	4334
1998	55092	24919	30173	4077
			TOTAL	$151,075

(1) Annual heat load of 3 X 10^{10} BTU's per year for 150 homes in Fairfield divided by 91,500 BTU's per gallon to convert to gallons, then multiplied by 57.9¢ per gallon of propane to convert to annual cost of heating. This cost was then projected over 20 years at rates presented in the Dames & moore report to the Idaho Public Utilities Commission (6.7% through 1982, 5.8% through 1987, 5.5% thereafter)

(2) Geothermal operating cost = Power cost plus maintenance.

(3) Savings = Propane Cost minus Geothermal Cost.

(4) Savings stream converted to present worth at 10% discount rate.

4.4 Economic Conclusions

The costs at the wellhead for Sites #1 through #4 are all very low compared to alternative fuel costs. Even though these costs do not include a disposal system, they are so low as to suggest that any commercial or industrial establishment able to locate at the heat source would derive huge benefits in terms of fuel savings from use of geothermal fluids. For Site #5, space heating of Fairfield, it also appears that even with the possible inclusion of additional costs for possible disposal or management fees geothermal space heating would be a tremendously attractive proposition. Table 4.4 indicates operating cost savings from use of geothermal for space heating in Fairfield.

5.0 Development Process

5.1 Private Funding Potential

To obtain private funding for geothermal development, the owner/developer can approach private investors, investment companies and lending institutions. The key to private funding is sufficient collateral to offset the bank risk. In Idaho, lending institutions lack experience in the economics of alternative energy development. A developer must be prepared to prove that the investment is sound. Although there has been interest from private investors in developing geothermal resources in Camas County, the high cost of drilling has deterred any action by local landowners.

5.2 Public Funding Potential

There are a number of public funding mechanisms available. Fairfield can revenue bond a geothermal district heating system under current Idaho Code regarding public water systems.

The Economic Development Administration has technical assistance and public works grants for public services and/or facilities. The application for these funds can be made by a public or private nonprofit organization such as a water district. These funds are generally cost-share projects.

The Federal Department of Energy has two funding programs which could be used for funding a district heating system. The Program Opportunity Notice program is a competitive grant program which emphasizes a cost-share. The Geothermal Loan Guaranty Program provides loan guarantees for up to 75% of project cost with the Federal government guaranteeing up to 100% of the amount borrowed and the applicant contributing 25% equity.

5.3 Resource Ownership

There are no Federal lands leased for geothermal resources in the Fairfield area. All available State lands in Camas County have been leased to Simasko Production Company for geothermal resources. Several large land owners in Camas County have joined together to form the Camas Geothermal Resource Association. Several private landowners have leased their lands to Gulf Oil Corporation for geothermal exploration.

5.4 Permitting Requirements for Geothermal Development

5.4.1 State Permits

Idaho Department of Water Resources Regulations through authority granted by Section 42-4003 (f), Idaho Code, states the Director shall have the authority to and may designate any area of the state a geothermal resource area where the director finds or has reason to believe that such designation is necessary to protect the geothermal resource from waste and to protect other resources of the state from contamination or waste.

Information pertaining to the classification of lands as G.R.A (Geothermal Resource Areas) in the State of Idaho fall into four categories:

a) Geology, including geochemical and geophysical data;

b) Competitive interests;

c) Nearby discoveries to already classified areas;

d) Other; any pertinent geological, engineering and/or economic data may be considered along with other available data in determining G.R.A's. New methods of evaluation may be incorporated from time to time as they become available and various new theories may be applied to determining G.R.A's as they are proposed.

The Director of the Idaho Department of Water Resources has designated the Camas Prairie of Camas County, Idaho a Geothermal Resource Area. Under the authority of this designation (Idaho Code 42-4003 (g)(h)) the following special conditions apply to all exploration drilling in the Camas Prairie:

a) No person shall drill a well for any purpose to a depth of three thousand (3,000) feet or more below land surface in a designated geothermal resource area without first obtaining a permit under the provisions of this section. Such permits shall be in addition to any permit required by other provisions of law.

b) The owner of any well constructed or being constructed pursuant to Section 42-320, Idaho Code, which encounters a geothermal resource, and who intends or desires to utilize such resource, shall make application for a geothermal permit as required under this section, provided however, that no additional filing fee shall be required.

An approved permit from the Department of Water Resources is generally required before work can begin on geothermal wells. The permit forms required under the Geothermal Resource Act are:

5.4.1 State Requirements - Continued

a) Form 4003-1, Application for Permit to drill for Geothermal Resources;

b) Form 4003 - 2, Application for Permit to Alter a Geothermal Well;

c) Form 4003-3, Application for Permit to Convert a Well to a Geothermal Injection Well;

d) Form 4005, Geothermal Resources Surety Bond;

e) Form 4007, Notice of Intent to Abandon a Well;

f) Form 4009, Report of Abandonment of a Well

Permit applications must be accompanied by a filing fee of:

a) One hundred dollars (100) for any production or exploratory well;

b) Fifty dollars ($50) for an injection well;

c) Fifty dollars ($50) for an amendment to a permit

d) No filing fee shall be charged for filing a Notice of Intent to construct a hole for gathering geotechnical data.

Bonds are required as a condition of every permit. A bond of not less than ten thousand dollars ($10,000) is required for each well.

The two exemptions to the Geothermal Resource Permit requirements relate to exploration wells and to low temperature geothermal wells.

a) If an exploration well is less than six inches in diameter and less than 1,000 feet deep and is used only for collecting geotechnical data, the owner must simply file a Notice of intent to drill with the Department of Water Resources

b) As explained in Section 42-003(e), Idaho Code, wells from which low temperature water is used for such purposes as space heating or fish propagation need only obtain an approved water right.

Although a water right is not required under the geothermal permit, it is highly recommended that water rights be applied for in order to obtain assurances against subsequent developers.

REFERENCES

Boise City Energy Office, Geothermal Energy Systems Plan for Boise City, City of Boise, 1979.

Dames & Moore Co., Natural Gas Supply Requirements for the State of Idaho, Report to the Idaho Public Utilities Commission, 1977.

Dewey, J.W., W.L. Dillinger, J. Taggart, and S.W. Algermissen, A Technique For Seismic Zoning: Analysis of Earthquake Locations and Mechanisms in Northern Utah, Wyoming, Idaho, and Montana, Proc. Intern. and Microzonation, 2nd, Seattle WA, 1972.

Drysdale, F.R. and C.E. Calef, The Energetics of the United States of America: An Atlas, Brookhaven National Laboratory, 1977.

EG & G Idaho, Inc., Rules of Thumb for Geothermal Direct Applications, September, 1978.

Idaho Department of Water Resources, Population and Employment Forecast, State of Idaho, 1978.

Idaho Division of Budget, Policy Planning and Coordination, County Profiles of Idaho, State of Idaho, 1978.

Lienau, P.J., Agribusiness Geothermal Energy Utilization Potential of Klamath and Western Snake River Basins, Oregon. Geo-Heat Utilization Center, Oregon Institute of Technology, 1978.

Makey, D.R. and C.M. Tschanz, Aeromagnetic Survey Map of Idaho, U.S. Geological Survey, 1978.

Mitchell, J.C., Geochemistry and Geological Setting of Thermal Waters of the Camas Prairie Area, Blaine and Camas Counties, Idaho, Water Information Bull. 30, Part 7, Geothermal Investigations in Idaho, Idaho Department of Water Resources, 1976.

Mitchell, J.C., L.L. Johnson, and J.E. Anderson, Potential for Direct Heat Applications of Geothermal Resources, Water Information Bull. 30, Part 9, Geothermal Investigations in Idaho, Idaho Department of Water Resources, 1979.

Muffler, L.P., Edt., Assessment of Geothermal Resources of the United States - 1978, U.S. Geological Survey Circular 790, 1979.

National Weather Service, Idaho Climatological Summary Data by Counties, N.O.A.A. in Cooperation with Idaho Department of Commerce and Development, October 1971.

Pennington, W.D., R.B. Smith and A.B. Trinkle, A Microearthquake Survey of Parts of the Snake River Plain and Central Idaho, Bull. of the Seismological Society of America, Vol. 64, No. 2 pp. 307-312, April 1974.

Rember, W.C., and E.H. Bennett, Geological Map of Hailey Quadrangle Idaho, Idaho Bureau of Mines, Moscow, Idaho, 1979.

Rember, W.C., and E.H. Bennett, Geologic Map of the Challis Quadrangle, Idaho, Idaho Bureau of Mines, Moscow, Idaho, 1979.

Ross, Sylvia, Geothermal Potential of Idaho, Idaho Bureau of Mines and Geology, Pamphlet 150, Moscow, Idaho, Nov. 1971.

Sisco, H.G., Ground Water Levels and Descriptions of Observation Wells in Idaho, 1975, Idaho Department of Water Resources Bulletin 43, Boise, Idaho, Dec. 1976.

Smith, R.B. and M. Sbar, Intraplate Tectonics and Seismicity of the Western United States, cited in Pennington, et al, Bull. of the Seismological Society of America, Vol. 64, No. 2, April 1974.

State of California, Economic Study of Low Temperature Geothermal Energy in Lassen and Modoc Counties, California, Division of Oil and Gas, 1977.

Stocker, R.C., Geothermal Evaluation of the Fairfield, Idaho Area, Energy Services, Inc., Idaho Falls, Idaho, for Idaho Office of Energy, 1979.

University of Idaho, Manufacturing Directory of Idaho, Center for Business Development and Research, 1979.

Vincent, K.R. and J.K. Applegate, A Preliminary Evaluation of the Seismicity of Southwestern Idaho and Eastern Oregon: Implications for Geological Engineering Studies, Department of Geology and Geophysics, Boise State University, Boise, Idaho, 1978.

Young, H.W. and J.C. Mitchell, Geochemistry and Geological Setting of Selected Thermal Waters, Geothermal Investigations in Idaho, Water Info. Bull. 30, Part I, Idaho Department of Water Resources, 1973.